FIRST AID FOR THE®

USMLE® - STEP



Time-proven blueprint for Step 1 success

1,300+ must-know concepts with many new high-yield facts

1,200+ color photos and illustrations, expanded and revised

Student-proven exam strategies designed to boost your score



TAO LE VIKAS BHUSHAN MATTHEW SOCHAT VAISHNAVI VAIDYANATHAN

FIRST AID FOR THE®

USMLE STEP 1 2020

TAO LE, MD, MHS

Founder, ScholarRx Associate Clinical Professor, Department of Medicine University of Louisville School of Medicine

VIKAS BHUSHAN, MD

Boracay

MATTHEW SOCHAT Fellow, Department of Hema Constructions St. Louis University School of Westigne

SARAH SCHIMANSKY, MB BCh BAO

Resident, Department of Ophthalmology Royal United Hospitals Bath

KIMBERLY KALLIANOS, MD

Assistant Professor, Department of Radiology and Biomedical Imaging University of California, San Francisco School of Medicine

VAISHNAVI VAIDYANATHAN, MD

Resident, Department of Pediatric Neurology Barrow Neurological Institute at Phoenix Children's Hospital

JORDAN ABRAMS

St. George's University School of Medicine Class of 2020



New York / Chicago / San Francisco / Athens / London / Madrid / Mexico City Milan / New Delhi / Singapore / Sydney / Toronto

FAS1_2019_00_Frontmatter.indd 1 11/14/19 4:35 PM

Copyright © 2020 by Tao Le and Vikas Bhushan. All rights reserved. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

ISBN: 978-1-26-046205-0 MHID: 1-26-046205-6

The material in this eBook also appears in the print version of this title: ISBN: 978-1-26-046204-3,

MHID: 1-26-046204-8.

eBook conversion by codeMantra

Version 1.0

All trademarks are trademarks of their respective owners. Rather than put a trademark symbol after every occurrence of a trademarked name, we use names in an editorial fashion only, and to the benefit of the trademark owner, with no intention of infringement of the trademark. Where such designations appear in this book, they have been printed with initial caps.

McGraw-Hill Education eBooks are available at special quantity discounts to use as premiums and sales promotions or for use in corporate training programs. To contact a representative, please visit the Contact Us page at www.mhprofessional.com.

Notice

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required. The authors and the publisher of this work have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication. However, in view of the possibility of human error or changes in medical sciences, neither the authors nor the publisher nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions or for the results obtained from use of the information contained in this work. Readers are encouraged to confirm the information contained herein with other sources. For example and in particular, readers are advised to check the product information sheet included in the package of each drug they plan to administer to be certain that the information contained in this work is accurate and that changes have not been made in the recommended dose or in the contraindications for administration. This recommendation is of particular importance in connection with new or infrequently used drugs.

TERMS OF USE

This is a copyrighted work and McGraw-Hill Education and its licensers reserve all rights in and to the work. Use of this work is subject to these terms. Except as permitted under the Copyring Wf 176 and 184 to store and retrieve one copy of the work, you may not decompile, disassemble, reverse engineer, reproduce, modify, create derivative works based upon, transmit, distribute, disseminate, sell, publish or sublicense the work or any part of it without McGraw-Hill Education's prior consent. You may use the work for your own noncommercial and personal use; any other use of the work is strictly prohibited. Your right to use the work may be terminated if you fail to comply with these terms.

THE WORK IS PROVIDED "AS IS." McGRAW-HILL EDUCATION AND ITS LICENSORS MAKE NO GUARANTEES OR WARRANTIES AS TO THE ACCURACY, ADEQUACY OR COMPLETENESS OF OR RESULTS TO BE OBTAINED FROM USING THE WORK, INCLUDING ANY INFORMATION THAT CAN BE ACCESSED THROUGH THE WORK VIA HYPERLINK OR OTHERWISE, AND EXPRESSLY DISCLAIM ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. McGraw-Hill Education and its licensors do not warrant or guarantee that the functions contained in the work will meet your requirements or that its operation will be uninterrupted or error free. Neither McGraw-Hill Education nor its licensors shall be liable to you or anyone else for any inaccuracy, error or omission, regardless of cause, in the work or for any damages resulting therefrom. McGraw-Hill Education has no responsibility for the content of any information accessed through the work. Under no circumstances shall McGraw-Hill Education and/ or its licensors be liable for any indirect, incidental, special, punitive, consequential or similar damages that result from the use of or inability to use the work, even if any of them has been advised of the possibility of such damages. This limitation of liability shall apply to any claim or cause whatsoever whether such claim or cause arises in contract, tort or otherwise.

Dedication

To the contributors to this and past editions, who took time to share their knowledge, insight, and humor for the benefit of students and physicians everywhere.



FAS1_2019_00_Frontmatter.indd 3 11/14/19 4:35 PM

(c) ketabton.com: The Digital Library

This page intentionally left blank

FAS1_2019_00_Frontmatter.indd 4 11/14/19 4:35 PM

Contents

Contributing Authors	vii	General Acknowledgments	XV
Associate Authors	viii	How to Contribute	xvii
Faculty Advisors	ix	How to Use This Book	xix
Thirtieth Anniversary Foreword	xi	Selected USMLE Laboratory Values	XX
Preface	xiii	First Aid Checklist for the USMLE Step 1	xxii
Special Acknowledgments	xiv		

▶ SECTION I	GUIDE TO EFFICIENT I	EXAM PREPARATION	1
Introduction	2	Test-Taking Strategies	22
USMLE Step 1—The Basics	2	Clinical Vignette Strategies	23
Defining Your Goal	12	If You Think You Failed	24
Learning Strategies	13	Testing Agencies	24
Timeline for Study	16	References	25
Study Materials	20		

▶ SECTION I SUPPLEMENT SPECIAL SITUATIONS	27
---	----

► SECTION II	HIGH-YIELD GEN	ERAL PRINCIPLES	29
How to Use the Database	30	Pathology	205
Biochemistry	33	Pharmacology	229
Immunology	95	Public Health Sciences	255
Microbiology	123		

FAS1_2019_00_Frontmatter.indd 5 11/14/19 4:35 PM

► SECTION III	HIGH-YIELD ORG	AN SYSTEMS	275
Approaching the Organ Systems	276	Neurology and Special Senses	489
Cardiovascular	279	Psychiatry	553
Endocrine	325	Renal	577
Gastrointestinal	357	Reproductive	611
Hematology and Oncology	403	Respiratory	659
Musculoskeletal, Skin, and Connective Tiss	ue 445	Rapid Review	689

► SECTION IV	TOP-RATED REVIEW RESOURCES		711	
How to Use the Database	712	Biochemistry	716	
Question Banks and Books	714	Cell Biology and Histology	716	
Web and Mobile Apps	714	Microbiology and Immunology	717	
Comprehensive	715	Pathology	717	
Anatomy, Embryology, and Neuroscience	e 715	Pharmacology	718	
Behavioral Science	716	Physiology	718	
Abbreviations and Symbols	719	Index	749	
•				
Image Acknowledgments	727	About the Editors	808	

FAS1_2019_00_Frontmatter.indd 6 11/14/19 4:35 PM

Contributing Authors

MAJED H. ALGHAMDI, MBBS

Resident, Joint Program of Preventive Medicine Jeddah, Saudi Arabia

LILIT ASLANYAN

New York Institute of Technology College of Osteopathic Medicine Class of 2020

HUMOOD BOQAMBAR, MB BCh BAO

Assistant Registrar, Department of Orthopaedic Surgery Farwaniya Hospital

WEELIC CHONG

Sidney Kimmel Medical College at Thomas Jefferson University MD/PhD Candidate

KRISTINA DAMISCH

University of Iowa Carver College of Medicine Class of 2020

YUMI KOVIC, MD

Resident, Department of Psychiatry University of Massachusetts Medical School

IMAGE AND ILLUSTRATION TEAM

CAROLINE COLEMAN

Emory University School of Medicine Class of 2020

MATTHEW HO ZHI GUANG

University College Dublin (MD), DFCI (PhD) MD/PhD Candidate

KAITLYN MELNICK, MD

Resident, Department of Neurological Surgery University of Florida College of Medicine, Gainesville

MARY KATHERINE MONTES de OCA, MD

Resident, Department of Obstetrics and Gynecology Duke University Hospital

SCOTT MOORE, DO

Assistant Professor of Medical Laboratory Sciences Weber State University

VASILY OVECHKO, MD

Resident, Department of Surgery Russian Medical Academy of Continuous Professional Education

VIVEK PODDER

MBBS Student Tairunnessa Memorial Medical College and Hospital, Bangladesh

CONNIE QIU

Lewis Katz School of Medicine at Temple University MD/PhD Candidate

VICTOR JOSE MARTINEZ LEON, MD

Central University of Venezuela

ALIREZA ZANDIFAR, MD

Research Fellow Isfahan University of Medical Sciences, Iran

FAS1_2019_00_Frontmatter.indd 7 11/14/19 4:35 PM

Associate Authors

HUZAIFA AHMAD, MD

Resident, Department of Medicine Georgetown University Hospital/MedStar Washington Hospital Center

ALEXANDER R. ASLESEN

Kirksville College of Osteopathic Medicine Class of 2020

ANUP K. BHATTACHARYA, MD

Resident, Mallinckrodt Institute of Radiology Washington University School of Medicine

ANUP CHALISE, MBBS

Resident, Department of General Surgery Nepal Medical College and Teaching Hospital

ASHTEN R. DUNCAN, MPH

University of Oklahoma-Tulsa School of Community Medicine Class of 2021

SARINA KOILPILLAI

St. George's University School of Medicine Class of 2020

LAUREN N. LESSOR, MPH, MD

Resident, Department of Pediatrics Mercy Health – St. Vincent Medical Center

ROHAN BIR SINGH, MD

Fellow, Department of Ophthalmology Massachusetts Eye and Ear Harvard Medical School

IMAGE AND ILLUSTRATION TEAM

YAMNA JADOON, MD

Research Associate Aga Khan University

DANA M. JORGENSON

Chicago College of Osteopathic Medicine Class of 2020

MITCHELL A. KATONA

University of Texas Health Science Center, Long School of Medicine Class of 2020

TAYLOR MANEY, MD

Resident, Department of Anesthesiology Brigham and Women's Hospital

viii

FAS1_2019_00_Frontmatter.indd 8 11/14/19 4:35 PM

Faculty Advisors

DIANA ALBA, MD

Clinical Instructor University of California, San Francisco School of Medicine

MARK A.W. ANDREWS, PhD

Professor of Physiology Lake Erie College of Osteopathic Medicine at Seton Hill

MARIA ANTONELLI, MD

Assistant Professor, Division of Rheumatology MetroHealth Medical Center, Case Western Reserve University

HERMAN SINGH BAGGA, MD

Urologist, Allegheny Health Network University of Pittsburgh Medical Center Passavant

SHIN C. BEH, MD

Assistant Professor, Department of Neurology & Neurotherapeutics UT Southwestern Medical Center at Dallas

JOHN R. BUTTERLY, MD

Professor of Medicine
Dartmouth Geisel School of Medicine

SHELDON CAMPBELL, MD, PhD

Professor of Laboratory Medicine Yale School of Medicine

BROOKS D. CASH, MD

Professor of Medicine, Division of Gastroenterology University of South Alabama School of Medicine

SHIVANI VERMA CHMURA, MD

Adjunct Clinical Faculty, Department of Psychiatry Stanford University School of Medicine

BRADLEY COLE, MD

Assistant Professor of Basic Sciences Loma Linda University School of Medicine

LINDA S. COSTANZO, PhD

Professor, Physiology & Biophysics Virginia Commonwealth University School of Medicine

MANAS DAS, MD, MS

Director, Clinical Anatomy, Embryology, and Histology University of Massachusetts Medical School

ANTHONY L. DeFRANCO, PhD

Professor, Department of Microbiology and Immunology University of California, San Francisco School of Medicine

CHARLES S. DELA CRUZ, MD, PhD

Associate Professor, Department of Pulmonary and Critical Care Medicine Yale School of Medicine

SAKINA FARHAT, MD

Consulting Gastroenterologist State University of New York Downstate Medical Center

CONRAD FISCHER, MD

Associate Professor, Medicine, Physiology, and Pharmacology Touro College of Medicine

RAYUDU GOPALAKRISHNA, PhD

Associate Professor, Department of Integrative Anatomical Sciences Keck School of Medicine of University of Southern California

RYAN C.W. HALL, MD

Assistant Professor, Department of Psychiatry University of South Florida School of Medicine

LOUISE HAWLEY, PhD

Immediate Past Professor and Chair, Department of Microbiology Ross University School of Medicine

JEFFREY W. HOFMANN, MD, PhD

Resident, Department of Pathology University of California, San Francisco School of Medicine

CLARK KEBODEAUX, PharmD

Clinical Assistant Professor, Pharmacy Practice and Science University of Kentucky College of Pharmacy

KRISTINE KRAFTS, MD

Assistant Professor, Department of Basic Sciences University of Minnesota School of Medicine

MATTHEW KRAYBILL, PhD

Clinical Neuropsychologist Cottage Health, Santa Barbara, California

GERALD LEE, MD

Assistant Professor, Departments of Pediatrics and Medicine Emory University School of Medicine

İΧ

KACHIU C. LEE, MD, MPH

Assistant Clinical Professor, Department of Dermatology The Warren Alpert Medical School of Brown University

WARREN LEVINSON, MD, PhD

Professor, Department of Microbiology and Immunology University of California, San Francisco School of Medicine

JAMES LYONS, MD

Professor of Pathology and Family Medicine Alabama College of Osteopathic Medicine

PETER MARKS, MD, PhD

Center for Biologics Evaluation and Research US Food and Drug Administration

DOUGLAS A. MATA, MD, MPH

Brigham Education Institute and Brigham and Women's Hospital Harvard Medical School

VICKI M. PARK, PhD, MS

Assistant Dean University of Tennessee College of Medicine

SOROUSH RAIS-BAHRAMI, MD

Assistant Professor, Departments of Urology and Radiology University of Alabama at Birmingham School of Medicine

SASAN SAKIANI, MD

Fellow, Transplant Hepatology Cleveland Clinic

MELANIE SCHORR, MD

Assistant in Medicine Massachusetts General Hospital

SHIREEN MADANI SIMS, MD

Chief, Division of Gynecology, Gynecologic Surgery, and Obstetrics University of Florida School of Medicine

NATHAN W. SKELLEY, MD

Assistant Professor, Department of Orthopaedic Surgery University of Missouri, The Missouri Orthopaedic Institute

HOWARD M. STEINMAN, PhD

Assistant Dean, Biomedical Science Education Albert Einstein College of Medicine

SUPORN SUKPRAPRUT-BRAATEN, PhD

Director of Research, Graduate Medical Education Unity Health, Searcy, Arkansas

RICHARD P. USATINE, MD

Professor, Dermatology and Cutaneous Surgery University of Texas Health Science Center San Antonio

J. MATTHEW VELKEY, PhD

Assistant Dean, Basic Science Education Duke University School of Medicine

TISHA WANG, MD

Associate Clinical Professor, Department of Medicine David Geffen School of Medicine at UCLA

SYLVIA WASSERTHEIL-SMOLLER, PhD

Professor Emerita, Department of Epidemiology and Population Health Albert Einstein College of Medicine

ADAM WEINSTEIN, MD

Assistant Professor, Pediatric Nephrology and Medical Education Geisel School of Medicine at Dartmouth

ABHISHEK YADAV, MBBS, MSc

Associate Professor of Anatomy Geisinger Commonwealth School of Medicine

KRISTAL YOUNG, MD

Clinical Instructor, Department of Cardiology Huntington Hospital, Pasadena, California

Thirtieth Anniversary Foreword

Our exam experiences remain vivid in our minds to this day as we reflect on 30 years of *First Aid*. In 1989, our big idea was to cobble together a "quick and dirty" study guide so that we would never again have to deal with the USMLE Step 1. We passed, but in a Faustian twist, we now relive the exam yearly while preparing each new edition.

Like all students before us, we noticed that certain topics tended to appear frequently on examinations. So we compulsively bought and rated review books and pored through a mind-numbing number of "recall" questions, distilling each into short facts. We had a love-hate relationship with mnemonics. They went against our purist desires for conceptual knowledge, but remained the best way to absorb the vocabulary and near-random associations that unlocked questions and eponyms.

To pull it all together, we used a then "state-of-the-art" computer database (Paradox/MS DOS 4) that fortuitously limited our entries to 256 characters. That length constraint (which predated Twitter by nearly two decades) imposed extreme brevity. The three-column layout created structure—and this was the blueprint upon which *First Aid* was founded.

The printed, three-column database was first distributed in 1989 at the University of California, San Francisco. The next year, the official first edition was self-published under the title *High-Yield Basic Science Boards Review:* A *Student-to-Student Guide*. The following year, our new publisher dismissed the *High-Yield* title as too confusing and came up with *First Aid for the Boards*. We thought the name was a bit cheesy, but it proved memorable. Interestingly, our "High-Yield" name resurfaced years later as the title of a competing board review series.

We lived in San Francisco and Los Angeles during medical school and residency. It was before the Web, and before med students could afford cell phones and laptops, so we relied on AOL e-mail and bulky desktops. One of us would drive down to the other person's place for multiple weekends of frenetic revisions fueled by triple-Swiss white chocolate lattes from the Coffee Bean & Tea Leaf, with R.E.M. and the Nusrat Fateh Ali Khan playing in the background. Everything was marked up on 11- by 17-inch "tearsheets," and at the end of the marathon weekend we would converge at the local 24-hour Kinko's followed by the FedEx box near LAX (10 years before these two great institutions merged). These days we work with our online collaborative platform A.nnotate, GoToMeeting, and ubiquitous broadband Internet, and sadly, we rarely get to see each other.

What hasn't changed, however, is the collaborative nature of the book. Thousands of authors, editors, and contributors have enriched our lives and made this book possible. Most helped for a year or two and moved on, but a few, like Ted Hon, Chirag Amin, and Andi Fellows, made lasting contributions. Like the very first edition, the team is always led by student authors who live and breathe (and fear) the exam, not professors years away from that reality.

We're proud of the precedent that *First Aid* set for the many excellent student-to-student publications that followed. More importantly, *First Aid* itself owes its success to the global community of medical students and international medical graduates (IMGs) who each year contribute ideas, suggestions, and new content. In the early days, we used book coupons and tear-out business reply mail forms. These days, we get many thousands of comments and suggestions each year via our blog FirstAidTeam.com and A.nnotate.

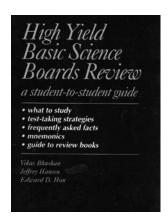
FAS1_2019_00_Frontmatter.indd 11 11/14/19 4:35 PM

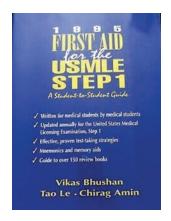
At the end of the day, we don't take any of this for granted. Students are expected to synthesize an ever increasing amount of information, and we have a bigger challenge ahead of us to try to keep *First Aid* indispensable to students and IMGs. We want and need your participation in the *First Aid* community. (See How to Contribute, p. xvii.) With your help, we hope editing *First Aid* will continue to be just as fun and rewarding as the past 30 years have been.

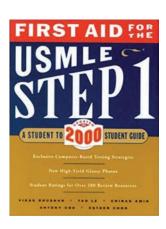
Louisville Tao Le Boracay Vikas Bhushan

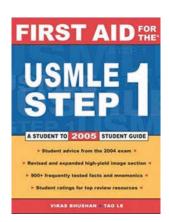
First Aid for the USMLE Step 1 Through the Years

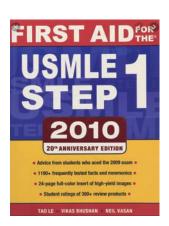


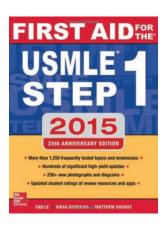














Xii

FAS1_2019_00_Frontmatter.indd 12 11/14/19 4:35 PM

Preface

With the 30th edition of *First Aid for the USMLE Step 1*, we continue our commitment to providing students with the most useful and up-to-date preparation guide for the USMLE Step 1. This edition represents an outstanding revision in many ways, including:

- 50 entirely new or heavily revised high-yield topics reflecting evolving trends in the USMLE Step 1.
- Reorganization of high-yield topics in Pharmacology, Endocrine, and Reproductive chapters for improved study.
- Extensive text revisions, new mnemonics, clarifications, and corrections curated by a team of more than 30 medical student and resident physician authors who excelled on their Step 1 examinations and verified by a team of expert faculty advisors and nationally recognized USMLE instructors.
- Updated with 178 new and revised diagrams and illustrations as part of our ongoing collaboration with USMLE-Rx and ScholarRx (MedIQ Learning, LLC).
- Updated with 75 new and revised photos to help visualize various disorders, descriptive findings, and basic science concepts. Additionally, revised imaging photos have been labeled and optimized to show both normal anatomy and pathologic findings.
- Updated study tips on the opening page of each chapter.
- Improved integration of clinical images and illustrations to better reinforce and learn key anatomic concepts.
- Improved organization and integration of text, illustrations, clinical images, and tables throughout for focused review of high-yield topics.
- Revised and expanded ratings of current, high-yield review resources, with clear explanations of their relevance to USMLE review.
- Real-time Step 1 updates and corrections can be found exclusively on our blog, www.firstaidteam.com.

We invite students and faculty to share their thoughts and ideas to help us continually improve *First Aid for the USMLE Step 1* through our blog and collaborative editorial platform. (See How to Contribute, p. xvii.)

Louisville Tao Le
Boracay Vikas Bhushan
St. Louis Matthew Sochat
Phoenix Vaishnavi Vaidyanathan
Bristol Sarah Schimansky
New York City Jordan Abrams
San Francisco Kimberly Kallianos

FAS1_2019_00_Frontmatter.indd 13 11/14/19 4:35 PM

Special Acknowledgments

This has been a collaborative project from the start. We gratefully acknowledge the thousands of thoughtful comments, corrections, and advice of the many medical students, international medical graduates, and faculty who have supported the authors in our continuing development of *First Aid for the USMLE Step 1*.

For support and encouragement throughout the process, we are grateful to Thao Pham, Jinky Flang, and Jonathan Kirsch, Esq. Thanks to Louise Petersen for organizing and supporting the project. Thanks to our publisher, McGraw-Hill, for the valuable assistance of its staff, including Bob Boehringer, Jeffrey Herzich, and Christina Thomas.

We are also very grateful to Dr. Fred Howell and Dr. Robert Cannon of Textensor Ltd for providing us extensive customization and support for their powerful Annotate.co collaborative editing platform (www.annotate.co), which allows us to efficiently manage thousands of contributions. Thanks to Dr. Richard Usatine and Dr. Kristine Krafts for their outstanding image contributions. Thanks also to Jean-Christophe Fournet (www.humpath.com), Dr. Ed Uthman, and Dr. Frank Gaillard (www.radiopaedia.org) for generously allowing us to access some of their striking photographs.

For exceptional editorial leadership, enormous thanks to Kathleen Naylor, Christine Diedrich and Emma Underdown. Thank you to our USMLE-Rx/ScholarRx team of editors, Jessie Schanzle, Ruth Kaufman, Janene Matragrano, Susan Mazik, Isabel Nogueira, Sharon Prevost, Jen Shimony, and Hannah Warnshuis. Special thanks to our indexer Dr. Anne Fifer. We are also grateful to our medical illustrator, Hans Neuhart, for his creative work on the new and updated illustrations. Lastly, tremendous thanks to Graphic World, especially Anne Banning, Sandy Brown, Gary Clark, and Cindy Geiss.

Louisville Tao Le

Boracay Vikas Bhushan St. Louis Matthew Sochat

Phoenix Vaishnavi Vaidyanathan Bristol Sarah Schimansky

Bristol Sarah Schimansky
New York City Jordan Abrams
San Francisco Kimberly Kallianos

XİV

General Acknowledgments

Each year we are fortunate to receive the input of thousands of medical students and graduates who provide new material, clarifications, and potential corrections through our website and our collaborative editing platform. This has been a tremendous help in clarifying difficult concepts, correcting errata from the previous edition, and minimizing new errata during the revision of the current edition. This reflects our long-standing vision of a true, student-to-student publication. We have done our best to thank each person individually below, but we recognize that errors and omissions are likely. Therefore, we will post an updated list of acknowledgments at our website, www. firstaidteam.com/bonus/. We will gladly make corrections if they are brought to our attention.

For submitting contributions and corrections, many thanks to Raed Ababneh, Antara Afrin, Rasim Agaev, Vanya Aggarwal, Ataa Ahmed, Hasan Alarouri, Basim Ali, Muhammad Faizan Ali, Moatasem Al-Janabi, Mohamed Almahmodi, Chima Amadi, Arman Amin, Jacqueline Aredo, Ranya Baddourah, Daniel Badin, Nida Bajwa, Dileni Bandarage, Jerrin Bawa, Esra Bayram, Craig Beavers, Jacqueline Bekhit, Matthias Bergmann, Stephanie Biecker, Aaron Birnbaum, Prateek Bommu, Nathaniel Borochov, Susan Brands, Olivia W. Brooks, Meghan Brown, Stanley Budzinski, Kevin Budziszewski, Pavel Burski, Elisa M. Cairns, Sergio Camba, Katie Carsky, Esteban Casasola, Marielys Castro, Jesse Chait, Bliss Chang, Santosh Cherian, Heewon Choi, Charilaos Chourpiliadis, Maruf Chowdhury, Matthew J. Christensen, Matthew Yat Hon Chung, Alexander Ciaramella, Dillon Clancy, Sofija Conic, M. Marwan Dabbagh, Parag Das, Ketan Dayma, Elmer De Camps, Charles de Leeuw, Xavier De Pena, Christopher DeAngelo, Elliott Delgado, Anthony DeMarinis, Stacy Diaz, Evan Dishion, Nicola Helen Duzak, Emily Edwards, Alec Egan, Mohamed Elashwal, Osama El-Gabalawy, Matthew Eli, Awab Elnaeem, Sally El Sammak, Dylan Erwin, Stephanie Estevez-Marin, Gray Evans, Najat Fadlallah, Aria Fariborzi, Richard Ferro, Adam Fletcher, Kimberly A. Foley, Kyle Fratta, Samantha Friday, Nikhila Gandrakota, Siva Garapati, Nicolas Curi Gawlinski, Joanna Georgakas, Beth Anne George, Ashley Ghaemi, E. Sophia Gonzalez, Justin Graff, Gabriel Graham, Donovan Griggs, David Gruen, Gursewak Hadday, Jacqueline Hairston, Hunter Harrison, Gull Shahmir Hasnat, Maximillan Hawkins, Grecia Haymee, Briana Hernandez, Robin Hilder, Tammy Hua, Derrek Humphries, Audrey Hunt, Nanki Hura, Danny Ibrahim, Jyothik Varun Inampudi, Hnin Ingyin, Maham Irfan, Mina Iskandar, Kritika Iyer, Christina Jacobs, Arpit Jain, Neil K. Jain, Ala Jamal, Natalie Jansen, Jordan Jay, Mohammad Jmasi, Colton Junod, Talia Kamdjou, Filip Kaniski, Lydia Kaoutzani, Panagiotis Kaparaliotis, Srikrishna Karnatapu, Patrick Keller, Olivia Keller-Baruch, Cameron Kerl, Ahmed Ali Khan, Sara Khan, Shaima Khandaker, Samir Khouzam, Sonya Klein, Elana Kleinman, Andrew Ko, Soheil Kooraki, Anna Kukharchuk, Dennis Vu Kulp, Anil A. Kumar, Julie Kurek, Chloe Lahoud, Mike Lawandy, Ramy Lawandy, Jessica Lazar, Andrea Leal-Lopez, Lynda Lee, Chime Lhatso, Christine Lin, Benjamin Lodge, Soon Khai Low, Estefanía Henríquez Luthje, Lisa-Qiao MacDonald, Divya Madhavarapu, Mahir Mameledzija, Keerer Mann, Rajver Mann, Nadeen Mansour, Yusra Mansour, Bridget Martinez, Ahmad Mashlah, Rick Mathews, Amy McGregor, Alexandra & Joshua Medeiros & Fowler, Viviana Medina, Areeka Memon, Pedro G. R. Menicucci, Ben Meyers, Stephan A. Miller, Fatima Mirza, Murli Mishra, Elana Molcho, Guarina Molina, John Moon, Nayla Mroueh, Neha Mylarapu, Behnam Nabavizadeh, Moeko Nagatsuka, Ghazal Naghibzadeh, Alice Nassar, Nadya Nee, Lucas Nelson, Zach Nelson, Monica Nemat, Kenneth Nguyen, Michael Nguyen, Christian

FAS1_2019_00_Frontmatter.indd 15 11/14/19 4:35 PM

Nieves, Nyia Njamfa, Ahmed Noor, Kyle Nyugen, Ahamd Obeidat, Gerald Olayan, Anndres Olson, Hasaan Omar, Daniel Ortiz, Michael O'Shea, Zonghao Pan, Vasilis Sebastian Paraschos, Christopher Parrino, Janak Patel, Vanisha Patel, Cyril Patra, Rita Paulis, Dmytro Pavlenko, Nancy A. Pina, Alexander Polyak, Jackeline Porto, Shannon D. Powell, Jacob Pruett, Laith Rahabneh, Kamleshun Ramphul, Janhvi Rana, Nidaa Rasheed, Abdul Sattar Raslan, Tomas Ream, Rashelle Ripa, Amanda Michelle Ritchie, Helio Manuel Grullón Rodríguez, Sarah Rohrig, Gessel Romero, Alexander Rose, Rachel Rose, Erica Rubin, Areesha Saati, Jeffrey Sackey, Raza H. Sagarwala, Chhavi Saini, Sergii Sakhno, Allie Sakowicz, Shadia Saleh, Roshun Sangani, Dhruv Sarwal, Abeer Sarwar, M. Sathyanarayanan, Neetu Scariya, Tonio Felix Schaffert, Melissa Schechter, Kathryn Scheinberg, Emma Schnuckle, Emma Schulte, Taylor Schweigert, Lee Seifert, Sheila Serin, Deeksha Seth, Omid Shafaat, Nirav Shah, Samir K. Shah, Wasif Nauman Shah, Muhanad Shaib, Ahmed Shakir, Purnima Sharma, Tina Sharma, Kayla Sheehan, Dr. Priya Shenwai, Sami Shoura, Kris Sifeldeen, Akhand Singh, Manik Inder Singh, Ramzi Y. Skaik, Samantha A. Smith, Timothy Smith, Emilie Song, Hang Song, Shichen Song, Luke Sorensen, Charles Starling, Jonathan Andrew Stone, Nathan Stumpf, Johnny Su, Bahaa Eddine Succar, Saranya Sundaram, Steven Svoboda, Clara Sze, Olive Tang, Brian Tanksley, Omar Tayh, Joshua Taylor, Valerie Teano, Warren Teltser, Steffanie Camilo Tertulien, Roger Torres, Michael Trainer, Andrew Trinh, Aalap K. Trivedi, Georgeanna Tsoumas, Elizabeth Tsui, Cem Turam, Methma Udawatta, Daramfon Udofia, Adaku Ume, Rio Varghese, Judith Vásquez, Earl Vialpando, Sagar Vinayak, Phuong Vo, Habiba Wada, Jason Wang, Tiffany Wang, Zoe Warczak, Mitchell Waters, Rachel Watson, Elizabeth Douglas Weigel, Rabbi Michael Weingarten, Kaystin Weisenberger, Aidan Woodthorpe, Mattia Wruble, Angela Wu, Catherine Xie, Rebecca Xu, Nicholas Yeisley, Sammy Yeroushalmi, Melissas Yuan, Sahil Zaveri, and Yolanda Zhang.

XVİ

How to Contribute

This version of *First Aid for the USMLE Step 1* incorporates thousands of contributions and improvements suggested by student and faculty advisors. We invite you to participate in this process. Please send us your suggestions for:

- Study and test-taking strategies for the USMLE Step 1
- New facts, mnemonics, diagrams, and clinical images
- High-yield topics that may appear on future Step 1 exams
- Personal ratings and comments on review books, question banks, apps, videos, and courses

For each new entry incorporated into the next edition, you will receive **up to a \$20 Amazon.com gift card** as well as personal acknowledgment in the next edition. Significant contributions will be compensated at the discretion of the authors. Also, let us know about material in this edition that you feel is low yield and should be deleted.

All submissions including potential errata should ideally be supported with hyperlinks to a dynamically updated Web resource such as UpToDate, AccessMedicine, and ClinicalKey.

We welcome potential errata on grammar and style if the change improves readability. Please note that *First Aid* style is somewhat unique; for example, we have fully adopted the *AMA Manual of Style* recommendations on eponyms ("We recommend that the possessive form be omitted in eponymous terms") and on abbreviations (no periods with eg, ie, etc). We also avoid periods in tables unless required for full sentences. Kindly refrain from submitting "style errata" unless you find specific inconsistencies with the *AMA Manual of Style*.

The preferred way to submit new entries, clarifications, mnemonics, or potential corrections with a valid, authoritative reference is via our website: www.firstaidteam.com.

This website will be continuously updated with validated errata, new high-yield content, and a new online platform to contribute suggestions, mnemonics, diagrams, clinical images, and potential errata.

Alternatively, you can email us at: firstaid@scholarrx.com.

Contributions submitted by May 15, 2020, receive priority consideration for the 2021 edition of *First Aid for the USMLE Step 1*. We thank you for taking the time to share your experience and apologize in advance that we cannot individually respond to all contributors as we receive thousands of contributions each year.

XVII

FAS1_2019_00_Frontmatter.indd 17 11/14/19 4:35 PM

► NOTE TO CONTRIBUTORS

All contributions become property of the authors and are subject to editing and reviewing. Please verify all data and spellings carefully. Contributions should be supported by at least two high-quality references.

Check our website first to avoid duplicate submissions. In the event that similar or duplicate entries are received, only the first complete entry received with valid, authoritative references will be credited. Please follow the style, punctuation, and format of this edition as much as possible.

▶ JOIN THE FIRST AID TEAM

The *First Aid* author team is pleased to offer part-time and full-time paid internships in medical education and publishing to motivated medical students and physicians. Internships range from a few months (eg, a summer) up to a full year. Participants will have an opportunity to author, edit, and earn academic credit on a wide variety of projects, including the popular *First Aid* series.

For 2020, we are actively seeking passionate medical students and graduates with a specific interest in improving our medical illustrations, expanding our database of medical photographs, and developing the software that supports our crowdsourcing platform. We welcome people with prior experience and talent in these areas. Relevant skills include clinical imaging, digital photography, digital asset management, information design, medical illustration, graphic design, tutoring, and software development.

Please email us at firstaid@scholarrx.com with a CV and summary of your interest or sample work.

XVIII

How to Use This Book

CONGRATULATIONS: You now possess the book that has guided nearly two million students to USMLE success for 30 years. With appropriate care, the binding should last the useful life of the book. Keep in mind that putting excessive flattening pressure on any binding will accelerate its failure. If you purchased a book that you believe is defective, please **immediately** return it to the place of purchase. If you encounter ongoing issues, you can also contact Customer Service at our publisher, McGraw-Hill Education, at https://www.mheducation.com/contact.html.

START EARLY: Use this book as early as possible while learning the basic medical sciences. The first semester of your first year is not too early! Devise a study plan by reading Section I: Guide to Efficient Exam Preparation, and make an early decision on resources to use by checking Section IV: Top-Rated Review Resources. Note that *First Aid* is neither a textbook nor a comprehensive review book, and it is not a panacea for inadequate preparation.

CONSIDER FIRST AID YOUR ANNOTATION HUB: Annotate material from other resources, such as class notes or comprehensive textbooks, into your book. This will keep all the high-yield information you need in one place. Other tips on keeping yourself organized:

- For best results, use fine-tipped ballpoint pens (eg, BIC Pro+, Uni-Ball Jetstream Sports, Pilot Drawing Pen, Zebra F-301). If you like gel pens, try Pentel Slicci, and for markers that dry almost immediately, consider Staedtler Triplus Fineliner, Pilot Drawing Pen, and Sharpies.
- Consider using pens with different colors of ink to indicate different sources of information (eg, blue for USMLE-Rx Step 1 Qmax, green for UWorld Step 1 Qbank).
- Choose highlighters that are bright and dry quickly to minimize smudging and bleeding through the page (eg, Tombow Kei Coat, Sharpie Gel).
- Many students de-spine their book and get it 3-hole-punched. This will allow you to insert materials from other sources, including curricular materials.

INTEGRATE STUDY WITH CASES, FLASH CARDS, AND QUESTIONS: To broaden your learning strategy, consider integrating your *First Aid* study with case-based reviews (eg, *First Aid Cases for the USMLE Step 1*), flash cards (eg, First Aid Flash Facts), and practice questions (eg, the USMLE-Rx Step 1 Qmax). Read the chapter in the book, then test your comprehension by using cases, flash cards, and questions that cover the same topics. Maintain access to more comprehensive resources (eg, *First Aid for the Basic Sciences: General Principles* and *Organ Systems* and First Aid Express videos) for deeper review as needed.

PRIME YOUR MEMORY: Return to your annotated Sections II and III several days before taking the USMLE Step 1. The book can serve as a useful way of retaining key associations and keeping high-yield facts fresh in your memory just prior to the exam. The Rapid Review section includes high-yield topics to help guide your studying.

CONTRIBUTE TO FIRST AID: Reviewing the book immediately after your exam can help us improve the next edition. Decide what was truly high and low yield and send us your comments. Feel free to send us scanned images from your annotated *First Aid* book as additional support. Of course, always remember that all examinees are under agreement with the NBME to not disclose the specific details of copyrighted test material.

xix

Selected USMLE Laboratory Values

* = Included in the Biochemical Profile (SMA-12)

Blood, Plasma, Serum	Reference Range	SI Reference Intervals
*Alanine aminotransferase (ALT, GPT at 30°C)	8–20 U/L	8–20 U/L
Amylase, serum	25–125 U/L	25–125 U/L
*Aspartate aminotransferase (AST, GOT at 30°C)	8–20 U/L	8–20 U/L
Bilirubin, serum (adult) Total // Direct	0.1–1.0 mg/dL // 0.0–0.3 mg/dL	2–17 μmol/L // 0–5 μmol/L
*Calcium, serum (Total)	8.4–10.2 mg/dL	2.1–2.8 mmol/L
*Cholesterol, serum (Total)	Rec: < 200 mg/dL	< 5.2 mmol/L
*Creatinine, serum (Total)	0.6–1.2 mg/dL	53–106 μmol/L
Electrolytes, serum Sodium (Na+) Chloride (Cl-) * Potassium (K+) Bicarbonate (HCO ₃ -) Magnesium (Mg2+)	136–145 mEq/L 95–105 mEq/L 3.5–5.0 mEq/L 22–28 mEq/L 1.5–2 mEq/L	136–145 mmol/L 95–105 mmol/L 3.5–5.0 mmol/L 22–28 mmol/L 0.75–1.0 mmol/L
Gases, arterial blood (room air) $\begin{array}{c} P_{O_2} \\ P_{CO_2} \\ pH \end{array}$	75–105 mm Hg 33–45 mm Hg 7.35–7.45	10.0–14.0 kPa 4.4–5.9 kPa [H+] 36–44 nmol/L
*Glucose, serum	Fasting: 70–110 mg/dL 2-h postprandial: < 120 mg/dL	3.8–6.1 mmol/L < 6.6 mmol/L
Growth hormone – arginine stimulation	Fasting: < 5 ng/mL provocative stimuli: > 7 ng/mL	< 5 μg/L > 7 μg/L
Osmolality, serum	275–295 mOsm/kg	275–295 mOsm/kg
*Phosphatase (alkaline), serum (p-NPP at 30°C)	20–70 U/L	20–70 U/L
*Phosphorus (inorganic), serum	3.0–4.5 mg/dL	1.0-1.5 mmol/L
Prolactin, serum (hPRL)	< 20 ng/mL	< 20 μg/L
*Proteins, serum Total (recumbent) Albumin Globulins	6.0–7.8 g/dL 3.5–5.5 g/dL 2.3–3.5 g/dL	60–78 g/L 35–55 g/L 23–35 g/L
Thyroid-stimulating hormone, serum or plasma	$0.5-5.0~\mu U/mL$	0.5-5.0 mU/L
*Urea nitrogen, serum (BUN)	7–18 mg/dL	1.2–3.0 mmol/L
*Uric acid, serum	3.0-8.2 mg/dL	0.18-0.48 mmol/L

XX

FAS1_2019_00_Frontmatter.indd 20 11/14/19 4:35 PM

Cerebrospinal Fluid	Reference Range	SI Reference Intervals
Glucose	40–70 mg/dL	2.2–3.9 mmol/L
Hematologic		
Erythrocyte count	Male: 4.3–5.9 million/mm ³ Female: 3.5–5.5 million/mm ³	$4.3-5.9 \times 10^{12}/L$ $3.5-5.5 \times 10^{12}/L$
Erythrocyte sedimentation rate (Westergen)	Male: 0–15 mm/h Female: 0–20 mm/h	0–15 mm/h 0–20 mm/h
Hematocrit	Male: 41–53% Female: 36–46%	0.41-0.53 0.36-0.46
Hemoglobin, blood	Male: 13.5–17.5 g/dL Female: 12.0–16.0 g/dL	2.09–2.71 mmol/L 1.86–2.48 mmol/L
Hemoglobin, plasma	1–4 mg/dL	0.16–0.62 μmol/L
Leukocyte count and differential Leukocyte count Segmented neutrophils Band forms Eosinophils Basophils Lymphocytes Monocytes Mean corpuscular hemoglobin Mean corpuscular volume Partial thromboplastin time (activated) Platelet count	4,500–11,000/mm³ 54–62% 3–5% 1–3% 0–0.75% 25–33% 3–7% 25.4–34.6 pg/cell 80–100 μm³ 25–40 seconds 150,000–400,000/mm³	$4.5-11.0 \times 10^{9}$ /L 0.54-0.62 0.03-0.05 0.01-0.03 0-0.0075 0.25-0.33 0.03-0.07 0.39-0.54 fmol/cell 80-100 fL 25-40 seconds $150-400 \times 10^{9}$ /L
Prothrombin time	11–15 seconds	11–15 seconds
Reticulocyte count	0.5–1.5% of red cells	0.005-0.015
Sweat		
Chloride	0–35 mmol/L	0–35 mmol/L
Urine		
Creatinine clearance	Male: 97–137 mL/min Female: 88–128 mL/min	
Osmolality	$50-1,400 \text{ mOsmol/kg } \text{H}_2\text{O}$	
Proteins, total	< 150 mg/24 h	< 0.15 g/24 h

FAS1_2019_00_Frontmatter.indd 21 11/14/19 4:35 PM

First Aid Checklist for the USMLE Step 1

This is an example of how you might use the information in Section I to prepare for the USMLE Step 1. Refer to corresponding topics in Section I for more details.

	 □ Use top-rated review resources for first-year medical school courses. □ Ask for advice from those who have recently taken the USMLE Step 1.
Months Prior —	 Review computer test format and registration information. Register six months in advance. Carefully verify name and address printed on scheduling permit. Make sure the name on scheduling permit matches the name printed on your photo ID. Go online for test date ASAP. Define your exam goals (pass comfortably, beat the mean, ace the test) Set up a realistic timeline for study. Cover less crammable subjects first. Evaluate and choose study materials (review books, question banks). Use a question bank to simulate the USMLE Step 1 to pinpoint strengths and weaknesses in knowledge and test-taking skills.
Weeks Prior —	 □ Do another test simulation in a question bank. □ Assess how close you are to your goal. □ Pinpoint remaining weaknesses. Stay healthy (exercise, sleep). □ Verify information on admission ticket (eg, location, date).
One Week Prior —	 □ Remember comfort measures (loose clothing, earplugs, etc). □ Work out test site logistics (eg, location, transportation, parking, lunch). □ Print or download your Scheduling Permit and Scheduling Confirmation to your phone.
One Day Prior —	 □ Relax. □ Lightly review short-term material if necessary. Skim high-yield facts. □ Get a good night's sleep.
Day of Exam —	 □ Relax. □ Eat breakfast. □ Minimize bathroom breaks during exam by avoiding excessive morning caffeine.
After Exam	 □ Celebrate, regardless of how well you feel you did. □ Send feedback to us on our website at www.firstaidteam.com.

XXII

SECTION I

Guide to Efficient Exam Preparation

"I don't love studying. I hate studying. I like learning. Learning is beautiful."

-Natalie Portman

"Finally, from so little sleeping and so much reading, his brain dried up and he went completely out of his mind."

-Miguel de Cervantes Saavedra, Don Quixote

"Sometimes the questions are complicated and the answers are simple."

—Dr. Seuss

"He who knows all the answers has not been asked all the questions."

—Confucius

"The expert in anything was once a beginner."

-Helen Hayes

"It always seems impossible until it's done."

-Nelson Mandela

▶ Introduction	2
► USMLE Step 1—The Basics	2
▶ Defining Your Goal	12
▶ Learning Strategies	13
▶ Timeline for Study	16
▶ Study Materials	20
▶ Test-Taking Strategies	22
Clinical Vignette Strategies	23
▶ If You Think You Failed	24
▶ Testing Agencies	24
▶ References	25

FAS1_2019_00_Section_Lindd 1 11/7/19 2:48 PM

▶ INTRODUCTION

Relax.

This section is intended to make your exam preparation easier, not harder. Our goal is to reduce your level of anxiety and help you make the most of your efforts by helping you understand more about the United States Medical Licensing Examination, Step 1 (USMLE Step 1). As a medical student, you are no doubt familiar with taking standardized examinations and quickly absorbing large amounts of material. When you first confront the USMLE Step 1, however, you may find it all too easy to become sidetracked from your goal of studying with maximal effectiveness. Common mistakes that students make when studying for Step 1 include the following:

- Starting to study (including First Aid) too late
- Starting to study intensely too early and burning out
- Starting to prepare for boards before creating a knowledge foundation
- Using inefficient or inappropriate study methods
- Buying the wrong resources or buying too many resources
- Buying only one publisher's review series for all subjects
- Not using practice examinations to maximum benefit
- Not understanding how scoring is performed or what the score means
- Not using review books along with your classes
- Not analyzing and improving your test-taking strategies
- Getting bogged down by reviewing difficult topics excessively
- Studying material that is rarely tested on the USMLE Step 1
- Failing to master certain high-yield subjects owing to overconfidence
- Using First Aid as your sole study resource
- Trying to prepare for it all alone

In this section, we offer advice to help you avoid these pitfalls and be more productive in your studies.

▶ The test at a glance:

- 8-hour exam
- Up to a total of 280 multiple choice items
- 7 test blocks (60 min/block)
- Up to 40 test items per block
- 45 minutes of break time, plus another 15 if you skip the tutorial

▶ USMLE STEP 1—THE BASICS

The USMLE Step 1 is the first of three examinations that you must pass in order to become a licensed physician in the United States. The USMLE is a joint endeavor of the National Board of Medical Examiners (NBME) and the Federation of State Medical Boards (FSMB). The USMLE serves as the single examination system for US medical students and international medical graduates (IMGs) seeking medical licensure in the United States.

FAS1 2019 00 Section Lindd 2 11/7/19 2:48 PM

The Step 1 exam includes test items that can be grouped by the organizational constructs outlined in Table 1 (in order of tested frequency).

TABLE 1. Frequency of Various Constructs Tested on the USMLE Step 1.*

Competency	Range, %	System	Range, %
Medical knowledge: applying foundational science concepts	52–62	General principles	13–17
Patient care: diagnosis	20-30	Behavioral health & nervous systems/special senses	9–13
Patient care: management	7–12	Respiratory & renal/urinary systems	9–13
Practice-based learning & improvement	5–7	Reproductive & endocrine systems	9–13
Communication/professionalism	2–5	Blood & lymphoreticular/immune systems	7–11
Discipline	Range, %	Multisystem processes & disorders	7–11
Pathology	45–52	Musculoskeletal, skin & subcutaneous tissue	6-10
Physiology	26–34	Cardiovascular system	6-10
Pharmacology	16–23	Gastrointestinal system	5–9
Biochemistry & nutrition	14–24	Biostatistics & epidemiology/population health	5–7
Microbiology & immunology	15–22	Social sciences: communication skills/ethics	3–5
Gross anatomy & embryology	11–15		
Histology & cell biology	9–13		
Behavioral sciences	8–12		
Genetics	5–9		

^{*}Percentages are subject to change at any time. www.usmle.org

How Is the Computer-Based Test (CBT) Structured?

The CBT Step 1 exam consists of one "optional" tutorial/simulation block and seven "real" question blocks of up to 40 questions per block with no more than 280 questions in total, timed at 60 minutes per block. A short 11-question survey follows the last question block. The computer begins the survey with a prompt to proceed to the next block of questions.

Once an examinee finishes a particular question block on the CBT, he or she must click on a screen icon to continue to the next block. Examinees cannot go back and change their answers to questions from any previously completed block. However, changing answers is allowed within a block of questions as long as the block has not been ended and if time permits.

What Is the CBT Like?

Given the unique environment of the CBT, it's important that you become familiar ahead of time with what your test-day conditions will be like. You can access a 15-minute tutorial and practice blocks at http://orientation.nbme.org/Launch/USMLE/STPF1. This tutorial interface is very similar to the one you will use in the exam; learn it now and you can skip taking it during the exam, giving you up to 15 extra minutes of break time. You can gain experience with the CBT format by taking the 120 practice questions (3 blocks with 40 questions each) available online or by signing up for a practice session at a test center for a fee.

FAS1_2019_00_Section_Lindd 3 11/7/19 2:48 PM

For security reasons, examinees are not allowed to bring any personal electronic equipment into the testing area. This includes both digital and analog watches, iPods, tablets, calculators, cell phones, and electronic paging devices. Examinees are also prohibited from carrying in their books, notes, pens/pencils, and scratch paper. Food and beverages are also prohibited in the testing area. The testing centers are monitored by audio and video surveillance equipment. However, most testing centers allot each examinee a small locker outside the testing area in which he or she can store snacks, beverages, and personal items.

- Questions are typically presented in multiple choice format, with 4–5 possible answer options. There is a countdown timer on the lower left corner of the screen as well. There is also a button that allows the examinee to mark a question for review. If a given question happens to be longer than the screen (which occurs very rarely), a scroll bar will appear on the right, allowing the examinee to see the rest of the question. Regardless of whether the examinee clicks on an answer choice or leaves it blank, he or she must click the "Next" button to advance to the next question.
- The USMLE features a small number of media clips in the form of audio and/or video. There may even be a question with a multimedia heart sound simulation. In these questions, a digital image of a torso appears on the screen, and the examinee directs a digital stethoscope to various auscultation points to listen for heart and breath sounds. The USMLE orientation materials include several practice questions in these formats. During the exam tutorial, examinees are given an opportunity to ensure that both the audio headphones and the volume are functioning properly. If you are already familiar with the tutorial and planning on skipping it, first skip ahead to the section where you can test your headphones. After you are sure the headphones are working properly, proceed to the exam.
- The examinee can call up a window displaying normal laboratory values. In order to do so, he or she must click the "Lab" icon on the top part of the screen. Afterward, the examinee will have the option to choose between "Blood," "Cerebrospinal," "Hematologic," or "Sweat and Urine." The normal values screen may obscure the question if it is expanded. The examinee may have to scroll down to search for the needed lab values. You might want to memorize some common lab values so you spend less time on questions that require you to analyze these.

The CBT interface provides a running list of questions on the left part of the screen at all times. The software also permits examinees to highlight or cross out information by using their mouse. There is a "Notes" icon on the top part of the screen that allows students to write notes to themselves for review at a later time. Finally, the USMLE has recently added new functionality including text magnification and reverse color (white text on black background). Being familiar with these features can save time and may help you better view and organize the information you need to answer a question.

- Keyboard shortcuts:
- A, B, etc—letter choices
- Enter or spacebar—move to next question
- Esc—exit pop-up Calculator and Notes windows
- Heart sounds are tested via media questions. Make sure you know how different heart diseases sound on auscultation.
- ▶ Be sure to test your headphones during the tutorial.
- ► Familiarize yourself with the commonly tested lab values (eg, Hgb, WBC, platelets, Na⁺, K⁺).
- ▶ Illustrations on the test include:
 - Gross specimen photos
 - Histology slides
- Medical imaging (eg, x-ray, CT, MRI)
- Electron micrographs
- Line drawings
- ► Ctrl-Alt-Delete are the keys of death during the exam. Don't touch them at the same time!

FAS1_2019_00_Section_Lindd 4 11/7/19 2:48 PM

For those who feel they might benefit, the USMLE offers an opportunity to take a simulated test, or "CBT Practice Session" at a Prometric center. Students are eligible to register for this three-and-one-half-hour practice session after they have received their scheduling permit.

The same USMLE Step 1 sample test items (120 questions) available on the USMLE website, www.usmle.org, are used at these sessions. **No new items will be presented.** The practice session is available at a cost of \$75 (or more if taken outside of the US and Canada) and is divided into a short tutorial and three 1-hour blocks of ~40 test items each. Students receive a printed percent-correct score after completing the session. **No explanations of questions are provided.**

You may register for a practice session online at www.usmle.org. A separate scheduling permit is issued for the practice session. Students should allow two weeks for receipt of this permit.

▶ You can take a shortened CBT practice test at a Prometric center.

How Do I Register to Take the Exam?

Prometric test centers offer Step 1 on a year-round basis, except for the first two weeks in January and major holidays. The exam is given every day except Sunday at most centers. Some schools administer the exam on their own campuses. Check with the test center you want to use before making your exam plans.

US students can apply to take Step 1 at the NBME website. This application allows you to select one of 12 overlapping three-month blocks in which to be tested (eg, April–May–June, June–July–August). Choose your three-month eligibility period wisely. If you need to reschedule outside your initial three-month period, you can request a one-time extension of eligibility for the next contiguous three-month period, and pay a rescheduling fee. The application also includes a photo ID form that must be certified by an official at your medical school to verify your enrollment. After the NBME processes your application, it will send you a scheduling permit.

The scheduling permit you receive from the NBME will contain your USMLE identification number, the eligibility period in which you may take the exam, and two additional numbers. The first of these is known as your "scheduling number." You must have this number in order to make your exam appointment with Prometric. The second number is known as the "candidate identification number," or CIN. Examinees must enter their CINs at the Prometric workstation in order to access their exams. However, you will not be allowed to bring your permit into the exam and will be asked to copy your CIN onto your scratch paper. Prometric has no access to the codes. Make sure to bring a paper or electronic copy of your permit with you to the exam! Also bring an unexpired, government-issued photo ID that includes your signature (such as a driver's license or passport). Make sure the name on your photo ID exactly matches the name that appears on your scheduling permit.

The Prometric website will display a calendar with open test dates.

FAS1_2019_00_Section_Lindd 5 11/7/19 2:48 PM

GUIDE TO EFFICIENT EXAM PREPARATION

- ► The confirmation emails that Prometric and NBME send are not the same as the scheduling permit.
- Test scheduling is done on a "first-come, first-served" basis. It's important to schedule an exam date as soon as you receive your scheduling permit.

► Register six months in advance for seating

and scheduling preference.

Once you receive your scheduling permit, you may access the Prometric website or call Prometric's toll-free number to arrange a time to take the exam. You may contact Prometric two weeks before the test date if you want to confirm identification requirements. Although requests for taking the exam may be completed more than six months before the test date, examinees will not receive their scheduling permits earlier than six months before the eligibility period. The eligibility period is the three-month period you have chosen to take the exam. Most medical students choose the April–June or June–August period. Because exams are scheduled on a "first-come, first-served" basis, it is recommended that you book an exam date on the Prometric website as soon as you receive your permit. Prometric will provide appointment confirmation on a print-out and by email. Be sure to read the latest USMLE Bulletin of Information for further details.

What If I Need to Reschedule the Exam?

You can change your test date and/or center by contacting Prometric at 1-800-MED-EXAM (1-800-633-3926) or www.prometric.com. Make sure to have your CIN when rescheduling. If you are rescheduling by phone, you must speak with a Prometric representative; leaving a voicemail message will not suffice. To avoid a rescheduling fee, you will need to request a change at least 31 calendar days before your appointment. Please note that your rescheduled test date must fall within your assigned three-month eligibility period.

When Should I Register for the Exam?

You should plan to register as far in advance as possible ahead of your desired test date (eg, six months), but, depending on your particular test center, new dates and times may open closer to the date. Scheduling early will guarantee that you will get either your test center of choice or one within a 50-mile radius of your first choice. For most US medical students, the desired testing window is in June, since most medical school curricula for the second year end in May or June. Thus, US medical students should plan to register before January in anticipation of a June test date. The timing of the exam is more flexible for IMGs, as it is related only to when they finish exam preparation. Talk with upperclassmen who have already taken the test so you have real-life experience from students who went through a similar curriculum, then formulate your own strategy.

Where Can I Take the Exam?

Your testing location is arranged with Prometric when you book your test date (after you receive your scheduling permit). For a list of Prometric locations nearest you, visit www.prometric.com.

FAS1_2019_00_Section_Lindd 6 11/7/19 2:48 PM

How Long Will I Have to Wait Before I Get My Scores?

The USMLE reports scores in three to four weeks, unless there are delays in score processing. Examinees will be notified via email when their scores are available. By following the online instructions, examinees will be able to view, download, and print their score report online for ~120 days after score notification, after which scores can only be obtained through requesting an official USMLE transcript. Additional information about score timetables and accessibility is available on the official USMLE website.

What About Time?

Time is of special interest on the CBT exam. Here's a breakdown of the exam schedule:

15 minutes Tutorial (skip if familiar with test format and features)

7 hours Seven 60-minute question blocks 45 minutes Break time (includes time for lunch)

The computer will keep track of how much time has elapsed on the exam. However, the computer will show you only how much time you have remaining in a given block. Therefore, it is up to you to determine if you are pacing yourself properly (at a rate of approximately one question per 90 seconds).

The computer does not warn you if you are spending more than your allotted time for a break. You should therefore budget your time so that you can take a short break when you need one and have time to eat. You must be especially careful not to spend too much time in between blocks (you should keep track of how much time elapses from the time you finish a block of questions to the time you start the next block). After you finish one question block, you'll need to click to proceed to the next block of questions. If you do not click within 30 seconds, you will automatically be entered into a break period.

Break time for the day is 45 minutes, but you are not required to use all of it, nor are you required to use any of it. You can gain extra break time (but not extra time for the question blocks) by skipping the tutorial or by finishing a block ahead of the allotted time. Any time remaining on the clock when you finish a block gets added to your remaining break time. Once a new question block has been started, you may not take a break until you have reached the end of that block. If you do so, this will be recorded as an "unauthorized break" and will be reported on your final score report.

Finally, be aware that it may take a few minutes of your break time to "check out" of the secure resting room and then "check in" again to resume testing, so plan accordingly. The "check-in" process may include fingerprints, pocket checks, and metal detector scanning. Some students recommend pocketless clothing on exam day to streamline the process.

 Gain extra break time by skipping the tutorial or finishing a block early.

► Be careful to watch the clock on your break time.

FAS1_2019_00_Section_Lindd 7 11/7/19 2:48 PM

If I Freak Out and Leave, What Happens to My Score?

Your scheduling permit shows a CIN that you will need to enter to start your exam. Entering the CIN is the same as breaking the seal on a test book, and you are considered to have started the exam when you do so. However, no score will be reported if you do not complete the exam. In fact, if you leave at any time from the start of the test to the last block, no score will be reported. The fact that you started but did not complete the exam, however, will appear on your USMLE score transcript. Even though a score is not posted for incomplete tests, examinees may still get an option to request that their scores be calculated and reported if they desire; unanswered questions will be scored as incorrect.

The exam ends when all question blocks have been completed or when their time has expired. As you leave the testing center, you will receive a printed test-completion notice to document your completion of the exam. To receive an official score, you must finish the entire exam.

What Types of Questions Are Asked?

All questions on the exam are **one-best-answer multiple choice items.** Most questions consist of a clinical scenario or a direct question followed by a list of five or more options. You are required to select the single best answer among the options given. There are no "except," "not," or matching questions on the exam. A number of options may be partially correct, in which case you must select the option that best answers the question or completes the statement. Additionally, keep in mind that experimental questions may appear on the exam, which do not affect your score.

How Is the Test Scored?

Each Step 1 examinee receives an electronic score report that includes the examinee's pass/fail status, a three-digit test score, a bar chart comparing the examinee's performance to that of other examinees', and a graphic depiction of the examinee's performance by physician task, discipline and organ system.

The USMLE score report highlights the examinee's strength and weaknesses by providing an overview of their performance by physician task, discipline and organ system compared to their overall performance on the exam. Each of the questions (minus experimental questions) is tagged according to any or all relevant content areas. Yellow-colored boxes (lower, same, higher) on your score report indicate your performance in each specific content area relative to your overall performance on the exam. This is often a direct consequence of the total number of questions for each physician task, discipline or system, which is indicated by percentage range after each specified content area on the score report (see Figure 1).

Nearly three fourths of Step 1 questions begin with a description of a patient.

FAS1_2019_00_Section_Lindd 8 11/7/19 2:48 PM



FIGURE 1. Samples from the USMLE Step 1 Performance Profile.

The NBME provides a three-digit test score based on the total number of items answered correctly on the examination, which corresponds to a particular percentile (see Figure 2). Your three-digit score will be qualified by the mean and standard deviation of US and Canadian medical school first-time examinees.

ird error of the estimate (SEE) of your current

Your score +/- SEE: 245 - 261

Since some questions may be experimental and are not counted, it is possible to get different scores for the same number of correct answers. In 2018, the mean score was 230 with a standard deviation of 19.

The passing score for Step 1 is 194. The NBME does not report the minimum number of correct responses needed to pass, but estimates that it is roughly 60–70%. The NBME may adjust the minimum passing score in the future, so please check the USMLE website or www.firstaidteam.com for updates.

According to the USMLE, medical schools receive a listing of total scores and pass/fail results plus group summaries by discipline and organ system. Students can withhold their scores from their medical school if they wish. Official USMLE transcripts, which can be sent on request to residency programs, include only total scores, not performance profiles.

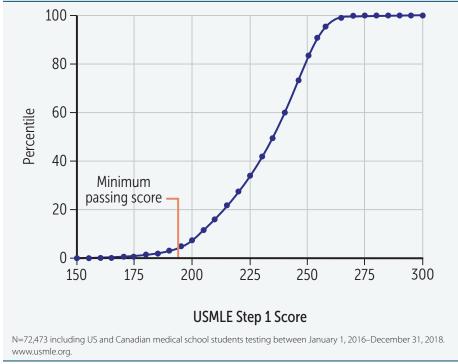
► The mean Step 1 score for US medical students continues to rise, from 200 in 1991 to 230 in 2018.

(9-13N)

(8-12%)

FAS1_2019_00_Section_Lindd 9 11/7/19 2:48 PM

FIGURE 2. Score and Percentile for First-time Step 1 Takers.



Consult the USMLE website or your medical school for the most current and accurate information regarding the examination.

What Does My Score Mean?

The most important point with the Step 1 score is passing versus failing. Passing essentially means, "Hey, you're on your way to becoming a fully licensed doc." As Table 2 shows, the majority of students pass the exam, so remember, we told you to relax.

TABLE 2. Passing Rates for the 2017–2018 USMLE Step 1.2

	201	2017		18
	No. Tested	% Passing	No. Tested	% Passing
Allopathic 1st takers	20,353	96%	20,670	96%
Repeaters	1,029	67%	941	67%
Allopathic total	21,382	94%	21,611	95%
Osteopathic 1st takers	3,786	95%	4,092	96%
Repeaters	49	76%	44	73%
Osteopathic total	3,835	95%	4,136	96%
Total US/Canadian	25,217	94%	25,747	94%
IMG 1st takers	14,900	78%	14,332	80%
Repeaters	2,303	41%	2,111	44%
IMG total	17,203	73%	16,443	75%
Total Step 1 examinees	42,420	85%	42,190	86%

FAS1_2019_00_Section_Lindd 10 11/7/19 2:48 PM

Beyond that, the main point of having a quantitative score is to give you a sense of how well you've done on the exam and to help schools and residencies rank their students and applicants, respectively.

Official NBME/USMLE Resources

The NBME offers a Comprehensive Basic Science Examination (CBSE) for practice that is a shorter version of the Step 1. The CBSE contains four blocks of 50 questions each and covers material that is typically learned during the basic science years. Scores range from 45 to 95 and correlate with a Step 1 equivalent (see Table 3). The standard error of measurement is approximately 3 points, meaning a score of 80 would estimate the student's proficiency is somewhere between 77 and 83. In other words, the actual Step 1 score could be predicted to be between 218 and 232. Of course, these values do not correlate exactly, and they do not reflect different test preparation methods. Many schools use this test to gauge whether a student is expected to pass Step 1. If this test is offered by your school, it is usually conducted at the end of regular didactic time before any dedicated Step 1 preparation. If you do not encounter the CBSE before your dedicated study time, you need not worry about taking it. Use the information to help set realistic goals and timetables for your success.

The NBME also offers six forms of Comprehensive Basic Science Self-Assessment (CBSSA). Students who prepared for the exam using this web-based tool reported that they found the format and content highly indicative of questions tested on the actual exam. In addition, the CBSSA is a fair predictor of USMLE performance (see Table 4). The test interface, however, does not match the actual USMLE test interface, so practicing with these forms alone is not advised.

The CBSSA exists in two formats: standard-paced and self-paced, both of which consist of four sections of 50 questions each (for a total of 200 multiple choice items). The standard-paced format allows the user up to 75 minutes to complete each section, reflecting time limits similar to the actual exam. By contrast, the self-paced format places a 5-hour time limit on answering all multiple choice questions. Every few years, a new form is released and an older one is retired, reflecting changes in exam content. Therefore, the newer exams tend to be more similar to the actual Step 1, and scores from these exams tend to provide a better estimation of exam day performance.

Keep in mind that this bank of questions is available only on the web. The NBME requires that users start and complete the exam within 90 days of purchase. Once the assessment has begun, users are required to complete the sections within 20 days. Following completion of the questions, the CBSSA provides a performance profile indicating the user's relative strengths and weaknesses, much like the report profile for the USMLE Step 1 exam. The profile is scaled with an average score of 500 and a standard deviation of 100. In addition to the performance profile, examinees will be informed of the number of questions answered incorrectly. You will have the ability to review the text of the incorrect question with the correct answer.

TABLE 3. CBSE to USMLE Score Prediction.

CBSE Score	Step 1 Equivalent
≥ 94	≥ 260
92	255
90	250
88	245
86	240
84	235
82	230
80	225
78	220
76	215
74	210
72	205
70	200
68	195
66	190
64	185
62	180
60	175
58	170
56	165
54	160
52	155
50	150
48	145
46	140
≤ 44	≤ 135

FAS1_2019_00_Section_Lindd 11 11/7/19 2:48 PM

Practice questions may be easier than the actual exam.

TABLE 4. CBSSA to USMLE Score Prediction.

CBSSA Score	Approximate USMLE Step 1 Score
150	155
200	165
250	175
300	186
350	196
400	207
450	217
500	228
550	238
600	248
650	259
700	269
750	280
800	290

Explanations for the correct answer, however, will not be provided. The NBME charges \$60 for assessments with expanded feedback. The fees are payable by credit card or money order. For more information regarding the CBSE and the CBSSA, visit the NBME's website at www.nbme.org.

The NBME scoring system is weighted for each assessment exam. While some exams seem more difficult than others, the score reported takes into account these inter-test differences when predicting Step 1 performance. Also, while many students report seeing Step 1 questions "word-for-word" out of the assessments, the NBME makes special note that no live USMLE questions are shown on any NBME assessment.

Lastly, the International Foundations of Medicine (IFOM) offers a Basic Science Examination (BSE) practice exam at participating Prometric test centers for \$200. Students may also take the self-assessment test online for \$35 through the NBME's website. The IFOM BSE is intended to determine an examinee's relative areas of strength and weakness in general areas of basic science—not to predict performance on the USMLE Step 1 exam—and the content covered by the two examinations is somewhat different. However, because there is substantial overlap in content coverage and many IFOM items were previously used on the USMLE Step 1, it is possible to roughly project IFOM performance onto the USMLE Step 1 score scale. More information is available at http://www.nbme.org/ifom/.

▶ DEFINING YOUR GOAL

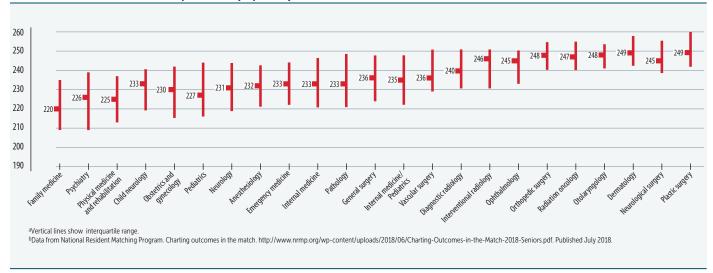
It is useful to define your own personal performance goal when approaching the USMLE Step 1. Your style and intensity of preparation can then be matched to your goal. Furthermore, your goal may depend on your school's requirements, your specialty choice, your grades to date, and your personal assessment of the test's importance. Do your best to define your goals early so that you can prepare accordingly.

The value of the USMLE Step 1 score in selecting residency applicants remains controversial, and some have called for less emphasis to be placed on the score when selecting or screening applicants.³ For the time being, however, it continues to be an important part of the residency application, and it is not uncommon for some specialties to implement filters that screen out applicants who score below a certain cutoff. This is more likely to be seen in competitive specialties (eg, orthopedic surgery, ophthalmology, dermatology, otolaryngology). Independent of your career goals, you can maximize your future options by doing your best to obtain the highest score possible (see Figure 3). At the same time, your Step 1 score is only one of a number of factors that are assessed when you apply for residency. In fact, many residency programs value other criteria such as letters of recommendation, third-year clerkship grades, honors, and research experience more than a high score on Step 1. Fourth-year medical students who have recently completed the residency application process can be a valuable resource in this regard.

- Some competitive residency programs place more weight on Step 1 scores when choosing candidates to interview.
- Fourth-year medical students have the best feel for how Step 1 scores factor into the residency application process.

FAS1_2019_00_Section_l.indd 12 11/7/19 2:48 PM





▶ LEARNING STRATEGIES

Many students feel overwhelmed during the preclinical years and struggle to find an effective learning strategy. Table 5 lists several learning strategies you can try and their estimated effectiveness for Step 1 preparation based on the literature (see References). These are merely suggestions, and it's important to take your learning preferences into account. Your comprehensive learning approach will contain a combination of strategies (eg, elaborative interrogation followed by practice testing, mnemonics review using spaced repetition, etc). Regardless of your choice, the foundation of knowledge you build during your basic science years is the most important resource for success on the USMLE Step 1.

▶ The foundation of knowledge you build during your basic science years is the most important resource for success on the USMLE Step 1.

HIGH EFFICACY

Practice Testing

Also called "retrieval practice," practice testing has both direct and indirect benefits to the learner. Effortful retrieval of answers does not only identify weak spots—it directly strengthens long-term retention of material.⁵ The more effortful the recall, the better the long-term retention. This advantage has been shown to result in higher test scores and GPAs.⁶ In fact, research has shown a positive correlation between the number of boards-style practice questions completed and Step 1 scores among medical students.⁷

Practice testing should be done with "interleaving" (mixing of questions from different topics in a single session). Question banks often allow you to intermingle topics. Interleaved practice helps learners develop their ability to focus on the relevant concept when faced with many possibilities. Practicing topics in massed fashion (eg, all cardiology, then all dermatology) may seem intuitive, but there is strong evidence that interleaving correlates with longerResearch has shown a positive correlation between the number of boards-style practice questions completed and Step 1 scores among medical students.

FAS1 2019 00 Section Lindd 13 11/7/19 2:48 PM

TABLE 5. Effective Learning Strategies.

EFFICACY	STRATEGY	EXAMPLE RESOURCES
High efficacy	Practice testing (retrieval practice)	UWorld Qbank NBME Self-Assessments USMLE-Rx QMax Kaplan Qbank
	Distributed practice	USMLE-Rx Flash Facts Anki Firecracker Memorang Osmosis
Moderate efficacy	Mnemonics	Pre-made: SketchyMedical Picmonic Self-made: Mullen Memory
	Elaborative interrogation/ self-explanation	
	Concept mapping	Coggle FreeMind XMind MindNode
Low efficacy	Rereading	
	Highlighting/underlining	
	Summarization	

term retention and increased student achievement, especially on tasks that involve problem solving.⁵

In addition to using question banks, you can test yourself by arranging your notes in a question-answer format (eg, via flash cards). Testing these Q&As in random order allows you to reap the benefit of interleaved practice. Bear in mind that the utility of practice testing comes from the practice of information retrieval, so simply reading through Q&As will attenuate this benefit.

Distributed Practice

Also called "spaced repetition," distributed practice is the opposite of massed practice or "cramming." Learners review material at increasingly spaced out intervals (days to weeks to months). Massed learning may produce more short-term gains and satisfaction, but learners who use distributed practice have better mastery and retention over the long term.^{5,9}

Flash cards are a simple way to incorporate both distributed practice and practice testing. Studies have linked spaced repetition learning with flash

FAS1_2019_00_Section_Lindd 14 11/7/19 2:48 PM

cards to improved long-term knowledge retention and higher exam scores. ^{6,8,10} Apps with automated spaced-repetition software (SRS) for flash cards exist for smartphones and tablets, so the cards are accessible anywhere. Proceed with caution: there is an art to making and reviewing cards. The ease of quickly downloading or creating digital cards can lead to flash card overload (it is unsustainable to make 50 flash cards per lecture!). Even at a modest pace, the thousands upon thousands of cards are too overwhelming for Step 1 preparation. Unless you have specific high-yield cards (and have checked the content with high-yield resources), stick to pre-made cards by reputable sources that curate the vast amount of knowledge for you.

If you prefer pen and paper, consider using a planner or spreadsheet to organize your study material over time. Distributed practice allows for some forgetting of information, and the added effort of recall over time strengthens the learning.

MODERATE EFFICACY

Mnemonics

A "mnemonic" refers to any device that assists memory, such as acronyms, mental imagery (eg, keywords with or without memory palaces), etc. Keyword mnemonics have been shown to produce superior knowledge retention when compared with rote memorization in many scenarios. However, they are generally more effective when applied to memorization-heavy, keyword-friendly topics and may not be broadly suitable.⁵ Keyword mnemonics may not produce long-term retention, so consider combining mnemonics with distributed, retrieval-based practice (eg, via flash cards with SRS).

Self-made mnemonics may have an advantage when material is simple and keyword friendly. If you can create your own mnemonic that accurately represents the material, this will be more memorable. When topics are complex and accurate mnemonics are challenging to create, pre-made mnemonics may be more effective, especially if you are inexperienced at creating mnemonics.¹¹

Elaborative Interrogation/Self-Explanation

Elaborative interrogation ("why" questions) and self-explanation (general questioning) prompt learners to generate explanations for facts. When reading passages of discrete facts, consider using these techniques, which have been shown to be more effective than rereading (eg, improved recall and better problem-solving/diagnostic performance).^{5,12,13}

Concept Mapping

Concept mapping is a method for graphically organizing knowledge, with concepts enclosed in boxes and lines drawn between related concepts.

Studies have linked spaced repetition learning with flash cards to improved longterm knowledge retention and higher exam scores

► Elaborative interrogation and selfexplanation prompt learners to generate explanations for facts, which improves recall and problem solving.

FAS1 2019 00 Section Lindd 15 11/7/19 2:48 PM

16 SECTION I

GUIDE TO EFFICIENT EXAM PREPARATION

Creating or studying concept maps may be more effective than other activities (eg, writing or reading summaries/outlines). However, studies have reached mixed conclusions about its utility, and the small size of this effect raises doubts about its authenticity and pedagogic significance.¹⁴

LOW EFFICACY

Rereading

While the most commonly used method among surveyed students, rereading has not been shown to correlate with grade point average. Due to its popularity, rereading is often a comparator in studies on learning. Other strategies that we have discussed (eg, practice testing) have been shown to be significantly more effective than rereading.

Highlighting/Underlining

Because this method is passive, it tends to be of minimal value for learning and recall. In fact, lower-performing students are more likely to use these techniques. Students who highlight and underline do not learn how to actively recall learned information and thus find it difficult to apply knowledge to exam questions.

Summarization

While more useful for improving performance on generative measures (eg, free recall or essays), summarization is less useful for exams that depend on recognition (eg, multiple choice). Findings on the overall efficacy of this method have been mixed.⁵

► TIMELINE FOR STUDY

Before Starting

Your preparation for the USMLE Step 1 should begin when you enter medical school. Organize and commit to studying from the beginning so that when the time comes to prepare for the USMLE, you will be ready with a strong foundation.

Make a Schedule

After you have defined your goals, map out a study schedule that is consistent with your objectives, your vacation time, the difficulty of your ongoing coursework, and your family and social commitments (see Figure 4). Determine whether you want to spread out your study time or concentrate it into 14-hour study days in the final weeks. Then factor in your own history in

FAS1_2019_00_Section_Lindd 16 11/7/19 2:48 PM

FIGURE 4. Typical Timeline for the USMLE Step 1.



 Customize your schedule. Tackle your weakest section first.

preparing for standardized examinations (eg, SAT, MCAT). Talk to students at your school who have recently taken Step 1. Ask them for their study schedules, especially those who have study habits and goals similar to yours. Sample schedules can be found at https://firstaidteam.com/schedules/.

Typically, US medical schools allot between four and eight weeks for dedicated Step 1 preparation. The time you dedicate to exam preparation will depend on your target score as well as your success in preparing yourself during the first two years of medical school. Some students reserve about a week at the end of their study period for final review; others save just a few days. When you have scheduled your exam date, do your best to adhere to it. Studies show that a later testing date does not translate into a higher score, so avoid pushing back your test date without good reason.¹⁵

Make your schedule realistic, and set achievable goals. Many students make the mistake of studying at a level of detail that requires too much time for a comprehensive review—reading *Gray's Anatomy* in a couple of days is not a realistic goal! Have one catch-up day per week of studying. No matter how well you stick to your schedule, unexpected events happen. But don't let yourself procrastinate because you have catch-up days; stick to your schedule as closely as possible and revise it regularly on the basis of your actual progress. Be careful not to lose focus. Beware of feelings of inadequacy when comparing study schedules and progress with your peers. **Avoid others who stress you out.** Focus on a few top-rated resources that suit your learning style—not on some obscure books your friends may pass down to you. Accept the fact that you cannot learn it all.

You will need time for uninterrupted and focused study. Plan your personal affairs to minimize crisis situations near the date of the test. Allot an adequate number of breaks in your study schedule to avoid burnout. Maintain a healthy lifestyle with proper diet, exercise, and sleep.

Another important aspect of your preparation is your studying environment. Study where you have always been comfortable studying. Be sure to include everything you need close by (review books, notes, coffee, snacks, etc). If you're the kind of person who cannot study alone, form a study group with other students taking the exam. The main point here is to create a comfortable environment with minimal distractions.

Avoid burnout. Maintain proper diet, exercise, and sleep habits.

FAS1 2019 00 Section Lindd 17 11/7/19 2:48 PM

18

SECTION I

GUIDE TO EFFICIENT EXAM PREPARATION

Buy review books early (first year) and use while studying for courses.

► In the final two weeks, focus on review, practice questions, and endurance. Stay confident!

▶ Simulate the USMLE Step 1 under "real"

conditions before beginning your studies.

Year(s) Prior

The knowledge you gained during your first two years of medical school and even during your undergraduate years should provide the groundwork on which to base your test preparation. Student scores on NBME subject tests (commonly known as "shelf exams") have been shown to be highly correlated with subsequent Step 1 scores. Moreover, undergraduate science GPAs as well as MCAT scores are strong predictors of performance on the Step 1 exam. To

We also recommend that you buy highly rated review books early in your first year of medical school and use them as you study throughout the two years. When Step 1 comes along, these books will be familiar and personalized to the way in which you learn. It is risky and intimidating to use unfamiliar review books in the final two or three weeks preceding the exam. Some students find it helpful to personalize and annotate *First Aid* throughout the curriculum.

Months Prior

Review test dates and the application procedure. Testing for the USMLE Step 1 is done on a year-round basis. If you have disabilities or special circumstances, contact the NBME as early as possible to discuss test accommodations (see the Section I Supplement at www.firstaidteam.com/bonus).

Use this time to finalize your ideal schedule. Consider upcoming breaks and whether you want to relax or study. Work backward from your test date to make sure you finish at least one question bank. Also add time to redo missed or flagged questions (which may be half the bank). This is the time to build a structured plan with enough flexibility for the realities of life.

Begin doing blocks of questions from reputable question banks under "real" conditions. Don't use tutor mode until you're sure you can finish blocks in the allotted time. It is important to continue balancing success in your normal studies with the Step 1 test preparation process.

Weeks Prior (Dedicated Preparation)

Your dedicated prep time may be one week or two months. You should have a working plan as you go into this period. Finish your schoolwork strong, take a day off, and then get to work. Start by simulating a full-length USMLE Step 1 if you haven't yet done so. Consider doing one NBME CBSSA and the free questions from the NBME website. Alternatively, you could choose 7 blocks of randomized questions from a commercial question bank. Make sure you get feedback on your strengths and weaknesses and adjust your studying accordingly. Many students study from review sources or comprehensive programs for part of the day, then do question blocks. Also, keep in mind that reviewing a question block can take upward of two hours. Feedback from CBSSA exams and question banks will help you focus on your weaknesses.

FAS1 2019 00 Section Lindd 18 11/7/19 2:48 PM

One Week Prior

Make sure you have your CIN (found on your scheduling permit) as well as other items necessary for the day of the examination, including a current driver's license or another form of photo ID with your signature (make sure the name on your ID exactly matches that on your scheduling permit). Confirm the Prometric testing center location and test time. Work out how you will get to the testing center and what parking and traffic problems you might encounter. Drive separately from other students taking the test on the same day, and exchange cell phone numbers in case of emergencies. If possible, visit the testing site to get a better idea of the testing conditions you will face. Determine what you will do for lunch. Make sure you have everything you need to ensure that you will be comfortable and alert at the test site. It may be beneficial to adjust your schedule to start waking up at the same time that you will on your test day. And of course, make sure to maintain a healthy lifestyle and get enough sleep.

One Day Prior

Try your best to relax and rest the night before the test. Double-check your admissions and test-taking materials as well as the comfort measures discussed earlier so that you will not have to deal with such details on the morning of the exam. At this point it will be more effective to review short-term memory material that you're already familiar with than to try to learn new material. The Rapid Review section at the end of this book is high yield for last-minute studying. Remember that regardless of how hard you have studied, you cannot know everything. There will be things on the exam that you have never even seen before, so do not panic. Do not underestimate your abilities.

Many students report difficulty sleeping the night prior to the exam. This is often exacerbated by going to bed much earlier than usual. Do whatever it takes to ensure a good night's sleep (eg, massage, exercise, warm milk, no back-lit screens at night). Do not change your daily routine prior to the exam. Exam day is not the day for a caffeine-withdrawal headache.

Morning of the Exam

On the morning of the Step 1 exam, wake up at your regular time and eat a normal breakfast. If you think it will help you, have a close friend or family member check to make sure you get out of bed. Make sure you have your scheduling permit admission ticket, test-taking materials, and comfort measures as discussed earlier. Wear loose, comfortable clothing. Plan for a variable temperature in the testing center. Arrive at the test site 30 minutes before the time designated on the admission ticket; however, do not come too early, as doing so may intensify your anxiety. When you arrive at the test site, the proctor should give you a USMLE information sheet that will explain critical factors such as the proper use of break time. Seating may be assigned, but ask to be reseated if necessary; you need to be seated in an area

- One week before the test:
- Sleep according to the same schedule you'll use on test day
- Review the CBT tutorial one last time
- Call Prometric to confirm test date and time

No notes, books, calculators, pagers, cell phones, recording devices, or watches of any kind are allowed in the testing area, but they are allowed in lockers.

FAS1 2019 00 Section Lindd 19 11/7/19 2:48 PM OO SECTION I

GUIDE TO EFFICIENT EXAM PREPARATION

Arrive at the testing center 30 minutes before your scheduled exam time. If you arrive more than half an hour late, you will not be allowed to take the test. that will allow you to remain comfortable and to concentrate. Get to know your testing station, especially if you have never been in a Prometric testing center before. Listen to your proctors regarding any changes in instructions or testing procedures that may apply to your test site.

Finally, remember that it is natural (and even beneficial) to be a little nervous. Focus on being mentally clear and alert. Avoid panic. When you are asked to begin the exam, take a deep breath, focus on the screen, and then begin. Keep an eye on the timer. Take advantage of breaks between blocks to stretch, maybe do some jumping jacks, and relax for a moment with deep breathing or stretching.

After the Test

After you have completed the exam, be sure to have fun and relax regardless of how you may feel. Taking the test is an achievement in itself. Remember, you are much more likely to have passed than not. Enjoy the free time you have before your clerkships. Expect to experience some "reentry" phenomena as you try to regain a real life. Once you have recovered sufficiently from the test (or from partying), we invite you to send us your feedback, corrections, and suggestions for entries, facts, mnemonics, strategies, resource ratings, and the like (see p. xvii, How to Contribute). Sharing your experience will benefit fellow medical students and IMGs.

► STUDY MATERIALS

Quality Considerations

Although an ever-increasing number of review books and software are now available on the market, the quality of such material is highly variable. Some common problems are as follows:

- Certain review books are too detailed to allow for review in a reasonable amount of time or cover subtopics that are not emphasized on the exam.
- Many sample question books were originally written years ago and have not been adequately updated to reflect recent trends.
- Some question banks test to a level of detail that you will not find on the exam.

Review Books

In selecting review books, be sure to weigh different opinions against each other, read the reviews and ratings in Section IV of this guide, examine the books closely in the bookstore, and choose carefully. You are investing not only money but also your limited study time. Do not worry about finding the "perfect" book, as many subjects simply do not have one, and different students prefer different formats. Supplement your chosen books with personal notes from other sources, including what you learn from question banks.

If a given review book is not working for you, stop using it no matter how highly rated it may be or how much it costs.

FAS1_2019_00_Section_Lindd 20 11/7/19 2:48 PM

There are two types of review books: those that are stand-alone titles and those that are part of a series. Books in a series generally have the same style, and you must decide if that style works for you. However, a given style is not optimal for every subject.

You should also find out which books are up to date. Some recent editions reflect major improvements, whereas others contain only cursory changes. Take into consideration how a book reflects the format of the USMLE Step 1.

Charts and diagrams may be the best approach for physiology and biochemistry, whereas tables and outlines may be preferable for microbiology.

Apps

With the explosion of smartphones and tablets, apps are an increasingly popular way to review for the Step 1 exam. The majority of apps are compatible with both iOS and Android. Many popular Step 1 review resources (eg, UWorld, USMLE-Rx) have apps that are compatible with their software. Many popular web references (eg, UpToDate) also now offer app versions. All of these apps offer flexibility, allowing you to study while away from a computer (eg, while traveling).

Practice Tests

Taking practice tests provides valuable information about potential strengths and weaknesses in your fund of knowledge and test-taking skills. Some students use practice examinations simply as a means of breaking up the monotony of studying and adding variety to their study schedule, whereas other students rely almost solely on practice. You should also subscribe to one or more high-quality question banks. In addition, students report that many current practice-exam books have questions that are, on average, shorter and less clinically oriented than those on the current USMLE Step 1.

Additionally, some students preparing for the Step 1 exam have started to incorporate case-based books intended primarily for clinical students on the wards or studying for the Step 2 CK exam. First Aid Cases for the USMLE Step 1 aims to directly address this need.

After taking a practice test, spend time on each question and each answer choice whether you were right or wrong. There are important teaching points in each explanation. Knowing why a wrong answer choice is incorrect is just as important as knowing why the right answer is correct. Do not panic if your practice scores are low as many questions try to trick or distract you to highlight a certain point. Use the questions you missed or were unsure about to develop focused plans during your scheduled catch-up time.

Textbooks and Course Syllabi

Limit your use of textbooks and course syllabi for Step 1 review. Many textbooks are too detailed for high-yield review and include material that is generally not tested on the USMLE Step 1 (eg, drug dosages, complex chemical structures). Syllabi, although familiar, are inconsistent across

► Most practice exams are shorter and less clinical than the real thing.

Use practice tests to identify concepts and areas of weakness, not just facts that you missed.

FAS1 2019 00 Section Lindd 21 11/7/19 2:48 PM

medical schools and frequently reflect the emphasis of individual faculty, which often does not correspond to that of the USMLE Step 1. Syllabi also tend to be less organized than top-rated books and generally contain fewer diagrams and study questions.

► TEST-TAKING STRATEGIES

Practice! Develop your test-taking skills and strategies well before the test date. Your test performance will be influenced by both your knowledge and your test-taking skills. You can strengthen your performance by considering each of these factors. Test-taking skills and strategies should be developed and perfected well in advance of the test date so that you can concentrate on the test itself. We suggest that you try the following strategies to see if they might work for you.

Pacing

You have seven hours to complete up to 280 questions. Note that each one-hour block contains up to 40 questions. This works out to approximately 90 seconds per question. We recommend following the "1 minute rule" to pace yourself. Spend no more than 1 minute on each question. If you are still unsure about the answer after this time, mark the question, make an educated guess, and move on. Following this rule, you should have approximately 20 minutes left after all questions are answered, which you can use to revisit all of your marked questions. Remember that some questions may be experimental and do not count for points (and reassure yourself that these experimental questions are the ones that are stumping you). In the past, pacing errors have been detrimental to the performance of even highly prepared examinees. The bottom line is to keep one eye on the clock at all times!

Time management is an important skill for exam success.

Dealing with Each Question

There are several established techniques for efficiently approaching multiple choice questions; find what works for you. One technique begins with identifying each question as easy, workable, or impossible. Your goal should be to answer all easy questions, resolve all workable questions in a reasonable amount of time, and make quick and intelligent guesses on all impossible questions. Most students read the stem, think of the answer, and turn immediately to the choices. A second technique is to first skim the answer choices to get a context, then read the last sentence of the question (the lead-in), and then read through the passage quickly, extracting only information relevant to answering the question. This can be particularly helpful for questions with long clinical vignettes. Try a variety of techniques on practice exams and see what works best for you. If you get overwhelmed, remember that a 30-second time out to refocus may get you back on track.

FAS1 2019 00 Section Lindd 22 11/7/19 2:48 PM

Guessing

There is **no penalty** for wrong answers. Thus, **no test block should be left with unanswered questions**. A hunch is probably better than a random guess. If you have to guess, we suggest selecting an answer you recognize over one with which you are totally unfamiliar.

Changing Your Answer

The conventional wisdom is not to change answers that you have already marked unless there is a convincing and logical reason to do so—in other words, go with your "first hunch." Many question banks tell you how many questions you changed from right to wrong, wrong to wrong, and wrong to right. Use this feedback to judge how good a second-guesser you are. If you have extra time, reread the question stem and make sure you didn't misinterpret the question.

► Go with your first hunch, unless you are certain that you are a good second-guesser.

► CLINICAL VIGNETTE STRATEGIES

In recent years, the USMLE Step 1 has become increasingly clinically oriented. This change mirrors the trend in medical education toward introducing students to clinical problem solving during the basic science years. The increasing clinical emphasis on Step 1 may be challenging to those students who attend schools with a more traditional curriculum.

Be prepared to read fast and think on your feet!

What Is a Clinical Vignette?

A clinical vignette is a short (usually paragraph-long) description of a patient, including demographics, presenting symptoms, signs, and other information concerning the patient. Sometimes this paragraph is followed by a brief listing of important physical findings and/or laboratory results. The task of assimilating all this information and answering the associated question in the span of one minute can be intimidating. So be prepared to read quickly and think on your feet. Remember that the question is often indirectly asking something you already know.

Practice questions that include case histories or descriptive vignettes are critical for Step 1 preparation.

Strategy

Remember that Step 1 vignettes usually describe diseases or disorders in their most classic presentation. So look for cardinal signs (eg, malar rash for SLE or nuchal rigidity for meningitis) in the narrative history. Be aware that the question will contain classic signs and symptoms instead of buzzwords. Sometimes the data from labs and the physical exam will help you confirm or reject possible diagnoses, thereby helping you rule answer choices in or out. In some cases, they will be a dead giveaway for the diagnosis.

Step 1 vignettes usually describe diseases or disorders in their most classic presentation.

FAS1_2019_00_Section_Lindd 23 11/7/19 2:48 PM

Making a diagnosis from the history and data is often not the final answer. Not infrequently, the diagnosis is divulged at the end of the vignette, after you have just struggled through the narrative to come up with a diagnosis of your own. The question might then ask about a related aspect of the diagnosed disease. Consider skimming the answer choices and lead-in before diving into a long stem. However, be careful with skimming the answer choices; going too fast may warp your perception of what the vignette is asking.

▶ IF YOU THINK YOU FAILED

After the test, many examinees feel that they have failed, and most are at the very least unsure of their pass/fail status. There are several sensible steps you can take to plan for the future in the event that you do not achieve a passing score. First, save and organize all your study materials, including review books, practice tests, and notes. Familiarize yourself with the reapplication procedures for Step 1, including application deadlines and upcoming test dates.

Make sure you know both your school's and the NBME's policies regarding retakes. The NBME allows a maximum of six attempts to pass each Step examination.¹⁸ You may take Step 1 no more than three times within a 12-month period. Your fourth and subsequent attempts must be at least 12 months after your first attempt at that exam and at least six months after your most recent attempt at that exam.

The performance profiles on the back of the USMLE Step 1 score report provide valuable feedback concerning your relative strengths and weaknesses. Study these profiles closely. Set up a study timeline to strengthen gaps in your knowledge as well as to maintain and improve what you already know. Do not neglect high-yield subjects. It is normal to feel somewhat anxious about retaking the test, but if anxiety becomes a problem, seek appropriate counseling.

If you pass Step 1 (score of 194 or above), you are not allowed to retake the exam.

▶ TESTING AGENCIES

National Board of Medical Examiners (NBME) / USMLE Secretariat
Department of Licensing Examination Services
3750 Market Street
Philadelphia, PA 19104-3102
(215) 590-9500 (operator) or
(215) 590-9700 (automated information line)
Email: webmail@nbme.org
www.nbme.org

FAS1_2019_00_Section_Lindd 24 11/7/19 2:48 PM

Educational Commission for Foreign Medical Graduates (ECFMG)

3624 Market Street Philadelphia, PA 19104-2685 (215) 386-5900 Email: info@ecfmg.org

www.ecfmg.org

▶ REFERENCES

- 1. United States Medical Licensing Examination. Available from: https:// www.usmle.org/pdfs/step-1/content_step1.pdf. Accessed October 17, 2019.
- 2. United States Medical Licensing Examination. 2018 Performance Data. Available from: https://www.usmle.org/performance-data/default. aspx#2018_step-1. Accessed October 17, 2019.
- 3. Prober CG, Kolars JC, First LR, et al. A plea to reassess the role of United States Medical Licensing Examination Step 1 scores in residency selection. Acad Med. 2016;91(1):12–15.
- 4. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. Trends Cogn Sci. 2011;15(1):20-27.
- 5. Dunlosky J, Rawson KA, Marsh EJ, et al. Improving students' learning with effective learning techniques: promising directions from cognitive and educational psychology. Psychol Sci Publ Int. 2013;14(1):4–58.
- 6. Larsen DP, Butler AC, Lawson AL, et al. The importance of seeing the patient: test-enhanced learning with standardized patients and written tests improves clinical application of knowledge. Adv Health Sci Educ. 2013;18(3):409-425.
- 7. Panus PC, Stewart DW, Hagemeier NE, et al. A subgroup analysis of the impact of self-testing frequency on examination scores in a pathophysiology course. Am J Pharm Educ. 2014;78(9):165.
- 8. Deng F, Gluckstein JA, Larsen DP. Student-directed retrieval practice is a predictor of medical licensing examination performance. Perspect Med Educ. 2015;4(6):308-313.
- 9. McAndrew M, Morrow CS, Atiyeh L, et al. Dental student study strategies: are self-testing and scheduling related to academic performance? I Dent Educ. 2016;80(5):542-552.
- 10. Augustin M. How to learn effectively in medical school: test yourself, learn actively, and repeat in intervals. Yale I Biol Med. 2014;87(2):207–212.
- 11. Bellezza FS. Mnemonic devices: classification, characteristics, and criteria. Rev Educ Res. 1981;51(2):247-275.
- 12. Dyer J-O, Hudon A, Montpetit-Tourangeau K, et al. Example-based learning: comparing the effects of additionally providing three different integrative learning activities on physiotherapy intervention knowledge. BMC Med Educ. 2015;15:37.
- 13. Chamberland M, Mamede S, St-Onge C, et al. Self-explanation in learning clinical reasoning: the added value of examples and prompts. Med Educ. 2015;49(2):193-202.
- 14. Nesbit JC, Adesope OO. Learning with concept and knowledge maps: a meta-analysis. Rev Educ Res. 2006;76(3):413-448.

FAS1 2019 00 Section Lindd 25 11/7/19 2:48 PM 26

SECTION I

GUIDE TO EFFICIENT EXAM PREPARATION

- 15. Pohl CA, Robeson MR, Hojat M, et al. Sooner or later? USMLE Step 1 performance and test administration date at the end of the second year. *Acad Med.* 2002;77(10):S17–S19.
- 16. Holtman MC, Swanson DB, Ripkey DR, et al. Using basic science subject tests to identify students at risk for failing Step 1. *Acad Med*. 2001;76(10):S48–S51.
- 17. Basco WT, Way DP, Gilbert GE, et al. Undergraduate institutional MCAT scores as predictors of USMLE Step 1 performance. *Acad Med.* 2002;77(10):S13–S16.
- United States Medical Licensing Examination. 2019 USMLE Bulletin of Information. Available from: https://www.usmle.org/pdfs/bulletin/ 2019bulletin.pdf. Accessed July 23, 2018.

FAS1_2019_00_Section_l.indd 26 11/7/19 2:48 PM

SECTION I SUPPLEMENT

Special Situations

Please visit www.firstaidteam.com/bonus/ to view this section.

- ▶ First Aid for the International Medical Graduate
- 2
- First Aid for the
 Osteopathic Medical
 Student
- ► First Aid for the Podiatric Medical Student 17
- ► First Aid for the
 Student Requiring Test
 Accommodations 20

7/

28 SECTION

SECTION I SPECIAL SITUATIONS

► NOTES	

FAS1_2019_00_Section_Lindd 28 11/7/19 2:48 PM

SECTION I SUPPLEMENT

Special Situations

- ▶ First Aid for the International Medical Graduate
- ► First Aid for the Osteopathic Medical Student 1
- ► First Aid for the Podiatric Medical Student 17
- ► First Aid for the Student Requiring Test Accommodations 20

1

► IMGs make up approximately 25% of the US physician population.

More detailed information can be found in the ECFMG Information Booklet, available at www.ecfmq.org/pubshome.html.

Applicants may apply online for USMLE Step 1, Step 2 CK, or Step 2 CS at www.ecfmg.org.

▶ FIRST AID FOR THE INTERNATIONAL MEDICAL GRADUATE

"International medical graduate" (IMG) is the term used to describe any student or graduate of a non-US, non-Canadian, non-Puerto Rican medical school, regardless of whether he or she is a US citizen/resident or not.

IMG's Steps to Licensure in the United States

To be eligible to take the USMLE Steps, you (the applicant) must be officially enrolled in a medical school located outside the United States and Canada that is listed in the World Directory of Medical Schools (WDOMS; www.wdoms.org) and meet the ECFMG eligibility requirements, both at the time you apply for examination and on your test day. In addition, your "Graduation Year" must be listed as "Current" at the time you apply and on your test day.

If you are an IMG, you must go through the following steps (not necessarily in this order) to apply for residency programs and become licensed to practice in the United States. You must complete these steps even if you are already a practicing physician and have completed a residency program in your own country.

- Pass USMLE Step 1, Step 2 CK, and Step 2 CS, as well as obtain a medical school diploma (not necessarily in this order). All three exams can be taken during medical school. If you have already graduated prior to taking any of the Steps, then you will need to verify your academic credentials (confirmation of enrollment and medical degree) prior to applying for any Step exam.
- You will be certified electronically by the Educational Commission for Foreign Medical Graduates (ECFMG) after above steps are successfully completed. You should receive your formal ECFMG certificate in the mail within the next 1–2 weeks. The ECFMG will not issue a certificate (even if all the USMLE scores are submitted) until it verifies your medical diploma with your medical school.
- You must have a valid ECFMG certificate before entering an accredited residency program in the United States, although you can begin the Electronic Residency Application Service (ERAS) application and interviews before you receive the certificate.
- Apply for residency positions in your fields of interest, either directly or through the ERAS and the National Residency Matching Program (NRMP), otherwise known as "the Match." To be entered into the Match, you need to have passed all the examinations necessary for ECFMG certification (ie, Step 1, Step 2 CK, and Step 2 CS) by the rank order list deadline (usually in late February before the Match). If you do not pass these exams by the deadline, you will be withdrawn from the Match.

- If you are not a US citizen or green-card holder (permanent resident), you will need to obtain a visa that will allow you to enter and work in the United States after you have matched successfully.
- Sign up to receive the ECFMG and ERAS email newsletter to keep up to date with their most current policies and deadlines.
- If required by the state in which your residency program is located, obtain an educational/training/limited medical license. Your residency program may assist you with this application. Note that medical licensing is the prerogative of each individual state, not of the federal government, and that states vary with respect to their laws about licensing.
- Once you have the ECFMG certification, take the USMLE Step 3 during your residency, and then obtain a full medical license. Once you have a state-issued license, you are permitted to practice in federal institutions such as Veterans Affairs (VA) hospitals and Indian Health Service facilities in any state. This can open the door to "moonlighting" opportunities and possibilities for an H1B visa application if relevant. For details on individual state rules, write to the licensing board in the state in question or contact the Federation of State Medical Boards (FSMB). If you need to apply for an H1B visa for starting residency, you need to first take and pass the USMLE Step 3 exam, preferably before you Match. However, you will be able to apply for and take the USMLE Step 3 exam only after you graduate from medical school.
- Complete your residency and then take the appropriate specialty board exams if you wish to become board certified (eg, in internal medicine or surgery). If you already have a specialty certification in another country, some specialty boards may grant you six months' or one year's credit toward your total residency time.
- Currently, most residency programs are accepting applications through ERAS. For more information, see *First Aid for the Match* or contact:

ECFMG/ERAS Program

3624 Market Street Philadelphia, PA 19104-2685 USA (215) 386-5900 Email: eras-support@ecfmg.org www.ecfmg.org/eras

For detailed information on the USMLE Steps, visit the USMLE website at http://www.usmle.org.

The USMLE and the IMG

The USMLE is a series of standardized exams that give IMGs and US medical graduates a level playing field. The passing marks for IMGs for Step 1, Step 2 CK, and Step 2 CS are determined by a statistical distribution that is based on the scores of US medical school students. For example, to pass Step 1, you will probably have to score higher than the bottom 8–10% of US and Canadian graduates.

▶ Keep informed by signing up for the ECFMG email newsletter at www.ecfmg.org/resources.

4

► IMGs have a maximum of six attempts to pass any USMLE Step, and must pass the USMLE Steps required for ECFMG certification within a seven-year period. Under USMLE program rules, a maximum of six attempts will be permitted to pass any USMLE Step or component exam. There is a limit of three attempts within a 12-month period for any of the USMLE Steps.

Timing of the USMLE

For an IMG, the timing of a complete application is critical. It is extremely important that you send in your application early if you are to obtain the maximum number of interviews. Complete all exam requirements by August of the year in which you wish to apply. Check the ECFMG website for deadlines to take and pass the various Step exams to be eligible for the NRMP Match.

IMG applicants must pass the USMLE Steps required for ECFMG certification (Step 1, Steps 2 CK and 2 CS) within a seven-year period. The USMLE program recommends, although not all jurisdictions impose, a seven-year limit for completion of the three-step USMLE program.

In terms of USMLE exam order, arguments can be made for taking the Step 1 or the Step 2 CK exam first. For example, you may consider taking the Step 2 CK exam first if you have just graduated from medical school and the clinical topics are still fresh in your mind. However, keep in mind that there is substantial overlap between Step 1 and Step 2 CK topics in areas such as pharmacology, pathophysiology, and biostatistics. You might therefore consider taking the Step 1 and Step 2 CK exams close together to take advantage of this overlap in your test preparation.

USMLE Step 1 and the IMG

Significance of the Test. Step 1 is one of the three exams required for the ECFMG certification. Since most US graduates apply to residency with their Step 1 scores only, it may be the only objective tool available with which to compare IMGs with US graduates.

Signing Up. We advise that you read the FAQ section on the ECFMG website carefully. Most of the services you will need to use involve either IWA or OASIS. If you have not yet completed medical school, follow these steps to sign up for Step 1:

- Apply and pay for an ECFMG/USMLE ID number on the ECFMG website
- After receiving an email with your ID number, log in to IWA/OASIS, enter your details, and complete the "On-Line part of your USMLE Step 1 application." Choose your test center location and 3-month eligibility period. Additional fees apply if you need to change your eligibility period.
- Pay the Step 1 fee plus any international test surcharges that may apply.
- Access and complete Form 186 (Certification of Identity Form) from IWA as part of the Application for ECFMG Certification.

- Follow the instructions on the form to notarize Form 186 using the online service NotaryCam.com. The fee for this service is included in the ECFMG application fee.
- Once notarized by NotaryCam.com and submitted, Form 186 will remain valid indefinitely. A valid, previously completed Form 186 will remain valid for five years from the date it was accepted.
- After receiving a confirmation email from the ECFMG, you may book an exam date and location on www.prometric.com.

Eligibility Period. A three-month period of your choice.

Fee. The fee for Step 1 is \$940 plus an international test delivery surcharge (if you choose a testing region other than the United States or Canada).

Statistics. In 2018–2019, 80% of IMG examinees passed Step 1 on their first attempt, compared with 96% of MD degree examinees from the United States and Canada.

Tips. Although few if any students feel totally prepared to take Step 1, IMGs in particular require serious study and preparation in order to reach their full potential on this exam. It is also imperative that IMGs do their best on Step 1, as a poor score on Step 1 is a distinct disadvantage in applying for most residencies. Remember that if you pass Step 1, you cannot retake it in an attempt to improve your score. Your goal should thus be to beat the mean, because you can then assert with confidence that you have done better than average for US students (see Table 1). Higher Step 1 scores will also

▶ A higher Step 1 score will improve your chances of getting into a highly competitive specialty.

TABLE 1. USMLE Step 1 Mean Score of Matched Applicants in 2018.

Specialty	US Graduates	US IMGs	Non-US IMGs	
All specialties	233	222	234	
Anesthesiology	232	231	240	
Dermatology	249	_	238	
Diagnostic radiology	240	239	241	
Emergency medicine	233	232	229	
Family medicine	220	211	220	
General surgery	236	237	242	
Internal medicine	233	225	236	
Neurology	231	227	236	
Obstetrics and gynecology	230	229	231	
Pathology	233	226	230	
Pediatrics	227	221	230	
Physical medicine and rehabilitation	225	226	238	
Psychiatry	226	214	222	

Source: www.nrmp.org

lend credibility to your residency application and help you get into highly competitive specialties such as radiology, orthopedics, and dermatology.

Commercial Review Courses. Do commercial review courses help improve your scores? Reports vary, and such courses can be expensive. For some students these programs can provide a more structured learning environment with professional support. However, review courses consume a significant chunk of time away from independent study. Many IMGs participate in review courses as they typically need higher scores to compete effectively with US and Canadian candidates for residency positions. (For more information on review courses, see Section IV in the book.)

USMLE Step 2 CK and the IMG

What Is the Step 2 CK? It is a computerized test of the clinical sciences consisting of up to 318 multiple-choice questions divided into eight blocks. Each block contains a maximum of 40 questions and needs to be completed within 60 minutes. It can be taken at Prometric centers in the United States and several other countries.

Content. The Step 2 CK includes test items in the following content areas:

- Internal medicine
- Obstetrics and gynecology
- Pediatrics
- Preventive medicine
- Psychiatry
- Surgery
- Other areas relevant to the provision of care under supervision

Significance of the Test. The Step 2 CK is required for the ECFMG certificate. It reflects the level of clinical knowledge of the applicant. It tests clinical subjects, primarily internal medicine. Other areas tested are orthopedics, ENT, ophthalmology, safety science, epidemiology, professionalism, and ethics.

Eligibility. Students and graduates from medical schools that are listed in WDOMS and meet the ECFMG eligibility requirement to take the Step 2 CK. Students must have completed at least two years of medical school. This means that students must have completed the basic medical science component of the medical school curriculum by the beginning of the eligibility period selected.

Eligibility Period. A three-month period of your choice.

Fee. The fee for the Step 2 CK is \$940 plus an international test delivery surcharge (if you choose a testing region other than the United States or Canada).

► The areas tested on the Step 2 CK relate to the clerkships provided at US medical schools.

Statistics. In 2017–2018, 83% of ECFMG candidates passed the Step 2 CK on their first attempt, compared with 97% of MD degree examinees from US and Canadian schools.

Tips. It's better to take the Step 2 CK after your internal medicine rotation because most of the questions on the exam give clinical scenarios and ask you to make medical diagnoses and clinical decisions. In addition, because this is a clinical sciences exam, cultural and geographic considerations play a greater role than is the case with Step 1. For example, if your medical education gave you ample exposure to malaria, brucellosis, and malnutrition but little to alcohol withdrawal, child abuse, and cholesterol screening, you must work to familiarize yourself with topics that are more heavily emphasized in US medicine. You must also have a basic understanding of the legal and social aspects of US medicine, because you will be asked questions about communicating with and advising patients.

▶ Be familiar with topics that are heavily emphasized in US medicine, such as cholesterol screening.

USMLE Step 2 CS and the IMG

What Is the Step 2 CS? The Step 2 CS is a test of clinical and communication skills administered as a one-day, eight-hour exam. It includes 12 encounters with standardized patients (15 minutes each, with 10 minutes to write a note after each encounter).

Content. The Step 2 CS tests the ability to communicate in English as well as interpersonal skills, data-gathering skills, the ability to perform a physical exam, and the ability to formulate a brief note, a differential diagnosis, and a list of diagnostic tests. The areas that are covered in the exam are as follows:

- Internal medicine
- Surgery
- Obstetrics and gynecology
- Pediatrics
- Psychiatry
- Family medicine

Unlike the USMLE Step 1, Step 2 CK, or Step 3, there are no numerical grades for the Step 2 CS—it's simply either a "pass" or a "fail." To pass, a candidate must attain a passing performance in each of the following three components:

- Integrated Clinical Encounter (ICE): includes Data Gathering, Physical Exam, and the electronic Patient Note
- Spoken English Proficiency (SEP)
- Communication and Interpersonal Skills (CIS)

According to the NBME, the most commonly failed component for IMGs is the CIS.

▶ The Step 2 CS is graded as pass/fail.

▶ Try to take the Step 2 CS the year

before you plan to Match.

Significance of the Test. The Step 2 CS assesses spoken English language proficiency and is required for the ECFMG certificate. The Test of English as a Foreign Language (TOEFL) is no longer required.

Eligibility. Students must have completed at least two years of medical school in order to take the test. That means students must have completed the basic medical science component of the medical school curriculum at the time they apply for the exam.

Fee. The fee for the Step 2 CS is \$1580.

Statistics. In 2017–2018, 75% of ECFMG candidates passed the Step 2 CS on their first attempt, compared with 95% of MD degree examinees from US and Canadian schools.

Scheduling. You must schedule the Step 2 CS within four months of the date indicated on your notification of registration. You must take the exam within 12 months of the date indicated on your notification of registration. It is generally advisable to take the Step 2 CS as soon as possible in the year before your Match, as often the results either come in late or arrive too late to allow you to retake the test and pass it before the Match.

Test Site Locations. The Step 2 CS is currently administered at the following five locations:

- Philadelphia, PA
- Atlanta, GA
- Los Angeles, CA
- Chicago, IL
- Houston, TX

For more information about the Step 2 CS exam, please refer to *First Aid for the Step* 2 CS.

USMLE Step 3 and the IMG

What Is the USMLE Step 3? It is a two-day computerized test in clinical medicine consisting of 413 multiple-choice questions and 13 computer-based case simulations (CCS). The exam aims to test your knowledge and its application to patient care and clinical decision making (ie, this exam tests if you can safely practice medicine independently and without supervision). Please go to the USMLE website to learn more about recent changes to the exam.

Significance of the Test. Taking Step 3 before residency is critical for IMGs seeking an H1B visa and is also a bonus that can be added to the residency application. Step 3 is also required to obtain a full medical license in the United States and can be taken during residency for this purpose.

Fee. The fee for Step 3 is \$895.

Complete the Step 3 exam before you apply for an H1B visa. Eligibility. Examinees are no longer required to apply to the Step 3 exam under the eligibility requirements of a specific medical licensing authority. Those wishing to sit for the Step 3 exam, independent of the place of residence, must meet the following requirements:

- Have completed an MD or DO degree from an LCME- or AOAaccredited US or Canadian medical school, or from a medical school outside the US and Canada listed in the World Directory of Medical Schools.
- Have taken and passed the Step 1, Step 2 CK, and Step 2 CS exams.
- If an IMG, be certified by the ECFMG.

The Step 3 exam is not available outside the United States. Applications can be found online at www.fsmb.org and must be submitted to the FSMB.

Statistics. In 2018, 90% of IMG candidates passed the Step 3 on their first attempt, compared with 98% of MD degree examinees from US and Canadian schools.

Residencies and the IMG

In the Match, the number of US-citizen IMG applications has grown over the past few years, while the percentage accepted has remained constant (see Table 2). More information about residency programs can be obtained at www.ama-assn.org.

The Match and the IMG

Given the growing number of IMG candidates with strong applications, you should bear in mind that good USMLE scores are not the only way to gain a competitive edge. However, USMLE Step 1 and Step 2 CK scores continue to be used as the initial screening mechanism when candidates are being considered for interviews.

TABLE 2. IMGs in the Match.

Applicants	2016	2017	2018	2019
US-citizen IMGs	5,323	5,069	5,075	5,080
% US-citizen IMGs accepted	53.9	54.8	57.1	59
Non-US-citizen IMGs	7,460	7,284	7,067	6,869
% non-US-citizen IMGs accepted	50.5	52.4	56.1	58.6
US seniors (non-IMGs)	18,187	18,539	18,818	18,925
% US seniors accepted	93.8	94.3	94.3	93.9
DO graduates		3,590	4,617	6,001
% DO graduates accepted		81.7	81.7	84.6

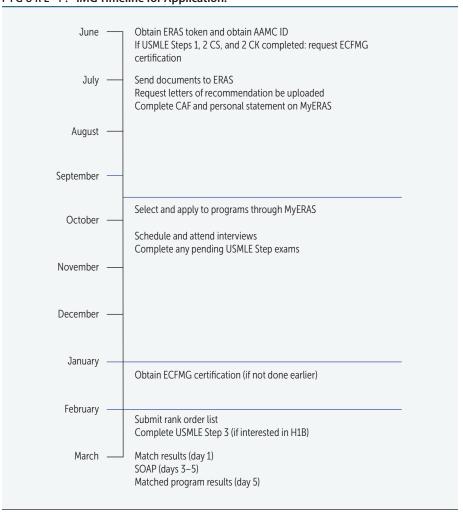
Source: www.nrmp.org.

Based on accumulated IMG Match experiences over recent years, here are a few pointers to help IMGs maximize their chances for a residency interview:

- Apply early. Programs offer a limited number of interviews and often select candidates on a first-come, first-served basis. Because of this, you should aim to complete the entire process of applying for the ERAS token, registering with the Association of American Medical Colleges (AAMC), mailing necessary documents to ERAS, and completing the ERAS application by mid-September (see Figure 1). Community programs usually send out interview offers earlier than do university and university-affiliated programs.
- OUS clinical experience helps. Externships and observerships in a US hospital setting have emerged as an important credential on an IMG application. Externships are like short-term medical school internships and offer hands-on clinical experience. Observerships, also called "shadowing," involve following a physician and observing how he or she manages patients. Some programs require students to have participated in an externship or observership before applying. It is best to gain such an experience before or at the time you apply to various programs so that you can mention it on your

 All US hospitals allow externship only when the applicant is actively enrolled in a medical school, so plan ahead.

FIGURE 1. IMG Timeline for Application.



ERAS application. If such an experience or opportunity comes up after you apply, be sure to inform the programs accordingly.

- Clinical research helps. University programs are attracted to candidates who show a strong interest in clinical research and academics. They may even relax their application criteria for individuals with unique backgrounds and strong research experience. Publications in well-known journals are an added bonus.
- Time the Step 2 CS well. ECFMG has published the new Step 2 CS score-reporting schedule for 2019–2020 at http://www.ecfmg.org. Most program directors would like to see a passing score on the Step 1, Step 2 CK, and Step 2 CS exams before they rank an IMG on their rank order list in mid-February. There have been many instances in which candidates have lost a potential Match—either because of delayed CS results or because they have been unable to retake the exam on time following a failure. It is difficult to predict a result on the Step 2 CS, since the grading process is not very transparent. Therefore, it is advisable to take the Step 2 CS as early as possible in the application year.
- US letters of recommendation help. Letters of recommendation from clinicians practicing in the United States carry more weight than recommendations from home countries.
- Step up the Step 3. If H1B visa sponsorship is desired, aim to have Step 3 results by January of the Match year. In addition to the visa advantage you will gain, an early and good Step 3 score may benefit IMGs who have been away from clinical medicine for a while as well as those who have low scores on Step 1 and the Step 2 CK. Note that the Step 3 can be taken only after medical school graduation.
- Verify medical credentials in a timely manner. Do not overlook the medical school credential verification process. The ECFMG certificate arrives only after credentials have been verified and after you have passed Step 1, the Step 2 CK, and the Step 2 CS, so you should keep track of the process and check their application status online using IWA/OASIS.
- Don't count on a pre-Match. Programs participating in NRMP Match can no longer offer a pre-Match.

What if You Do Not Match?

For applicants who do not Match into a residency program, there's SOAP (Supplemental Offer and Acceptance Program). Under SOAP, unmatched applicants will have access to the list of unfilled programs at noon Eastern time on the Monday of Match week. The unfilled programs electing to participate in SOAP will offer positions to unmatched applicants through the Registration, Ranking, and Results (R3) system. A series of "rounds" will begin at noon Eastern time on Wednesday of Match week until 5:00 pm Eastern time on Friday of Match week. Detailed information about SOAP can be found at the NRMP website at http://www.nrmp.org.

▶ A good score on the Step 3 may help offset poorer scores on the Step 1 or 2 CK exams.

Resources for the IMG

Educational Commission for Foreign Medical Graduates (ECFMG)

3624 Market Street

Philadelphia, PA 19104-2685

(215) 386-5900

Fax: (215) 386-9196

Email: info@ecfmg.org

www.ecfmg.org

The ECFMG telephone number is answered only between 9:00 AM—5:00 PM Monday through Friday EST. The ECFMG often takes a long time to answer the phone, which is frequently busy at peak times of the year, and then gives you a long voice-mail message—so it is better to email early than to rely on a last-minute phone call. When contacting the ECFMG by email, include your USMLE/ECFMG Identification Number and use the email address that you registered with the ECFMG. Do not contact the NBME, as all IMG exam matters are conducted by the ECFMG. The ECFMG also publishes an information booklet on ECFMG certification and the USMLE program, which gives details on the dates and locations of forthcoming Step tests for IMGs together with application forms. The *Information Booklet* is available to view and download on the ECFMG's website at www.ecfmg.org, where they also have a complete list of fees for certification posted (see Table 3).

TABLE 3. Estimated Costs for IMGs (as of 2019).

Exams and Services	Fee(s)	
USMLE Step 1	\$940 + international surcharge (eg, \$195 in all European countries offering the exam)	
USMLE Step 2 CK \$940 + international surcharge (eg, \$220 in European countries offering the exam)		
USMLE Step 2 CS	\$1580	
USMLE Step 3	\$895	
ERAS	\$130 registration fee (ECFMG token fee) \$80 USMLE transcript assessment \$99 for programs 1–10 \$15 each for programs 11–20 \$19 each for programs 21–30 \$26 each for programs 31+	
NRMP	\$85 registration fee (for ranking 20 programs) \$30 per additional program ranked \$35 per partner (couples match only) \$50 late registration fee (sign up before November 30 to avoid paying this fee)	
J-1 visa application fee	\$160 visa application fee \$340 annual ECFMG application fee \$220 payable to Homeland Security (SEVIS fee)	

Federation of State Medical Boards (FSMB)

400 Fuller Wiser Road, Suite 300 Euless, TX 76039-3856 (817) 868-4041 Email: usmle@fsmb.org www.fsmb.org

The FSMB has a number of publications available, including free policy documents. All of these documents are available to view and download for free on the FSMB's website at www.fsmb.org. For Step 3 inquiries, the telephone number is (817) 868-4041.

The AMA has dedicated a portion of its website to information on IMG demographics, residencies, immigration, and the like. This information can be found at www.ama-assn.org.

▶ FIRST AID FOR THE OSTEOPATHIC MEDICAL STUDENT

What Is the COMLEX-USA Level 1?

The National Board of Osteopathic Medical Examiners (NBOME) administers the Comprehensive Osteopathic Medical Licensing Examination, or COMLEX-USA. Like the USMLE, the COMLEX-USA is administered over three levels.

The COMLEX-USA series assesses osteopathic medical knowledge and clinical skills using clinical presentations and physician tasks. A description of the COMLEX-USA Written Examination Blueprints for each level, which outline the various clinical presentations and physician tasks that examinees will encounter, is given on the NBOME website. Another stated goal of the COMLEX-USA Level 1 is to create a more primary careoriented exam that integrates osteopathic principles into clinical situations.

To be eligible to take the COMLEX-USA Level 1, you must be on track to satisfactorily complete your first two years in an AOA-accredited medical school. The office of the dean at each school informs the NBOME that the student will complete the first two years of medical school and is in good standing. At this point, the NBOME sends out an email with detailed instructions on how to register for the exam.

For all three levels of the COMLEX-USA, raw scores are converted to a percentile score and a score ranging from 5 to 800. For Levels 1 and 2, a score of 400 is required to pass; for Level 3, a score of 350 is needed. COMLEX-USA scores are posted at the NBOME website 4–6 weeks after the test and usually mailed within 8 weeks after the test. The mean score is always 500.

If you pass a COMLEX-USA examination, you are not allowed to retake it to improve your grade. Currently, if you fail, there is no specific limit to the number of times you can retake it in order to pass. However, a student may not take the exam more than four times in one year. Levels 2 and 3 exams must be passed in sequential order within seven years of passing Level 1.

Note that candidates taking COMLEX-USA examinations will be limited to a total of six attempts for each examination.

What Is the Structure of the COMLEX-USA Level 1?

The COMLEX-USA Level 1 is a computer-based examination consisting of 400 questions over an eight-hour period in a single day (nine hours counting breaks). Most of the questions are in one-best-answer format, but a small number are matching-type questions. Some one-best-answer questions are bundled together around a common question stem that usually takes the form of a clinical scenario. Every section of the COMLEX-USA Level 1 ends with either matching questions, multiple questions around a single stem, or both. New question formats may gradually be introduced, but candidates will be notified if this occurs. Multimedia questions are also included on the exam.

Questions are grouped into eight subsections of 50 questions each in a manner similar to that of the USMLE. The individual subsections are not timed, but the exam is divided into two blocks consisting of four subsections. Each subsection consists of 200 questions to be completed within four hours. Reviewing and changing answers may be done only in the current subsection. A "review page" is presented for each subsection in order to advise test takers of questions completed, questions marked for further review, and incomplete questions for which no answer has been given.

Breaks are even more structured with COMLEX-USA than they are with the USMLE. Students are allowed to take an optional 10-minute break at the end of the second and sixth subsections. After subsection 4, students are given a 40-minute lunch break. These are the only times a student is permitted a break. Any unused break time will not be added to the time allotted for taking the examination. More information about the computer-based COMLEX-USA examinations can be obtained from www.nbome.org.

What Is the Difference Between the USMLE and the COMLEX-USA?

According to the NBOME, the COMLEX-USA Level 1 focuses broadly on the following categories, with osteopathic principles and practices integrated into each section:

- Health promotion and disease prevention
- The history and physical
- Diagnostic technologies

- Management
- Scientific understanding of mechanisms
- Health care delivery

Although the COMLEX-USA and the USMLE are similar in scope, content, and emphasis, some differences are worth noting. For example, the interface is different; you cannot search for lab values. Instead, lab values and reference ranges (where appropriate) are included directly in the clinical vignette or test question. Fewer details are given about a patient's condition, so a savvy student needs to know how to differentiate between similar pathologies. Also, age, gender, and race are key factors for diagnosis on the COMLEX-USA. Images or videos are embedded in the question stem and the examinee has to click an attachment button to see the image. If you don't read the question carefully, the attachment buttons are very easy to miss. A standard calculator feature is embedded in the examination interface.

COMLEX-USA Level 1 tests osteopathic principles in addition to basic science materials but does not emphasize lab techniques. Although both exams often require that you apply and integrate knowledge over several areas of basic science to answer a given question, many students who took both tests reported that the questions differed somewhat in style. Students reported, for example, that USMLE questions generally required that the test taker reason and draw from the information given (often a two-step process), whereas those on the COMLEX-USA exam tended to be more straightforward and that multiple different questions are asked pertaining to one question stem.

COMLEX-USA test takers can expect to have only a few questions on biochemistry, molecular biology, or lab technique. On the other hand, microbiology is very heavily tested by clinical presentation and by lab identification. The COMLEX-USA exam also focuses more on disease management, specific legal principles (eg, Tarasoff case and the Emergency Treatment Act) and more detailed ethical principles (eg, res ipsa loquitur) than the USMLE Step 1. Another main difference is that the COMLEX-USA exam stresses osteopathic manipulative medicine. Therefore, question banks specific to the USMLE will not be adequate, and supplementation with a question bank specific to the COMLEX-USA is highly recommended. The most commonly used are COMBANK or COMQUEST.

Students also commented that the COMLEX-USA utilized "buzzwords," although limited in their use (eg, "rose spots" in typhoid fever), whereas the USMLE avoided buzzwords in favor of descriptions of clinical findings or symptoms (eg, rose-colored papules on the abdomen rather than rose spots). Finally, USMLE appeared to have more photographs than did the COMLEX-USA. In general, the overall impression was that the USMLE was a more "thought-provoking" exam, while the COMLEX-USA was more of a "knowledge-based" exam.

▶ The test interface for the COMLEX-USA Level 1 is not the same as the USMLE Step 1 interface. ▶ If you're not sure whether you need to take either the COMLEX-USA Level 1 or the USMLE Step 1, consider taking both to keep your Match options open.

Who Should Take Both the USMLE and the COMLEX-USA?

Aside from facing the COMLEX-USA Level 1, you must decide if you will also take the USMLE Step 1. We recommend that you consider taking both the USMLE and the COMLEX-USA under the following circumstances:

- If you are applying to allopathic residencies. Although there is growing acceptance of COMLEX-USA certification on the part of allopathic residencies, some allopathic programs prefer or even require passage of the USMLE Step 1. These include many academic programs, programs in competitive specialties (eg, orthopedics, ophthalmology, or dermatology), and programs in competitive geographic areas (eg, Vermont, Utah, and California). Fourth-year osteopathic medical students who have already Matched may be a good source of information about which programs and specialties look for USMLE scores. It is also a good idea to contact program directors at the institutions you are interested in to ask about their policy regarding the COMLEX-USA versus the USMLE.
- If you are unsure about your postgraduate training plans. Successful passage of both the COMLEX-USA Level 1 and the USMLE Step 1 is certain to provide you with the greatest possible range of options when you are applying for internship and residency training.

In addition, the COMLEX-USA Level 1 has in recent years placed increasing emphasis on questions related to primary care medicine and prevention. Having a strong background in family or primary care medicine can help test takers when they face questions on prevention.

How Do I Prepare for the COMLEX-USA Level 1?

Student experience suggests that you should start studying for the COMLEX-USA four to six months before the test is given, as an early start will allow you to spend up to a month on each subject. The recommendations made in Section I regarding study and testing methods, strategies, and resources, as well as the books suggested in Section IV for the USMLE Step 1, hold true for the COMLEX-USA as well.

Another important source of information is in the *Examination Guidelines* and *Sample Exam*, a booklet that discusses the breakdown of each subject while also providing sample questions and corresponding answers. Many students, however, felt that this breakdown provided only a general guideline and was not representative of the level of difficulty of the actual COMLEX-USA. The sample questions did not provide examples of clinical vignettes, which made up approximately 25% of the exam. You will receive this publication with registration materials for the COMLEX-USA Level 1, but you can also receive a copy and additional information by writing:

NBOME

8765 W. Higgins Road, Suite 200 Chicago, IL 60631-4174 (773) 714-0622 www.nbome.org The NBOME developed the Comprehensive Osteopathic Medical Self-Assessment Examination (COMSAE) series to fill the need for selfassessment on the part of osteopathic medical students. Many students take the COMSAE exam before the COMLEX-USA in addition to using testbank questions and board review books. Students can purchase a copy of this exam at www.nbome.org/comsae.asp.

In recent years, students have reported an emphasis in certain areas. For example:

- There was an increased emphasis on upper limb anatomy/brachial
- Specific topics were repeatedly tested on the exam. These included cardiovascular physiology and pathology, acid-base physiology, diabetes, benign prostatic hyperplasia, sexually transmitted diseases, measles, and rubella. Thyroid and adrenal function, neurology (head injury), specific drug treatments for bacterial infection, migraines/cluster headaches, and drug mechanisms also received heavy emphasis.
- Behavioral science questions were based on psychiatry.
- High-yield osteopathic manipulative technique (OMT) topics included an emphasis on the sympathetic and parasympathetic innervations of viscera and nerve roots, rib mechanics/diagnosis, and basic craniosacral theory. Students who spend time reviewing basic anatomy, studying nerve and dermatome innervations, and understanding how to perform basic OMT techniques (eg, muscle energy or counterstrain) can improve their scores.

The COMLEX-USA Level 1 also includes multimedia-based questions. Such questions test the student's ability to perform a good physical exam and to elicit various physical diagnostic signs (eg, Murphy sign).

▶ FIRST AID FOR THE PODIATRIC MEDICAL STUDENT

The National Board of Podiatric Medical Examiners (NBPME) offers the American Podiatric Medical Licensing Examinations (APMLE), which are designed to assess whether a candidate possesses the knowledge required to practice as a minimally competent entry-level podiatric surgeon. The APMLE is used as part of the licensing process governing the practice of podiatric medicine and surgery. The APMLE is recognized by all 50 states and the District of Columbia, the US Army, the US Navy, and the Canadian provinces of Alberta, British Columbia, and Ontario. Individual states use the examination scores differently; therefore, doctor of podiatric medicine (DPM) candidates should refer to the NBPME Part I and Part II Information Bulletin 2019.

- You must know the Chapman reflex points and the obscure names of physical exam signs.
- ► COMLEX is heavy on "bugs and drugs."

- ▶ Areas tested on the NBPME Part I:
- General anatomy
- Lower extremity anatomy
- Biochemistry
- Physiology
- Medical microbiology & immunology
- Pathology
- Pharmacology

The APMLE Part I is generally taken after the completion of the second year of podiatric medical education. Unlike the USMLE Step 1, there is no behavioral science section, nor is biomechanics tested. The exam samples seven basic science disciplines: general anatomy (13%); lower extremity anatomy (25%); biochemistry (10%); physiology (13%); microbiology and immunology (13%); pathology (13%); and pharmacology (13%). A detailed outline of topics and subtopics covered on the exam can be found in the *Candidate Information Bulletin Part I Examination*, available at www.apmle.org.

Your APMLE Appointment

Applicants have to register for the exam online at www.prometric.com/NBPME. Once registration is completed, you will receive an Authorization to Test (ATT) email notification that allows you to schedule your exam online. This should be done promptly to secure the testing location and exam date of your choice. The exam will be offered at an independent Prometric testing facility. Test centers within a 50-mile radius of a podiatric medicine school specifically reserve a number of seats on each APMLE Part I exam date. You may take the exam at any Prometric site regardless of which school you attend. Specific instructions about exam dates and registration deadlines can be found in the Candidate Information Bulletin.

Exam Format

The APMLE Part I is a written exam consisting of 205 questions. The test consists exclusively of one-best-answer multiple choice questions with four options per question. A review screen showing all answered, unanswered, and marked questions will be available at the end. Students are encouraged to mark questions and return to these for review at the end of the exam if time allows. Examinees have four hours in which to complete the exam and are given scratch paper that must be turned in at the end of the exam. Some questions on the exam will be "trial questions." These questions are evaluated as future board questions but are not counted in your score.

Interpreting Your Score

Exam results are emailed to examinees approximately four weeks after the exam date, and are also available online via the Prometric dashboard. APMLE scores are reported as pass/fail, with a scaled score of at least 75 needed to pass. Historically, 85% of first-time test takers pass the APMLE Part I. Failing candidates receive a report with a score between 55 and 74 in addition to diagnostic messages intended to help identify strengths or weaknesses in specific content areas. If you fail the APMLE Part I, you must retake the entire examination at a later date. There is no limit to the number of times you can retake the exam.

Preparation for the APMLE Part I

Begin studying for the APMLE Part I at least three months prior to the test date. The suggestions made in Section I regarding study and testing methods for the USMLE Step 1 can be applied to the APMLE as well. This book should, however, be used as a supplement and not as the sole source of information. Neither you nor your school or future residency will ever see your actual passing numerical score. Competing with colleagues should not be an issue, and study groups are beneficial to many.

A study method that helps many students is to copy the outline of the material to be tested from the *Candidate Information Bulletin*. Check off each topic during your study, because doing so will ensure that you have engaged each topic. If you are pressed for time, prioritize subjects on the basis of their weight on the exam. A full 25% of the APMLE Part I focuses on lower extremity anatomy. In this area, students should rely on the notes and material that they received from their class. Remember, lower extremity anatomy is the podiatric physician's specialty—so everything about it is important. Do not forget to study osteology. Keep your old tests and look through old lower extremity class exams, since each of the podiatric colleges submits questions from its faculty. This strategy will give you an understanding of the types of questions that may be asked. On the APMLE Part I, you will see some of the same classic lower extremity anatomy questions you were tested on in school.

The APMLE, like the USMLE, requires that you apply and integrate knowledge over several areas of basic science in order to answer exam questions. Students report that many questions emphasize clinical presentations; however, the facts in this book are very useful in helping students recall the various diseases and organisms. DPM candidates should expand on the high-yield pharmacology section and study antifungal drugs and treatments for *Pseudomonas*, methicillin-resistant *S aureus*, candidiasis, and erythrasma. The high-yield section focusing on pathology is very useful; however, additional emphasis on diabetes mellitus and all its secondary manifestations, particularly peripheral neuropathy, should not be overlooked. Students should also focus on renal physiology and drug elimination, the biochemistry of gout, and neurophysiology, all of which have been noted to be important topics on the APMLE Part I exam.

A sample set of questions is found on the APMLE website www.apmle.org. These samples are somewhat similar in difficulty to actual board questions. If you have any questions regarding registration, fees, test centers, authorization forms, or score reports, please contact your college registrar or:

Prometric

877-302-8952

Email: nbpmeinquiry@prometric.com

www.prometric.com

► Know the anatomy of the lower extremity!

▶ FIRST AID FOR THE STUDENT REQUIRING TEST ACCOMMODATIONS

The USMLE provides accommodations for students with documented disabilities. The basis for such accommodations is the Americans with Disabilities Act (ADA) of 1990. The ADA defines a disability as "a significant limitation in one or more major life activities." This includes both "observable/physical" disabilities (eg, blindness, hearing loss, narcolepsy) and "hidden/mental disabilities" (eg, attention-deficit hyperactivity disorder, chronic fatigue syndrome, learning disabilities).

To provide appropriate support, the administrators of the USMLE must be informed of both the nature and the severity of an examinee's disability. Such documentation is required for an examinee to receive testing accommodations. Accommodations include extra time on tests, low-stimulation environments, extra or extended breaks, and zoom text.

 US students seeking ADA-compliant accommodations must contact the NBME directly; IMGs, contact the ECFMG.

Who Can Apply for Accommodations?

Students or graduates of a school in the United States or Canada that is accredited by the Liaison Committee on Medical Education (LCME) or the AOA may apply for test accommodations directly from the NBME. Requests are granted only if they meet the ADA definition of a disability. If you are a disabled student or a disabled graduate of a foreign medical school, you must contact the ECFMG (see the following page).

Who Is Not Eligible for Accommodations?

Individuals who do not meet the ADA definition of disabled are not eligible for test accommodations. Difficulties not eligible for test accommodations include test anxiety, slow reading without an identified underlying cognitive deficit, English as a second language, and learning difficulties that have not been diagnosed as a medically recognized disability.

Understanding the Need for Documentation

Although most learning-disabled medical students are all too familiar with the often exhausting process of providing documentation of their disability, you should realize that applying for USMLE accommodation is different from these previous experiences. This is because the NBME determines whether an individual is disabled solely on the basis of the guidelines set by the ADA. Previous accommodation does not in itself justify provision of an accommodation for the USMLE, so be sure to review the NBME guidelines carefully.

Getting the Information

The first step in applying for USMLE special accommodations is to contact the NBME and obtain a guidelines and questionnaire booklet. For the Step 1, Step 2 CK, and Step 2 CS exams, this can be obtained by calling or writing to:

Disability Services

National Board of Medical Examiners 3750 Market Street Philadelphia, PA 19104-3102 (215) 590-9509 Email: disabilityservices@nbme.org www.usmle.org/test-accommodations

Internet access to this information is also available at www.nbme.org. This information is also relevant for IMGs, since the information is the same as that sent by the ECFMG.

Foreign graduates should contact the ECFMG to obtain information on special accommodations by calling or writing to:

ECFMG

3624 Market Street Philadelphia, PA 19104-2685 (215) 386-5900 www.ecfmg.org

When you get this information, take some time to read it carefully. The guidelines are clear and explicit about what you need to do to obtain accommodations.

SECTION II

High-Yield General Principles

"There comes a time when for every addition of knowledge you forget something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones."

—Sir Arthur Conan Doyle, A Study in Scarlet

"Never regard study as a duty, but as the enviable opportunity to learn."

—Albert Einstein

"Live as if you were to die tomorrow. Learn as if you were to live forever."

—Gandl

► How to Use the Database	30
▶Biochemistry	33
▶Immunology	95
▶ Microbiology	123
▶ Pathology	205
▶ Pharmacology	229
▶ Public Health Sciences	255

FAS1_2019_01-Biochem.indd 29 11/7/19 3:16 PM

► HOW TO USE THE DATABASE

The 2020 edition of *First Aid for the USMLE Step 1* contains a revised and expanded database of basic science material that students, student authors, and faculty authors have identified as high yield for board review. The information is presented in a partially organ-based format. Hence, Section II is devoted to the foundational principles of biochemistry, microbiology, immunology, basic pathology, basic pharmacology, and public health sciences. Section III focuses on organ systems, with subsections covering the embryology, anatomy and histology, physiology, clinical pathology, and clinical pharmacology relevant to each. Each subsection is then divided into smaller topic areas containing related facts. Individual facts are generally presented in a three-column format, with the **Title** of the fact in the first column, the **Description** of the fact in the second column, and the **Mnemonic** or **Special Note** in the third column. Some facts do not have a mnemonic and are presented in a two-column format. Others are presented in list or tabular form in order to emphasize key associations.

The database structure used in Sections II and III is useful for reviewing material already learned. These sections are **not** ideal for learning complex or highly conceptual material for the first time.

The database of high-yield facts is not comprehensive. Use it to complement your core study material and not as your primary study source. The facts and notes have been condensed and edited to emphasize the essential material, and as a result, each entry is "incomplete" and arguably "over-simplified." Often, the more you research a topic, the more complex it becomes, with certain topics resisting simplification. Work with the material, add your own notes and mnemonics, and recognize that not all memory techniques work for all students.

We update the database of high-yield facts annually to keep current with new trends in boards emphasis, including clinical relevance. However, we must note that inevitably many other high-yield topics are not yet included in our database.

We actively encourage medical students and faculty to submit high-yield topics, well-written entries, diagrams, clinical images, and useful mnemonics so that we may enhance the database for future students. We also solicit recommendations of alternate tools for study that may be useful in preparing for the examination, such as charts, flash cards, apps, and online resources (see How to Contribute, p. xix).

FAS1_2019_01-Biochem.indd 30 11/7/19 3:16 PM

Image Acknowledgments

All images and diagrams marked with ☑ are © USMLE-Rx.com (MedIQ Learning, LLC) and reproduced here by special permission. All images marked with ☑ are © Dr. Richard P. Usatine, author of *The Color Atlas of Family Medicine*, *The Color Atlas of Internal Medicine*, and *The Color Atlas of Pediatrics*, and are reproduced here by special permission (www. usatinemedia.com). Images and diagrams marked with ☑ are adapted or reproduced with permission of other sources as listed on page 727. Images and diagrams with no acknowledgment are part of this book.

Disclaimer

The entries in this section reflect student opinions of what is high yield. Because of the diverse sources of material, no attempt has been made to trace or reference the origins of entries individually. We have regarded mnemonics as essentially in the public domain. Errata will gladly be corrected if brought to the attention of the authors, either through our online errata submission form at www.firstaidteam.com or directly by email to firstaid@scholarrx.com.

FAS1_2019_01-Biochem.indd 31 11/7/19 3:16 PM

32 **SECTIO**

SECTION II HIGH-YIELD GENERAL PRINCIPLES

► NOTES	

FAS1_2019_01-Biochem.indd 32 11/7/19 3:16 PM

HIGH-YIELD PRINCIPLES IN

Biochemistry

"Biochemistry is the study of carbon compounds that crawl."

-Mike Adams

"We think we have found the basic mechanism by which life comes from life."

-Francis H. C. Crick

"The biochemistry and biophysics are the notes required for life; they conspire, collectively, to generate the real unit of life, the organism."

-Ursula Goodenough

This high-yield material includes molecular biology, genetics, cell biology, and principles of metabolism (especially vitamins, cofactors, minerals, and single-enzyme-deficiency diseases). When studying metabolic pathways, emphasize important regulatory steps and enzyme deficiencies that result in disease, as well as reactions targeted by pharmacologic interventions. For example, understanding the defect in Lesch-Nyhan syndrome and its clinical consequences is higher yield than memorizing every intermediate in the purine salvage pathway.

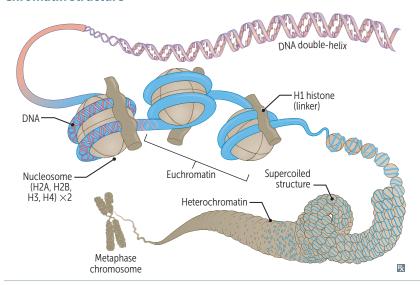
Do not spend time learning details of organic chemistry, mechanisms, or physical chemistry. Detailed chemical structures are infrequently tested; however, many structures have been included here to help students learn reactions and the important enzymes involved. Familiarity with the biochemical techniques that have medical relevance—such as ELISA, immunoelectrophoresis, Southern blotting, and PCR—is useful. Review the related biochemistry when studying pharmacology or genetic diseases as a way to reinforce and integrate the material.

▶ Molecular	34
▶ Cellular	46
▶ Laboratory Techniques	52
▶ Genetics	56
▶Nutrition	65
N Motabolism	72

FAS1_2019_01-Biochem.indd 33 11/7/19 3:16 PM

▶ BIOCHEMISTRY—MOLECULAR

Chromatin structure



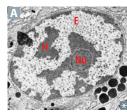
DNA exists in the condensed, chromatin form to fit into the nucleus. DNA loops twice around a histone octamer to form a nucleosome ("beads on a string"). HI binds to the nucleosome and to "linker DNA," thereby stabilizing the chromatin fiber.

Phosphate groups give DNA a \ominus charge. Lysine and arginine give histones a \oplus charge.

In mitosis, DNA condenses to form chromosomes. DNA and histone synthesis occurs during S phase.

Mitochondria have their own DNA, which is circular and does not utilize histones.

Heterochromatin



Condensed, appears darker on EM (labeled H in ♠; Nu, nucleolus). Sterically inaccessible, thus transcriptionally inactive. ↑ methylation, ↓ acetylation.

HeteroChromatin = Highly Condensed.
Barr bodies (inactive X chromosomes) may be visible on the periphery of nucleus.

Euchromatin	Less condensed, appears lighter on EM (labeled E in A). Transcriptionally active, sterically accessible.	Eu = true, "truly transcribed." E uchromatin is E xpressed.
DNA methylation	Changes the expression of a DNA segment without changing the sequence. Involved with aging, carcinogenesis, genomic imprinting, transposable element repression, and inactivation of the X chromosome.	DNA is methylated in imprinting. Methylation within gene promoter (CpG islands) typically represses (silences) gene transcription. CpG Methylation Makes DNA Mute.
Histone methylation	Usually causes reversible transcriptional suppression, but can also cause activation depending on location of methyl groups.	Histone Methylation Mostly Makes DNA Mute.
Histone acetylation	Removal of histone's ⊕ charge → relaxed DNA coiling → ↑ transcription.	Histone Acetylation makes DNA Active.
Histone deacetylation	Removal of acetyl groups → tightened DNA coiling → ↓ transcription.	

FAS1_2019_01-Biochem.indd 34 11/7/19 3:16 PM

Nucleotides

Nucleo Side = base + (deoxy)ribose (Sugar).

NucleoTide = base + (deoxy)ribose + phosphaTe; 5' end of incoming nucleotide bears the linked by 3'-5' phosphodiester bond. 5' end of incoming nucleotide bears the triphosphate (energy source for the bond).

PURines (A,G)—2 rings. PYrimidines (C,U,T)—1 ring.

Deamination reactions:

Cytosine → uracil

Adenine → hypoxanthine

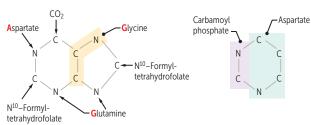
Guanine → xanthine

5-methylcytosine → thymine

Uracil found in RNA; thymine in DNA. Methylation of uracil makes thymine.

Purine (A, G)

Pyrimidine (C, U, T)



5' end of incoming nucleotide bears the triphosphate (energy source for the bond). Triphosphate bond is target of 3' hydroxyl attack.

PURe As Gold.

CUT the PY (pie).

Thymine has a methyl.

C-G bond (3 H bonds) stronger than A-T bond (2 H bonds). ↑ C-G content → ↑ melting temperature of DNA. "C-G bonds are like Crazy Glue."

Amino acids necessary for **pur**ine synthesis (cats **pur**r until they **GAG**):

Glycine

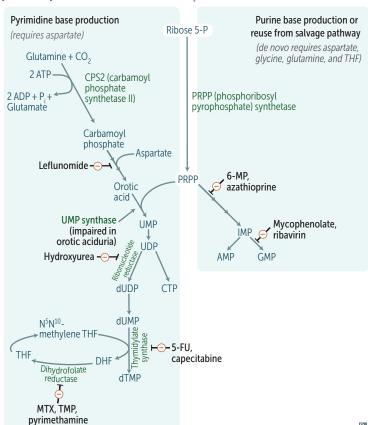
Aspartate

Glutamine

FAS1_2019_01-Biochem.indd 35 11/7/19 3:16 PM

De novo pyrimidine and purine synthesis

Various immunosuppressive, antineoplastic, and antibiotic drugs function by interfering with nucleotide synthesis:



Pyrimidine synthesis:

- Leflunomide: inhibits dihydroorotate dehydrogenase
- 5-fluorouracil (5-FU) and its prodrug capecitabine: form 5-F-dUMP, which inhibits thymidylate synthase (↓ dTMP)

Purine synthesis:

- 6-mercaptopurine (6-MP) and its prodrug azathioprine: inhibit de novo purine synthesis
- Mycophenolate and ribavirin: inhibit inosine monophosphate dehydrogenase

Purine and pyrimidine synthesis:

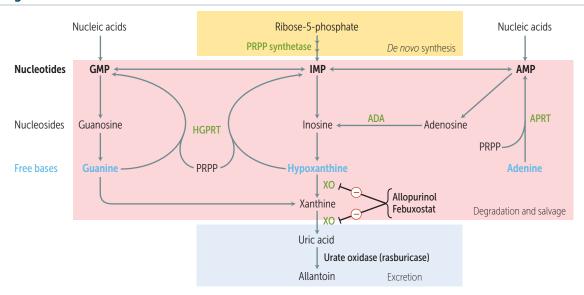
- Hydroxyurea: inhibits ribonucleotide reductase
- Methotrexate (MTX), trimethoprim (TMP), and pyrimethamine: inhibit dihydrofolate reductase (↓ deoxythymidine monophosphate [dTMP]) in humans, bacteria, and protozoa, respectively

CPS1 = m1tochondria (urea cycle) CPS2 = cyTWOsol

Ŗ

FAS1_2019_01-Biochem.indd 36 11/7/19 3:16 PM

Purine salvage deficiencies



ADA, adenosine deaminase; APRT, adenine phosphoribosyltransferase; HGPRT, hypoxanthine guanine phosphoribosyltransferase; XO, xanthine oxidase.

Adenosine deaminase deficiency

Lesch-Nyhan

syndrome

ADA is required for degradation of adenosine and deoxyadenosine. ↓ ADA → ↑ dATP

→ ↓ ribonucleotide reductase activity

→ lymphotoxicity.

Defective purine salvage due to absent HGPRT,

which converts hypoxanthine to IMP and guanine to GMP. Results in excess uric acid production and de novo purine synthesis.

X-linked recessive.

Findings: intellectual disability, self-mutilation, aggression, hyperuricemia (orange "sand" [sodium urate crystals] in diaper), gout, dystonia, macrocytosis.

Treatment: allopurinol or febuxostat (2nd line).

One of the major causes of autosomal recessive

Ŗ

HGPRT:

SCID.

Hyperuricemia

Gout

Pissed off (aggression, self-mutilation)

Retardation (intellectual disability)

DysTonia

Genetic code features

Unambiguous	Each codon specifies only 1 amino acid.	
Degenerate/ redundant	Most amino acids are coded by multiple codons. Wobble—codons that differ in 3rd ("wobble") position may code for the same tRNA/amino acid. Specific base pairing is usually required only in the first 2 nucleotide positions of mRNA codon.	Exceptions: methionine (AUG) and tryptophan (UGG) encoded by only 1 codon.
Commaless, nonoverlapping	Read from a fixed starting point as a continuous sequence of bases.	Exceptions: some viruses.
Universal	Genetic code is conserved throughout evolution.	Exception in humans: mitochondria.

FAS1_2019_01-Biochem.indd 37

DNA replication	•	in prokaryotes but uses many enzymes analogous to votes, DNA replication is semiconservative, involves by synthesis, and occurs in the $5' \rightarrow 3'$ direction.
Origin of replication A	Particular consensus sequence in genome where DNA replication begins. May be single (prokaryotes) or multiple (eukaryotes).	AT-rich sequences (such as TATA box regions) are found in promoters and origins of replication.
Replication fork B	Y-shaped region along DNA template where leading and lagging strands are synthesized.	
Helicase (Unwinds DNA template at replication fork.	Helicase Halves DNA. Deficient in Bloom syndrome (BLM gene mutation).
Single-stranded binding proteins D	Prevent strands from reannealing.	
DNA topoisomerases E	Create a single- or double-stranded break in the helix to add or remove supercoils.	In eukaryotes: irinotecan/topotecan inhibit topoisomerase (TOP) I, etoposide/teniposide inhibit TOP II. In prokaryotes: fluoroquinolones inhibit TOP II (DNA gyrase) and TOP IV.
Primase F	Makes an RNA primer on which DNA polymerase III can initiate replication.	
DNA polymerase III G	Prokaryotes only. Elongates leading strand by adding deoxynucleotides to the 3' end. Elongates lagging strand until it reaches primer of preceding fragment.	DNA polymerase III has 5' → 3' synthesis and proofreads with 3' → 5' exonuclease. Drugs blocking DNA replication often have a modified 3' OH, thereby preventing addition of the next nucleotide ("chain termination").
DNA polymerase I H	Prokaryotes only. Degrades RNA primer; replaces it with DNA.	Same functions as DNA polymerase III, also excises RNA primer with 5′ → 3′ exonuclease.
DNA ligase II	Catalyzes the formation of a phosphodiester bond within a strand of double-stranded DNA.	Joins Okazaki fragments. Ligase Links DNA.
Telomerase	Eukaryotes only. A reverse transcriptase (RNA-dependent DNA polymerase) that adds DNA (TTAGGG) to 3' ends of chromosomes to avoid loss of genetic material with every duplication.	Often dysregulated in cancer cells, allowing unlimited replication. Telomerase TAGs for Greatness and Glory.
Area of interest	A Single stranged	DNA polymerase III A Origin of replication Leading strand Okazaki fragment DNA primer
Leading strand Lagging strand	Origin of replication Lagging strand Fork movement movement Correction Single-Strander binding protein Frimase	RNA primer DNA ligase DNA polymerase II

11/7/19 3:16 PM FAS1_2019_01-Biochem.indd 38

Mutations in DNA

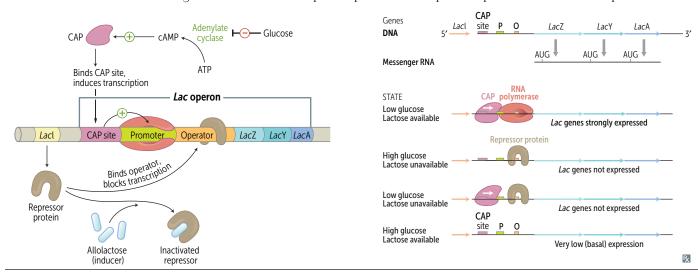
Severity of damage: silent << missense < nonsense < frameshift. Types of single nucleotide (point) mutations: • Transition—purine to purine (eg, A to G) or pyrimidine to pyrimidine (eg, C to T). **Transversion**—purine to pyrimidine (eg, A to T) or pyrimidine to purine (eg, C to G). Single nucleotide substitutions **Silent mutation** Nucleotide substitution codes for same (synonymous) amino acid; often base change in 3rd position of codon (tRNA wobble). Missense mutation Nucleotide substitution results in changed amino acid (called conservative if new amino acid has similar chemical structure). Examples include sickle cell disease (substitution of glutamic acid with valine). Nucleotide substitution results in early stop codon (UGA, UAA, UAG). Usually results in **Nonsense mutation** nonfunctional protein. Stop the nonsense! Other mutations **Frameshift mutation** Deletion or insertion of a number of nucleotides not divisible by 3 → misreading of all nucleotides downstream. Protein may be shorter or longer, and its function may be disrupted or altered. Examples include Duchenne muscular dystrophy, Tay-Sachs disease. **Splice site mutation** Retained intron in mRNA → protein with impaired or altered function. Examples include rare causes of cancers, dementia, epilepsy, some types of β-thalassemia, Gaucher disease, Marfan syndrome. Original Silent Missense Nonsense Frameshift Frameshift sequence mutation mutation mutation deletion insertion Coding DNA mRNA codon Glu Glu Val Amino acid Stop Asp Asp Altered amino acids Ŗ

FAS1_2019_01-Biochem.indd 39 11/7/19 3:16 PM

Lac operon

Classic example of a genetic response to an environmental change. Glucose is the preferred metabolic substrate in *E coli*, but when glucose is absent and lactose is available, the *lac* operon is activated to switch to lactose metabolism. Mechanism of shift:

- Low glucose → ↑ adenylate cyclase activity → ↑ generation of cAMP from ATP → activation of catabolite activator protein (CAP) → ↑ transcription.
- High lactose → unbinds repressor protein from repressor/operator site → † transcription.

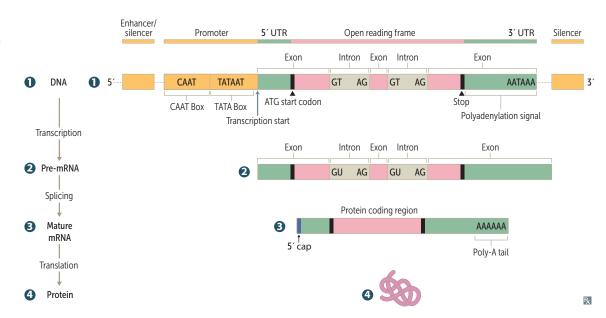


DNA repair

Single strand		
Nucleotide excision repair	Specific endonucleases release the oligonucleotides containing damaged bases; DNA polymerase and ligase fill and reseal the gap, respectively. Repairs bulky helix-distorting lesions. Occurs in G_1 phase of cell cycle.	Defective in xeroderma pigmentosum (inability to repair DNA pyrimidine dimers caused by UV exposure). Findings: dry skin, extreme light sensitivity, skin cancer.
Base excision repair	Base-specific Glycosylase removes altered base and creates AP site (apurinic/apyrimidinic). One or more nucleotides are removed by AP-Endonuclease, which cleaves 5' end. AP-Lyase cleaves 3' end. DNA Polymerase-β fills the gap and DNA Ligase seals it. Occurs throughout cell cycle.	Important in repair of spontaneous/toxic deamination. "GEL PLease"
Mismatch repair	Mismatched nucleotides in newly synthesized (unmethylated) strand are removed and gap is filled and resealed. Occurs predominantly in S phase of cell cycle.	Defective in Lynch syndrome (hereditary nonpolyposis colorectal cancer [HNPCC]).
Double strand		
Nonhomologous end joining	Brings together 2 ends of DNA fragments to repair double-stranded breaks.	Defective in ataxia-telangiectasia. No requirement for homology. Some DNA may be lost.

FAS1_2019_01-Biochem.indd 40 11/7/19 3:16 PM

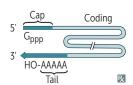
Functional organization of a eukaryotic gene



Regulation of gene expression

Promoter	Site where RNA polymerase II and multiple other transcription factors bind to DNA upstream from gene locus (AT-rich upstream sequence with TATA and CAAT boxes).	Promoter mutation commonly results in dramatic ↓ in level of gene transcription.
Enhancer	DNA locus where regulatory proteins ("activators") bind, increasing expression of a gene on the same chromosome.	Enhancers and silencers may be located close to, far from, or even within (in an intron) the gene whose expression they regulate.
Silencer	DNA locus where regulatory proteins ("repressors") bind, decreasing expression of a gene on the same chromosome.	

RNA processing (eukaryotes)



Initial transcript is called heterogeneous nuclear RNA (hnRNA). hnRNA is then modified and becomes mRNA.

The following processes occur in the nucleus:

- Capping of 5' end (addition of 7-methylguanosine cap)
- Polyadenylation of 3' end (≈ 200 As)
- Splicing out of introns

Capped, tailed, and spliced transcript is called mRNA.

mRNA is transported out of nucleus to be translated in cytosol.

mRNA quality control occurs at cytoplasmic processing bodies (P-bodies), which contain exonucleases, decapping enzymes, and microRNAs; mRNAs may be degraded or stored in P-bodies for future translation.

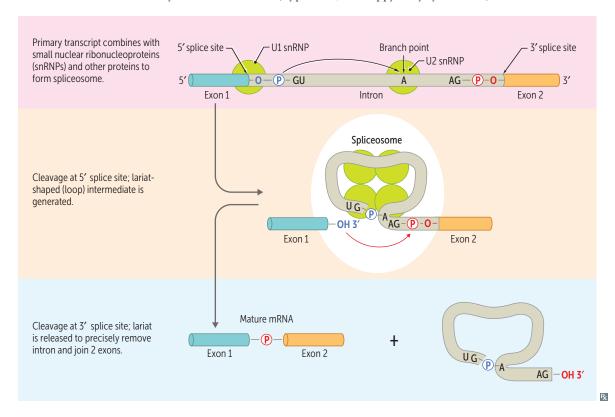
Poly-A polymerase does not require a template. AAUAAA = polyadenylation signal.

FAS1_2019_01-Biochem.indd 41 11/7/19 3:16 PM

Eukaryotes	RNA polymerase I makes rRNA, the most common (rampant) type; present only in nucleolus. RNA polymerase II makes mRNA (massive), microRNA (miRNA), and small nuclear RNA (snRNA). RNA polymerase III makes 5S rRNA, tRNA (tiny). No proofreading function, but can initiate chains. RNA polymerase II opens DNA at promoter site.	I, II, and III are numbered in the same order that their products are used in protein synthesis: rRNA, mRNA, then tRNA. α-amanitin, found in Amanita phalloides (death cap mushrooms), inhibits RNA polymerase II. Causes severe hepatotoxicity if ingested. Actinomycin D, also called dactinomycin, inhibits RNA polymerase in both prokaryotes and eukaryotes.
Prokaryotes	1 RNA polymerase (multisubunit complex) makes all 3 kinds of RNA.	Rifampin inhibits DNA-dependent RNA polymerase in prokaryotes.

Splicing of pre-mRNA

Part of process by which precursor mRNA (pre-mRNA) is transformed into mature mRNA. Alterations in snRNP assembly can cause clinical disease; eg, in spinal muscular atrophy, snRNP assembly is affected due to ↓ SMN protein → congenital degeneration of anterior horns of spinal cord → symmetric weakness (hypotonia, or "floppy baby syndrome").



FAS1_2019_01-Biochem.indd 42 11/7/19 3:16 PM

Introns vs exons

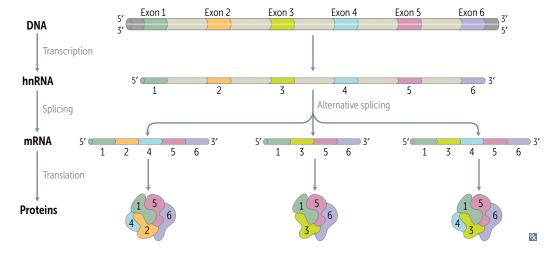
Exons contain the actual genetic information coding for protein.

Introns do not code for protein, but are important in regulation of gene expression.

Different exons are frequently combined by alternative splicing to produce a larger number of unique proteins.

Alternative splicing can produce a variety of protein products from a single hnRNA sequence (eg, transmembrane vs secreted Ig, tropomyosin variants in muscle, dopamine receptors in the brain).

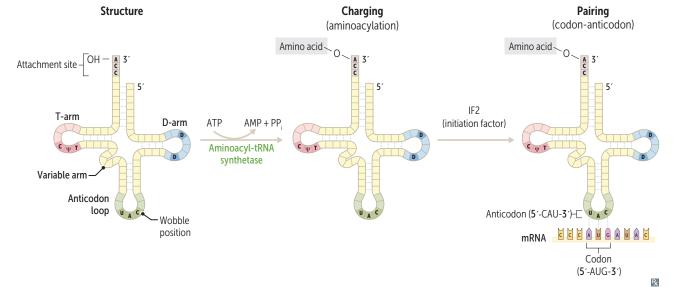
Introns are intervening sequences and stay in the nucleus, whereas exons exit and are expressed.



FAS1_2019_01-Biochem.indd 43 11/7/19 3:16 PM

tRNA

Structure 75–90 nucleotides, 2° structure, cloverleaf form, anticodon end is opposite 3' aminoacyl end. All tRNAs, both eukaryotic and prokaryotic, have CCA at 3' end along with a high percentage of chemically modified bases. The amino acid is covalently bound to the 3' end of the tRNA. CCA Can Carry Amino acids. T-arm: contains the TΨC (ribothymidine, pseudouridine, cytidine) sequence necessary for tRNAribosome binding. **T**-arm **T**ethers tRNA molecule to ribosome. D-arm: contains Dihydrouridine residues necessary for tRNA recognition by the correct aminoacyltRNA synthetase. **D**-arm allows **D**etection of the tRNA by aminoacyl-tRNA synthetase. Attachment site: the 5'-CCA-3' is the amino acid acceptor site. Charging Aminoacyl-tRNA synthetase (uses ATP; 1 unique enzyme per respective amino acid) and binding of charged tRNA to the codon are responsible for the accuracy of amino acid selection. Aminoacyl-tRNA synthetase matches an amino acid to the tRNA by scrutinizing the amino acid before and after it binds to tRNA. If an incorrect amino acid is attached, the bond is hydrolyzed. A mischarged tRNA reads the usual codon but inserts the wrong amino acid.



Start and stop codons

mRNA start codons	AUG (or rarely GUG).	AUG in AUG urates protein synthesis.
Eukaryotes	Codes for methionine, which may be removed before translation is completed.	
Prokaryotes	Codes for N-formylmethionine (fMet).	fMet stimulates neutrophil chemotaxis
mRNA stop codons	UGA, UAA, UAG.	UGA = U Go Away.
		UAA = U Are Away.
		UAG = U Are Gone.

FAS1_2019_01-Biochem.indd 44 11/7/19 3:16 PM

Protein synthesis

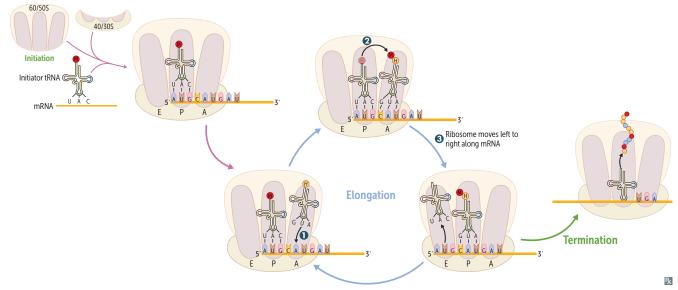
Initiation 1. Eukaryotic initiation factors (eIFs) identify the 5' cap. 2. eIFs help assemble the 40S ribosomal subunit with the initiator tRNA. 3. eIFs released when the mRNA and the ribosomal 60S subunit assemble with the complex. Requires GTP. Aminoacyl-tRNA binds to A site (except for **Elongation** initiator methionine, which binds the P site), requires an elongation factor and GTP. 2 rRNA ("ribozyme") catalyzes peptide bond formation, transfers growing polypeptide to amino acid in A site. 3 Ribosome advances 3 nucleotides toward 3' end of mRNA, moving peptidyl tRNA to P site (translocation). **Termination** Eukaryotic release factors (eRFs) recognize the stop codon and halt translation → completed polypeptide is released from ribosome. Requires GTP.

Eukaryotes: 40S + 60S → 80S (Even). Prokaryotes: 30S + 50S → 70S (Prime). Synthesis occurs from N-terminus to C-terminus.

ATP—tRNA Activation (charging).
GTP—tRNA Gripping and Going places (translocation).

Think of "going APE":

- \mathbf{A} site = incoming \mathbf{A} minoacyl-tRNA.
- **P** site = accommodates growing **P**eptide.
- **E** site = holds **E**mpty tRNA as it **E**xits.



Posttranslational modifications

Trimming	Removal of N- or C-terminal propeptides from zymogen to generate mature protein (eg, trypsinogen to trypsin).
Covalent alterations	Phosphorylation, glycosylation, hydroxylation, methylation, acetylation, and ubiquitination.
Chaperone protein	Intracellular protein involved in facilitating and maintaining protein folding. In yeast, heat shock proteins (eg, HSP60) are expressed at high temperatures to prevent protein denaturing/misfolding.

FAS1_2019_01-Biochem.indd 45

▶ BIOCHEMISTRY—CE	LLULAR	
Cell cycle phases	Checkpoints control transitions between phases of cyclin-dependent kinases (CDKs), and tumor su includes mitosis (prophase, prometaphase, meta (cytoplasm splits in two). G ₁ and G ₀ are of variables	appressors. M phase (shortest phase of cell cycle) phase, anaphase, telophase) and cytokinesis
REGULATION OF CELL CYCLE		
Cyclin-dependent kinases	Constitutively expressed but inactive when not bound to cyclin.	XX
Cyclins	Regulatory proteins that control cell cycle events; phase specific; activate CDKs.	G ₂ Mitosis M
Cyclin-CDK complexes	Phosphorylate other proteins to coordinate cell cycle progression; must be activated and inactivated at appropriate times for cell cycle to progress.	Chokinesis (1)
Tumor suppressors	p53 → p21 induction → CDK inhibition → Rb hypophosphorylation (activation) → G ₁ -S progression inhibition. Mutations in tumor suppressor genes can result in unrestrained cell division (eg, Li-Fraumeni syndrome). Growth factors (eg, insulin, PDGF, EPO, EGF) bind tyrosine kinase receptors to transition the cell from G ₁ to S phase.	Rb, p53 modulate G ₁ restriction point
CELL TYPES	*	
Permanent	Remain in G_0 , regenerate from stem cells.	Neurons, skeletal and cardiac muscle, RBCs.
Stable (quiescent)	Enter G_1 from G_0 when stimulated.	Hepatocytes, lymphocytes, PCT, periosteal cells.
Labile	Never go to G_0 , divide rapidly with a short G_1 . Most affected by chemotherapy.	Bone marrow, gut epithelium, skin, hair follicles germ cells.
Rough endoplasmic reticulum	Site of synthesis of secretory (exported) proteins and of N-linked oligosaccharide addition to lysosomal and other proteins. Nissl bodies (RER in neurons)—synthesize peptide neurotransmitters for secretion. Free ribosomes—unattached to any membrane; site of synthesis of cytosolic, peroxisomal, and mitochondrial proteins.	Mucus-secreting goblet cells of the small intestine and antibody-secreting plasma cells are rich in RER. Proteins within organelles (eg, ER, Golgi bodies lysosomes) are formed in RER.
Smooth endoplasmic reticulum	Site of steroid synthesis and detoxification of drugs and poisons. Lacks surface ribosomes. Location of glucose-6-phosphatase (last step of glycogenolysis).	Liver hepatocytes and steroid hormone— producing cells of the adrenal cortex and gonads are rich in SER.

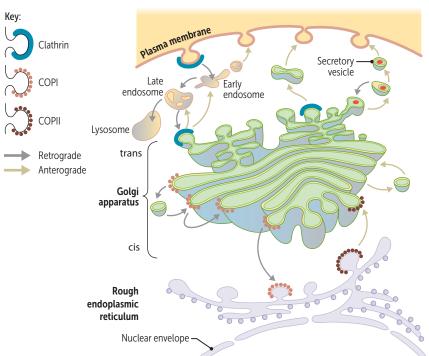
11/7/19 3:16 PM FAS1_2019_01-Biochem.indd 46

Cell trafficking

Golgi is distribution center for proteins and lipids from ER to vesicles and plasma membrane. Posttranslational events in Golgi include modifying N-oligosaccharides on asparagine, adding O-oligosaccharides on serine and threonine, and adding mannose-6-phosphate to proteins for lysosomal trafficking.

Endosomes are sorting centers for material from outside the cell or from the Golgi, sending it to lysosomes for destruction or back to the membrane/Golgi for further use.

I-cell disease (inclusion cell disease/mucolipidosis type II)—inherited lysosomal storage disorder (autosomal recessive); defect in N-acetylglucosaminyl-1-phosphotransferase → failure of the Golgi to phosphorylate mannose residues (↓ mannose-6-phosphate) on glycoproteins → proteins are secreted extracellularly rather than delivered to lysosomes. Results in coarse facial features, gingival hyperplasia, clouded corneas, restricted joint movements, claw hand deformities, kyphoscoliosis, and high plasma levels of lysosomal enzymes. Often fatal in childhood.



Signal recognition particle (SRP)

Abundant, cytosolic ribonucleoprotein that traffics polypeptide-ribosome complex from the cytosol to the RER. Absent or dysfunctional SRP → accumulation of protein in cytosol.

Vesicular trafficking proteins

COPI: Golgi → Golgi (retrograde); *cis*-Golgi → ER.

COPII: ER → *cis*-Golgi (anterograde).

"Two (COPII) steps forward (anterograde); one (COPI) step back (retrograde)."

Clathrin: *trans*-Golgi → lysosomes; plasma membrane → endosomes (receptor-mediated endocytosis [eg, LDL receptor activity]).

Peroxisome

Membrane-enclosed organelle involved in:

- β-oxidation of very-long-chain fatty acids (VLCFA) (strictly peroxisomal process)
- α-oxidation of branched-chain fatty acids (strictly peroxisomal process)
- Catabolism of amino acids and ethanol
- Synthesis of cholesterol, bile acids, and plasmalogens (important membrane phospholipid, especially in white matter of brain)

Zellweger syndrome—autosomal recessive disorder of peroxisome biogenesis due to mutated *PEX* genes. Hypotonia, seizures, hepatomegaly, early death.

Refsum disease—autosomal recessive disorder of α -oxidation \rightarrow phytanic acid not metabolized to pristanic acid. Scaly skin, ataxia, cataracts/night blindness, shortening of 4th toe, epiphyseal dysplasia. Treatment: diet, plasmapheresis.

Adrenoleukodystrophy—X-linked recessive disorder of β -oxidation due to mutation in ABCDI gene \rightarrow VLCFA buildup in adrenal glands, white (leuko) matter of brain, testes. Progressive disease that can lead to adrenal gland crisis, coma, and death.

FAS1_2019_01-Biochem.indd 47 11/7/19 3:16 PM

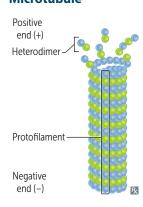
Proteasome

Barrel-shaped protein complex that degrades damaged or ubiquitin-tagged proteins. Defects in the ubiquitin-proteasome system have been implicated in some cases of Parkinson disease.

Cytoskeletal elements A network of protein fibers within the cytoplasm that supports cell structure, cell and organelle movement, and cell division.

TYPE OF FILAMENT	PREDOMINANT FUNCTION	EXAMPLES
Microfilaments	Muscle contraction, cytokinesis	Actin, microvilli.
Intermediate filaments	Maintain cell structure	Vimentin, desmin, cytokeratin, lamins, glial fibrillary acidic protein (GFAP), neurofilaments.
Microtubules	Movement, cell division	Cilia, flagella, mitotic spindle, axonal trafficking, centrioles.

Microtubule



Cylindrical outer structure composed of a helical array of polymerized heterodimers of α - and β -tubulin. Each dimer has 2 GTP bound. Incorporated into flagella, cilia, mitotic spindles. Grows slowly, collapses quickly. Also involved in slow axoplasmic transport in

Molecular motor proteins—transport cellular cargo toward opposite ends of microtubule.

- **RE**trograde to microtubule $(+ \rightarrow -)$ —**DY**nein.
- Anterograde to microtubule $(- \rightarrow +)$ —Kinesin.

Clostridium tetani, herpes simplex virus, poliovirus, and rabies virus use dynein for retrograde transport to the neuronal cell body. Drugs that act on microtubules (Microtubules

Get Constructed Very Poorly):

- Mebendazole (antihelminthic)
- Griseofulvin (antifungal)
- Colchicine (antigout)
- Vincristine/Vinblastine (anticancer)
- Paclitaxel (anticancer)

Negative end Near Nucleus.

Positive end Points to Periphery.

REaDY? AttacK!

FAS1_2019_01-Biochem.indd 48 11/7/19 3:16 PM

Cilia structure

9 doublet + 2 singlet arrangement of microtubules A.

Basal body (base of cilium below cell membrane) consists of 9 microtubule triplets **B** with no central microtubules.

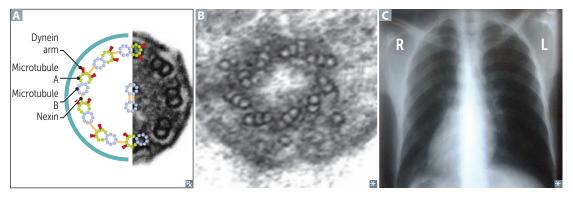
Axonemal dynein—ATPase that links peripheral

9 doublets and causes bending of cilium by differential sliding of doublets.

Gap junctions enable coordinated ciliary movement.

Kartagener syndrome (1° ciliary dyskinesia)—

immotile cilia due to a dynein arm defect. Autosomal recessive. Results in ↓ male and female fertility due to immotile sperm and dysfunctional fallopian tube cilia, respectively; ↑ risk of ectopic pregnancy. Can cause bronchiectasis, recurrent sinusitis, chronic ear infections, conductive hearing loss, and situs inversus (eg, dextrocardia on CXR). ↓ nasal nitric oxide (used as screening test). (Kartagener's restaurant: take-out only; there's no dynein "dine-in".)



Sodium-potassium pump

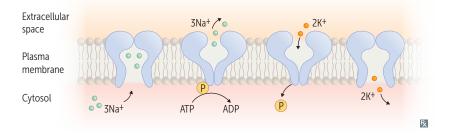
Na⁺-K⁺ ATPase is located in the plasma membrane with ATP site on cytosolic side. For each ATP consumed, 3 Na⁺ leave the cell (pump phosphorylated) and 2 K⁺ enter the cell (pump dephosphorylated).

Plasma membrane is an asymmetric lipid bilayer containing cholesterol, phospholipids, sphingolipids, glycolipids, and proteins.

Pumpkin = pump K^+ in.

Ouabain (a cardiac glycoside) inhibits by binding to K⁺ site.

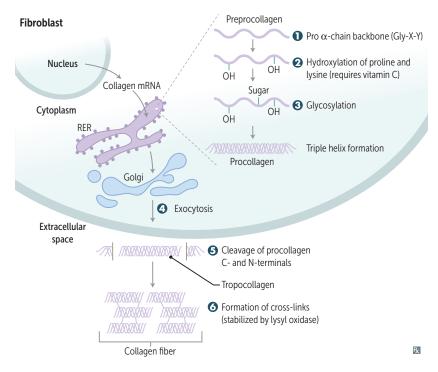
Cardiac glycosides (digoxin and digitoxin) directly inhibit the Na⁺-K⁺ ATPase, which leads to indirect inhibition of Na⁺/Ca²⁺ exchange $\rightarrow \uparrow$ [Ca²⁺]_i $\rightarrow \uparrow$ cardiac contractility.



FAS1_2019_01-Biochem.indd 49 11/7/19 3:16 PM

Collagen	Most abundant protein in the human body. Extensively modified by posttranslational modification. Organizes and strengthens extracellular matrix.	Be So Totally Cool, Read Books.
Туре І	Most common (90%)—Bone (made by osteoblasts), Skin, Tendon, dentin, fascia, cornea, late wound repair.	Type I : bone. ↓ production in osteogenesis imperfecta type I.
Type II	Cartilage (including hyaline), vitreous body, nucleus pulposus.	Type II: cartwolage.
Type III	Reticulin—skin, blood vessels, uterus, fetal tissue, early wound repair.	Type III: deficient in the uncommon, vascular type of Ehlers-Danlos syndrome (ThreE D).
Type IV	Basement membrane (basal lamina), lens.	Type IV: under the floor (basement membrane). Defective in Alport syndrome; targeted by autoantibodies in Goodpasture syndrome.

Collagen synthesis and structure



- Synthesis—translation of collagen α chains (preprocollagen)—usually Gly-X-Y (X and Y are proline or lysine). Collagen is ½ glycine; glycine content of collagen is less variable than that of lysine and proline. Hydroxyproline is used for lab quantification of collagen.
- 2 Hydroxylation—hydroxylation of specific proline and lysine residues. Requires vitamin C; deficiency → scurvy.
- 3 Glycosylation—glycosylation of pro-α-chain hydroxylysine residues and formation of procollagen via hydrogen and disulfide bonds (triple helix of 3 collagen α chains). Problems forming triple helix → osteogenesis imperfecta.
- Exocytosis—exocytosis of procollagen into extracellular space.
- Proteolytic processing—cleavage of disulfide-rich terminal regions of procollagen
 → insoluble tropocollagen.
- 6 Cross-linking—reinforcement of many staggered tropocollagen molecules by covalent lysine-hydroxylysine cross-linkage (by copper-containing lysyl oxidase) to make collagen fibrils. Problems with cross-linking
 - → Menkes disease.

FAS1_2019_01-Biochem.indd 50 11/7/19 3:16 PM

Osteogenesis imperfecta



Genetic bone disorder (brittle bone disease) caused by a variety of gene defects (most commonly *COL1A1* and *COL1A2*).

Most common form is autosomal dominant with ↓ production of otherwise normal type I collagen. Manifestations include:

- Multiple fractures and bone deformities after minimal trauma (eg, during birth)
- Blue sclerae B due to the translucent connective tissue over choroidal veins
- Some forms have tooth abnormalities, including opalescent teeth that wear easily due to lack of dentin (dentinogenesis imperfecta)
- Conductive hearing loss (abnormal ossicles)

May be confused with child abuse.

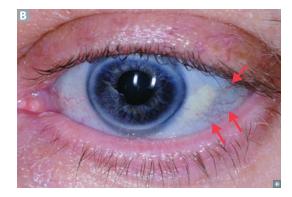
Treat with bisphosphonates to ↓ fracture risk. Patients can't **BITE**:

Bones = multiple fractures

I (eye) = blue sclerae

Teeth = dental imperfections

 \mathbf{E} ar = hearing loss



Ehlers-Danlos syndrome

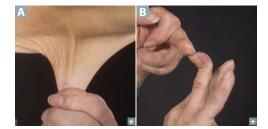
Faulty collagen synthesis causing hyperextensible skin A, hypermobile joints B, and tendency to bleed (easy bruising).

Multiple types. Inheritance and severity vary. Can be autosomal dominant or recessive. May be associated with joint dislocation, berry and aortic aneurysms, organ rupture.

Hypermobility type (joint instability): most common type.

Classical type (joint and skin symptoms): caused by a mutation in type V collagen (eg, COL5A1, COL5A2).

Vascular type (fragile tissues including vessels [eg, aorta], muscles, and organs that are prone to rupture [eg, gravid uterus]): mutations in type III procollagen (eg, COL3A1).

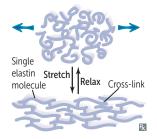


Menkes disease

X-linked recessive connective tissue disease caused by impaired copper absorption and transport due to defective Menkes protein (ATP7A, vs ATP7B in Wilson disease). Low copper levels (vs high levels in Wilson disease). Leads to ↓ activity of lysyl oxidase (copper is a necessary cofactor) → defective collagen. Results in brittle, "kinky" hair, growth retardation, hypotonia, † risk of cerebral aneurysms.

FAS1_2019_01-Biochem.indd 51 11/7/19 3:16 PM

Elastin



Stretchy protein within skin, lungs, large arteries, elastic ligaments, vocal cords, ligamenta flava (connect vertebrae → relaxed and stretched conformations).

Rich in nonhydroxylated proline, glycine, and lysine residues, vs the hydroxylated residues of collagen.

Tropoelastin with fibrillin scaffolding.

Cross-linking takes place extracellularly and gives elastin its elastic properties.

Broken down by elastase, which is normally inhibited by α_1 -antitrypsin.

 α_{l} -Antitrypsin deficiency results in unopposed elastase activity, which can cause COPD.

Changes with aging: ↓ dermal collagen and elastin, ↓ synthesis of collagen fibrils; cross-linking remains normal.

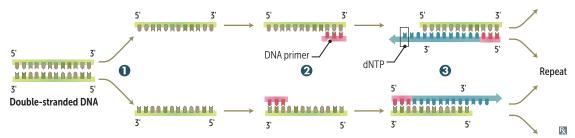


Marfan syndrome—autosomal dominant (with variable expression) connective tissue disorder affecting skeleton, heart, and eyes. *FBN1* gene mutation on chromosome 15 (fifteen) results in defective fibrillin, a glycoprotein that forms a sheath around elastin. Findings: tall with long extremities; pectus carinatum (more specific) or pectus excavatum A; hypermobile joints; long, tapering fingers and toes (arachnodactyly); cystic medial necrosis of aorta; aortic root aneurysm rupture or dissection (most common cause of death); mitral valve prolapse. Subluxation of lenses, typically upward and temporally (vs downward and medially in homocystinuria).

▶ BIOCHEMISTRY—LABORATORY TECHNIQUES

Polymerase chain reaction

Molecular biology lab procedure used to amplify a desired fragment of DNA. Useful as a diagnostic tool (eg, neonatal HIV, herpes encephalitis).



- **1 Denaturation**—DNA is heated to ~95°C to separate the strands.
- ② Annealing—Sample is cooled to ~55°C. DNA primers, a heat-stable DNA polymerase (*Taq*), and deoxynucleotide triphosphates (dNTPs) are added. DNA primers anneal to the specific sequence to be amplified on each strand.
- **3 Elongation**—Temperature is increased to ~72°C. DNA polymerase attaches dNTPs to the strand to replicate the sequence after each primer.

Heating and cooling cycles continue until the DNA sample size is sufficient.

Reverse transcriptase polymerase chain reaction

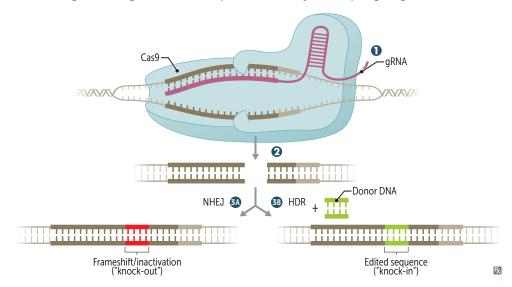
Detects and quantifies mRNA levels in a sample. Uses reverse transcription to create a complementary DNA template that is amplified via standard PCR procedure.

FAS1 2019 01-Biochem.indd 52 11/7/19 3:16 PM

CRISPR/Cas9

A genome editing tool derived from bacteria. Consists of a guide RNA (gRNA) ①, which is complementary to a target DNA sequence, and an endonuclease (Cas9), which makes a single-or double-strand break at the target site ②. Break imperfectly repaired by nonhomologous end joining (NHEJ) → accidental frameshift mutations ("knock-out") ③, or a donor DNA sequence can be added to fill in the gap using homology-directed repair (HDR) ③.

Not used clinically. Potential applications include removing virulence factors from pathogens, replacing disease-causing alleles of genes with healthy variants, and specifically targeting tumor cells.



Blotting procedures

Southern blot	 DNA sample is enzymatically cleaved into smaller pieces, which are separated on a gel by electrophoresis, and then transferred to a 		I: Parents
	filter.	PEDICREE	II: Children
	2. Filter is exposed to radiolabeled DNA probe that recognizes and anneals to its	Aa Aa aa Aa AA	Genotype
	complementary strand. 3. Resulting double-stranded, labeled piece of DNA is visualized when filter is exposed to film.	SOUTHERN BLOT	Mutant ■ Normal
Northern blot	Similar to Southern blot, except that an RNA sample is electrophoresed. Useful for studying mRNA levels, which are reflective of gene expression.	SNoW DRoP: Southern = DNA	
Western blot	Sample protein is separated via gel electrophoresis and transferred to a membrane. Labeled antibody is used to bind to relevant protein .	Northern = RNA Western = Protein	
Southwestern blot	Identifies DNA-binding proteins (eg, c-Jun, c-Fos [leucine zipper motif]) using labeled double-stranded DNA probes.		

FAS1_2019_01-Biochem.indd 53 11/7/19 3:16 PM

Flow cytometry

Laboratory technique to assess size, granularity, and protein expression (immunophenotype) of individual cells in a sample.

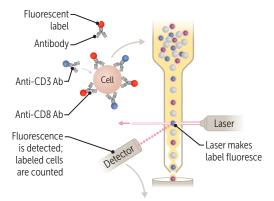
Cells are tagged with antibodies specific to surface or intracellular proteins. Antibodies are then tagged with a unique fluorescent dye. Sample is analyzed one cell at a time by focusing a laser on the cell and measuring light scatter and intensity of fluorescence.

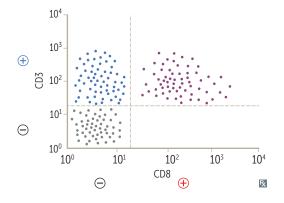
Data are plotted either as histogram (one measure) or scatter plot (any two measures, as shown). In illustration:

- Cells in left lower quadrant

 for both CD8 and CD3.
- Cells in right lower quadrant ⊕ for CD8 and ⊝ for CD3. In this example, right lower quadrant is empty because all CD8-expressing cells also express CD3.
- Cells in left upper quadrant ⊕ for CD3 and ⊕ for CD8.
- Cells in right upper quadrant ⊕ for both CD8 and CD3.

Commonly used in workup of hematologic abnormalities (eg, leukemia, paroxysmal nocturnal hemoglobinuria, fetal RBCs in mother's blood) and immunodeficiencies (eg, CD4⁺ cell count in HIV).





Microarrays

Thousands of nucleic acid sequences are arranged in grids on glass or silicon. DNA or RNA probes are hybridized to the chip, and a scanner detects the relative amounts of complementary binding. Used to profile gene expression levels of thousands of genes simultaneously to study certain diseases and treatments. Able to detect single nucleotide polymorphisms (SNPs) and copy number variations (CNVs) for a variety of applications including genotyping, clinical genetic testing, forensic analysis, cancer mutations, and genetic linkage analysis.

Enzyme-linked immunosorbent assay

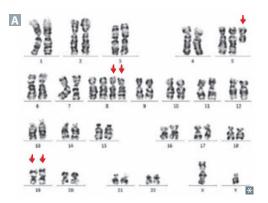
Immunologic test used to detect the presence of either a specific antigen or antibody in a patient's blood sample. Detection involves the use of an antibody linked to an enzyme. Added substrate reacts with enzyme, producing a detectable signal. Can have high sensitivity and specificity, but is less specific than Western blot.

FAS1_2019_01-Biochem.indd 54 11/7/19 3:16 PM

Karyotyping

Colchicine is added to cultured cells to halt chromosomes in metaphase. Chromosomes are stained, ordered, and numbered according to morphology, size, arm-length ratio, and banding pattern (arrows in A point to extensive abnormalities in a cancer cell).

Can be performed on a sample of blood, bone marrow, amniotic fluid, or placental tissue. Used to diagnose chromosomal imbalances (eg, autosomal trisomies, sex chromosome disorders).

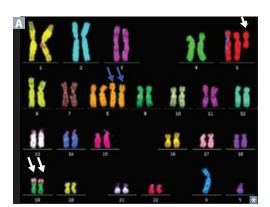


Fluorescence in situ hybridization

Fluorescent DNA or RNA probe binds to specific gene site of interest on chromosomes (arrows in A point to abnormalities in a cancer cell, whose karyotype is seen above; each fluorescent color represents a chromosomespecific probe).

Used for specific localization of genes and direct visualization of chromosomal anomalies at the molecular level.

- Microdeletion—no fluorescence on a chromosome compared to fluorescence at the same locus on the second copy of that chromosome.
- Translocation—fluorescence signal that corresponds to one chromosome is found in a different chromosome (two white arrows in A show fragments of chromosome 17 that have translocated to chromosome 19).
- Duplication—a second copy of a chromosome, resulting in a trisomy or tetrasomy (two blue arrows show duplicated chromosomes 8, resulting in a tetrasomy).



Molecular cloning

Production of a recombinant DNA molecule in a bacterial host.

- 1. Isolate eukaryotic mRNA (post-RNA processing) of interest.
- 2. Add reverse transcriptase (an RNA-dependent DNA polymerase) to produce complementary DNA (cDNA, lacks introns).
- 3. Insert cDNA fragments into bacterial plasmids containing antibiotic resistance genes.
- 4. Transform (insert) recombinant plasmid into bacteria.
- 5. Surviving bacteria on antibiotic medium produce cloned DNA (copies of cDNA).

FAS1_2019_01-Biochem.indd 55

56

SECTION II BIOCHEMISTRY → BIOCHEMISTRY—GENETICS

Transgenic strategies in mice involve: Random insertion of gene into mouse genome Targeted insertion or deletion of gene through homologous recombination with mouse gene		Knock-out = removing a gene, taking it out. Knock-in = inserting a gene. Random insertion—constitutive expression. Targeted insertion—conditional expression.
Cre-lox system Can inducibly manipulate genes at specific developmental points (eg, to study a gene whose deletion causes embryonic death).		opmental points (eg, to study a gene whose
RNA interference Process whereby small non-coding RNA molecules target mRNAs to inhibit gene exp		es target mRNAs to inhibit gene expression.
MicroRNA (miRNA) Naturally produced by the cell as hairpin structures. Loose nucleotide pairing allows to certain r		Abnormal expression of miRNAs contributes to certain malignancies (eg, by silencing an mRNA from a tumor suppressor gene).
Small interfering RNA (siRNA) Usually derived from exogenous dsRNA source (eg, virus). Once inside a cell, siRNA requires complete nucleotide pairing, leading to highly specific mRNA targeting. Results in mRNA cleavage prior to translation.		Can be produced by in vitro transcription for gene "knockdown" experiments.

▶ BIOCHEMISTRY—GENETICS

Genetic terms

TERM	DEFINITION	EXAMPLE	
Codominance	Both alleles contribute to the phenotype of the heterozygote.	Blood groups A, B, AB; α _l -antitrypsin deficiency; HLA groups.	
Variable expressivity	Patients with the same genotype have varying phenotypes.	2 patients with neurofibromatosis type 1 (NF1) may have varying disease severity.	
Incomplete penetrance	Not all individuals with a mutant genotype show the mutant phenotype. % penetrance × probability of inheriting genotype = risk of expressing phenotype.	BRCA1 gene mutations do not always result in breast or ovarian cancer.	
Pleiotropy	One gene contributes to multiple phenotypic effects.	Untreated phenylketonuria (PKU) manifests with light skin, intellectual disability, and musty body odor.	
Anticipation	Increased severity or earlier onset of disease in succeeding generations.	Trinucleotide repeat diseases (eg, Huntington disease).	
Loss of heterozygosity	If a patient inherits or develops a mutation in a tumor suppressor gene, the complementary allele must be deleted/mutated before cancer develops. This is not true of oncogenes.	Retinoblastoma and the "two-hit hypothesis," Lynch syndrome (HNPCC), Li-Fraumeni syndrome.	

11/7/19 3:16 PM FAS1_2019_01-Biochem.indd 56

Genetic terms (continued)

TERM	DEFINITION	EXAMPLE
Dominant negative mutation	Exerts a dominant effect. A heterozygote produces a nonfunctional altered protein that also prevents the normal gene product from functioning.	A single mutated <i>p53</i> tumor suppressor gene results in a protein that is able to bind DNA and block the nonmutated p53 from binding to the promoter.
Linkage disequilibrium	Tendency for certain alleles at 2 linked loci to occur together more or less often than expected by chance. Measured in a population, not in a family, and often varies in different populations.	
Mosaicism	Presence of genetically distinct cell lines in the same individual. Somatic mosaicism—mutation arises from mitotic errors after fertilization and propagates through multiple tissues or organs. Gonadal mosaicism—mutation only in egg or sperm cells. If parents and relatives do not have the disease, suspect gonadal (or germline) mosaicism.	McCune-Albright syndrome —due to G _s -protein activating mutation. Presents with unilateral café-au-lait spots A with ragged edges, polyostotic fibrous dysplasia (bone is replaced by collagen and fibroblasts), and at least one endocrinopathy (eg, precocious puberty). Lethal if mutation occurs before fertilization (affecting all cells), but survivable in patients with mosaicism.
Locus heterogeneity	Mutations at different loci can produce a similar phenotype.	Albinism.
Allelic heterogeneity	Different mutations in the same locus produce the same phenotype.	β-thalassemia.
Heteroplasmy	Presence of both normal and mutated mtDNA, resulting in variable expression in mitochondrially inherited disease.	mtDNA passed from mother to all children.
Uniparental disomy	Offspring receives 2 copies of a chromosome from 1 parent and no copies from the other parent. HeterodIsomy (heterozygous) indicates a meiosis I error. IsodIsomy (homozygous) indicates a meiosis II error or postzygotic chromosomal duplication of one of a pair of chromosomes, and loss of the other of the original pair.	Uniparental is euploid (correct number of chromosomes). Most occurrences of uniparental disomy (UPD) → normal phenotype. Consider isodisomy in an individual manifesting a recessive disorder when only one parent is a carrier. Examples: Prader-Willi and Angelman syndromes.

Hardy-Weinberg population genetics

	A (p)	a (q)
A (p)	AA (p²)	Aa (<mark>pq</mark>)
a (q)	Aa (<mark>pq</mark>)	aa (q²)

If \mathbf{p} and \mathbf{q} represent the frequencies of alleles A and a, respectively, in a population, then $\mathbf{p} + \mathbf{q} = 1$:

- \mathbf{p}^2 = frequency of homozygosity for allele A
- q^2 = frequency of homozygosity for allele a
- 2pq = frequency of heterozygosity (carrier frequency, if an autosomal recessive disease)

Therefore, the sum of the frequencies of these genotypes is $\mathbf{p}^2 + 2\mathbf{p}\mathbf{q} + \mathbf{q}^2 = 1$.

The frequency of an X-linked recessive disease in males = q and in females = q^2 .

Hardy-Weinberg law assumptions include:

- No mutation occurring at the locus
- Natural selection is not occurring
- Completely random mating
- No net migration
- Large population

If a population is in Hardy-Weinberg equilibrium, then the values of p and q remain constant from generation to generation.

FAS1_2019_01-Biochem.indd 57 11/7/19 3:16 PM

58 SECTION

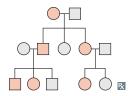
SECTION II BIOCHEMISTRY ▶ BIOCHEMISTRY—GENETICS

	→ parent-of-origin effects.	
	Prader-Willi syndrome	AngelMan syndrome
WHICH GENE IS SILENT?	Maternally derived genes are silenced Disease occurs when the Paternal allele is deleted or mutated	Paternally derived <i>UBE3A</i> is silenced Disease occurs when the Maternal allele is deleted or mutated
SIGNS AND SYMPTOMS	Hyperphagia, obesity, intellectual disability, hypogonadism, hypotonia	Seizures, Ataxia, severe Intellectual disability, inappropriate Laughter ("happy puppet") Set SAIL for Angel Island
CHROMOSOMES INVOLVED	Chromosome 15 of paternal origin	UBE3A on maternal copy of chromosome 15
NOTES	25% of cases are due to maternal uniparental disomy	5% of cases are due to paternal uniparental disomy
	Prader has no Dad (Paternal Deletion)	MDs are angels (Maternal Deletion)

FAS1_2019_01-Biochem.indd 58 11/7/19 3:16 PM

Modes of inheritance

Autosomal dominant

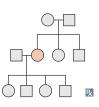


Often due to defects in structural genes. Many generations, both males and females are affected.



Often pleiotropic (multiple apparently unrelated effects) and variably expressive (different between individuals). Family history crucial to diagnosis. With one affected (heterozygous) parent, on average, ½ of children affected.

Autosomal recessive



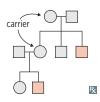
With 2 carrier (heterozygous) parents, on average: 1/4 of children will be affected (homozygous), ½ of children will be carriers, and ¼ of children will be neither affected nor carriers.

	Α	a
Α	AA	Aa
a	Aa	aa

Often due to enzyme deficiencies. Usually seen in only 1 generation. Commonly more severe than dominant disorders; patients often present in childhood.

† risk in consanguineous families. Unaffected individual with affected sibling has 2/3 probability of being a carrier.

X-linked recessive

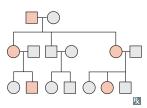


Sons of heterozygous mothers have a 50% chance of being affected. No male-to-male transmission. Skips generations.

	Χ	Χ		Χ	Х
Χ	XX	XX	Χ	XX	XX
Υ	XY	XY	Υ	XY	XY

Commonly more severe in males. Females usually must be homozygous to be affected.

X-linked dominant

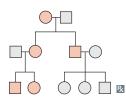


Transmitted through both parents. Mothers transmit to 50% of daughters and sons; fathers transmit to all daughters but no sons.

	Χ	Χ		Χ	Χ	
	XX	XX	Χ	XX	XX	
,	XY	XY	Υ	XY	XY	

Examples: fragile X syndrome, Alport syndrome, hypophosphatemic rickets (also called X-linked hypophosphatemia)—phosphate wasting at proximal tubule → rickets-like presentation.

Mitochondrial inheritance



Transmitted only through the mother. All offspring of affected females may show signs of disease.

Variable expression in a population or even within a family due to heteroplasmy.

Mitochondrial myopathies—rare disorders; often present with myopathy, lactic acidosis, and CNS disease, eg, MELAS syndrome (mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episodes). 2° to failure in oxidative phosphorylation. Muscle biopsy often shows "ragged red fibers" (due to accumulation of diseased mitochondria in the subsarcolemma of the muscle fiber).

Leber hereditary optic neuropathy—cell death in optic nerve neurons → subacute

bilateral vision loss in teens/young adults, 90% males. Usually permanent.





FAS1 2019 01-Biochem.indd 59 11/7/19 3:16 PM

Autosomal dominant diseases

Achondroplasia, autosomal dominant polycystic kidney disease, familial adenomatous polyposis, familial hypercholesterolemia, hereditary hemorrhagic telangiectasia (Osler-Weber-Rendu syndrome), hereditary spherocytosis, Huntington disease, Li-Fraumeni syndrome, Marfan syndrome, multiple endocrine neoplasias, myotonic muscular dystrophy, neurofibromatosis type 1 (von Recklinghausen disease), neurofibromatosis type 2, tuberous sclerosis, von Hippel-Lindau disease.

Autosomal recessive diseases

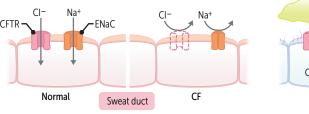
Oculocutaneous albinism, autosomal recessive polycystic kidney disease (ARPKD), cystic fibrosis, Friedreich ataxia, glycogen storage diseases, hemochromatosis, Kartagener syndrome, mucopolysaccharidoses (except Hunter syndrome), phenylketonuria, sickle cell anemia, sphingolipidoses (except Fabry disease), thalassemias, Wilson disease.

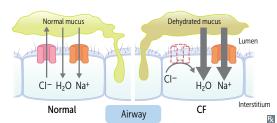
Cystic fibrosis

GENETICS	Autosomal recessive; defect in CFTR gene on chromosome 7; commonly a deletion of Phe508. Most common lethal genetic disease in Caucasian population.
PATHOPHYSIOLOGY	CFTR encodes an ATP-gated Cl ⁻ channel that secretes Cl ⁻ in lungs and GI tract, and reabsorbs Cl ⁻ in sweat glands. Most common mutation → misfolded protein → protein retained in RER and not transported to cell membrane, causing ↓ Cl ⁻ (and H ₂ O) secretion; ↑ intracellular Cl ⁻ results in compensatory ↑ Na ⁺ reabsorption via epithelial Na ⁺ channels (ENaC) → ↑ H ₂ O reabsorption → abnormally thick mucus secreted into lungs and GI tract. ↑ Na ⁺ reabsorption also causes more negative transepithelial potential difference.
DIAGNOSIS	↑ Cl ⁻ concentration in pilocarpine-induced sweat test is diagnostic. Can present with contraction alkalosis and hypokalemia (ECF effects analogous to a patient taking a loop diuretic) because of ECF H ₂ O/Na ⁺ losses via sweating and concomitant renal K ⁺ /H ⁺ wasting. ↑ immunoreactive trypsinogen (newborn screening).
COMPLICATIONS	Recurrent pulmonary infections (eg, <i>S aureus</i> [infancy and early childhood], <i>P aeruginosa</i> [adulthood], allergic bronchopulmonary aspergillosis [ABPA]), chronic bronchitis and bronchiectasis → reticulonodular pattern on CXR, opacification of sinuses. Pancreatic insufficiency, malabsorption with steatorrhea, fat-soluble vitamin deficiencies (A, D, E, K), biliary cirrhosis, liver disease. Meconium ileus in newborns. Infertility in men (absence of vas deferens, spermatogenesis may be unaffected) and subfertility in women (amenorrhea, abnormally thick cervical mucus). Nasal polyps, clubbing of nails.

TREATMENT

Multifactorial: chest physiotherapy, albuterol, aerosolized dornase alfa (DNase), and hypertonic saline facilitate mucus clearance. Azithromycin used as anti-inflammatory agent. Ibuprofen slows disease progression. Pancreatic enzyme replacement therapy for pancreatic insufficiency. In patients with Phe508 deletion: combination of lumacaftor (corrects misfolded proteins and improves their transport to cell surface) and ivacaftor (opens Cl⁻ channels → improved chloride transport).





FAS1_2019_01-Biochem.indd 60 11/7/19 3:16 PM

X-linked recessive disorders

Ornithine transcarbamylase deficiency, Fabry disease, Wiskott-Aldrich syndrome, Ocular albinism, G6PD deficiency, Hunter syndrome, Bruton agammaglobulinemia, Hemophilia A and B, Lesch-Nyhan syndrome, Duchenne (and Becker) muscular dystrophy.

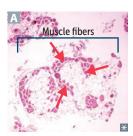
X-inactivation (lyonization)—one copy of female X chromosome forms a transcriptionally inactive Barr body. Female carriers variably affected depending on the pattern of inactivation of the X chromosome carrying the mutant vs normal gene.

Oblivious Female Will Often Give Her Boys Her x-Linked Disorders

Females with Turner syndrome (45,XO) are more likely to have an X-linked recessive disorder.

Muscular dystrophies

Duchenne



X-linked disorder typically due to **frameshift** deletions or nonsense mutations → truncated or absent dystrophin protein → progressive myofiber damage. Weakness begins in pelvic girdle muscles and progresses superiorly. Pseudohypertrophy of calf muscles due to fibrofatty replacement of muscle A. Waddling gait.

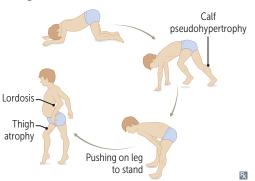
Onset before 5 years of age. Dilated cardiomyopathy is common cause of death. **Gowers sign**—patient uses upper extremities to help stand up. Classically seen in Duchenne muscular dystrophy, but also seen in other muscular dystrophies and inflammatory

myopathies (eg, polymyositis).

Duchenne = deleted dystrophin.

Dystrophin gene (*DMD*) is the largest protein-coding human gene $\rightarrow \uparrow$ chance of spontaneous mutation. Dystrophin helps anchor muscle fibers, primarily in skeletal and cardiac muscle. It connects the intracellular cytoskeleton (actin) to the transmembrane proteins α - and β -dystroglycan, which are connected to the extracellular matrix (ECM). Loss of dystrophin \rightarrow myonecrosis.

† CK and aldolase; genetic testing confirms diagnosis.



Becker

X-linked disorder typically due to **non-frameshift** deletions in dystrophin gene (partially functional instead of truncated).

Less severe than Duchenne (**B**ecker is **b**etter).

Onset in adolescence or early adulthood.

Deletions can cause both Duchenne and Becker muscular dystrophies. ²/₃ of cases have large deletions spanning one or more exons.

Myotonic dystrophy

Autosomal dominant. **CTG** trinucleotide repeat expansion in the *DMPK* gene → abnormal expression of myotonin protein kinase → myotonia (eg, difficulty releasing hand from handshake), muscle wasting, cataracts, testicular atrophy, frontal balding, arrhythmia.

Autosomal dominant. CTG trinucleotide repeat expansion in the *DMPK* gene → abnormal atrophy. Cataracts, Toupee (early balding in men), Gonadal atrophy.

FAS1_2019_01-Biochem.indd 61 11/7/19 3:16 PM

Rett syndrome

Sporadic disorder seen almost exclusively in girls (affected males die in utero or shortly after birth). Most cases are caused by de novo mutation of *MECP2* on X chromosome. Symptoms of **Rett** syndrome usually appear between ages 1–4 and are characterized by regression (**Rett**urn) in motor, verbal, and cognitive abilities; ataxia; seizures; growth failure; and stereotyped handwringing.

Fragile X syndrome

X-linked dominant inheritance. Trinucleotide repeat in *FMR1* gene → hypermethylation → ↓ expression. Most common inherited cause of intellectual disability (Down syndrome is the most common genetic cause, but most cases occur sporadically).

Findings: post-pubertal macroorchidism (enlarged testes), long face with a large jaw, large everted ears, autism, mitral valve prolapse, hypermobile joints.

Trinucleotide repeat expansion $[(CGG)_n]$ occurs during oogenesis.

Trinucleotide repeat expansion diseases

Huntington disease, myotonic dystrophy, fragile X syndrome, and Friedreich ataxia.

May show genetic anticipation (disease severity

↑ and age of onset ↓ in successive generations).

Try (trinucleotide) hunting for my fragile cagefree eggs (X).

DISEASE	TRINUCLEOTIDE REPEAT	MODE OF INHERITANCE	MNEMONIC
Huntington disease	$(CAG)_n$	AD	Caudate has ↓ ACh and GABA
Myotonic dystrophy	(CTG) _n	AD	Cataracts, Toupee (early balding in men), Gonadal atrophy in men, reduced fertility in women
Fragile X syndrome	$(\mathbf{CGG})_{n}$	XD	Chin (protruding), Giant Gonads
Friedreich ataxia	(GAA) _n	AR	Ataxic GAAit

FAS1_2019_01-Biochem.indd 62 11/7/19 3:16 PM

Autosomal trisomies

Down syndrome (trisomy 21)



Single palmar crease

Findings: intellectual disability, flat facies, prominent epicanthal folds, single palmar crease, incurved 5th finger, gap between 1st 2 toes, duodenal atresia, Hirschsprung disease, congenital heart disease (eg, ASD), Brushfield spots. Associated with early-onset Alzheimer disease (chromosome 21 codes for amyloid precursor protein), † risk of AML/ALL.

95% of cases due to meiotic nondisjunction († with advanced maternal age; from 1:1500 in women < 20 to 1:25 in women > 45 years old).

4% of cases due to unbalanced Robertsonian translocation, most typically between chromosomes 14 and 21. Only 1% of cases are due to postfertilization mitotic error.

Incidence 1:700.

Drinking age (21).

Most common viable chromosomal disorder and most common cause of genetic intellectual disability.

First-trimester ultrasound commonly shows

† nuchal translucency and hypoplastic nasal
bone. Markers for Down syndrome are HI up:
† hCG, † inhibin.

The **5 A**'s of Down syndrome:

- Advanced maternal age
- Atresia (duodenal)
- Atrioventricular septal defect
- Alzheimer disease (early onset)
- AML/ALL

Edwards syndrome (trisomy 18)



Overlapping fingers 🛚

Findings: PRINCE Edward—Prominent occiput, Rocker-bottom feet, Intellectual disability, Nondisjunction, Clenched fists with overlapping fingers, low-set Ears, micrognathia (small jaw), congenital heart disease, omphalocele, myelomeningocele. Death usually occurs by age 1 year.

Incidence 1:8000.

Election age (18).

2nd most common autosomal trisomy resulting in live birth (most common is Down syndrome).

Patau syndrome (trisomy 13)



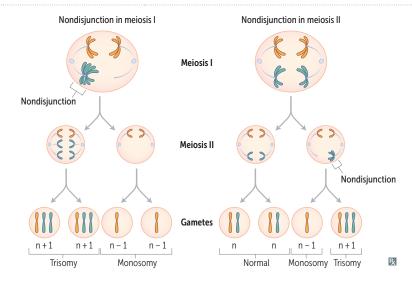
Cutis aplasia 🛚 🗵

Findings: severe intellectual disability, rockerbottom feet, microphthalmia, microcephaly, cleft liP/Palate, holoProsencephaly, Polydactyly, cutis aPlasia, congenital heart (Pump) disease, Polycystic kidney disease, omphalocele. Death usually occurs by age 1. Incidence 1:15,000.

Puberty (13).

Defect in fusion of prechordal mesoderm

→ midline defects.



1st trimester screening			
Trisomy	β-hCG	PAPP-A	
21	t	1	
18	1	1	
13	1	1	

2nd trimester screening					
Trisomy	β-hCG	Inhibin A	Estriol	AFP	
21	t	t	1	ţ	
18	1	— or ↓	1	1	
13	_	_	_	_	

FAS1_2019_01-Biochem.indd 63 11/7/19 3:16 PM

Genetic disorders by chromosome

CHROMOSOME	SELECTED EXAMPLES		
3	von Hippel-Lindau disease, renal cell carcinoma		
4	ADPKD (PKD2), achondroplasia, Huntington disease		
5	Cri-du-chat syndrome, familial adenomatous polyposis		
6	Hemochromatosis (HFE)		
7	Williams syndrome, cystic fibrosis		
9	Friedreich ataxia, tuberous sclerosis (TSCl)		
11	Wilms tumor, β -globin gene defects (eg, sickle cell disease, β -thalassemia), MEN1		
13	Patau syndrome, Wilson disease, retinoblastoma (RBI), BRCA2		
15	Prader-Willi syndrome, Angelman syndrome, Marfan syndrome		
16	ADPKD (PKD1), α-globin gene defects (eg, α-thalassemia), tuberous sclerosis (TSC2)		
17	Neurofibromatosis type 1, BRCA1, TP53		
18	Edwards syndrome		
21	Down syndrome		
22	Neurofibromatosis type 2, DiGeorge syndrome (22q11)		
X	Fragile X syndrome, X-linked agammaglobulinemia, Klinefelter syndrome (XXY)		

Robertsonian translocation

Chromosomal translocation that commonly involves chromosome pairs 21, 22, 13, 14, and 15. One of the most common types of translocation. Occurs when the long arms of 2 acrocentric chromosomes (chromosomes with centromeres near their ends) fuse at the centromere and the 2 short arms are lost.

Balanced translocations normally do not cause any abnormal phenotype. Unbalanced translocations can result in miscarriage, stillbirth, and chromosomal imbalance (eg, Down syndrome, Patau syndrome).

Cri-du-chat syndrome

Cri du chat = **cry** of the **cat**. Congenital deletion on short arm of chromosome 5 (46,XX or XY, 5p–).

Findings: microcephaly, moderate to severe intellectual disability, high-pitched **cry**ing/**meow**ing, epicanthal folds, cardiac abnormalities (VSD).

Williams syndrome



Congenital microdeletion of long arm of chromosome 7 (deleted region includes elastin gene). Findings: distinctive "elfin" facies A, intellectual disability, hypercalcemia, well-developed verbal skills, extreme friendliness with strangers, cardiovascular problems (eg, supravalvular aortic stenosis, renal artery stenosis). Think Will Ferrell in Elf.

FAS1_2019_01-Biochem.indd 64 11/7/19 3:16 PM

▶ BIOCHEMISTRY—NUTRITION

Vitamins: fat soluble

A, D, E, K. Absorption dependent on ileum and pancreas. Toxicity more common than for water-soluble vitamins because fat-soluble vitamins accumulate in fat.

Malabsorption syndromes with steatorrhea (eg, cystic fibrosis and celiac disease) or mineral oil intake can cause fat-soluble vitamin deficiencies.

Vitamins: water soluble

B₁ (thiamine: TPP)

B₂ (riboflavin: FAD, FMN)

B₃ (niacin: NAD⁺)

B₅ (pantothenic acid: CoA) B₆ (pyridoxine: PLP)

B₇ (biotin) B₉ (folate) B_{12} (cobalamin) C (ascorbic acid) All wash out easily from body except B₁₂ and B₉ (folate). B_{12} stored in liver for $\sim 3-4$ years. B_9 stored in liver for $\sim 3-4$ months.

B-complex deficiencies often result in dermatitis, glossitis, and diarrhea. Can be coenzymes (eg, ascorbic acid) or precursors to coenzymes (eg, FAD, NAD+).

FAS1_2019_01-Biochem.indd 65 11/7/19 3:16 PM 66

SECTION II

BIOCHEMISTRY ▶ BIOCHEMISTRY—NUTRITION

Vitamin A

Includes retinal, retinol, retinoic acid.

FUNCTION

Antioxidant; constituent of visual pigments (retinal); essential for normal differentiation of epithelial cells into specialized tissue (pancreatic cells, mucus-secreting cells); prevents squamous metaplasia. Used to treat measles and acute promyelocytic leukemia (APL).

Retinol is vitamin A, so think retin-A (used topically for wrinkles and Acne). Found in liver and leafy vegetables. Supplementation in vitamin A-deficient measles patients may improve outcomes. Use oral isotretinoin to treat severe cystic acne. Use *all*-trans retinoic acid to treat acute

DEFICIENCY



Night blindness (nyctalopia); dry, scaly skin (xerosis cutis); corneal squamous metaplasia → Bitot spots (keratin debris; foamy appearance on conjunctiva A); corneal degeneration (keratomalacia); immunosuppression.

EXCESS

Acute toxicity—nausea, vomiting, vertigo, and blurred vision.

Chronic toxicity—alopecia, dry skin (eg, scaliness), hepatic toxicity and enlargement, arthralgias, and idiopathic intracranial hypertension.

Teratogenic (cleft palate, cardiac abnormalities), therefore a ⊖ pregnancy test and two forms of contraception are required before isotretinoin (vitamin A derivative) is prescribed.

Isotretinoin is teratogenic.

promyelocytic leukemia.

Vitamin B₁

Also called thiamine.

FUNCTION

In thiamine pyrophosphate (TPP), a cofactor for several dehydrogenase enzyme reactions:

- Branched-chain ketoacid dehydrogenase
- α-ketoglutarate dehydrogenase (TCA cycle)
- Pyruvate dehydrogenase (links glycolysis to TCA cycle)
- Transketolase (HMP shunt)

DEFICIENCY

Impaired glucose breakdown → ATP depletion worsened by glucose infusion; highly aerobic tissues (eg, brain, heart) are affected first. In alcoholic or malnourished patients, give thiamine before dextrose to ↓ risk of precipitating Wernicke encephalopathy. Diagnosis made by ↑ in RBC transketolase activity following vitamin B₁ administration.

Be APT.

Spell beriberi as BerlBerl to remember vitamin B₁.

Wernicke encephalopathy—acute, lifethreatening, neurologic condition; classic triad of confusion, ophthalmoplegia, ataxia.

Korsakoff syndrome—amnestic disorder due to chronic alcohol consumption; presents with confabulation, personality changes, memory loss (permanent).

Wernicke-Korsakoff syndrome—damage to medial dorsal nucleus of thalamus, mammillary bodies. Presentation is combination of Wernicke encephalopathy and Korsakoff syndrome.

Dry beriberi—polyneuropathy, symmetric muscle wasting.

Wet beriberi—high-output cardiac failure (dilated cardiomyopathy), edema.

FAS1_2019_01-Biochem.indd 66 11/7/19 3:16 PM

Vitamin B ₂	Also called riboflavin.			
FUNCTION	Component of flavins FAD and FMN, used as cofactors in redox reactions, eg, the succinate dehydrogenase reaction in the TCA cycle.	FAD and FMN are derived from riboFlavin ($B_2 \approx 2$ ATP).		
DEFICIENCY	Cheilosis (inflammation of lips, scaling and fissures at the corners of the mouth), Corneal vascularization.	The 2 C's of B ₂ .		
Vitamin B ₃	Also called niacin, nicotinic acid.			
FUNCTION	Constituent of NAD ⁺ , NADP ⁺ (used in redox reactions). Derived from tryptophan. Synthesis requires vitamins B ₂ and B ₆ . Used to treat dyslipidemia; lowers levels of VLDL and raises levels of HDL.	NAD derived from Niacin ($B_3 \approx 3$ ATP).		
DEFICIENCY	Glossitis. Severe deficiency leads to pellagra, which can also be caused by Hartnup disease, malignant carcinoid syndrome († tryptophan metabolism), and isoniazid (‡ vitamin B ₆). Symptoms of pellagra: Diarrhea, Dementia (also hallucinations), Dermatitis (C3/C4 dermatome circumferential "broad collar" rash [Casal necklace], hyperpigmentation of sunexposed limbs A).	The 3 D's of B ₃ . Hartnup disease—autosomal recessive. Deficiency of neutral amino acid (eg, tryptophan) transporters in proximal renal tubular cells and on enterocytes → neutral aminoaciduria and ↓ absorption from the gut → ↓ tryptophan for conversion to niacin → pellagra-like symptoms. Treat with highprotein diet and nicotinic acid. Deficiency of vitamin B ₃ → pellagra.		
EXCESS	Facial flushing (induced by prostaglandin, not histamine; can avoid by taking aspirin with niacin), hyperglycemia, hyperuricemia.	Excess of vitamin $B_3 \rightarrow \mathbf{pod}$ agra.		
Vitamin B₅	Also called pantothenic acid.			
FUNCTION	Essential component of coenzyme A (CoA, a cofactor for acyl transfers) and fatty acid synthase.	B ₅ is "pento" thenic acid.		
DEFICIENCY	Dermatitis, enteritis, alopecia, adrenal insufficiency.			
Vitamin B ₆	Also called pyridoxine.			
FUNCTION		or used in transamination (eg, ALT and AST), ase. Synthesis of glutathione, cystathionine, heme ing serotonin, epinephrine, norepinephrine (NE),		
DEFICIENCY	Convulsions, hyperirritability, peripheral neuropa contraceptives), sideroblastic anemia (due to imp			

11/7/19 3:16 PM FAS1_2019_01-Biochem.indd 67

68 SECTION II

BIOCHEMISTRY ► BIOCHEMISTRY—NUTRITION

Vitamin B ₇	Also called biotin.	
FUNCTION	Cofactor for carboxylation enzymes (which add a l-carbon group): ■ Pyruvate carboxylase: pyruvate (3C) → oxaloacetate (4C) ■ Acetyl-CoA carboxylase: acetyl-CoA (2C) → malonyl-CoA (3C) ■ Propionyl-CoA carboxylase: propionyl-CoA (3C) → methylmalonyl-CoA (4C)	
DEFICIENCY	Relatively rare. Dermatitis, enteritis, alopecia. Caused by long-term antibiotic use or excessive ingestion of raw egg whites.	"Avidin in egg whites avidly binds biotin."
Vitamin B ₉	Also called folate.	
FUNCTION	Converted to tetrahydrofolic acid (THF), a coenzyme for 1-carbon transfer/methylation reactions. Important for the synthesis of nitrogenous bases in DNA and RNA.	Found in leafy green vegetables. Absorbed in jejunum. Folate from foliage. Small reserve pool stored primarily in the liver.
DEFICIENCY	Macrocytic, megaloblastic anemia; hypersegmented polymorphonuclear cells (PMNs); glossitis; no neurologic symptoms (as opposed to vitamin B ₁₂ deficiency). Labs: † homocysteine, normal methylmalonic acid levels. Seen in alcoholism and pregnancy.	Deficiency can be caused by several drugs (eg, phenytoin, sulfonamides, methotrexate). Supplemental maternal folic acid at least 1 month prior to conception and during early pregnancy to \$\frac{1}{2}\$ risk of neural tube defects. Give vitamin B ₉ for the 9 months of pregnancy.

FAS1_2019_01-Biochem.indd 68 11/7/19 3:16 PM

Vitamin B ₁₂	Also called cobalamin.	
FUNCTION	Cofactor for methionine synthase (transfers CH ₃ groups as methylcobalamin) and methylmalonyl-CoA mutase. Important for DNA synthesis.	Found in animal products. Synthesized only by microorganisms. Very large reserve pool (several years) stored primarily in the liver. Deficiency caused by malabsorption
DEFICIENCY	Macrocytic, megaloblastic anemia; hypersegmented PMNs; paresthesias and subacute combined degeneration (degeneration of dorsal columns, lateral corticospinal tracts, and spinocerebellar tracts) due to abnormal myelin. Associated with ↑ serum homocysteine and methylmalonic acid levels, along with 2° folate deficiency. Prolonged deficiency → irreversible nerve damage.	(eg, sprue, enteritis, <i>Diphyllobothrium latum</i> , achlorhydria, bacterial overgrowth, alcohol excess), lack of intrinsic factor (eg, pernicious anemia, gastric bypass surgery), absence of terminal ileum (surgical resection, eg, for Crohn disease), certain drugs (eg, metformin), or insufficient intake (eg, veganism). Anti-intrinsic factor antibodies diagnostic for pernicious anemia. Folate supplementation can mask the hematologic symptoms of B ₁₂ deficiency, but not the neurologic symptoms.
	Protein	Fatty acids with odd number of carbons, branched-chain amino acids
	THF-CH ₃ Methionine SAM Methionine synthase Homocysteine Adenosin	CH ₃ to anabolic pathways S-adenosyl homocysteine Methylmalonyl-CoA mutase Succinyl-CoA B ₁₂ Methylmalonyl-CoA mutase TCA
	Cysteine	B

Vitamin C	Also called ascorbic acid.	
FUNCTION	Antioxidant; also facilitates iron absorption by reducing it to Fe ²⁺ state. Necessary for hydroxylation of proline and lysine in collagen synthesis. Necessary for dopamine β-hydroxylase, which converts dopamine to NE.	Found in fruits and vegetables. Pronounce "absorbic" acid. Ancillary treatment for methemoglobinemia by reducing Fe ³⁺ to Fe ²⁺ .
DEFICIENCY	Scurvy—swollen gums, easy bruising, petechiae, hemarthrosis, anemia, poor wound healing, perifollicular and subperiosteal hemorrhages, "corkscrew" hair. Weakened immune response.	Vitamin C deficiency causes sCurvy due to a Collagen synthesis defect.
EXCESS	Nausea, vomiting, diarrhea, fatigue, calcium oxalate nephrolithiasis. Can † iron toxicity in predisposed individuals by increasing dietary iron absorption (ie, can worsen hereditary hemochromatosis or transfusion-related iron overload).	

FAS1_2019_01-Biochem.indd 69 11/7/19 3:16 PM

70

SECTION II

BIOCHEMISTRY ► BIOCHEMISTRY—NUTRITION

Vitamin D	 D₃ (cholecalciferol) from exposure of skin (stratum basale) to sun, ingestion of fish, milk, plants. D₂ (ergocalciferol) from ingestion of plants, fungi, yeasts. Both converted to 25-OH D₃ (storage form) in liver and to the active form 1,25-(OH)₂ D₃ (calcitriol) in kidney.
FUNCTION	† intestinal absorption of Ca ²⁺ and PO ₄ ³⁻ . † bone mineralization at low levels. † bone resorption at higher levels.
REGULATION	 ↑ PTH, ↓ Ca²⁺, ↓ PO₄³⁻ → ↑ 1,25-(OH)₂D₃ production. 1,25-(OH)₂D₃ feedback inhibits its own production. ↑ PTH → ↑ Ca²⁺ reabsorption and ↓ PO₄³⁻ reabsorption in the kidney.
	D: 1 , : 1:11 /1f :, 1

DEFICIENCY



Rickets in children (deformity, such as genu varum "bowlegs" A), osteomalacia in adults (bone pain and muscle weakness), hypocalcemic tetany.

Caused by malabsorption, ↓ sun exposure, poor diet, chronic kidney disease (CKD), advanced liver disease.

Give oral vitamin D to breastfed infants.

Deficiency is exacerbated by pigmented skin, premature birth.

EXCESS

Hypercalcemia, hypercalciuria, loss of appetite, stupor. Seen in granulomatous diseases († activation of vitamin D by epithelioid macrophages).

Vitamin E	Includes tocopherol, tocotrienol.	
FUNCTION	Antioxidant (protects RBCs and membranes from free radical damage).	
DEFICIENCY	Hemolytic anemia, acanthocytosis, muscle weakness, demyelination of posterior columns (‡ position and vibration sensation) and spinocerebellar tract (ataxia).	Neurologic presentation may appear similar to vitamin B ₁₂ deficiency, but without megaloblastic anemia, hypersegmented neutrophils, or † serum methylmalonic acid levels.
EXCESS	Risk of enterocolitis in infants.	High-dose supplementation may alter metabolism of vitamin K → enhanced anticoagulant effects of warfarin.

FAS1_2019_01-Biochem.indd 70 11/7/19 3:16 PM

C	E/	7	7	Λ	VD.	V I	п	
	ы	u I		W	I۱	ч	ш	ш

Vitamin K	Includes phytomenadione, phylloquinone, phytor	Includes phytomenadione, phylloquinone, phytonadione, menaquinone.			
FUNCTION	Activated by epoxide reductase to the reduced form, which is a cofactor for the γ-carboxylation of glutamic acid residues on various proteins required for blood clotting. Synthesized by intestinal flora.	K is for K oagulation. Necessary for the maturation of clotting factors II, VII, IX, X, and proteins C and S. Warfarin inhibits vitamin K–dependent synthesis of these factors and proteins.			
DEFICIENCY	Neonatal hemorrhage with † PT and † aPTT but normal bleeding time (neonates have sterile intestines and are unable to synthesize vitamin K). Can also occur after prolonged use of broad-spectrum antibiotics.	Not in breast milk; neonates are given vitamin K injection at birth to prevent hemorrhagic disease of the newborn.			

Zinc

FUNCTION

Mineral essential for the activity of 100+ enzymes. Important in the formation of zinc fingers (transcription factor motif).

DEFICIENCY



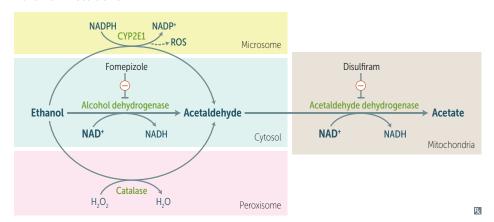
Delayed wound healing, suppressed immunity, male hypogonadism, ↓ adult hair (axillary, facial, pubic), dysgeusia, anosmia. Associated with acrodermatitis enteropathica (A, defect in intestinal zinc absorption). May predispose to alcoholic cirrhosis.

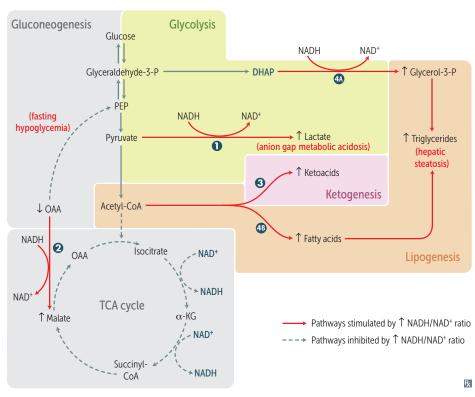
Protein-energy malnutrition

Kwashiorkor	Protein malnutrition resulting in skin lesions, edema due to ↓ plasma oncotic pressure, liver malfunction (fatty change due to ↓ apolipoprotein synthesis). Clinical picture is small child with swollen abdomen ⚠. Kwashiorkor results from protein- deficient MEALS: Malnutrition Edema Anemia Liver (fatty) Skin lesions (eg, hyperkeratosis, dyspigmentation)	B
Marasmus	Malnutrition not causing edema. Diet is deficient in calories but no nutrients are entirely absent. Marasmus results in Muscle wasting B.	

FAS1_2019_01-Biochem.indd 71 11/7/19 3:16 PM

Ethanol metabolism





Fomepizole—blocks alcohol
DH; antidote For Overdoses of
Methanol or Ethylene glycol.
Disulfiram— blocks acetaldehyde
dehydrogenase → ↑ acetaldehyde
→ ↑ hangover symptoms
→ discouraging drinking.
NAD+ is the limiting reagent.
Alcohol dehydrogenase operates via

Ethanol metabolism † NADH/ NAD+ ratio in liver, causing:

zero-order kinetics.

- Lactic acidosis—† pyruvate conversion to lactate
- Pasting hypoglycemia—
 ↓ gluconeogenesis due to
 ↑ conversion of OAA to malate
- **3** Ketoacidosis—diversion of acetyl-CoA into ketogenesis rather than TCA cycle
- ◆ Hepatosteatosis ↑ conversion of DHAP to glycerol-3-P
 ♠; acetyl-CoA diverges into fatty acid synthesis
 ♠, which combines with glycerol-3-P to synthesize triglycerides
- ↑ NADH/NAD⁺ ratio inhibits TCA cycle → ↑ acetyl-CoA used in ketogenesis (→ ketoacidosis), lipogenesis (→ hepatosteatosis).

▶ BIOCHEMISTRY—METABOLISM

Metabolism sites

Mitochondria	Fatty acid oxidation (β-oxidation), acetyl- CoA production, TCA cycle, oxidative phosphorylation, ketogenesis.
Cytoplasm	Glycolysis, HMP shunt, and synthesis of cholesterol (SER), proteins (ribosomes, RER), fatty acids, and nucleotides.
Both	Heme synthesis, Urea cycle, Gluconeogenesis. HUGs take two (both).

FAS1_2019_01-Biochem.indd 72 11/7/19 3:16 PM

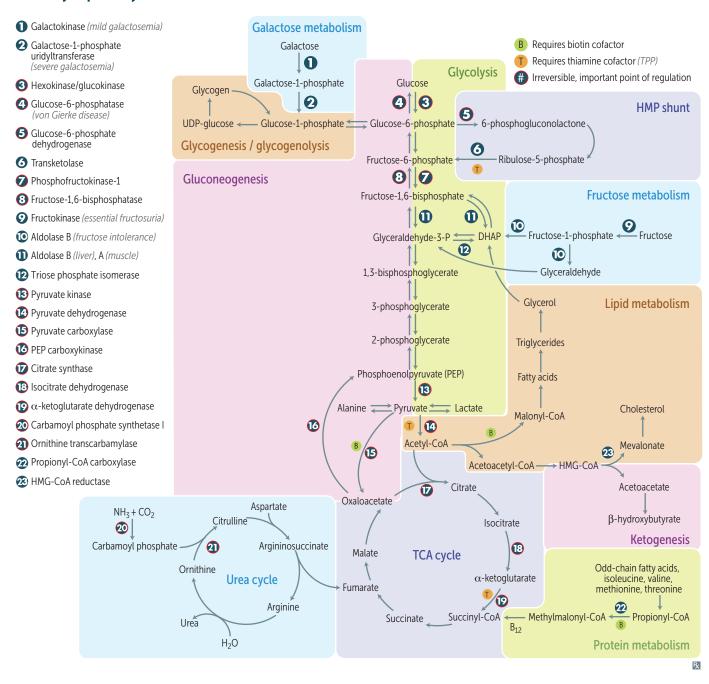
Enzyme terminology	An enzyme's name often describes its function. For example, glucokinase is an enzyme that catalyzes the phosphorylation of glucose using a molecule of ATP. The following are commonly used enzyme descriptors.
Kinase	Catalyzes transfer of a phosphate group from a high-energy molecule (usually ATP) to a substrate (eg, phosphofructokinase).
Phosphorylase	Adds inorganic phosphate onto substrate without using ATP (eg, glycogen phosphorylase).
Phosphatase	Removes phosphate group from substrate (eg, fructose-1,6-bisphosphatase).
Dehydrogenase	Catalyzes oxidation-reduction reactions (eg, pyruvate dehydrogenase).
Hydroxylase	Adds hydroxyl group (–OH) onto substrate (eg, tyrosine hydroxylase).
Carboxylase	Transfers CO ₂ groups with the help of biotin (eg, pyruvate carboxylase).
Mutase	Relocates a functional group within a molecule (eg, vitamin B_{12} —dependent methylmalonyl-CoA mutase).
Synthase/synthetase	Joins two molecules together using a source of energy (eg, ATP, acetyl-CoA, nucleotide sugar).

Rate-determining enzymes of metabolic processes

PROCESS	ENZYME	REGULATORS		
Glycolysis	Phosphofructokinase-1 (PFK-1)	AMP \oplus , fructose-2,6-bisphosphate \oplus ATP \ominus , citrate \ominus		
Gluconeogenesis	Fructose-1,6-bisphosphatase	AMP ⊖, fructose-2,6-bisphosphate ⊖		
TCA cycle	Isocitrate dehydrogenase	ADP ⊕ ATP ⊝, NADH ⊝		
Glycogenesis	Glycogen synthase	Glucose-6-phosphate ⊕, insulin ⊕, cortisol ⊕ Epinephrine ⊖, glucagon ⊝		
Glycogenolysis	Glycogen phosphorylase	Epinephrine \oplus , glucagon \oplus , AMP \oplus Glucose-6-phosphate \ominus , insulin \ominus , ATP \ominus		
HMP shunt	Glucose-6-phosphate dehydrogenase (G6PD)	NADP⁺ ⊕ NADPH ⊝		
De novo pyrimidine synthesis	Carbamoyl phosphate synthetase II	ATP ⊕, PRPP ⊕ UTP ⊝		
De novo purine synthesis	Glutamine-phosphoribosylpyrophosphate (PRPP) amidotransferase	$AMP \ominus$, inosine monophosphate (IMP) \ominus , $GMP \ominus$		
Urea cycle	Carbamoyl phosphate synthetase I	N-acetylglutamate ⊕		
Fatty acid synthesis	Acetyl-CoA carboxylase (ACC)	Insulin ⊕, citrate ⊕ Glucagon ⊝, palmitoyl-CoA ⊝		
Fatty acid oxidation	Carnitine acyltransferase I	Malonyl-CoA ⊝		
Ketogenesis	HMG-CoA synthase			
Cholesterol synthesis	HMG-CoA reductase	Insulin ⊕, thyroxine ⊕, estrogen ⊕ Glucagon ⊝, cholesterol ⊝		

FAS1_2019_01-Biochem.indd 73 11/7/19 3:16 PM

Summary of pathways



ATP production

Aerobic metabolism of one glucose molecule produces 32 net ATP via malate-aspartate shuttle (heart and liver), 30 net ATP via glycerol-3-phosphate shuttle (muscle).

Anaerobic glycolysis produces only 2 net ATP per glucose molecule.

ATP hydrolysis can be coupled to energetically unfavorable reactions.

Arsenic causes glycolysis to produce zero net ATP.

FAS1_2019_01-Biochem.indd 74 11/7/19 3:16 PM

Activated carriers

CARRIER MOLECULE	CARRIED IN ACTIVATED FORM	
ATP	Phosphoryl groups	
NADH, NADPH, FADH ₂	Electrons	
CoA, lipoamide	Acyl groups	
Biotin	CO_2	
Tetrahydrofolates	l-carbon units	
S-adenosylmethionine (SAM)	CH3 groups	
TPP	Aldehydes	

Universal electron acceptors

Nicotinamides (NAD⁺, NADP⁺ from vitamin B₃) and flavin nucleotides (FAD from vitamin B₂). NAD⁺ is generally used in **catabolic** processes to carry reducing equivalents away as NADH. NADPH is used in **anabolic** processes (eg, steroid and fatty acid synthesis) as a supply of reducing equivalents.

NADPH is a product of the HMP shunt. NADPH is used in:

- Anabolic processes
- Respiratory burst
- Cytochrome P-450 system
- Glutathione reductase

Hexokinase vs glucokinase

Phosphorylation of glucose to yield glucose-6-phosphate is catalyzed by glucokinase in the liver and hexokinase in other tissues. Hexokinase sequesters glucose in tissues, where it is used even when glucose concentrations are low. At high glucose concentrations, glucokinase helps to store glucose in liver.

	Hexokinase	Glucokinase
Location	Most tissues, except liver and pancreatic β cells	Liver, β cells of pancreas
K _m	Lower († affinity)	Higher (↓ affinity)
V _{max}	Lower († capacity)	Higher († capacity)
Induced by insulin	No	Yes
Feedback inhibition by	Glucose-6-phosphate	Fructose-6-phosphate

FAS1_2019_01-Biochem.indd 75 11/7/19 3:16 PM

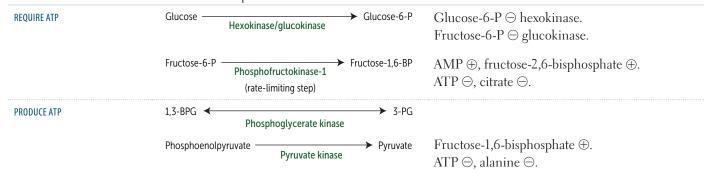
Glycolysis regulation, key enzymes

SECTION II

Net glycolysis (cytoplasm):

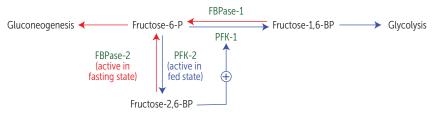
Glucose + 2 P_i + 2 ADP + 2 NAD^+ \rightarrow 2 pyruvate + 2 ATP + 2 NADH + 2 H^+ + 2 H_2O .

Equation not balanced chemically, and exact balanced equation depends on ionization state of reactants and products.



Regulation by fructose-2,6bisphosphate

Fructose bisphosphatase-2 (FBPase-2) and phosphofructokinase-2 (PFK-2) are the same bifunctional enzyme whose function is reversed by phosphorylation by protein kinase A.



Fasting state: ↑ glucagon → ↑ cAMP → ↑ protein kinase A \rightarrow † FBPase-2, \downarrow PFK-2, less glycolysis, more gluconeogenesis.

FaBian the Peasant (FBP) has to work hard when starving.

Fed state: ↑ insulin → ↓ cAMP → ↓ protein kinase A $\rightarrow \downarrow$ FBPase-2, † PFK-2, more glycolysis, less gluconeogenesis.

Prince FredericK (PFK) works only when fed.

Pyruvate dehydrogenase complex

Mitochondrial enzyme complex linking glycolysis and TCA cycle. Differentially regulated in fed (active)/fasting (inactive) states. Reaction: pyruvate + $NAD^+ + CoA \rightarrow acetyl$ $CoA + CO_2 + NADH$.

The complex is similar to the α -ketoglutarate dehydrogenase complex (same cofactors, similar substrate and action), which converts α-ketoglutarate → succinyl-CoA (TCA cycle).

Contains 3 enzymes requiring 5 cofactors:

- 1. Thiamine pyrophosphate (B₁)
- 2. Lipoic acid
- 3. CoA (B₅, pantothenic acid)
- 4. FAD (B₂, riboflavin)
- 5. NAD^+ (B₃, niacin)

Activated by: † NAD+/NADH ratio, † ADP \uparrow Ca²⁺.

The Lovely Coenzymes For Nerds. Arsenic inhibits lipoic acid. Arsenic poisoning clinical findings: imagine a vampire (pigmentary skin changes, skin cancer), vomiting and having diarrhea, running away from a cutie (QT prolongation) with garlic breath.

FAS1 2019 01-Biochem.indd 76 11/7/19 3:16 PM

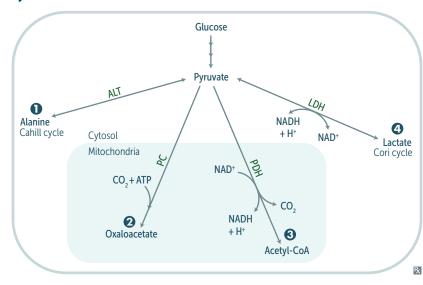
Pyruvate dehydrogenase complex deficiency

Causes a buildup of pyruvate that gets shunted to lactate (via LDH) and alanine (via ALT). X-linked.

FINDINGS TREATMENT Neurologic defects, lactic acidosis, † serum alanine starting in infancy.

† intake of ketogenic nutrients (eg, high fat content or † lysine and leucine).

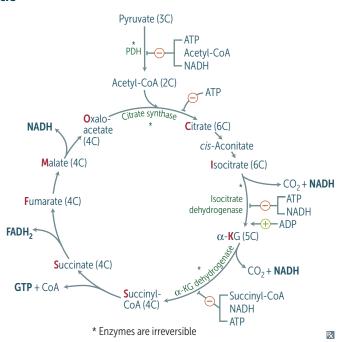
Pyruvate metabolism



Functions of different pyruvate metabolic pathways (and their associated cofactors):

- ◆ Alanine aminotransferase (B₆): alanine carries amino groups to the liver from muscle
- 2 Pyruvate carboxylase (biotin): oxaloacetate can replenish TCA cycle or be used in gluconeogenesis
- **3** Pyruvate dehydrogenase (B₁, B₂, B₃, B₅, lipoic acid): transition from glycolysis to the TCA cycle
- 4 Lactic acid dehydrogenase (B₃): end of anaerobic glycolysis (major pathway in RBCs, WBCs, kidney medulla, lens, testes, and cornea)

TCA cycle



Also called Krebs cycle. Pyruvate → acetyl-CoA produces 1 NADH, 1 CO₂.

The TCA cycle produces 3 NADH, 1 FADH₂, 2 CO₂, 1 GTP per acetyl-CoA = 10 ATP/ acetyl-CoA (2× everything per glucose). TCA cycle reactions occur in the mitochondria.

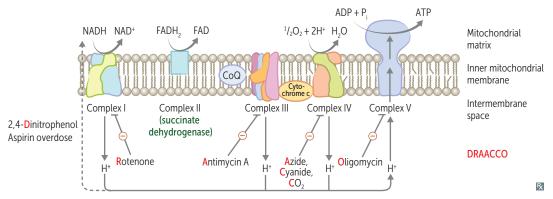
 α -ketoglutarate dehydrogenase complex requires the same cofactors as the pyruvate dehydrogenase complex (vitamins B_1 , B_2 , B_3 , B_5 , lipoic acid).

Citrate Is Krebs' Starting Substrate For Making Oxaloacetate.

FAS1_2019_01-Biochem.indd 77 11/7/19 3:16 PM

Electron transport chain and oxidative phosphorylation

NADH electrons from glycolysis enter mitochondria via the malate-aspartate or glycerol-3-phosphate shuttle. FADH₂ electrons are transferred to complex II (at a lower energy level than NADH). The passage of electrons results in the formation of a proton gradient that, coupled to oxidative phosphorylation, drives the production of ATP.



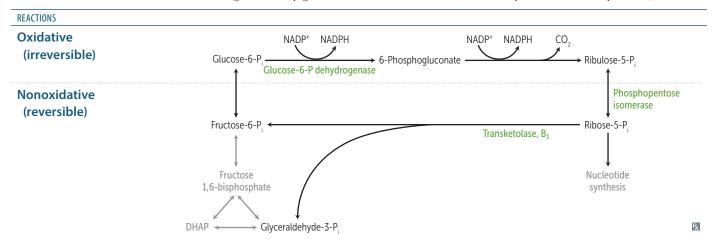
	1 NADH → 2.5 ATP; 1 FADH ₂ → 1.5 ATP.	
OXIDATIVE PHOSPHORYLATION POISON	2	
Electron transport inhibitors	Directly inhibit electron transport, causing a ↓ proton gradient and block of ATP synthesis.	Rotenone: complex one inhibitor. "An-3-mycin" (antimycin) A: complex 3 inhibitor. Cyanide, carbon monoxide, azide (the -ides, 4 letters) inhibit complex IV.
ATP synthase inhibitors	Directly inhibit mitochondrial ATP synthase, causing an † proton gradient. No ATP is produced because electron transport stops.	Oligomycin.
Uncoupling agents	↑ permeability of membrane, causing a ↓ proton gradient and ↑ O ₂ consumption. ATP synthesis stops, but electron transport continues. Produces heat.	2,4-Dinitrophenol (used illicitly for weight loss), aspirin (fevers often occur after overdose), thermogenin in brown fat (has more mitochondria than white fat).
_		Pathway Produces Fresh Glucose.
_	In mitochondria. Pyruvate → oxaloacetate.	Pathway Produces Fresh Glucose. Requires biotin, ATP. Activated by acetyl-CoA.
rreversible enzymes	In mitochondria. Pyruvate → oxaloacetate. In cytosol. Oxaloacetate → phosphoenolpyruvate.	· · · · · · · · · · · · · · · · · · ·
Pyruvate carboxylase Phosphoenolpyruvate	In cytosol. Oxaloacetate	Requires biotin, ATP. Activated by acetyl-CoA. Requires GTP.
Phosphoenolpyruvate carboxykinase Fructose-1,6-	In cytosol. Oxaloacetate → phosphoenolpyruvate. In cytosol. Fructose-1,6-bisphosphate	Requires biotin, ATP. Activated by acetyl-CoA.

FAS1_2019_01-Biochem.indd 78 11/7/19 3:16 PM

Pentose phosphate pathway

Also called HMP shunt. Provides a source of NADPH from abundantly available glucose-6-P (NADPH is required for reductive reactions, eg, glutathione reduction inside RBCs, fatty acid and cholesterol biosynthesis). Additionally, this pathway yields ribose for nucleotide synthesis. Two distinct phases (oxidative and nonoxidative), both of which occur in the cytoplasm. No ATP is used or produced.

Sites: lactating mammary glands, liver, adrenal cortex (sites of fatty acid or steroid synthesis), RBCs.

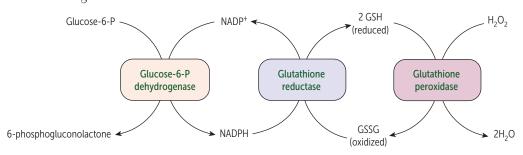


Glucose-6-phosphate dehydrogenase deficiency

NADPH is necessary to keep glutathione reduced, which in turn detoxifies free radicals and peroxides. ↓ NADPH in RBCs leads to hemolytic anemia due to poor RBC defense against oxidizing agents (eg, fava beans, sulfonamides, nitrofurantoin, primaquine/ chloroquine, antituberculosis drugs). Infection (most common cause) can also precipitate hemolysis; inflammatory response produces free radicals that diffuse into RBCs, causing oxidative damage.

X-linked recessive disorder; most common human enzyme deficiency; more prevalent among African Americans. † malarial resistance.

Heinz bodies—denatured globin chains precipitate within RBCs due to oxidative stress. Bite cells—result from the phagocytic removal of Heinz bodies by splenic macrophages. Think, "Bite into some Heinz ketchup."



FAS1_2019_01-Biochem.indd 79 11/7/19 3:16 PM

Disorders of fructose metabolism

Essential fructosuria

Involves a defect in **fructokinase**. Autosomal recessive. A benign, asymptomatic condition (fructokinase deficiency is **kin**der), since fructose is not trapped in cells. Hexokinase becomes 1° pathway for converting fructose to fructose-6-phosphate.

Symptoms: fructose appears in blood and urine.

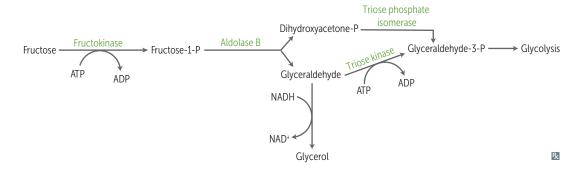
Disorders of fructose metabolism cause milder symptoms than analogous disorders of galactose metabolism.

Hereditary fructose intolerance

Hereditary deficiency of **aldolase B**. Autosomal recessive. Fructose-1-phosphate accumulates, causing a ↓ in available phosphate, which results in inhibition of glycogenolysis and gluconeogenesis. Symptoms present following consumption of fruit, juice, or honey. Urine dipstick will be ⊝ (tests for glucose only); reducing sugar can be detected in the urine (nonspecific test for inborn errors of carbohydrate metabolism).

Symptoms: hypoglycemia, jaundice, cirrhosis, vomiting.

Treatment: 1 intake of fructose, sucrose (glucose + fructose), and sorbitol (metabolized to fructose).



Disorders of galactose metabolism

Galactokinase deficiency

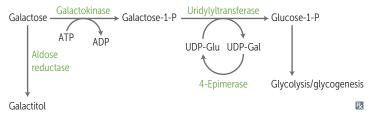
Hereditary deficiency of **galactokinase**. Galactitol accumulates if galactose is present in diet. Relatively mild condition. Autosomal recessive.

Symptoms: galactose appears in blood (galactosemia) and urine (galactosuria); infantile cataracts. May present as failure to track objects or to develop a social smile. Galactokinase deficiency is kinder (benign condition).

Classic galactosemia

Absence of **galactose-1-phosphate uridyltransferase**. Autosomal recessive. Damage is caused by accumulation of toxic substances (including galactitol, which accumulates in the lens of the eye). Symptoms develop when infant begins feeding (lactose present in breast milk and routine formula) and include failure to thrive, jaundice, hepatomegaly, infantile cataracts, intellectual disability. Can predispose to *E coli* sepsis in neonates.

Treatment: exclude galactose and lactose (galactose + glucose) from diet.



Fructose is to Aldolase B as Galactose is to UridylTransferase (FAB GUT).

The more serious defects lead to PO₄³⁻ depletion.

FAS1_2019_01-Biochem.indd 80 11/7/19 3:16 PM

Sorbitol

An alternative method of trapping glucose in the cell is to convert it to its alcohol counterpart, sorbitol, via aldose reductase. Some tissues then convert sorbitol to fructose using sorbitol dehydrogenase; tissues with an insufficient amount/activity of this enzyme are at risk of intracellular sorbitol accumulation, causing osmotic damage (eg, cataracts, retinopathy, and peripheral neuropathy seen with chronic hyperglycemia in diabetes).

High blood levels of galactose also result in conversion to the osmotically active galactitol via aldose reductase.

Liver, Ovaries, and Seminal vesicles have both enzymes (they LOSe sorbitol).



Lens has primarily aldose reductase. Retina, Kidneys, and Schwann cells have only aldose reductase (LuRKS).

Lactase deficiency

Insufficient lactase enzyme → dietary lactose intolerance. Lactase functions on the intestinal brush border to digest lactose (in milk and milk products) into glucose and galactose.

Primary: age-dependent decline after childhood (absence of lactase-persistent allele), common in people of Asian, African, or Native American descent.

Secondary: loss of intestinal brush border due to gastroenteritis (eg, rotavirus), autoimmune disease. Congenital lactase deficiency: rare, due to defective gene.

Stool demonstrates \(\psi \) pH and breath shows \(\dagger \) hydrogen content with lactose hydrogen breath test. Intestinal biopsy reveals normal mucosa in patients with hereditary lactose intolerance.

FINDINGS

Bloating, cramps, flatulence, osmotic diarrhea.

TREATMENT

Avoid dairy products or add lactase pills to diet; lactose-free milk.

Amino acids

Only L-amino acids are found in proteins.

Essential

PVT TIM HaLL: Phenylalanine, Valine, Tryptophan, Threonine, Isoleucine, Methionine,

Histidine, Leucine, Lysine.

Glucogenic: Methionine, histidine, valine. We met his valentine, she is so sweet (glucogenic). Glucogenic/ketogenic: Isoleucine, phenylalanine, threonine, tryptophan.

Ketogenic: Leucine, Lysine. The onLy pureLy ketogenic amino acids.

Aspartic acid, glutamic acid.

Negatively charged at body pH.

Basic

Acidic

Arginine, histidine, lysine.

Arginine is most basic. Histidine has no charge at body pH.

Arginine and histidine are required during periods of growth.

Arginine and lysine are † in histones which bind negatively charged DNA.

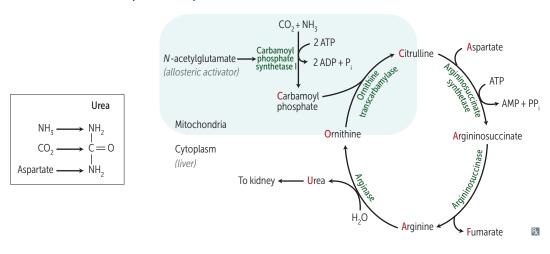
His lys (lies) are basic.

FAS1_2019_01-Biochem.indd 81 11/7/19 3:16 PM

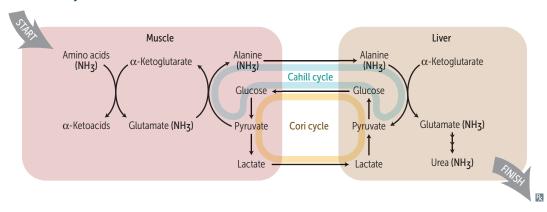
Urea cycle

Amino acid catabolism results in the formation of common metabolites (eg, pyruvate, acetyl-CoA), which serve as metabolic fuels. Excess nitrogen generated by this process is converted to urea and excreted by the kidneys.

Ordinarily, Careless Crappers Are Also Frivolous About Urination.



Transport of ammonia by alanine



Hyperammonemia



Can be acquired (eg, liver disease) or hereditary (eg, urea cycle enzyme deficiencies).

Presents with flapping tremor (eg, asterixis), slurring of speech, somnolence, vomiting, cerebral edema, blurring of vision.

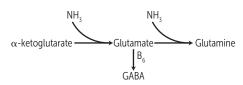
↑ NH₃ changes relative amounts of α-ketoglutarate, glutamate, GABA, and glutamine to favor ↑ glutamine. CNS toxicity may involve ↓ GABA, ↓ α-ketoglutarate, TCA cycle inhibition, and cerebral edema due to glutamine-induced osmotic shifts.

Treatment: limit protein in diet.

May be given to ↓ ammonia levels:

- Lactulose to acidify GI tract and trap NH₄⁺ for excretion.
- Antibiotics (eg, rifaximin, neomycin) to

 ‡ ammoniagenic bacteria.
- Benzoate, phenylacetate, or phenylbutyrate react with glycine or glutamine, forming products that are excreted renally.



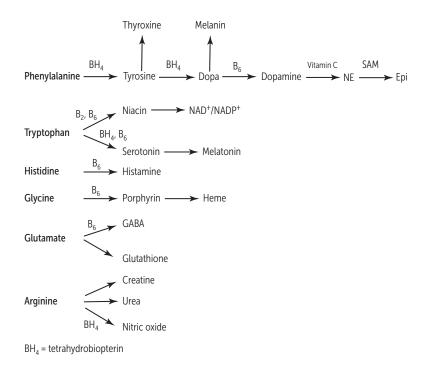
FAS1_2019_01-Biochem.indd 82 11/7/19 3:16 PM

Ornithine transcarbamylase deficiency

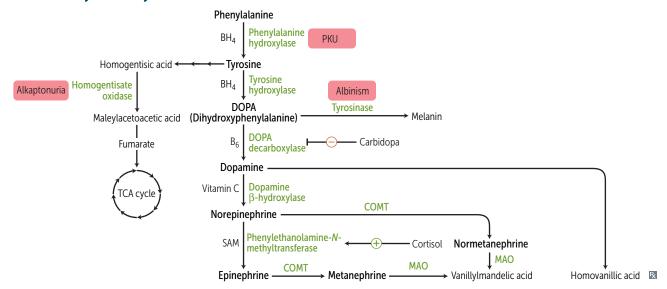
Most common urea cycle disorder. X-linked recessive (vs other urea cycle enzyme deficiencies, which are autosomal recessive). Interferes with the body's ability to eliminate ammonia. Often evident in the first few days of life, but may present later. Excess carbamoyl phosphate is converted to orotic acid (part of the pyrimidine synthesis pathway).

Findings: ↑ orotic acid in blood and urine, ↓ BUN, symptoms of hyperammonemia. No megaloblastic anemia (vs orotic aciduria).

Amino acid derivatives



Catecholamine synthesis/tyrosine catabolism



FAS1_2019_01-Biochem.indd 83 11/7/19 3:16 PM

Phenylketonuria

Due to ↓ phenylalanine hydroxylase or ↓ tetrahydrobiopterin (BH₄) cofactor (malignant PKU). Tyrosine becomes essential. ↑ phenylalanine → ↑ phenyl ketones in urine.

Findings: intellectual disability, growth retardation, seizures, fair complexion, eczema, musty body odor.

Treatment: ↓ phenylalanine and ↑ tyrosine in diet, tetrahydrobiopterin supplementation.

Maternal PKU—lack of proper dietary therapy during pregnancy. Findings in infant: microcephaly, intellectual disability, growth retardation, congenital heart defects.

Autosomal recessive. Incidence ≈ 1:10,000.

Screening occurs 2–3 days after birth (normal at birth because of maternal enzyme during fetal life).

Phenyl ketones—phenylacetate, phenyllactate, and phenylpyruvate.

Disorder of **aromatic** amino acid metabolism → musty body **odor**.

PKU patients must avoid the artificial sweetener aspartame, which contains phenylalanine.

Maple syrup urine disease

Blocked degradation of **branched** amino acids (**I**soleucine, **L**eucine, **V**aline) due to ↓ branched-chain α-ketoacid dehydrogenase (B₁). Causes ↑ α-ketoacids in the blood, especially those of leucine.

Treatment: restriction of isoleucine, leucine, valine in diet, and thiamine supplementation.

Autosomal recessive.

Presentation: vomiting, poor feeding, urine smells like maple syrup/burnt sugar. Causes severe CNS defects, intellectual disability, death.

I Love Vermont maple syrup from maple trees (with B₁ranches).

Alkaptonuria



Congenital deficiency of homogentisate oxidase in the degradative pathway of tyrosine to fumarate → pigment-forming homogentisic acid builds up in tissue A. Autosomal recessive. Usually benign. Findings: bluish-black connective tissue, ear cartilage, and sclerae (ochronosis); urine turns black on prolonged exposure to air. May have debilitating arthralgias (homogentisic acid toxic to cartilage).

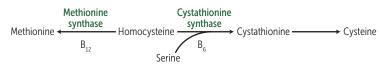
Homocystinuria

Causes (all autosomal recessive):

- Cystathionine synthase deficiency (treatment: ↓ methionine, ↑ cysteine, ↑ B₆, B₁₂, and folate in diet)
- I affinity of cystathionine synthase for pyridoxal phosphate (treatment: 11 B₆ and 1 cysteine in diet)
- Methionine synthase (homocysteine methyltransferase) deficiency (treatment: † methionine in diet)
- Methylenetetrahydrofolate reductase (MTHFR) deficiency (treatment: † folate in diet)

All forms result in excess homocysteine.

HOMOCYstinuria: ↑↑ Homocysteine in
urine, Osteoporosis, Marfanoid habitus,
Ocular changes (downward and inward
lens subluxation), Cardiovascular effects
(thrombosis and atherosclerosis → stroke
and MI), kYphosis, intellectual disability, fair
complexion. In homocystinuria, lens subluxes
"down and in" (vs Marfan, "up and fans out").



FAS1 2019 01-Biochem.indd 84 11/7/19 3:16 PM

Cystinuria



Hereditary defect of renal PCT and intestinal amino acid transporter that prevents reabsorption of Cystine, Ornithine, Lysine, and Arginine (COLA).

Excess cystine in the urine can lead to recurrent precipitation of hexagonal cystine stones A. Treatment: urinary alkalinization (eg, potassium citrate, acetazolamide) and chelating agents (eg, penicillamine) † solubility of cystine stones; good hydration.

Autosomal recessive. Common (1:7000). Urinary cyanide-nitroprusside test is diagnostic.

Cystine is made of 2 cysteines connected by a disulfide bond.

Organic acidemias

Most commonly present in infancy with poor feeding, vomiting, hypotonia, high anion gap metabolic acidosis, hepatomegaly, seizures. Organic acid accumulation:

- Inhibits gluconeogenesis → ↓ fasting blood glucose levels, ↑ ketoacidosis → high anion gap metabolic acidosis
- Inhibits urea cycle → hyperammonemia

Propionic acidemia

Deficiency of propionyl-CoA carboxylase

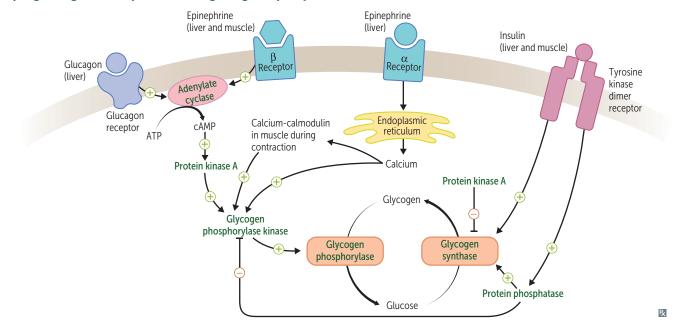
→ ↑ propionyl-CoA, ↓ methylmalonic acid.

Methylmalonic acidemia

Deficiency of methylmalonyl-CoA mutase or vitamin B_{12} .

Treatment: low-protein diet limited in substances that metabolize into propionyl-CoA: Valine, Odd-chain fatty acids, Methionine, Isoleucine, Threonine (VOMIT).

Glycogen regulation by insulin and glucagon/epinephrine



FAS1_2019_01-Biochem.indd 85

Glycogen	Branches have α -(1,6)	bonds; linkages have α -(1,4) bonds.	
Skeletal muscle	Glycogen undergoes glycogenolysis → glucose-l-phosphate → glucose-6-phosphate, which is rapidly metabolized during exercise.		
Glucose Glucose-6-P Glucose-1-P UDP-glucose	Glycogen phosphoryl glucose units remain 3 of the 4 glucose units enzyme (6) cleaves of	on a branch. Then 4-α-D-glucanotra its from the branch to the linkage. The ff the last residue, liberating glucose. to the two to four residues remaining	residues off branched glycogen until 4 unsferase (debranching enzyme 5) moves then α-1,6-glucosidase (debranching
	Lysosome only		Glycogen storage disease type I Von Gierke disease II Pompe disease III Cori disease V McArdle disease V McArdle disease Olycogen enzymes UDP-glucose pyrophosphorylase Glycogen synthase Glycogen phosphorylase Glycogen phosphorylase Debranching enzyme (4-α-υ-glucanotransferase) Debranching enzyme (α-1,6-glucosidase)
Glycogen		V Limit dextrin	α -1,4-glucosidase

Note: A small amount of glycogen is degraded in lysosomes by ${\bf 20}$ α -1,4-glucosidase (acid maltase).

FAS1_2019_01-Biochem.indd 86 11/7/19 3:16 PM

Glycogen storage diseases

At least 15 types have been identified, all resulting in abnormal glycogen metabolism and an accumulation of glycogen within cells. Periodic acid–Schiff stain identifies glycogen and is useful in identifying these diseases.

Very Poor Carbohydrate Metabolism.

Types I, II, III, and V are autosomal recessive.

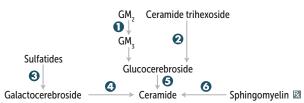
DISEASE	FINDINGS	DEFICIENT ENZYME	COMMENTS
Von Gierke disease (type I)	Severe fasting hypoglycemia, †† Glycogen in liver and kidneys, † blood lactate, † triglycerides, † uric acid (Gout), and hepatomegaly, renomegaly. Liver does not regulate blood glucose.	Glucose-6-phosphatase	Treatment: frequent oral glucose/cornstarch; avoidance of fructose and galactose Impaired gluconeogenesis and glycogenolysis
Pompe disease (type II)	Cardiomegaly, hypertrophic cardiomyopathy, hypotonia, exercise intolerance, and systemic findings lead to early death.	Lysosomal acid α -1,4-glucosidase (acid maltase) with α -1,6-glucosidase activity	PomPe trashes the PumP (1st and 4th letter; heart, liver, and muscle)
Cori disease (type III)	Similar to von Gierke disease, but milder symptoms and normal blood lactate levels. Can lead to cardiomyopathy. Limit dextrin–like structures accumulate in cytosol.	Debranching enzymes $(\alpha\text{-}1,6\text{-}glucosidase and }4\text{-}\alpha\text{-}D\text{-}glucanotransferase})$	Gluconeogenesis is intact
McArdle disease (type V)	↑ glycogen in muscle, but muscle cannot break it down → painful Muscle cramps, Myoglobinuria (red urine) with strenuous exercise, and arrhythmia from electrolyte abnormalities. Second-wind phenomenon noted during exercise due to ↑ muscular blood flow.	Skeletal muscle glycogen phosphorylase (Myophosphorylase) Characterized by a flat venous lactate curve with normal rise in ammonia levels during exercise	Blood glucose levels typically unaffected McArdle = Muscle

FAS1_2019_01-Biochem.indd 87 11/7/19 3:16 PM

Lysosomal storage diseases

Each is caused by a deficiency in one of the many lysosomal enzymes. Results in an accumulation of abnormal metabolic products.

	_			
DISEASE	FINDINGS	DEFICIENT ENZYME	ACCUMULATED SUBSTRATE	INHERITANCE
Sphingolipidoses				
Tay-Sachs disease	Progressive neurodegeneration, developmental delay, hyperreflexia, hyperacusis, "cherry-red" spot on macula A, lysosomes with onion skin, no hepatosplenomegaly (vs Niemann-Pick).	• HeXosaminidase A ("TAy-SaX")	GM_2 ganglioside	AR
Fabry disease	Early: triad of episodic peripheral neuropathy, angiokeratomas B, hypohidrosis. Late: progressive renal failure, cardiovascular disease.	2 α-galactosidase A	Ceramide trihexoside (globotriaosylce- ramide)	XR
Metachromatic leukodystrophy	Central and peripheral demyelination with ataxia, dementia.	3 Arylsulfatase A	Cerebroside sulfate	AR
Krabbe disease	Peripheral neuropathy, destruction of oligodendrocytes, developmental delay, optic atrophy, globoid cells.	4 Galactocerebrosidase (galactosylceramidase)	Galactocerebroside, psychosine	AR
Gaucher disease	Most common. Hepatosplenomegaly, pancytopenia, osteoporosis, avascular necrosis of femur, bone crises, Gaucher cells (lipid-laden macrophages resembling crumpled tissue paper).	6 Glucocerebrosidase (β-glucosidase); treat with recombinant glucocerebrosidase	Glucocerebroside	AR
liemann-Pick disease	Progressive neurodegeneration, hepatosplenomegaly, foam cells (lipid-laden macrophages) D, "cherry-red" spot on macula A.	6 Sphingomyelinase	Sphingomyelin	AR
Mucopolysaccharidoses				
Hurler syndrome	Developmental delay, gargoylism, airway obstruction, corneal clouding, hepatosplenomegaly.	α-L-iduronidase	Heparan sulfate, dermatan sulfate	AR
Hunter syndrome	Mild Hurler + aggressive behavior, no corneal clouding.	Iduronate-2-sulfatase	Heparan sulfate, dermatan sulfate	XR



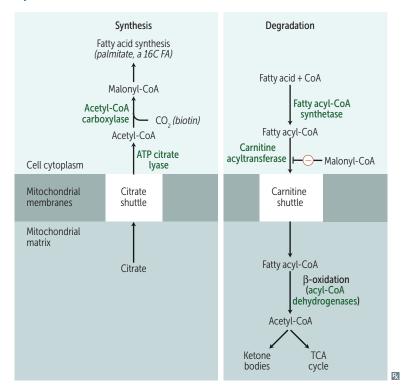
his **sphing**er (**sphing**omyelinase).

Hunters see clearly (no corneal clouding) and aggressively aim for the X (X-linked recessive).

† incidence of Tay-Sachs, Niemann-Pick, some forms of Gaucher disease in Ashkenazi Jews.

FAS1_2019_01-Biochem.indd 88 11/7/19 3:16 PM

Fatty acid metabolism



Fatty acid synthesis requires transport of citrate from mitochondria to cytosol. Predominantly occurs in liver, lactating mammary glands, and adipose tissue.

Long-chain fatty acid (LCFA) degradation requires carnitine-dependent transport into the mitochondrial matrix.

"SYtrate" = SYnthesis.
CARnitine = CARnage of fatty acids.

Systemic 1° carnitine deficiency—no cellular uptake of carnitine → no transport of LCFAs into mitochondria → toxic accumulation of LCFAs in the cytosol. Causes weakness, hypotonia, hypoketotic hypoglycemia, dilated cardiomyopathy.

Medium-chain acyl-CoA dehydrogenase deficiency—↓ ability to break down fatty acids into acetyl-CoA → accumulation of fatty acyl carnitines in the blood with hypoketotic hypoglycemia. Causes vomiting, lethargy, seizures, coma, liver dysfunction, hyperammonemia. Can lead to sudden death in infants or children. Treat by avoiding fasting.

FAS1_2019_01-Biochem.indd 89 11/7/19 3:16 PM

Ketone bodies

In the liver, fatty acids and amino acids are metabolized to acetoacetate and β-hydroxybutyrate (to be used in muscle and brain).

In prolonged starvation and diabetic ketoacidosis, oxaloacetate is depleted for gluconeogenesis. In alcoholism, excess NADH shunts oxaloacetate to malate. All of these processes lead to a buildup of acetyl-CoA, which is shunted into ketone body synthesis.

Ketone bodies: acetone, acetoacetate, β-hydroxybutyrate.

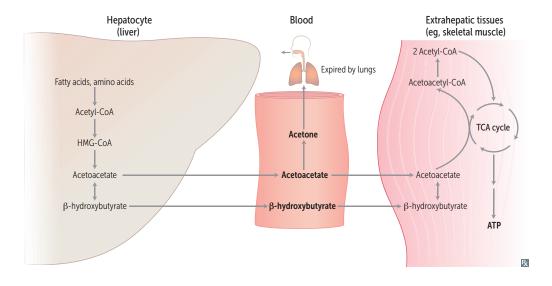
Breath smells like acetone (fruity odor).

Urine test for ketones can detect acetoacetate, but not β -hydroxybutyrate.

RBCs cannot utilize ketones; they strictly use glucose.

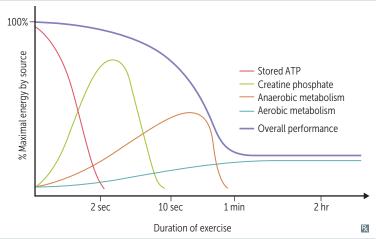
HMG-CoA lyase for ketone production.

HMG-CoA reductase for cholesterol synthesis.



FAS1_2019_01-Biochem.indd 90 11/7/19 3:16 PM

Metabolic fuel use



 $lg \frac{carb}{protein} = 4 kcal$ \lg alcohol = 7 kcal lg fatty acid = 9 kcal (# letters = # kcal)

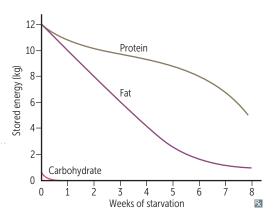
	Duration of exercise	及
Fasting and starvation	Priorities are to supply sufficient glucose to	the brain and RBCs and to preserve protein.
Fed state (after a meal)	Glycolysis and aerobic respiration.	Insulin stimulates storage of lipids, proglycogen.
Fasting (between meals)	Hepatic glycogenolysis (major); hepatic gluconeogenesis, adipose release of FFA (minor).	Glucagon and epinephrine stimulate reserves.
Starvation days 1–3	 Blood glucose levels maintained by: Hepatic glycogenolysis Adipose release of FFA Muscle and liver, which shift fuel use freglucose to FFA Hepatic gluconeogenesis from peripheratissue lactate and alanine, and from adipose tissue glycerol and propionyl-CoA (from odd-chain FFA—the only triacylglycerol components that contributo gluconeogenesis) 	al 10- Protein (b) 8- Fat
Starvation after day 3	Adipose stores (ketone bodies become the n source of energy for the brain). After these depleted, vital protein degradation acceler leading to organ failure and death. Amount of excess stores determines survival time.	erare 0 Carbohydrate rates, 0 1 2 3 4 5 6 Weeks of starvation

glycogen. Glucagon and epinephrine stimulate use of fuel

Insulin stimulates storage of lipids, proteins, and

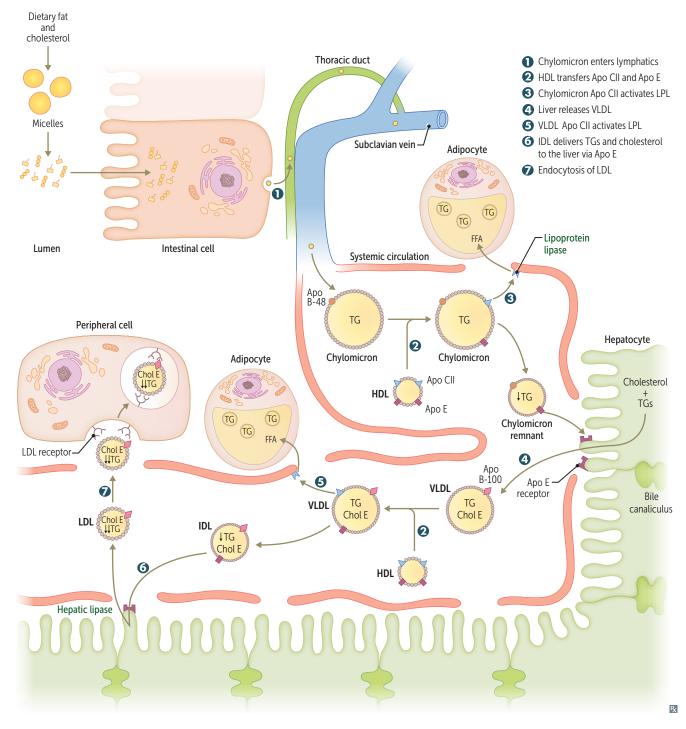
reserves.

Glycogen reserves depleted after day 1. RBCs lack mitochondria and therefore cannot use ketones.



FAS1_2019_01-Biochem.indd 91 11/7/19 3:16 PM

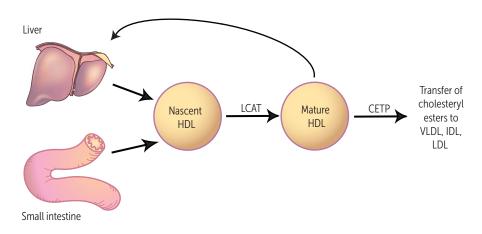
Lipid transport



FAS1_2019_01-Biochem.indd 92 11/7/19 3:16 PM

Key enzymes in lipid transport

Cholesteryl ester transfer protein	Mediates transfer of cholesteryl esters to other lipoprotein particles.
Hepatic lipase	Degrades TGs remaining in IDL.
Hormone-sensitive lipase	Degrades TGs stored in adipocytes.
Lecithin-cholesterol acyltransferase	Catalyzes esterification of ¾ of plasma cholesterol.
Lipoprotein lipase	Degrades TGs in circulating chylomicrons.
Pancreatic lipase	Degrades dietary TGs in small intestine.
PCSK9	Degrades LDL receptor → ↑ serum LDL. Inhibition → ↑ LDL receptor recycling → ↓ serum LDL.



Major apolipoproteins

	Chylomicron						
Apolipoprotein	Function	Chylomicron	remnant	VLDL	IDL	LDL	HDL
E	Mediates remnant uptake (everything except LDL)	✓	✓	✓	✓		✓
A-I	Found only on alphalipoproteins (HDL), activates LCAT						✓
C-II	Lipoprotein lipase cofactor that catalyzes cleavage.	✓		✓	✓		✓
B-48	Mediates chylomicron secretion into lymphatics Only on particles originating from the intestines	✓	✓				
B-100	Binds LDL receptor Only on particles originating from the liver			✓	√	√	

FAS1_2019_01-Biochem.indd 93 11/7/19 3:16 PM

SECTION II

Lipoprotein functions	Lipoproteins are composed of varying proportions of cholesterol, TGs, and phospholipids. LDL and HDL carry the most cholesterol. Cholesterol is needed to maintain cell membrane integrity and synthesize bile acids, steroids, and vitamin D.
Chylomicron	Delivers dietary TGs to peripheral tissues. Delivers cholesterol to liver in the form of chylomicron remnants, which are mostly depleted of their TGs. Secreted by intestinal epithelial cells.
VLDL	Delivers hepatic TGs to peripheral tissue. Secreted by liver.
IDL	Delivers TGs and cholesterol to liver. Formed from degradation of VLDL.
LDL	Delivers hepatic cholesterol to peripheral tissues. Formed by hepatic lipase modification of IDL in the liver and peripheral tissue. Taken up by target cells via receptor-mediated endocytosis. LDL is Lethal.
HDL	Mediates reverse cholesterol transport from peripheral tissues to liver. Acts as a repository for apolipoproteins C and E (which are needed for chylomicron and VLDL metabolism). Secreted from both liver and intestine. Alcohol † synthesis. HDL is Healthy.

Abetalipoproteinemia

Autosomal recessive. Mutation in gene that encodes microsomal transfer protein (*MTP*). Chylomicrons, VLDL, LDL absent. Deficiency in ApoB-48, ApoB-100. Affected infants present with severe fat malabsorption, steatorrhea, failure to thrive. Later manifestations include retinitis pigmentosa, spinocerebellar degeneration due to vitamin E deficiency, progressive ataxia, acanthocytosis. Intestinal biopsy shows lipid-laden enterocytes.

Treatment: restriction of long-chain fatty acids, large doses of oral vitamin E.

Familial dyslipidemias

ТҮРЕ	INHERITANCE	PATHOGENESIS	† BLOOD LEVEL	CLINICAL
I—Hyper- chylomicronemia	AR	Lipoprotein lipase or apolipoprotein C-II deficiency	Chylomicrons, TG, cholesterol	Pancreatitis, hepatosplenomegaly, and eruptive/pruritic xanthomas (no † risk for atherosclerosis). Creamy layer in supernatant.
II—Familial hyper- cholesterolemia	AD	Absent or defective LDL receptors, or defective ApoB-100	IIa: LDL, cholesterol IIb: LDL, cholesterol, VLDL	Heterozygotes (1:500) have cholesterol ≈ 300 mg/dL; homozygotes (very rare) have cholesterol ≥ 700 mg/dL. Accelerated atherosclerosis (may have MI before age 20), tendon (Achilles) xanthomas, and corneal arcus.
III—Dysbeta- lipoproteinemia	AR	Defective ApoE	Chylomicrons, VLDL	Premature atherosclerosis, tuberoeruptive and palmar xanthomas.
IV—Hyper- triglyceridemia	AD	Hepatic overproduction of VLDL	VLDL, TG	Hypertriglyceridemia (> 1000 mg/dL) can cause acute pancreatitis. Related to insulin resistance.

FAS1_2019_01-Biochem.indd 94 11/7/19 3:16 PM

HIGH-YIELD PRINCIPLES IN

Immunology

"I hate to disappoint you, but my rubber lips are immune to your charms."

—Batman & Robin

"The fully engaged heart is the antibody for the infection of violence."

-Mark Nepo

Learning the components of the immune system and their roles in host defense at the cellular level is essential for both the understanding of disease pathophysiology and clinical practice. Know the immune mechanisms of responses to vaccines. Both congenital and acquired immunodeficiencies are very testable. Cell surface markers are high yield for understanding immune cell interactions and for laboratory diagnosis. Know the roles and functions of major cytokines and chemokines.

- ▶ Lymphoid Structures 96
- ▶ Cellular Components 99
- ▶ Immune Responses 104
- ▶ Immunosuppressants 120

FAS1_2019_02-Immunology.indd 95 11/7/19 3:24 PM

▶ IMMUNOLOGY—LYMPHOID STRUCTURES

Immune system organs

l° organs:

- Bone marrow—immune cell production, B cell maturation
- Thymus—T cell maturation

2° organs:

- Spleen, lymph nodes, tonsils, Peyer patches
- Allow immune cells to interact with antigen

Lymph node

A 2° lymphoid organ that has many afferents, 1 or more efferents. Encapsulated, with trabeculae A B. Functions are nonspecific filtration by macrophages, circulation of B and T cells, and immune response activation.

Follicle

Site of B-cell localization and proliferation. In outer cortex. 1° follicles are dense and quiescent. 2° follicles have pale central germinal centers and are active.

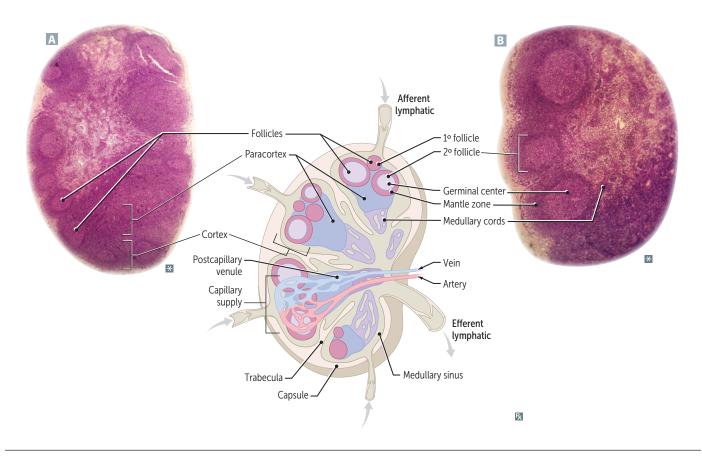
Medulla

Consists of medullary cords (closely packed lymphocytes and plasma cells) and medullary sinuses. Medullary sinuses communicate with efferent lymphatics and contain reticular cells and macrophages.

Paracortex

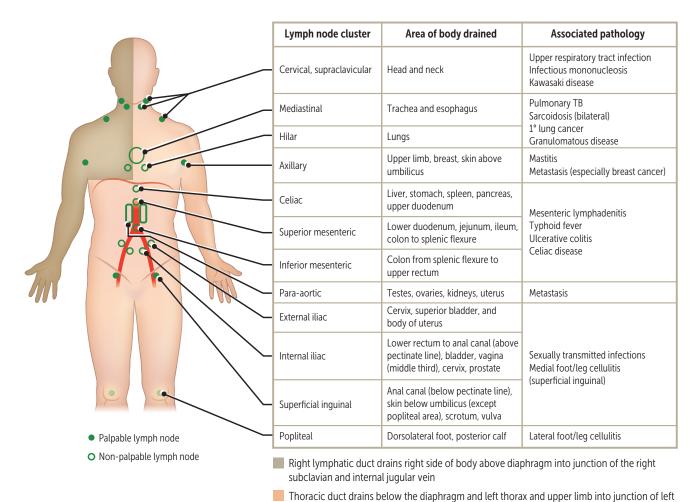
Contains T cells. Region of cortex between follicles and medulla. Contains high endothelial venules through which T and B cells enter from blood. Not well developed in patients with DiGeorge syndrome.

Paracortex enlarges in an extreme cellular immune response (eg, EBV and other viral infections → paracortical hyperplasia → lymphadenopathy).



FAS1_2019_02-Immunology.indd 96 11/7/19 3:24 PM

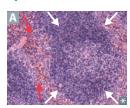
Lymphatic drainage associations



subclavian and internal jugular veins (rupture of thoracic duct can cause chylothorax)

FAS1_2019_02-Immunology.indd 97 11/7/19 3:24 PM

Spleen



Located in LUQ of abdomen, anterolateral to left kidney, protected by 9th-11th ribs. Sinusoids are long, vascular channels in red pulp (red arrows in A) with fenestrated "barrel hoop" basement membrane.

- T cells are found in the periarteriolar lymphatic sheath (PALS) within the white pulp (white arrows in A).
- B cells are found in follicles within the white pulp.
- The marginal zone, in between the red pulp and white pulp, contains macrophages and specialized B cells, and is where antigenpresenting cells (APCs) capture blood-borne antigens for recognition by lymphocytes.

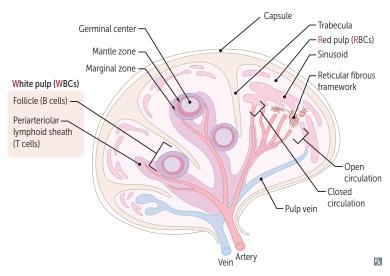
Splenic macrophages remove encapsulated bacteria.

Splenic dysfunction (eg, postsplenectomy state, sickle cell disease autosplenectomy):

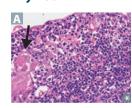
↓ IgM → ↓ complement activation → ↓ C3b opsonization → ↑ susceptibility to encapsulated organisms.

Postsplenectomy blood findings:

- Howell-Jolly bodies (nuclear remnants)
- Target cells
- Thrombocytosis (loss of sequestration and removal)
- Lymphocytosis (loss of sequestration)
 Vaccinate patients undergoing splenectomy or with splenic dysfunction against encapsulated organisms (pneumococci, Hib, meningococci).



Thymus





Located in the anterosuperior mediastinum. Site of T-cell differentiation and maturation. Encapsulated. Thymus epithelium is derived from Third pharyngeal pouch (endoderm), whereas thymic lymphocytes are of mesodermal origin. Cortex is dense with immature T cells; Medulla is pale with Mature T cells and Hassall corpuscles A containing epithelial reticular cells. Normal neonatal thymus "sail-shaped" on CXR B, involutes by age 3 years.

T cells = T hymus

 \mathbf{B} cells = \mathbf{B} one marrow

Absent thymic shadow or hypoplastic thymus seen in some immunodeficiencies (eg, SCID, DiGeorge syndrome).

Thymoma—neoplasm of thymus. Associated with myasthenia gravis, superior vena cava syndrome, pure red cell aplasia, Good syndrome.

FAS1_2019_02-Immunology.indd 98 11/7/19 3:24 PM

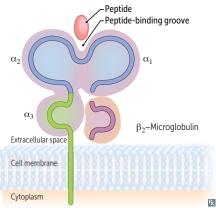
► IMMUNOLOGY—CELLULAR COMPONENTS

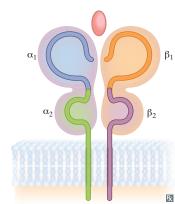
Innate vs adaptive immunity

	Innate immunity	Adaptive immunity
COMPONENTS	Neutrophils, macrophages, monocytes, dendritic cells, natural killer (NK) cells (lymphoid origin), complement, physical epithelial barriers, secreted enzymes	T cells, B cells, circulating antibodies
MECHANISM	Germline encoded	Variation through V(D)J recombination during lymphocyte development
RESISTANCE	Resistance persists through generations; does not change within an organism's lifetime	Microbial resistance not heritable
RESPONSE TO PATHOGENS	Nonspecific Occurs rapidly (minutes to hours) No memory response	Highly specific, refined over time Develops over long periods; memory response is faster and more robust
SECRETED PROTEINS	Lysozyme, complement, C-reactive protein (CRP), defensins, cytokines	Immunoglobulins
KEY FEATURES IN PATHOGEN RECOGNITION	Toll-like receptors (TLRs): pattern recognition receptors that recognize pathogen-associated molecular patterns (PAMPs) and lead to activation of NF-κB. Examples of PAMPs include LPS (gram ⊖ bacteria), flagellin (bacteria), nucleic acids (viruses)	Memory cells: activated B and T cells; subsequent exposure to a previously encountered antigen → stronger, quicker immune response

FAS1_2019_02-Immunology.indd 99 11/7/19 3:24 PM

Major histocompatibility complex I and II	MHC encoded by HLA genes. Present antigen fragments to T cells and bind T-cell receptors (TCRs).		
	MHCI	MHCII	
LOCI	HLA-A, HLA-B, HLA-C MHC I loci have 1 letter	HLA-DP, HLA-DQ, HLA-DR MHC II loci have 2 letters	
BINDING	TCR and CD8	TCR and CD4	
STRUCTURE	1 long chain, 1 short chain	2 equal-length chains $(^{2}\alpha, ^{2}\beta)$	
EXPRESSION	All nucleated cells, APCs, platelets (except RBCs)	APCs	
FUNCTION	Present endogenous antigens (eg, viral or cytosolic proteins) to CD8+ cytotoxic T cells	Present exogenous antigens (eg, bacterial proteins) to CD4+ helper T cells	
ANTIGEN LOADING	Antigen peptides loaded onto MHC I in RER after delivery via TAP (transporter associated with antigen processing)	Antigen loaded following release of invariant chain in an acidified endosome	
ASSOCIATED PROTEINS	eta_2 -microglobulin	Invariant chain	
STRUCTURE	Peptide Peptide-binding groove		





HLA subtypes associated with diseases

HLA SUBTYPE	DISEASE	MNEMONIC
A3	Hemochromatosis	HA3mochromatosis
B8	Addison disease, myasthenia gravis, Graves disease	Don't B e late(8), Dr. Addison , or else you'll send my patient to the grave
B27	Psoriatic arthritis, Ankylosing spondylitis, IBD-associated arthritis, Reactive arthritis	PAIR. Also called seronegative arthropathies
С	Psoriasis	
DQ2/DQ8	Celiac disease	I ate (8) too (2) much gluten at Dairy Queen
DR2	Multiple sclerosis, hay fever, SLE, Good <mark>pasture</mark> syndrome	DRive 2 multiple hay pastures
DR3	DM type 1, SLE , Graves disease, Hashimoto thyroiditis, Addison disease	2-3, S-L-E
DR4	Rheumatoid arthritis, DM type 1, Addison disease	There are 4 walls in 1 "rheum" (room)
DR5	Hashimoto thyroiditis	Hashimoto is an odd Dr (DR3, DR5)

FAS1_2019_02-Immunology.indd 100 11/7/19 3:24 PM

Functions of natural killer cells

Lymphocyte member of innate immune system.

Use perforin and granzymes to induce apoptosis of virally infected cells and tumor cells.

Activity enhanced by IL-2, IL-12, IFN- α , and IFN- β .

Induced to kill when exposed to a nonspecific activation signal on target cell and/or to an absence

of MHC I on target cell surface.

Also kills via antibody-dependent cell-mediated cytotoxicity (CD16 binds Fc region of bound IgG,

activating the NK cell).

Major functions of B and T cells

B cells Humoral immunity.

Recognize and present antigen—undergo somatic hypermutation to optimize antigen specificity.

Produce antibody—differentiate into plasma cells to secrete specific immunoglobulins.

Maintain immunologic memory—memory B cells persist and accelerate future response to antigen.

T cells Cell-mediated immunity.

CD4+ T cells help B cells make antibodies and produce cytokines to recruit phagocytes and

activate other leukocytes.

CD8+ T cells directly kill virus-infected and tumor cells via perforin and granzymes (similar to NK

cells).

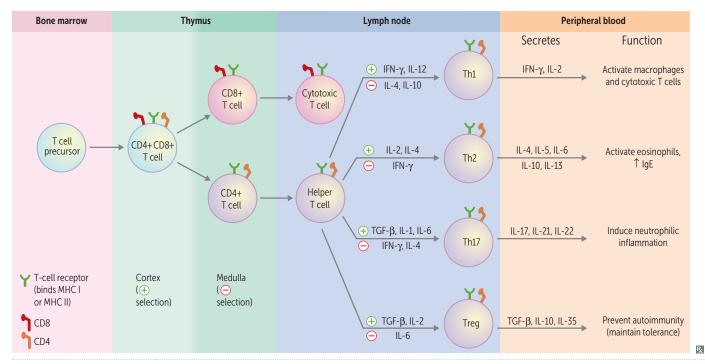
Delayed cell-mediated hypersensitivity (type IV).

Acute and chronic cellular organ rejection.

Rule of 8: MHC II \times CD4 = 8; MHC I \times CD8 = 8.

FAS1_2019_02-Immunology.indd 101 11/7/19 3:24 PM

Differentiation of T cells



Positive selection

Thymic cortex. T cells expressing TCRs capable of binding self-MHC on cortical epithelial cells survive.

Negative selection

Thymic medulla. T cells expressing TCRs with high affinity for self antigens undergo apoptosis or become regulatory T cells. Tissue-restricted self-antigens are expressed in the thymus due to the action of autoimmune regulator (AIRE); deficiency leads to autoimmune polyendocrine syndrome-l (Chronic mucocutaneous candidiasis, Hypoparathyroidism, Adrenal insufficiency, Recurrent Candida infections). "Without AIRE, your body will CHAR".

Macrophagelymphocyte interaction

Th1 cells secrete IFN- γ , which enhances the ability of monocytes and macrophages to kill microbes they ingest. This function is also enhanced by interaction of T cell CD40L with CD40 on macrophages. Macrophages also activate lymphocytes via antigen presentation.

Cytotoxic T cells

Kill virus-infected, neoplastic, and donor graft cells by inducing apoptosis. Release cytotoxic granules containing preformed proteins (eg, perforin, granzyme B). Cytotoxic T cells have CD8, which binds to MHC I on virus-infected cells.

Regulatory T cells

Help maintain specific immune tolerance by suppressing CD4⁺ and CD8⁺ T-cell effector functions. Identified by expression of CD3, CD4, CD25, and FOXP3. Activated regulatory T cells (Tregs) produce anti-inflammatory cytokines (eg, IL-10, TGF-β).

IPEX (Immune dysregulation, Polyendocrinopathy, Enteropathy, X-linked) syndrome—genetic deficiency of FOXP3 → autoimmunity. Characterized by enteropathy, endocrinopathy, nail dystrophy, dermatitis, and/or other autoimmune dermatologic conditions. Associated with diabetes in male infants.

FAS1_2019_02-Immunology.indd 102 11/7/19 3:24 PM

T- and B-cell activation

APCs: B cells, dendritic cells, Langerhans cells, macrophages.

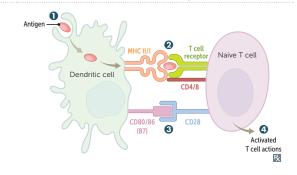
Two signals are required for T-cell activation, B-cell activation, and class switching.

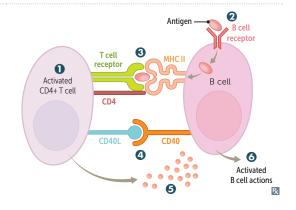
T-cell activation

- Dendritic cell (specialized APC) samples and processes antigen, then migrates to the draining lymph node.
- 2 T-cell activation (signal 1): exogenous antigen is presented on MHC II and recognized by TCR on Th (CD4+) cell. Endogenous or cross-presented antigen is presented on MHC I to Tc (CD8+) cell.
- Proliferation and survival (signal 2): costimulatory signal via interaction of B7 protein (CD80/86) on dendritic cell and CD28 on naïve T cell.
- **4** Activated Th cell produces cytokines. To cell able to recognize and kill virus-infected cell.



- Th-cell activation as above.
- **2** B-cell receptor–mediated endocytosis.
- **3** Exogenous antigen is presented on MHC II and recognized by TCR on Th cell.
- 4 CD40 receptor on B cell binds CD40 ligand (CD40L) on Th cell.
- **5** Th cells secrete cytokines that determine Ig class switching of B cells.
- **6** B cells are activated, undergo class switching and affinity maturation, and begin producing antibodies.



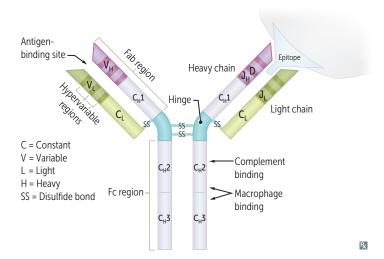


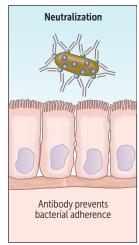
FAS1_2019_02-Immunology.indd 103 11/7/19 3:24 PM

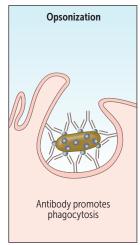
► IMMUNOLOGY—IMMUNE RESPONSES

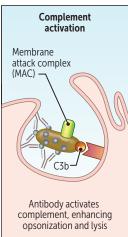
Antibody structure and function

Fab (containing the variable/hypervariable regions) consisting of light (L) and heavy (H) chains recognizes antigens. Fc region of IgM and IgG fixes complement. Heavy chain contributes to Fc and Fab regions. Light chain contributes only to Fab region.









Fab

- Fragment, antigen binding
- Determines idiotype: unique antigen-binding pocket; only 1 antigenic specificity expressed per B cell

Fc (5 C's):

- Constant
- Carboxy terminal
- Complement binding
- Carbohydrate side chains
- Confers (determines) isotype (IgM, IgD, etc)

Generation of antibody diversity (antigen independent)

- 1. Random recombination of VJ (light-chain) or V(D)J (heavy-chain) genes
- 2. Random addition of nucleotides to DNA during recombination by terminal deoxynucleotidyl transferase (TdT)
- 3. Random combination of heavy chains with light chains

Generation of antibody specificity (antigen dependent)

- 4. Somatic hypermutation and affinity maturation (variable region)
- 5. Isotype switching (constant region)

FAS1_2019_02-Immunology.indd 104 11/7/19 3:24 PM

Immunoglobulin isotypes

All isotypes can exist as monomers. Mature, naïve B cells prior to activation express IgM and IgD on their surfaces. They may differentiate in germinal centers of lymph nodes by isotype switching (gene rearrangement; induced by cytokines and CD40L) into plasma cells that secrete IgA, IgE, or IgG.

Affinity refers to the individual antibody-antigen interaction, while avidity describes the cumulative binding strength of all antibody-antigen interactions in a multivalent molecule.

lgG



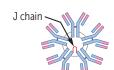
Main antibody in 2° response to an antigen. Most abundant isotype in serum. Fixes complement, opsonizes bacteria, neutralizes bacterial toxins and viruses. Only isotype that crosses the placenta (provides infants with passive immunity that starts to wane after birth). "IgG Greets the Growing fetus."

IgA



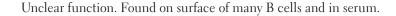
Prevents attachment of bacteria and viruses to mucous membranes; does not fix complement. Monomer (in circulation) or dimer (with J chain when secreted). Crosses epithelial cells by transcytosis. Produced in GI tract (eg, by Peyer patches) and protects against gut infections (eg, *Giardia*). Most produced antibody overall, but has lower serum concentrations. Released into secretions (tears, saliva, mucus) and breast milk. Picks up secretory component from epithelial cells, which protects the Fc portion from luminal proteases.

IgM



Produced in the 1° (immediate) response to an antigen. Fixes complement. Antigen receptor on the surface of B cells. Monomer on B cell, pentamer with J chain when secreted. Pentamer enables avid binding to antigen while humoral response evolves.

IgD





IgE



Binds mast cells and basophils; cross-links when exposed to allergen, mediating immediate (type I) hypersensitivity through release of inflammatory mediators such as histamine. Contributes to immunity to parasites by activating eosinophils.

Antigen type and memory

Thymus-in	dependent
antigens	

Antigens lacking a peptide component (eg, lipopolysaccharides from gram ⊖ bacteria); cannot be presented by MHC to T cells. Weakly immunogenic; vaccines often require boosters and adjuvants (eg, capsular polysaccharide subunit of *Streptococcus pneumoniae* PPSV23 vaccine).

Thymus-dependent antigens

Antigens containing a protein component (eg, *Streptococcus pneumoniae* PCV13 vaccine, polysaccharides conjugated to diphtheria toxin-like protein). Class switching and immunologic memory occur as a result of direct contact of B cells with Th cells.

FAS1_2019_02-Immunology.indd 105 11/7/19 3:24 PM

FAS1_2019_02-Immunology.indd 106 11/7/19 3:24 PM

SECTION II

Complement disorders

Complement protein deficiencies

Early complement deficiencies (C1-C4) Increased risk of severe, recurrent pyogenic sinus and respiratory tract infections. Increased risk of

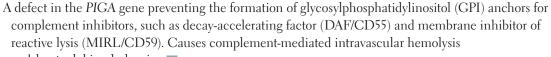
Terminal complement Increased susceptibility to recurrent Neisseria bacteremia. deficiencies (C5-C9)

Complement regulatory protein deficiencies

C1 esterase inhibitor deficiency

Causes hereditary angioedema due to unregulated activation of kallikrein → ↑ bradykinin. Characterized by \$\ddot C4\$ levels. ACE inhibitors are contraindicated (also \$\ddot\$ bradykinin).

Paroxysmal nocturnal hemoglobinuria





→ \ haptoglobin, dark urine A.

FAS1_2019_02-Immunology.indd 107 11/7/19 3:24 PM 108 SECTION I

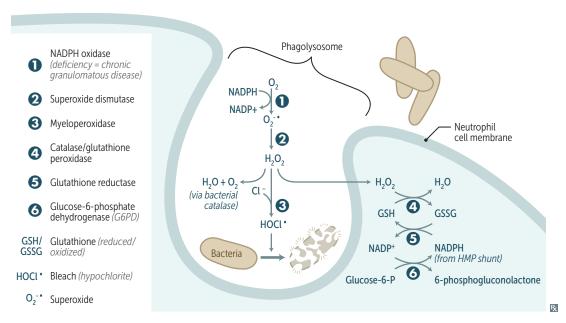
SECTION II IMMUNOLOGY ► IMMUNOLOGY—IMMUNE RESPONSES

mportant cytokines Acute (IL-1, IL-6, TNF-α), then recruit (IL-8, IL-12).			
SECRETED BY MACROPHAGES			
Interleukin-1	Causes fever, acute inflammation. Activates endothelium to express adhesion molecules. Induces chemokine secretion to recruit WBCs. Also called osteoclast-activating factor.	"Hot T-bone stEAK": IL-1: fever (hot). IL-2: stimulates T cells. IL-3: stimulates bone marrow. IL-4: stimulates IgE production. IL-5: stimulates IgA production. IL-6: stimulates aKute-phase protein production.	
Interleukin-6	Causes fever and stimulates production of acute- phase proteins.		
Tumor necrosis factor- α	Activates endothelium. Causes WBC recruitment, vascular leak.	Causes cachexia in malignancy. Maintains granulomas in TB. IL-1, IL-6, TNF-α can mediate fever and sepsis.	
Interleukin-8	Major chemotactic factor for neutrophils.	"Clean up on aisle 8." Neutrophils are recruited by IL-8 to clear infections.	
Interleukin-12	Induces differentiation of T cells into Th1 cells. Activates NK cells.		
SECRETED BY ALL T CELLS			
Interleukin-2	Stimulates growth of helper, cytotoxic, and regulatory T cells, and NK cells.		
Interleukin-3	Supports growth and differentiation of bone marrow stem cells. Functions like GM-CSF.		
FROM Th1 CELLS			
Interferon-γ	Secreted by NK cells and T cells in response to antigen or IL-12 from macrophages; stimulates macrophages to kill phagocytosed pathogens. Inhibits differentiation of Th2 cells.	Also activates NK cells to kill virus-infected cells. Increases MHC expression and antigen presentation by all cells. Activates macrophages to induce granuloma formation.	
FROM Th2 CELLS			
Interleukin-4	Induces differentiation of T cells into Th (helper) 2 cells. Promotes growth of B cells. Enhances class switching to IgE and IgG.	Ain't too proud 2 BEG 4 help.	
Interleukin-5	Promotes growth and differentiation of B cells. Enhances class switching to IgA. Stimulates growth and differentiation of eosinophils.		
Interleukin-10	Attenuates inflammatory response. Decreases expression of MHC class II and Th1 cytokines. Inhibits activated macrophages and dendritic cells. Also secreted by regulatory T cells.	TGF-β and IL-10 both attenuate the immune response.	

FAS1_2019_02-Immunology.indd 108 11/7/19 3:24 PM

Respiratory burst

Also called oxidative burst. Involves the activation of the phagocyte NADPH oxidase complex (eg, in neutrophils, monocytes), which utilizes O_2 as a substrate. Plays an important role in the immune response \rightarrow rapid release of reactive oxygen species (ROS). NADPH plays a role in both the creation and neutralization of ROS. Myeloperoxidase contains a blue-green, heme-containing pigment that gives sputum its color.



Phagocytes of patients with CGD can utilize H_2O_2 generated by invading organisms and convert it to ROS. Patients are at † risk for infection by catalase \oplus species (eg, *S aureus*, *Aspergillus*) capable of neutralizing their own H_2O_2 , leaving phagocytes without ROS for fighting infections. Pyocyanin of *P aeruginosa* generates ROS to kill competing pathogens. Oxidative burst also leads to K^+ influx, which releases lysosomal enzymes. Lactoferrin is a protein found in secretory fluids and neutrophils that inhibits microbial growth via iron chelation.

Interferons	IFN- α , IFN- β , IFN- γ
MECHANISM	A part of innate host defense, interferons interfere with both RNA and DNA viruses. Cells infected with a virus synthesize these glycoproteins, which act on local cells, priming them for viral defense by downregulating protein synthesis to resist potential viral replication and by upregulating MHC expression to facilitate recognition of infected cells. Also play a major role in activating antitumor immunity.
CLINICAL USE	Chronic HBV, Kaposi sarcoma, hairy cell leukemia, condyloma acuminatum, renal cell carcinoma malignant melanoma, multiple sclerosis, chronic granulomatous disease.
ADVERSE EFFECTS	Flu-like symptoms, depression, neutropenia, myopathy, interferon-induced autoimmunity.

FAS1_2019_02-Immunology.indd 109 11/7/19 3:24 PM

Cell surface proteins

T cells	TCR (binds antigen-MHC complex)	
	CD3 (associated with TCR for signal	
	transduction) CD28 (binds B7 on APC)	
Helper T cells	CD4, CD40L, CXCR4/CCR5 (co-receptors for HIV)	
Cytotoxic T cells	CD8	
Regulatory T cells	CD4, CD25	
B cells	Ig (binds antigen)	
	CD19, CD20, CD21 (receptor for Epstein-Barr virus), CD40 MHC II, B7	Must be 21 to drink B eer in a Barr
Macrophages	CD14 (receptor for PAMPs, eg, LPS), CD40	
	CCR5	
	MHC II, B7 (CD80/86) Fc and C3b receptors (enhanced phagocytosis)	
NK cells	CD16 (binds Fc of IgG), CD56 (suggestive marker for NK)	
Hematopoietic stem cells	CD34	
	State during which a call connet become activate	

Anergy

State during which a cell cannot become activated by exposure to its antigen. T and B cells become anergic when exposed to their antigen without costimulatory signal (signal 2). Another mechanism of self-tolerance.

Passive vs active immunity

	Passive	Active	
MEANS OF ACQUISITION	Receiving preformed antibodies	Exposure to exogenous antigens	
ONSET	Rapid	Slow	
DURATION	Short span of antibodies (half-life = 3 weeks)	Long-lasting protection (memory)	
IgA in breast milk, maternal IgG crossing placenta, antitoxin, humanized monoclonal antibody		Natural infection, vaccines, toxoid	
NOTES	After exposure to Tetanus toxin, Botulinum toxin, HBV, Varicella, Rabies virus, or Diphtheria toxin, unvaccinated patients are given preformed antibodies (passive)—"To Be Healed Very Rapidly before Dying"	Combined passive and active immunizations can be given for hepatitis B or rabies exposure	

FAS1_2019_02-Immunology.indd 110 11/7/19 3:24 PM

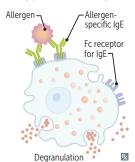
Vaccination Induces an active immune response (humoral and/or cellular) to specific pathogens.

VACCINE TYPE	DESCRIPTION	PROS/CONS	EXAMPLES
Live attenuated vaccine	Microorganism loses its pathogenicity but retains capacity for transient growth within inoculated host. Induces cellular and humoral responses . MMR and varicella vaccines can be given to HIV ⊕ patients without evidence of immunity if CD4 cell count ≥ 200 cells/mm ³ .	Pros: induces strong, often lifelong immunity. Cons: may revert to virulent form. Often contraindicated in pregnancy and immunodeficiency.	Adenovirus (nonattenuated, given to military recruits), Typhoid (Ty2la, oral), Polio (Sabin), Varicella (chickenpox), Smallpox, BCG, Yellow fever, Influenza (intranasal), MMR, Rotavirus "Attention Teachers! Please Vaccinate Small, Beautiful Young Infants with MMR Regularly!"
Killed or inactivated vaccine	Pathogen is inactivated by heat or chemicals. Maintaining epitope structure on surface antigens is important for immune response. Mainly induces a humoral response.	Pros: safer than live vaccines. Cons: weaker immune response; booster shots usually required.	Hepatitis A, Typhoid (Vi polysaccharide, intramuscular), Rabies, Influenza, Polio (SalK) A TRIP could Kill you
Subunit	Includes only the antigens that best stimulate the immune system.	Pros: lower chance of adverse reactions. Cons: expensive, weaker immune response.	HBV (antigen = HBsAg), HPV (types 6, 11, 16, and 18), acellular pertussis (aP), Neisseria meningitidis (various strains), Streptococcus pneumoniae, Haemophilus influenzae type b.
Toxoid	Denatured bacterial toxin with an intact receptor binding site. Stimulates the immune system to make antibodies without potential for causing disease.	Pros: protects against the bacterial toxins. Cons: antitoxin levels decrease with time, may require a booster.	Clostridium tetani, Corynebacterium diphtheriae

FAS1_2019_02-Immunology.indd 111 11/7/19 3:24 PM

Hypersensitivity types Four types (ABCD): Anaphylactic and Atopic (type I), AntiBody-mediated (type II), Immune Complex (type III), Delayed (cell-mediated, type IV). Types I, II, and III are all antibody-mediated.

Type I hypersensitivity



Anaphylactic and atopic—two phases:

- Immediate (minutes): antigen crosslinks preformed IgE on presensitized mast cells → immediate degranulation → release of histamine (a vasoactive amine) and tryptase (a marker of mast cell activation).
- Late (hours): chemokines (attract inflammatory cells, eg, eosinophils) and other mediators (eg, leukotrienes) from mast cells → inflammation and tissue damage.

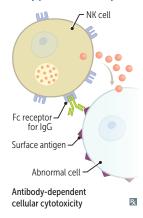
First (type) and Fast (anaphylaxis).

Test: skin test or blood test (ELISA) for allergenspecific IgE.

Example:

- Anaphylaxis (eg, food, drug, or bee sting allergies)
- Allergic asthma

Type II hypersensitivity



Antibodies bind to cell-surface antigens → cellular destruction, inflammation, and cellular dysfunction.

Cellular destruction—cell is opsonized (coated) by antibodies, leading to either:

- Phagocytosis and/or activation of complement system.
- NK cell killing (antibody-dependent cellular cytotoxicity).

Inflammation—binding of antibodies to cell surfaces → activation of complement system and Fc receptor-mediated inflammation.

Cellular dysfunction—antibodies bind to cell surface receptors → abnormal blockade or activation of downstream process.

Direct Coombs test—detects antibodies attached directly to the RBC surface. Indirect Coombs test—detects presence of unbound antibodies in the serum

Examples:

- Autoimmune-hemolytic anemia
- Immune thrombocytopenia
- Transfusion reactions
- Hemolytic disease of the newborn

Examples:

- Goodpasture syndrome
- Rheumatic fever
- Hyperacute transplant rejection

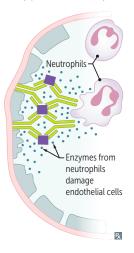
Examples:

- Myasthenia gravis
- Graves disease
- Pemphigus vulgaris

FAS1_2019_02-Immunology.indd 112 11/7/19 3:24 PM

Hypersensitivity types (continued)

Type III hypersensitivity



Immune complex—antigen-antibody (mostly IgG) complexes activate complement, which attracts neutrophils; neutrophils release lysosomal enzymes.

Can be associated with vasculitis and systemic manifestations.

Serum sickness—the prototypic immune complex disease. Antibodies to foreign proteins are produced and 1–2 weeks later, antibodyantigen complexes form and deposit in tissues → complement activation → inflammation and tissue damage.

Arthus reaction—a local subacute immune complex-mediated hypersensitivity reaction. Intradermal injection of antigen into a presensitized (has circulating IgG) individual leads to immune complex formation in the skin (eg, enhanced local reaction to a booster vaccination). Characterized by edema, necrosis, and activation of complement.

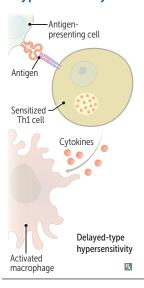
In type III reaction, imagine an immune complex as 3 things stuck together: antigenantibody-complement.

Examples:

- SLE
- Polyarteritis nodosa
- Poststreptococcal glomerulonephritis

Fever, urticaria, arthralgia, proteinuria, lymphadenopathy occur 1–2 weeks after antigen exposure. Serum sickness-like reactions are associated with some drugs (may act as haptens, eg, penicillin) and infections (eg, hepatitis B).

Type IV hypersensitivity



Two mechanisms, each involving T cells:

- 1. Direct cell cytotoxicity: CD8+ cytotoxic T cells kill targeted cells.
- 2. Inflammatory reaction: effector CD4+ T cells recognize antigen and release inflammation-inducing cytokines (shown in illustration).

Response does not involve antibodies (vs types I, II, and III).

Examples: contact dermatitis (eg, poison ivy, nickel allergy) and graft-versus-host disease.

Tests: PPD for TB infection; patch test for contact dermatitis; *Candida* skin test for T cell immune function.

4T's: T cells, Transplant rejections, TB skin tests, Touching (contact dermatitis).

Fourth (type) and last (delayed).

FAS1_2019_02-Immunology.indd 113 117/19 3:24 PM

Blood transfusion reactions

TYPE	PATHOGENESIS	TIMING	CLINICAL PRESENTATION	DONOR BLOOD	HOST BLOOD
Allergic/ anaphylactic reaction	Type I hypersensitivity reaction against plasma proteins in transfused blood IgA-deficient individuals should receive blood products without IgA	Within minutes to 2-3 hr (due to release of preformed inflammatory mediators in degranulating mast cells)	Allergies: urticaria, pruritus Anaphylaxis: wheezing, hypotension, respiratory arrest, shock	Donor plasma proteins, including IgA	IgE (anti-IgA) Host mast cell
Acute hemolytic transfusion reaction	Type II hypersensitivity reaction Typically causes intravascular hemolysis (ABO blood group incompatibility)	During transfusion or within 24 hr (due to preformed antibodies)	Fever, hypotension, tachypnea, tachycardia, flank pain, hemoglobinuria (intravascular), jaundice (extravascular)	Donor RBC with A and/ or B group antigens	Host anti-A, anti-B IgG, IgM
Febrile nonhemolytic transfusion reaction	Cytokines created by donor WBCs accumulate during storage of blood products Reactions prevented by leukoreduction of blood products	Within 1-6 hr (due to preformed cytokines)	Fever, headaches, chills, flushing More common in children	Donor WBC releases preformed cytokines ☑	
Transfusion- related acute lung injury	 Two-hit mechanism: Neutrophils are sequestered and primed in pulmonary vasculature due to recipient risk factors Neutrophils are activated by a product (eg, antileukocyte antibodies) in the transfused blood and release inflammatory mediators → † capillary permeability → pulmonary edema 	Within minutes to 6 hr	Respiratory distress, noncardiogenic pulmonary edema	Host neutrophi Donor antileukocyte IgG	ls ·
Delayed hemolytic transfusion reaction	Anamnestic response to a foreign antigen on donor RBCs (most commonly Rh or other minor blood group antigens) previously encountered by recipient Typically causes extravascular hemolysis	Onset over 24 hr Usually presents within 1-2 wk (due to slow destruction by reticuloendothelial system)	Generally self limited and clinically silent Mild fever, hyperbilirubinemia	Donor RBC with foreign antigens	Host IgG ▼

FAS1_2019_02-Immunology.indd 114 11/7/19 3:24 PM

Autoantibodies AUTOANTIBODY ASSOCIATED DISORDER Anti-postsynaptic ACh receptor Myasthenia gravis Anti-presynaptic voltage-gated calcium channel Lambert-Eaton myasthenic syndrome Anti-β₂ glycoprotein I Antiphospholipid syndrome Antinuclear (ANA) Nonspecific screening antibody, often associated with SLE Anticardiolipin, lupus anticoagulant SLE, antiphospholipid syndrome Anti-dsDNA, anti-Smith SLE Antihistone Drug-induced lupus Anti-U1 RNP (ribonucleoprotein) Mixed connective tissue disease Rheumatoid factor (IgM antibody against IgG Rheumatoid arthritis Fc region), anti-CCP (more specific) Anti-Ro/SSA, anti-La/SSB Sjögren syndrome Anti-Scl-70 (anti-DNA topoisomerase I) Scleroderma (diffuse) Anticentromere Limited scleroderma (CREST syndrome) Antisynthetase (eg, anti-Jo-1), anti-SRP, anti-Polymyositis, dermatomyositis helicase (anti-Mi-2) Antimitochondrial 1° biliary cholangitis Anti-smooth muscle Autoimmune hepatitis type 1 MPO-ANCA/p-ANCA Microscopic polyangiitis, eosinophilic granulomatosis with polyangiitis (Churg-Strauss syndrome), ulcerative colitis PR3-ANCA/c-ANCA Granulomatosis with polyangiitis (Wegener) Anti-phospholipase A2 receptor 1° membranous nephropathy Anti-hemidesmosome Bullous pemphigoid Anti-desmoglein (anti-desmosome) Pemphigus vulgaris Antithyroglobulin, antithyroid peroxidase Hashimoto thyroiditis (antimicrosomal) Anti-TSH receptor Graves disease IgA anti-endomysial, IgA anti-tissue Celiac disease transglutaminase, IgA and IgG deamidated gliadin peptide Anti-glutamic acid decarboxylase, islet cell Type 1 diabetes mellitus cytoplasmic antibodies Antiparietal cell, anti-intrinsic factor Pernicious anemia Anti-glomerular basement membrane Goodpasture syndrome

FAS1_2019_02-Immunology.indd 115 11/7/19 3:24 PM

Immunodeficiencies

DISEASE	DEFECT	PRESENTATION	FINDINGS			
B-cell disorders	B-cell disorders					
X-linked (Bruton) agammaglobulinemia	Defect in <i>BTK</i> , a tyrosine kinase gene → no B -cell maturation; X-linked recessive († in B oys)	Recurrent bacterial and enteroviral infections after 6 months (‡ maternal IgG)	Absent B cells in peripheral blood, ↓ Ig of all classes. Absent/scanty lymph nodes and tonsils (1° follicles and germinal centers absent) → live vaccines contraindicated			
Selective IgA deficiency	Cause unknown Most common 1° immunodeficiency	Majority Asymptomatic Can see Airway and GI infections, Autoimmune disease, Atopy, Anaphylaxis to IgA-containing products	↓ IgA with normal IgG, IgM levels ↑ susceptibility to giardiasis Can cause false-positive β-hCG test			
Common variable immunodeficiency	Defect in B-cell differentiation. Cause unknown in most cases	May present in childhood but usually diagnosed after puberty † risk of autoimmune disease, bronchiectasis, lymphoma, sinopulmonary infections	↓ plasma cells, ↓ immunoglobulins			
T-cell disorders						
Thymic aplasia	22q11 microdeletion; failure to develop 3rd and 4th pharyngeal pouches → absent thymus and parathyroids DiGeorge syndrome—thymic, parathyroid, cardiac defects Velocardiofacial syndrome—palate, facial, cardiac defects	CATCH-22: Cardiac defects (conotruncal abnormalities [eg, tetralogy of Fallot, truncus arteriosus]), Abnormal facies, Thymic hypoplasia → T-cell deficiency (recurrent viral/ fungal infections), Cleft palate, Hypocalcemia 2° to parathyroid aplasia → tetany	↓ T cells, ↓ PTH, ↓ Ca ²⁺ Thymic shadow absent on CXR			
IL-12 receptor deficiency	↓ Th1 response; autosomal recessive	Disseminated mycobacterial and fungal infections; may present after administration of BCG vaccine	↓ IFN-γ Most common cause of Mendelian susceptibility to mycobacterial diseases (MSMD)			
Autosomal dominant hyper-IgE syndrome	Deficiency of Th17 cells due to STAT3 mutation → impaired	Cold (noninflamed) staphylococcal Abscesses,	† IgE † eosinophils			
sites of infection facies, Derm (eczema), † I	retained Baby teeth, Coarse facies, Dermatologic problems (eczema), † IgE, bone Fractures from minor trauma	Learn the ABCDEF's to get a Job!				
Chronic mucocutaneous candidiasis	T-cell dysfunction Impaired cell-mediated immunity against Candida sp Classic form caused by defects in AIRE	Persistent noninvasive <i>Candida albicans</i> infections of skin and mucous membranes	Absent in vitro T-cell proliferation in response to Candida antigens Absent cutaneous reaction to Candida antigens			

FAS1_2019_02-Immunology.indd 116 11/7/19 3:24 PM

Immunodeficiencies (continued)

DISEASE	DEFECT	PRESENTATION	FINDINGS
B- and T-cell disorders			
Severe combined immunodeficiency	Several types including defective IL-2R gamma chain (most common, X-linked recessive); adenosine deaminase deficiency (autosomal recessive); RAG mutation → VDJ recombination defect	Failure to thrive, chronic diarrhea, thrush Recurrent viral, bacterial, fungal, and protozoal infections	↓ T-cell receptor excision circles (TRECs) Absence of thymic shadow (CXR), germinal centers (lymph node biopsy), and T cells (flow cytometry)
Ataxia-telangiectasia	Defects in ATM gene → failure to detect DNA damage → failure to halt progression of cell cycle → mutations accumulate; autosomal recessive	Triad: cerebellar defects (Ataxia), spider Angiomas (telangiectasia A), IgA deficiency † sensitivity to radiation (limit x-ray exposure)	↑ AFP ↓ IgA, IgG, and IgE Lymphopenia, cerebellar atrophy ↑ risk of lymphoma and leukemia
Hyper-IgM syndrome	Most commonly due to defective CD40L on Th cells → class switching defect; X-linked recessive	Severe pyogenic infections early in life; opportunistic infection with <i>Pneumocystis</i> , <i>Cryptosporidium</i> , CMV	Normal or ↑ IgM ↓↓ IgG, IgA, IgE Failure to make germinal centers
Wiskott-Aldrich syndrome	Mutation in WAS gene; leukocytes and platelets unable to reorganize actin cytoskeleton → defective antigen presentation; X-linked recessive	WATER: Wiskott-Aldrich: Thrombocytopenia, Eczema, Recurrent (pyogenic) infections ↑ risk of autoimmune disease and malignancy	↓ to normal IgG, IgM † IgE, IgA Fewer and smaller platelets
Phagocyte dysfunction			
Leukocyte adhesion deficiency (type 1)	Defect in LFA-1 integrin (CD18) protein on phagocytes; impaired migration and chemotaxis; autosomal recessive	Late separation (>30 days) of umbilical cord, absent pus, dysfunctional neutrophils → recurrent skin and mucosal bacterial infections	↑ neutrophils in blood Absence of neutrophils at infection sites → impaired wound healing
Chédiak-Higashi syndrome	Defect in lysosomal trafficking regulator gene (<i>LYST</i>) Microtubule dysfunction in phagosome-lysosome fusion; autosomal recessive	PLAIN: Progressive neurodegeneration, Lymphohistiocytosis, Albinism (partial), recurrent pyogenic Infections, peripheral Neuropathy	Giant granules (B , arrows) in granulocytes and platelets. Pancytopenia Mild coagulation defects
Chronic granulomatous disease	Defect of NADPH oxidase → ↓ reactive oxygen species (eg, superoxide) and ↓ respiratory burst in neutrophils; X-linked form most common	↑ susceptibility to catalase ⊕ organisms	Abnormal dihydrorhodamine (flow cytometry) test (‡ green fluorescence) Nitroblue tetrazolium dye reduction test (obsolete) fails to turn blue

FAS1_2019_02-Immunology.indd 117 11/7/19 3:24 PM

Infections in immunodeficiency

PATHOGEN	↓ T CELLS	↓ B CELLS	↓ GRANULOCYTES	↓ COMPLEMENT
Bacteria	Sepsis	Encapsulated (Please SHINE my SKiS): Pseudomonas aeruginosa, Streptococcus pneumoniae, Haemophilus Influenzae type b, Neisseria meningitidis, Escherichia coli, Salmonella, Klebsiella pneumoniae, Group B Streptococcus	Some Bacteria Produce No Serious granules: Staphylococcus, Burkholderia cepacia, Pseudomonas aeruginosa, Nocardia, Serratia	Encapsulated species with early complement deficiencies Neisseria with late complement (C5– C9) deficiencies
Viruses	CMV, EBV, JC virus, VZV, chronic infection with respiratory/GI viruses	Enteroviral encephalitis, poliovirus (live vaccine contraindicated)	N/A	N/A
Fungi/parasites	Candida (local), PCP, Cryptococcus	GI giardiasis (no IgA)	Candida (systemic), Aspergillus, Mucor	N/A

Note: **B**-cell deficiencies tend to produce recurrent bacterial infections, whereas T-cell deficiencies produce more fungal and viral infections.

FAS1_2019_02-Immunology.indd 118 11/7/19 3:24 PM

Transplant rejection

TYPE OF REJECTION	ONSET	PATHOGENESIS	FEATURES
Hyperacute A	Within minutes	Pre-existing recipient antibodies react to donor antigen (type II hypersensitivity reaction), activate complement	Widespread thrombosis of graft vessels (arrows within glomerulus ▲) → ischemia/necrosis Graft must be removed
Acute B	Weeks to months	Cellular: CD8+ T cells and/ or CD4+ T cells activated against donor MHCs (type IV hypersensitivity reaction) Humoral: similar to hyperacute, except antibodies develop after transplant	Vasculitis of graft vessels with dense interstitial lymphocytic infiltrate B Prevent/reverse with immunosuppressants
Chronic	Months to years	CD4+ T cells respond to recipient APCs presenting donor peptides, including allogeneic MHC Both cellular and humoral components (type II and IV hypersensitivity reactions)	Recipient T cells react and secrete cytokines → proliferation of vascular smooth muscle, parenchymal atrophy, interstitial fibrosis Dominated by arteriosclerosis C Organ-specific examples: Chronic allograft nephropathy Bronchiolitis obliterans Accelerated atherosclerosis (heart) Vanishing bile duct syndrome
Graft-versus-host disease	Varies	Grafted immunocompetent T cells proliferate in the immunocompromised host and reject host cells with "foreign" proteins → severe organ dysfunction Type IV hypersensitivity reaction	Maculopapular rash, jaundice, diarrhea, hepatosplenomegaly Usually in bone marrow and liver transplants (rich in lymphocytes) Potentially beneficial in bone marrow transplant for leukemia (graft-versus-tumor effect) For immunocompromised patients, irradiate blood products prior to transfusion to prevent GVHD

11/7/19 3:24 PM FAS1_2019_02-Immunology.indd 119

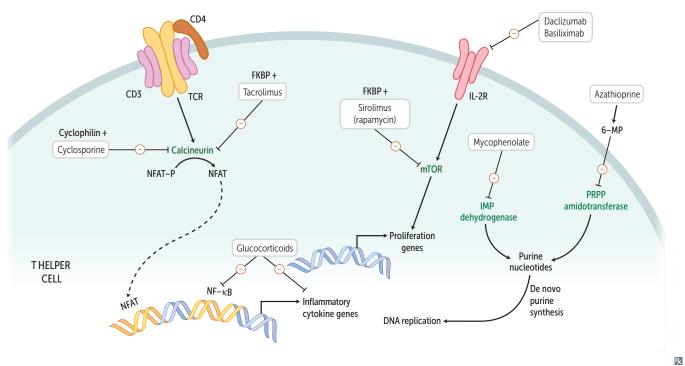
► IMMUNOLOGY—IMMUNOSUPPRESSANTS

Immunosuppressants	Agents that block lymphocyte activation and proliferation. Reduce acute transplant rejection by
	suppressing cellular immunity (used as prophylaxis). Frequently combined to achieve greater
	efficacy with \(\frac{1}{2}\) toxicity. Chronic suppression \(\frac{1}{2}\) risk of infection and malignancy

DRUG	MECHANISM	INDICATIONS	TOXICITY	NOTES
Cyclosporine	Calcineurin inhibitor; binds cyclophilin Blocks T-cell activation by preventing IL-2 transcription	Psoriasis, rheumatoid arthritis	Nephrotoxicity, hypertension, hyperlipidemia, neurotoxicity, gingival hyperplasia, hirsutism	Both calcineurin inhibitors are highly nephrotoxic,
Tacrolimus (FK506)	Calcineurin inhibitor; binds FK506 binding protein (FKBP) Blocks T-cell activation by preventing IL-2 transcription		Similar to cyclosporine, † risk of diabetes and neurotoxicity; no gingival hyperplasia or hirsutism	especially in higher doses or in patients with decreased renal function
Sirolimus (Rapamycin)	mTOR inhibitor; binds FKBP Blocks T-cell activation and B-cell differentiation by preventing response to IL-2	Kidney transplant rejection prophylaxis specifically Sir Basil's kidney transplant	"PanSirtopenia" (pancytopenia), insulin resistance, hyperlipidemia; not nephrotoxic	Kidney "sir-vives." Synergistic with cyclosporine Also used in drug- eluting stents
Basiliximab	Monoclonal antibody; blocks IL-2R		Edema, hypertension, tremor	
Azathioprine	Antimetabolite precursor of 6-mercaptopurine Inhibits lymphocyte proliferation by blocking nucleotide synthesis	Rheumatoid arthritis, Crohn disease, glomerulonephritis, other autoimmune conditions	Pancytopenia	6-MP degraded by xanthine oxidase; toxicity † by allopurinol Pronounce "azathiopurine"
Mycophenolate Mofetil	Reversibly inhibits IMP dehydrogenase, preventing purine synthesis of B and T cells	Lupus nephritis	GI upset, pancytopenia, hypertension, hyperglycemia Less nephrotoxic and neurotoxic	Associated with invasive CMV infection
Glucocorticoids	Inhibit NF-κB Suppress both B- and T-cell function by ↓ transcription of many cytokines Induce T cell apoptosis	Many autoimmune and inflammatory disorders, adrenal insufficiency, asthma, CLL, non-Hodgkin lymphoma	Cushing syndrome, osteoporosis, hyperglycemia, diabetes, amenorrhea, adrenocortical atrophy, peptic ulcers, psychosis, cataracts, avascular necrosis (femoral head)	Demargination of WBCs causes artificial leukocytosis Adrenal insufficiency may develop if drug is stopped abruptly after chronic use

FAS1_2019_02-Immunology.indd 120 11/7/19 3:24 PM

Immunosuppression targets



Recombinant cytokines and clinical uses

CYTOKINE	AGENT	CLINICAL USES
Bone marrow stimulati	on	
Erythropoietin	Epoetin alfa (EPO analog)	Anemias (especially in renal failure)
Colony stimulating factors	Filgrastim (G-CSF), Sargramostim (GM-CSF)	Leukopenia; recovery of granulocyte and monocyte counts
Thrombopoietin	Romi plostim (TPO analog), eltrombopag (TPO receptor agonist)	Autoimmune thrombocytopenia Platelet stimulator
Immunotherapy		
Interleukin-2	Aldesleukin	Renal cell carcinoma, metastatic melanoma
Interferons	IFN-α	Chronic hepatitis C (not preferred) and B, renal cell carcinoma
	IFN-β	Multiple sclerosis
	IFN-γ	Chronic granulomatous disease

FAS1_2019_02-Immunology.indd 121 11/7/19 3:24 PM

Therapeutic antibodies

AGENT AGENT	TARGET	CLINICAL USE	NOTES
Cancer therapy			
Alemtuzumab	CD52	CLL, multiple sclerosis	"A <mark>lym</mark> tuzumab"—chronic lymphocytic leukemia
Bevacizumab	VEGF	Colorectal cancer, renal cell carcinoma, non-small cell lung cancer	Also used for neovascular agerelated macular degeneration, proliferative diabetic retinopathy, and macular edema
Rituximab	CD20	B-cell non-Hodgkin lymphoma, CLL, rheumatoid arthritis, ITP, multiple sclerosis	Risk of PML in patients with JC virus CD20—"ri2ximab"
Trastuzumab	HER2	Breast cancer, gastric cancer	HER <mark>2</mark> —"tras <mark>2</mark> zumab"
Autoimmune disease the	erapy		
Adalimumab, infliximab	Soluble TNF-α	IBD, rheumatoid arthritis, ankylosing spondylitis, psoriasis	Etanercept is a decoy TNF-α receptor and not a monoclonal antibody
Eculizumab	Complement protein C5	Paroxysmal nocturnal hemoglobinuria	
Ixekizumab, secukinumab	IL-17A	Psoriasis, psoriatic arthritis	
Natalizumab	α4-integrin	Multiple sclerosis, Crohn disease	α4-integrin: WBC adhesion Risk of PML in patients with JC virus
Ustekinumab	IL-12/IL-23	Psoriasis, psoriatic arthritis	
Other applications			
Abciximab	Platelet glycoproteins IIb/IIIa	Antiplatelet agent for prevention of ischemic complications in patients undergoing percutaneous coronary intervention	ABC is as easy as 123
Denosumab	RANKL	Osteoporosis; inhibits osteoclast maturation (mimics osteoprotegerin)	Denosumab helps make dense bones
Omalizumab	IgE	Refractory allergic asthma; prevents IgE binding to FcεRI	
Palivizumab	RSV F protein	RSV prophylaxis for high-risk infants	Pali VI zumab— VI rus

FAS1_2019_02-Immunology.indd 122 11/7/19 3:24 PM

HIGH-YIELD PRINCIPLES IN

Microbiology

"Support bacteria. They're the only culture some people have."

-Steven Wright

"What lies behind us and what lies ahead of us are tiny matters compared to what lies within us."

-Henry S. Haskins

"Infectious disease is merely a disagreeable instance of a widely prevalent tendency of all living creatures to save themselves the bother of building, by their own efforts, the things they require."

-Hans Zinsser

Microbiology questions on the Step 1 exam often require two (or more) steps: Given a certain clinical presentation, you will first need to identify the most likely causative organism, and you will then need to provide an answer regarding some features of that organism or relevant antimicrobial agents. For example, a description of a child with fever and a petechial rash will be followed by a question that reads, "From what site does the responsible organism usually enter the blood?"

This section therefore presents organisms in two major ways: in individual microbial "profiles" and in the context of the systems they infect and the clinical presentations they produce. You should become familiar with both formats. When reviewing the systems approach, remind yourself of the features of each microbe by returning to the individual profiles. Also be sure to memorize the laboratory characteristics that allow you to identify microbes.

▶ Basic Bacteriology	124
▶ Clinical Bacteriology	134
▶ Mycology	151
▶ Parasitology	155
▶Virology	162
Systems	178
► Antimicrobials	197

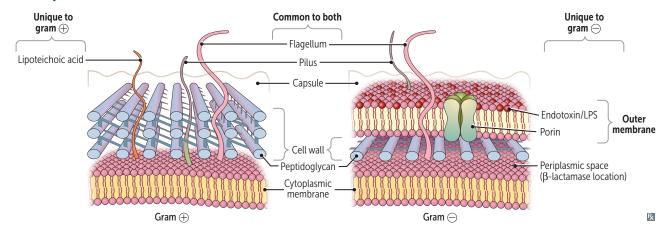
FAS1_2019_03-Microbiology.indd 123 11/14/19 12:19 PM

► MICROBIOLOGY—BASIC BACTERIOLOGY

-				-	
ка	cter	ıaı	stru	ctu	Ires

STRUCTURE	CHEMICAL COMPOSITION	FUNCTION
Appendages		
Flagellum	Proteins	Motility
Pilus/fimbria	Glycoprotein	Mediate adherence of bacteria to cell surface; sex pilus forms during conjugation
Specialized structures	5	
Spore	Keratin-like coat; dipicolinic acid; peptidoglycan, DNA	Gram ⊕ only Survival: resist dehydration, heat, chemicals
Cell envelope		
Capsule	Discrete layer usually made of polysaccharides (and rarely proteins)	Protects against phagocytosis
Slime (S) layer	Loose network of polysaccharides	Mediates adherence to surfaces, especially foreign surfaces (eg, indwelling catheters)
Outer membrane	Outer leaflet: contains endotoxin (LPS/LOS) Embedded proteins: porins and other outer membrane proteins (OMPs) Inner leaflet: phospholipids	Gram ⊝ only Endotoxin: lipid A induces TNF and IL-1; antigenic O polysaccharide component Most OMPs are antigenic Porins: transport across outer membrane
Periplasm	Space between cytoplasmic membrane and outer membrane in gram ⊖ bacterial (peptidoglycan in middle)	Accumulates components exiting gram ⊝ cells, including hydrolytic enzymes (eg, β-lactamases)
Cell wall	Peptidoglycan is a sugar backbone with peptide side chains cross-linked by transpeptidase	Net-like structure gives rigid support, protects against osmotic pressure damage
Cytoplasmic membrane	Phospholipid bilayer sac with embedded proteins (eg, penicillin-binding proteins [PBPs]) and other enzymes Lipoteichoic acids (gram positive) only extend from membrane to exterior	Site of oxidative and transport enzymes; PBPs involved in cell wall synthesis Lipoteichoic acids induce TNF-α and IL-1

Cell envelope



FAS1_2019_03-Microbiology.indd 124 11/14/19 12:19 PM

Gram stain	First-line lab test in bacterial identification. Bacteria with thick peptidoglycan layer retain crystal violet dye (gram ⊕); bacteria with thin peptidoglycan layer turn red or pink (gram ⊝) with counterstain. These bugs do not Gram stain well (These Little Microbes May Unfortunately Lack Real Color But Are Everywhere):			
	Treponema, Leptospira	Too thin to be visualized		
	Mycobacteria	Cell wall has high lipid content		
	Mycoplasma, Ureaplasma	No cell wall		
	Legionella, Rickettsia, Chlamydia, Bartonella, Anaplasma, Ehrlichia	Primarily intracellular; also, <i>Chlamydia</i> lack classic peptidoglycan because of ↓ muramic acid		
Giemsa stain	Rickettsia, Chlamydia, Trypanosomes A, Plasmodium, Borrelia, Helicobacter pylori	Ricky got Chlamydia as he Tried to Please the Bored Hot "Geisha"		
Periodic acid-Schiff stain	Stains glycogen , mucopolysaccharides; used to diagnose Whipple disease (<i>Tropheryma whipplei</i> B)	PaSs the sugar		
Ziehl-Neelsen stain (carbol fuchsin)	Acid-fast bacteria (eg, <i>Mycobacteria</i> C , <i>Nocardia</i> ; stains mycolic acid in cell wall); protozoa (eg, <i>Cryptosporidium</i> oocysts)	Auramine-rhodamine stain is more often used for screening (inexpensive, more sensitive)		
India ink stain	Cryptococcus neoformans D; mucicarmine can also be used to stain thick polysaccharide capsule red			
Silver stain	Fungi (eg, Coccidioides 🖪, Pneumocystis jirovecii), Legionella, Helicobacter pylori			
Fluorescent antibody stain	Used to identify many bacteria, viruses, Pneumocystis jirovecii, Giardia, and Cryptosporidium	Example is FTA-ABS for syphilis		
A	B C			

11/14/19 12:19 PM FAS1_2019_03-Microbiology.indd 125

Properties of growth media	The same type of media can possess both (or neither) of these properties.		
Selective media	Favors the growth of particular organism while preventing growth of other organisms. Example: Thayer-Martin agar contains antibiotics that allow the selective growth of <i>Neisseria</i> by inhibiting the growth of other sensitive organisms.		
Indicator (differential) media			
Special culture requiren	nents		
BUG	MEDIA USED FOR ISOLATION	MEDIA CONTENTS/OTHER	
H influenzae	Chocolate agar	Factors V (NAD+) and X (hematin)	
NII	7D1 3.4 .:		

BUG	MEDIA USED FOR ISOLATION	MEDIA CONTENTS/OTHER
H influenzae	Chocolate agar	Factors V (NAD+) and X (hematin)
N gonorrhoeae, N meningitidis	Thayer-Martin agar	Selectively favors growth of <i>Neisseria</i> by inhibiting growth of gram ⊕ organisms with Vancomycin, gram ⊝ organisms except <i>Neisseria</i> with Trimethoprim and Colistin, and fungi with Nystatin Very Typically Cultures <i>Neisseria</i>
B pertussis	Bordet-Gengou agar (<mark>Bordet</mark> for <i>Bordetella</i>) Regan-Lowe medium	Potato extract Charcoal, blood, and antibiotic
C diphtheriae	Tellurite agar, Löffler medium	
M tuberculosis	Löwenstein-Jensen medium, Middlebrook medium, rapid automated broth cultures	
M pneumoniae	Eaton agar	Requires cholesterol
Lactose-fermenting enterics	MacConkey agar	Fermentation produces acid, causing colonies to turn pink
E coli	Eosin-methylene blue (EMB) agar	Colonies with green metallic sheen
Brucella, Francisella, Legionella, Pasteurella	Charcoal yeast extract agar buffered with cysteine and iron	The Ella siblings, Bruce, Francis, a legionnaire, and a pasteur (pastor), built the Sistine (cysteine) chapel out of charcoal and iron.
Fungi	Sabouraud agar	"Sab's a fun guy!"
Aerobes	Use an O ₂ -dependent system to generate ATP. Examples include <i>Nocardia</i> , <i>Pseudomonas aeru pertussis</i> . Reactivation of <i>M tuberculosis</i> (eg, after immur predilection for the apices of the lung.	ginosa, Mycobacterium tuberculosis, and Bordetella nocompromise or TNF- $lpha$ inhibitor use) has a

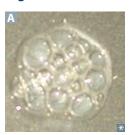
11/14/19 12:19 PM FAS1_2019_03-Microbiology.indd 126

Anaerobes	Examples include <i>Clostridium</i> , <i>Bacteroides</i> , <i>Fusobacterium</i> , and <i>Actinomyces israelii</i> . They lack catalase and/or superoxide dismutase and are thus susceptible to oxidative damage. Generally foul smelling (short-chain fatty acids), are difficult to culture, and produce gas in tissue (CO ₂ and H ₂).	Anaerobes Can't Breathe Fresh Air. Anaerobes are normal flora in GI tract, typically pathogenic elsewhere. AminO2glycosides are ineffective against anaerobes because these antibiotics require O2 to enter into bacterial cell.
Facultative anaerobes	May use O ₂ as a terminal electron acceptor to generate ATP, but can also use fermentation and other O ₂ -independent pathways.	Streptococci, staphylococci, and enteric gram ⊖ bacteria.
Intracellular bacteria		
Obligate intracellular	Rickettsia, Chlamydia, Coxiella Rely on host ATP	Stay inside (cells) when it is R eally Ch illy and Co ld
Facultative intracellular	Salmonella, Neisseria, Brucella, Mycobacterium, Listeria, Francisella, Legionella, Yersinia pestis	Some Nasty Bugs May Live FacultativeLY
Encapsulated bacteria A *** *** *** ***	Examples are Pseudomonas aeruginosa, Streptococcus pneumoniae A, Haemophilus influenzae type b, Neisseria meningitidis, Escherichia coli, Salmonella, Klebsiella pneumoniae, and group B Strep. Their capsules serve as an antiphagocytic virulence factor. Capsular polysaccharide + protein conjugate serves as an antigen in vaccines.	Please SHiNE my SKiS. Are opsonized, and then cleared by spleen. Asplenics (No Spleen Here) have ↓ opsonizing ability and thus ↑ risk for severe infections; need vaccines to protect against: N meningitidis S pneumoniae H influenzae
Encapsulated bacteria vaccines	Some vaccines containing polysaccharide capsule antigens are conjugated to a carrier protein, enhancing immunogenicity by promoting T-cell activation and subsequent class switching. A polysaccharide antigen alone cannot be presented to T cells.	Pneumococcal vaccines: PCV13 (pneumococcal conjugate vaccine), PPSV23 (pneumococcal polysaccharide vaccine with no conjugated protein). H influenzae type b (conjugate vaccine). Meningococcal vaccine (conjugate vaccine).
Urease-positive organisms	Proteus, Cryptococcus, H pylori, Ureaplasma, Nocardia, Klebsiella, S epidermidis, S saprophyticus. Urease hydrolyzes urea to release ammonia and CO ₂ → ↑ pH. Predisposes to struvite (ammonium magnesium phosphate) stones, particularly Proteus.	Pee CHUNKSS.

11/14/19 12:19 PM FAS1_2019_03-Microbiology.indd 127

MICROBIOLOGY → MICROBIOLOGY—BASIC BACTERIOLOGY

Catalase-positive organisms



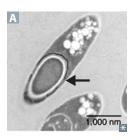
Catalase degrades H_2O_2 into H_2O and bubbles of O_2 \blacksquare before it can be converted to microbicidal products by the enzyme myeloperoxidase. People with chronic granulomatous disease (NADPH oxidase deficiency) have recurrent infections with certain catalase \oplus organisms.

Examples: Nocardia, Staphylococci, Serratia, Candida, Listeria, E coli, Burkholderia cepacia, Pseudomonas, Aspergillus, Helicobacter pylori, Bordetella pertussis.

Pigment-producing bacteria	Actinomyces israelii—yellow "sulfur" granules, which are composed of filaments of bacteria	Israel has yellow sand
	S aureus—yellow pigment	Aureus (Latin) = gold
	P aeruginosa—blue-green pigment (pyocyanin and pyoverdin)	Aerugula is green
	Serratia marcescens—red pigment	Think red Sriracha hot sauce
In vivo biofilm-	S epidermidis	Catheter and prosthetic device infections
producing bacteria	Viridans streptococci (S mutans, S sanguinis)	Dental plaques, infective endocarditis
	P aeruginosa	Respiratory tree colonization in patients with cystic fibrosis, ventilator-associated pneumonia Contact lens–associated keratitis
	Nontypeable (unencapsulated) H influenzae	Otitis media

FAS1_2019_03-Microbiology.indd 128 11/14/19 12:20 PM

Spore-forming bacteria



Some gram \oplus bacteria can form spores \blacksquare when nutrients are limited. Spores lack metabolic activity and are highly resistant to heat and chemicals. Core contains dipicolinic acid. Must autoclave to kill spores (as is done to surgical equipment) by steaming at 121°C for 15 minutes.

Examples: *B anthracis* (anthrax), *B cereus* (food poisoning), *C botulinum* (botulism), *C difficile* (pseudomembranous colitis), *C perfringens* (gas gangrene), *C tetani* (tetanus).

Bacterial virulence factors	These promote evasion of host immune response.		
Protein A	Binds Fc region of IgG. Prevents opsonization and phagocytosis. Expressed by S aureus.		
IgA protease	Enzyme that cleaves IgA, allowing bacteria to adhere to and colonize mucous membranes. Secreted by <i>S pneumoniae</i> , <i>H influenzae</i> type b, and <i>Neisseria</i> (SHiN).		
M protein	Helps prevent phagocytosis. Expressed by group A streptococci. Shares similar epitopes to human cellular proteins (molecular mimicry); possibly underlies the autoimmune response seen in acurheumatic fever.		

FAS1_2019_03-Microbiology.indd 129 11/14/19 12:20 PM

Bacterial genetics

Transformation Competent bacteria can bind and import short Degraded uncombined Recipient DNA pieces of environmental naked bacterial DNA Donor DNA chromosomal DNA (from bacterial cell lysis). The transfer and expression of newly Naked DNA Recipient cell Transformed cell transferred genes is called transformation. A feature of many bacteria, especially S pneumoniae, H influenzae type b, and Neisseria (SHiN). Adding deoxyribonuclease degrades naked DNA, preventing transformation. Conjugation $F^+ \times F^-$ F⁺ plasmid contains genes required for sex pilus Single strand Sex pilus transferred and conjugation. Bacteria without this plasmid are termed F⁻. Sex pilus on F⁺ bacterium contacts F bacterium. A single strand of plasmid DNA is transferred across the F+ cell F-cell F+ cell F-cell conjugal bridge ("mating bridge"). No transfer of chromosomal DNA. Transfer and replication F⁺ plasmid can become incorporated into Plasmid incorporates $Hfr \times F$ bacterial chromosomal DNA, termed highfrequency recombination (Hfr) cell. Transfer of leading part of plasmid and a few flanking Hfr cell Hfr cell F-cel chromosomal genes. High-frequency Ŗ recombination may integrate some of those bacterial genes. Recipient cell remains F- but now may have new bacterial genes. **Transduction** Generalized A packaging "error." Lytic phage infects Bacterial DNA packaged Cleavage of Bacteria bacterial DNA in phage capsids bacterium, leading to cleavage of bacterial DNA. Parts of bacterial chromosomal DNA may become packaged in phage capsid. Phage infects another bacterium, transferring these genes. Release of new phage Infects other Genes transferred from lysed cell bacteria to new bacteria Viral DNA Specialized An "excision" event. Lysogenic phage infects iral DNA incorporates in Phage particles Lysogenic bacterium; viral DNA incorporates into bacterial DNA bacterial chromosome. When phage DNA is excised, flanking bacterial genes may be excised with it. DNA is packaged into phage capsid and can infect another bacterium. Genes for the following 5 bacterial toxins are encoded in a lysogenic phage (ABCD'S): Group A strep erythrogenic toxin, Botulinum toxin, Release of new phage

FAS1_2019_03-Microbiology.indd 130 11/14/19 12:20 PM

Cholera toxin, Diphtheria toxin, Shiga toxin.

Infects other

bacteria

from lysed cell

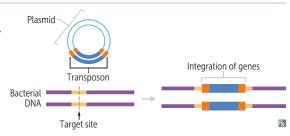
Genes different from

donor and recipient

Bacterial genetics (continued)

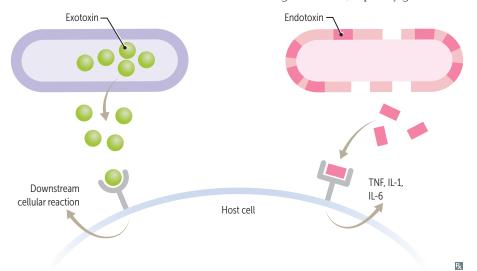
Transposition

A "jumping" process involving a transposon (specialized segment of DNA), which can copy and excise itself and then insert into the same DNA molecule or an unrelated DNA (eg, plasmid or chromosome). Critical in creating plasmids with multiple drug resistance and transfer across species lines (eg, Tn1546 with vanA from Enterococcus to S aureus).



Main features of exotoxins and endotoxins

	Exotoxins	Endotoxins	
SOURCE	Certain species of gram \oplus and gram \ominus bacteria	Outer cell membrane of most gram ⊖ bacteria	
SECRETED FROM CELL	Yes	No	
CHEMISTRY	Polypeptide	Lipid A component of LPS (structural part of bacteria; released when lysed)	
LOCATION OF GENES	Plasmid or bacteriophage	Bacterial chromosome	
ADVERSE EFFECTS	High (fatal dose on the order of 1 μg)	Low (fatal dose on the order of hundreds of micrograms)	
CLINICAL EFFECTS	Various effects (see following pages)	Fever, shock (hypotension), DIC	
MODE OF ACTION	Various modes (see following pages)	Induces TNF, IL-1, and IL-6	
ANTIGENICITY	Induces high-titer antibodies called antitoxins	Poorly antigenic	
VACCINES	Toxoids used as vaccines	No toxoids formed and no vaccine available	
HEAT STABILITY	Destroyed rapidly at 60°C (except staphylococcal enterotoxin and <i>E coli</i> heatstable toxin)	Stable at 100°C for 1 hr	
TYPICAL DISEASES	Tetanus, botulism, diphtheria, cholera	Meningococcemia; sepsis by gram ⊖ rods	



FAS1_2019_03-Microbiology.indd 131 11/14/19 12:20 PM

Bacteria with exotoxins

BACTERIA	TOXIN	MECHANISM	MANIFESTATION
Inhibit protein synthesis			
Corynebacterium diphtheriae	Diphtheria toxin ^a	Inactivate elongation factor (EF-2)	Pharyngitis with pseudomembranes in throat and severe lymphadenopathy (bull neck), myocarditis
Pseudomonas aeruginosa	Exotoxin A ^a		Host cell death
Shigella spp	Shiga toxin (ST) ^a	Inactivate 60S ribosome by removing adenine from rRNA	GI mucosal damage → dysentery; ST also enhances cytokine release, causing hemolytic- uremic syndrome (HUS)
Enterohemorrhagic <i>E coli</i>	Shiga-like toxin (SLT) ^a		SLT enhances cytokine release, causing HUS (prototypically in EHEC serotype O157:H7) Unlike <i>Shigella</i> , EHEC does not invade host cells
Increase fluid secretion			
Enterotoxigenic E coli	Heat-labile toxin (LT) ^a Heat-stable toxin (ST)	Overactivates adenylate cyclase († cAMP) → † Cl ⁻ secretion in gut and H ₂ O efflux Overactivates guanylate cyclase († cGMP) → ↓ resorption of NaCl and H ₂ O in gut	Watery diarrhea: "labile in the Air (Adenylate cyclase), stable on the Ground (Guanylate cyclase)"
Bacillus anthracis	Anthrax toxin ^a	Mimics adenylate cyclase († cAMP)	Likely responsible for characteristic edematous borders of black eschar in cutaneous anthrax
Vibrio cholerae	Cholera toxin ^a	Overactivates adenylate cyclase († cAMP) by permanently activating G _s → ↑ Cl ⁻ secretion in gut and H ₂ O efflux	Voluminous "rice-water" diarrhea
Inhibit phagocytic ability	/		
Bordetella pertussis	Pertussis toxin ^a	Inactivates inhibitory G subunit (G _i) → activation of adenylate cyclase → ↑ cAMP	Whooping cough—child coughs on expiration and "whoops" on inspiration (toxin may not actually be a cause of cough; can cause "100-day cough" in adults)
Inhibit release of neuroti	ansmitter		
Clostridium tetani	Tetanospasmin ^a	Both are proteases that cleave SNARE (soluble NSF attachment protein receptor), a set of proteins required for neurotransmitter release via vesicular fusion	Toxin prevents release of inhibitory (GABA and glycine) neurotransmitters from Renshaw cells in spinal cord → spastic paralysis, risus sardonicus, trismus (lockjaw)
Clostridium botulinum	Botulinum toxin ^a		Toxin prevents release of stimulatory (ACh) signals at neuromuscular junction → flaccid paralysis (floppy baby)

^aAn AB toxin (aka, two-component toxin [or three for anthrax]) with **B** enabling **b**inding and triggering uptake (endocytosis) of the **a**ctive **A** component. The A components are usually ADP ribosyltransferases; others have enzymatic activities as listed in chart.

FAS1_2019_03-Microbiology.indd 132 11/14/19 12:20 PM

Bacteria with exotoxins (continued)

BACTERIA	TOXIN	MECHANISM	MANIFESTATION	
Lyse cell membranes				
Clostridium perfringens	Alpha toxin	Phospholipase (lecithinase) that degrades tissue and cell membranes	Degradation of phospholipids → myonecrosis ("gas gangrene") and hemolysis ("double zone" of hemolysis on blood agar)	
Streptococcus pyogenes	Streptolysin O	Protein that degrades cell membrane	Lyses RBCs; contributes to β-hemolysis; host antibodies against toxin (ASO) used to diagnose rheumatic fever (do not confuse with immune complexes of poststreptococcal glomerulonephritis)	
Superantigens causing shock				
Staphylococcus aureus	Toxic shock syndrome toxin (TSST-1)	Cross-links β region of TCR to MHC class II on APCs outside of the antigen binding site → overwhelming release of IL-1, IL-2, IFN-γ, and TNF-α → shock	Toxic shock syndrome: fever, rash, shock; other toxins cause scalded skin syndrome (exfoliative toxin) and food poisoning (heat-stable enterotoxin)	
Streptococcus pyogenes	Erythrogenic exotoxin A		Toxic shock–like syndrome: fever, rash, shock; scarlet fever	

Endotoxin

LPS found in outer membrane of gram ⊖ bacteria (both cocci and rods). Composed of O antigen + core polysaccharide + lipid A (the toxic component).

Released upon cell lysis or by living cells by blebs detaching from outer surface membrane (vs exotoxin, which is actively secreted).

Three main effects: macrophage activation (TLR4/CD14), complement activation, and tissue factor activation.

ENDOTOXINS:

Edema

Nitric oxide

DIC/Death

Outer membrane

TNF-α

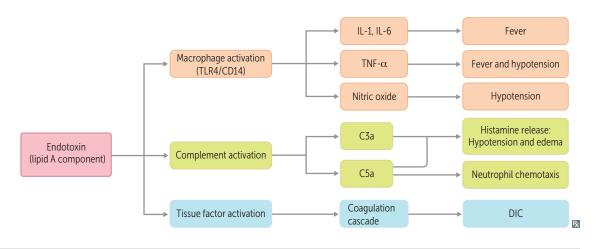
O-antigen + core polysaccharide + lipid A

eXtremely heat stable

IL-1 and IL-6

Neutrophil chemotaxis

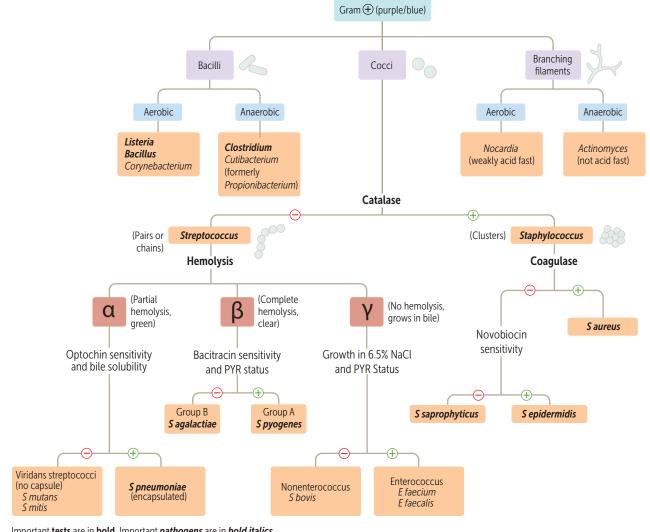
Shock



FAS1_2019_03-Microbiology.indd 133 11/14/19 12:20 PM

► MICROBIOLOGY — CLINICAL BACTERIOLOGY

Gram-positive lab algorithm



Important ${\it tests}$ are in ${\it bold}$. Important ${\it pathogens}$ are in ${\it bold italics}$.

Note: Enterococcus is either α - or γ -hemolytic.

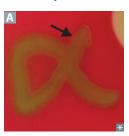
Gram-positive cocci antibiotic tests

Staphylococci	Novobiocin—Saprophyticus is Resistant; Epidermidis is Sensitive	On the office's "staph" retreat, there was no stress
Streptococci	Optochin—Viridans is Resistant; Pneumoniae is Sensitive	OVRPS (overpass)
	Bacitracin—group B strep are Resistant; group A strep are Sensitive	B-BRAS

Ŗ

FAS1_2019_03-Microbiology.indd 134 11/14/19 12:20 PM

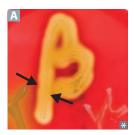
α-hemolytic bacteria



Gram ⊕ cocci. Partial oxidation of hemoglobin causes greenish or brownish color without clearing around growth on blood agar ⚠. Include the following organisms:

- *Streptococcus pneumoniae* (catalase ⊖ and optochin sensitive)
- Viridans streptococci (catalase
 ⊖ and optochin resistant)

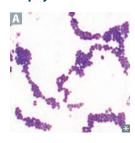
β-hemolytic bacteria



Gram ⊕ cocci. Complete lysis of RBCs → pale/clear area surrounding colony on blood agar A. Include the following organisms:

- Staphylococcus aureus (catalase and coagulase ⊕)
- *Streptococcus pyogenes*—group A strep (catalase \ominus and bacitracin sensitive)
- *Streptococcus agalactiae*—group *B* strep (catalase \ominus and bacitracin resistant)

Staphylococcus aureus



Gram ⊕, β-hemolytic, catalase ⊕, coagulase ⊕ cocci in clusters A. Protein A (virulence factor) binds Fc-IgG, inhibiting complement activation and phagocytosis. Commonly colonizes the nares, ears, axilla, and groin. Causes:

- Inflammatory disease—skin infections, organ abscesses, pneumonia (often after influenza virus infection), endocarditis, septic arthritis, and osteomyelitis.
- Toxin-mediated disease—toxic shock syndrome (TSST-1), scalded skin syndrome (exfoliative toxin), rapid-onset food poisoning (enterotoxins).

MRSA (methicillin-resistant Saureus)—

important cause of serious nosocomial and community-acquired infections; resistance due to altered penicillin-binding protein. *mecA* gene from staphylococcal chromosomal cassette involved in penicillin resistance.

TSST-1 is a superantigen that binds to MHC II and T-cell receptor, resulting in polyclonal T-cell activation and cytokine release.

Staphylococcal toxic shock syndrome (TSS)—

fever, vomiting, rash, desquamation, shock, end-organ failure. TSS results in † AST, † ALT, † bilirubin. Associated with prolonged use of vaginal tampons or nasal packing.

- Compare with *Streptococcus pyogenes* TSS (a toxic shock–like syndrome associated with painful skin infection).
- S aureus food poisoning due to ingestion of preformed toxin → short incubation period (2–6 hr) followed by nonbloody diarrhea and emesis. Enterotoxin is heat stable → not destroyed by cooking.
- S aureus makes coagulase and toxins. Forms fibrin clot around itself → abscess.

Staphylococcus epidermidis

Gram \oplus , catalase \oplus , coagulase \ominus , urease \oplus cocci in clusters. Novobiocin sensitive. Does not ferment mannitol (vs *S aureus*).

Normal flora of skin; contaminates blood cultures.

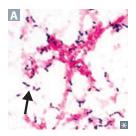
Infects prosthetic devices (eg, hip implant, heart valve) and IV catheters by producing adherent biofilms.

FAS1_2019_03-Microbiology.indd 135 11/14/19 12:20 PM

Staphylococcus saprophyticus

Gram \oplus , catalase \oplus , coagulase \ominus , urease \oplus cocci in clusters. Novobiocin resistant. Normal flora of female genital tract and perineum. Second most common cause of uncomplicated UTI in young women (most common is E coli).

Streptococcus pneumoniae



Gram ⊕, α-hemolytic, lancet-shaped diplococci A.

Encapsulated. IgA protease. Optochin sensitive and bile soluble. Most commonly causes:

- Meningitis
- Otitis media (in children)
- Pneumonia
- Sinusitis

Pneumococcus is associated with "rusty" sputum, sepsis in patients with sickle cell disease, and asplenic patients.

No virulence without capsule.

Viridans group streptococci

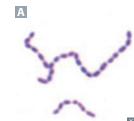
Gram \oplus , α -hemolytic cocci. Optochin resistant and bile insoluble. Normal flora of the oropharynx.

Streptococcus mutans and S mitis cause dental caries.

S sanguinis makes dextrans that bind to fibrinplatelet aggregates on damaged **heart** valves, causing subacute bacterial endocarditis. Viridans group strep live in the mouth, because they are not afraid of-the-chin (op-to-chin resistant).

Sanguinis = blood. Think, "there is lots of blood in the heart" (endocarditis).

Streptococcus pyogenes (group A streptococci)



Gram ⊕ cocci in chains A. Group A strep cause:

- Pyogenic—pharyngitis, cellulitis, impetigo ("honey-crusted" lesions), erysipelas
- Toxigenic—scarlet fever, toxic shock—like syndrome, necrotizing fasciitis
- Immunologic—rheumatic fever, glomerulonephritis

Bacitracin sensitive, β -hemolytic, pyrrolidonyl arylamidase (PYR) \oplus . Hyaluronic acid capsule and M protein inhibit phagocytosis. Antibodies to M protein enhance host defenses against S pyogenes but can give rise to rheumatic fever.

ASO titer or anti-DNase B antibodies indicate recent *S pyogenes* infection.

"Ph"yogenes pharyngitis can result in rheumatic "phever" and glomerulonephritis. Strains causing impetigo can induce glomerulonephritis.

Scarlet fever—blanching, sandpaper-like body rash, strawberry tongue, and circumoral pallor in the setting of group A streptococcal pharyngitis (erythrogenic toxin ⊕).

FAS1_2019_03-Microbiology.indd 136 11/14/19 12:20 PM

Streptococcus agalactiae (group B streptococci)

Gram ⊕ cocci, bacitracin resistant, β-hemolytic, Group B for Babies! colonizes vagina; causes pneumonia, meningitis, and sepsis, mainly in babies. Produces CAMP factor, which enlarges the area of hemolysis formed by S aureus. (Note: CAMP stands for the authors of the test, not cyclic AMP.) Hippurate test \oplus . PYR \ominus . Screen pregnant women at 35-37 weeks of gestation with rectal and vaginal swabs. Patients with ⊕ culture receive intrapartum penicillin/ampicillin prophylaxis.

Streptococcus bovis

Gram ⊕ cocci, colonizes the gut. S gallolyticus (S bovis biotype 1) can cause bacteremia and subacute endocarditis and is associated with colon cancer.

Bovis in the blood = cancer in the colon.

Enterococci

Gram ⊕ cocci. Enterococci (E faecalis and E faecium) are normal colonic flora that are penicillin G resistant and cause UTI, biliary tract infections, and subacute endocarditis (following GI/GU procedures). Catalase ⊖, PYR ⊕, variable hemolysis.

VRE (vancomycin-resistant enterococci) are an important cause of nosocomial infection.

Enterococci are more resilient than streptococci, can grow in 6.5% NaCl and bile (lab test).

Entero = intestine, faecalis = feces, strepto = twisted (chains), *coccus* = berry.

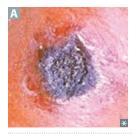
Bacillus anthracis

Gram

, spore-forming rod that produces anthrax toxin (an exotoxin consisting of protective antigen, lethal factor, and edema factor). Has a polypeptide capsule (poly D-glutamate). Colonies show a halo of projections, sometimes referred to as "medusa head" appearance.

Cutaneous anthrax

Painless papule surrounded by vesicles → ulcer with black eschar A (painless, necrotic) → uncommonly progresses to bacteremia and death.



Pulmonary anthrax

Inhalation of spores, most commonly from contaminated animals or animal products, although also a potential bioweapon → flu-like symptoms that rapidly progress to fever, pulmonary hemorrhage, mediastinitis (CXR may show widened mediastinum), and shock. Also called woolsorter's disease.

FAS1_2019_03-Microbiology.indd 137 11/14/19 12:20 PM

Bacillus cereus

Gram ⊕ rod. Causes food poisoning. Spores survive cooking rice (reheated rice syndrome). Keeping rice warm results in germination of spores and enterotoxin formation. Emetic type causes nausea and vomiting within 1–5 hours. Caused by cereulide, a preformed toxin. Diarrheal type causes watery, nonbloody diarrhea and GI pain within 8–18 hours. Management: supportive care (antibiotics are ineffective against toxins).

Clostridia

Gram ⊕, spore-forming, obligate anaerobic rods. Tetanus toxin and botulinum toxin are proteases that cleave SNARE proteins involved in neurotransmission.

Clostridium tetani

Produces tetanospasmin, an exotoxin causing tetanus. Tetanospasmin blocks release of GABA and glycine from Renshaw cells in spinal cord.

Causes **spast**ic paralysis, trismus (lockjaw), risus sardonicus (raised eyebrows and open grin), opisthotonos (spasms of spinal extensors).

Prevent with tetanus vaccine. Treat with antitoxin +/- vaccine booster, antibiotics, diazepam (for muscle spasms), and wound

Tetanus is tetanic paralysis.

Clostridium botulinum

Produces a heat-labile toxin that inhibits ACh release at the neuromuscular junction, causing botulism. In adults, disease is caused by ingestion of preformed toxin. In babies, ingestion of spores (eg, in honey) leads to disease (floppy baby syndrome). Treat with human botulinum immunoglobulin.

debridement.

Symptoms of botulism (the 4 D's): Diplopia, Dysarthria, Dysphagia, Dyspnea.

Botulinum is from bad bottles of food, juice, and honey (causes a descending flaccid paralysis).

Local botulinum toxin A (Botox) injections used to treat focal dystonia, hyperhidrosis, muscle spasms, and cosmetic reduction of facial wrinkles.

Clostridium perfringens



Produces α-toxin (lecithinase, a phospholipase) that can cause myonecrosis (gas gangrene A; presents as soft tissue crepitus) and hemolysis. If heavily spore-contaminated food is cooked but left standing too long at < 60°C, spores germinate → vegetative bacteria → heat-labile enterotoxin → food poisoning symptoms in 10-12 hours, resolution in 24 hours.

Perfringens perforates a gangrenous leg.

Clostridioides difficile



Produces toxins A and B, which damage enterocytes. Both toxins lead to watery diarrhea → pseudomembranous colitis ■. Often 2° to antibiotic use, especially clindamycin or ampicillin; associated with PPIs.

Diagnosed by PCR or antigen detection of one or both toxins in stool.

Complications: toxic megacolon.

Difficile causes diarrhea.

Treatment: oral vancomycin, metronidazole, or fidaxomicin. For recurrent cases, consider repeating prior regimen or fecal microbiota transplant.

FAS1_2019_03-Microbiology.indd 138 11/14/19 12:20 PM

Corynebacterium diphtheriae



Gram ⊕ rods occurring in angular arrangements; transmitted via respiratory droplets. Causes diphtheria via exotoxin encoded by β-prophage. Potent exotoxin inhibits protein synthesis via ADP-ribosylation of EF-2, leading to possible necrosis in pharynx, cardiac, and CNS tissue.

Symptoms include pseudomembranous pharyngitis (grayish-white membrane A) with lymphadenopathy. Toxin dissemination may cause myocarditis, arrhythmias, neuropathies.

Lab diagnosis based on gram ⊕ rods with metachromatic (blue and red) granules and ⊕ Elek test for toxin.

Toxoid vaccine prevents diphtheria.

Coryne = club shaped (metachromatic granules on Löffler media).

Black colonies on cystine-tellurite agar.

ABCDEFG:

ADP-ribosylation

β-prophage

Corynebacterium

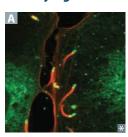
Diphtheriae

Elongation Factor 2

Granules

Treatment: antibiotic therapy +/- diphtheria antitoxin.

Listeria monocytogenes



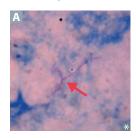
Gram \oplus , facultative intracellular rod; acquired by ingestion of unpasteurized dairy products and cold deli meats, transplacental transmission, by vaginal transmission during birth. Grows well at refrigeration temperatures ("cold enrichment").

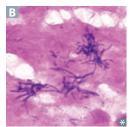
Forms "rocket tails" (red in A) via actin polymerization that allow intracellular movement and cell-to-cell spread across cell membranes, thereby avoiding antibody. Characteristic tumbling motility in broth.

Can cause amnionitis, septicemia, and spontaneous abortion in pregnant women; granulomatosis infantiseptica; meningitis in immunocompromised patients, neonates, and older adults; mild, self-limited gastroenteritis in healthy individuals.

Treatment: ampicillin.

Nocardia vs Actinomyces





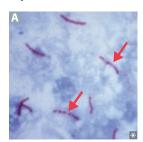
Both are gram ⊕ and form long, branching filaments resembling fungi

Nocardia	Actinomyces
Aerobe	Anaerobe
Acid fast (weak)	Not acid fast B
Found in soil	Normal oral, reproductive, and GI flora
Causes pulmonary infections in immunocompromised (can mimic TB but with ⊖ PPD); cutaneous infections after trauma in immunocompetent; can spread to CNS	Causes oral/facial abscesses that drain through sinus tracts; often associated with dental caries/ extraction and other maxillofacial trauma; forms yellow "sulfur granules"; can also cause PID with IUDs
Treat with sulfonamides (TMP-SMX)	Treat with penicillin

Treatment is a **SNAP**: Sulfonamides—Nocardia; Actinomyces—Penicillin

FAS1_2019_03-Microbiology.indd 139 11/14/19 12:20 PM

Mycobacteria



Gram ⊕ acid fast rods (pink rods, arrows in A). *Mycobacterium tuberculosis* (TB, often resistant to multiple drugs).

M avium—intracellulare (causes disseminated, non-TB disease in AIDS; often resistant to multiple drugs). Prophylaxis with azithromycin when CD4+ count < 50 cells/ mm³.

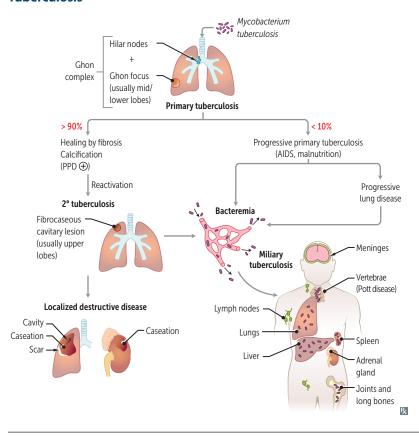
M scrofulaceum (cervical lymphadenitis in children).

M marinum (hand infection in aquarium handlers).

TB symptoms include fever, night sweats, weight loss, cough (nonproductive or productive), hemoptysis.

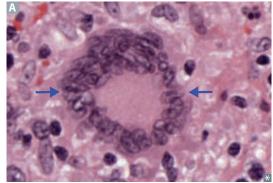
Cord factor creates a "serpentine cord" appearance in virulent M tuberculosis strains; activates macrophages (promoting granuloma formation) and induces release of TNF- α . Sulfatides (surface glycolipids) inhibit phagolysosomal fusion.

Tuberculosis



Interferon-γ release assay (IGRA) has fewer false positives from BCG vaccination.
PPD ⊕ if current infection or past exposure.
PPD ⊝ if no infection and in sarcoidosis or
HIV infection (especially with low CD4+ cell count).

Caseating granulomas with central necrosis and Langhans giant cell (single example in A) are characteristic of 2° tuberculosis.



FAS1_2019_03-Microbiology.indd 140 11/14/19 12:20 PM

Leprosy





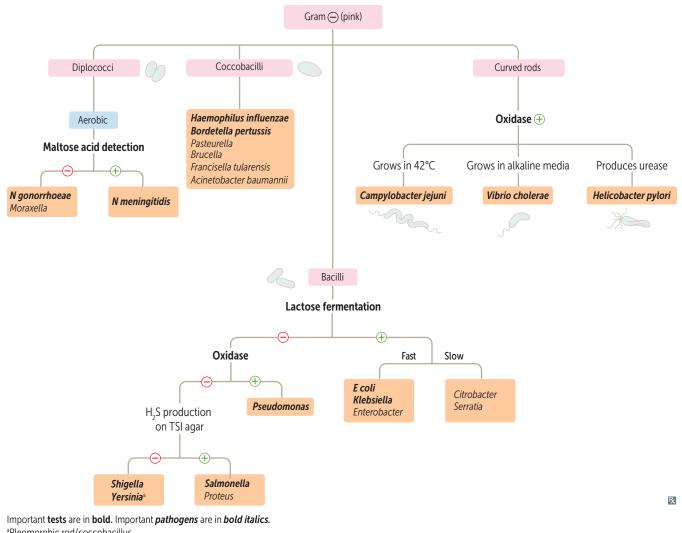
Also called Hansen disease. Caused by Mycobacterium leprae, an acid-fast bacillus that likes cool temperatures (infects skin and superficial nerves—"glove and stocking" loss of sensation A) and cannot be grown in vitro. Diagnosed via skin biopsy or tissue PCR. Reservoir in United States: armadillos.

Leprosy has 2 forms (many cases fall temporarily between two extremes):

- Lepromatous—presents diffusely over the skin, with Leonine (Lion-like) facies B, and is communicable (high bacterial load); characterized by low cell-mediated immunity with a largely Th2 response. Lepromatous form can be Lethal.
- Tuberculoid—limited to a few hypoesthetic, hairless skin plaques; characterized by high cellmediated immunity with a largely Th1-type response and low bacterial load.

Treatment: dapsone and rifampin for tuberculoid form; clofazimine is added for lepromatous form.

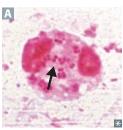
Gram-negative lab algorithm



^aPleomorphic rod/coccobacillus

FAS1_2019_03-Microbiology.indd 141 11/14/19 12:20 PM

Neisseria





Gram ⊜ diplococci. Metabolize glucose and produce IgA proteases. Contain lipooligosaccharides (LOS) with strong endotoxin activity. *N gonorrhoeae* is often intracellular (within neutrophils) A.

Acid production: MeninGococci—Maltose and Glucose; Gonococci—Glucose.

Gonococci	Meningococci
No polysaccharide capsule	Polysaccharide capsule
No maltose acid detection	Maltose acid detection
No vaccine due to antigenic variation of pilus proteins	Vaccine (type B vaccine available for at-risk individuals)
Sexually or perinatally transmitted	Transmitted via respiratory and oral secretions
Causes gonorrhea, septic arthritis, neonatal conjunctivitis (2–5 days after birth), pelvic inflammatory disease (PID), and Fitz-Hugh–Curtis syndrome	Causes meningococcemia with petechial hemorrhages and gangrene of toes B , meningitis, Waterhouse-Friderichsen syndrome (adrenal insufficiency, fever, DIC, shock)
Diagnosed with NAT	Diagnosed via culture-based tests or PCR
Condoms I sexual transmission, erythromycin eye ointment prevents neonatal blindness	Rifampin, ciprofloxacin, or ceftriaxone prophylaxis in close contacts
Treatment: ceftriaxone (+ azithromycin or doxycycline, for possible chlamydial coinfection)	Treatment: ceftriaxone or penicillin G

Haemophilus influenzae





Small gram ⊖ (coccobacillary) rod. Aerosol transmission. Nontypeable (unencapsulated) strains are the most common cause of mucosal infections (otitis media, conjunctivitis, bronchitis) as well as invasive infections since the vaccine for capsular type b was introduced. Produces IgA protease.

Culture on chocolate agar, which contains factors V (NAD+) and X (hematin) for growth; can also be grown with S aureus, which provides factor V via RBC hemolysis.

HaEMOPhilus causes Epiglottitis (endoscopic appearance in A, can be "cherry red" in children; "thumb sign" on lateral neck x-ray B), Meningitis, Otitis media, and Pneumonia.

Vaccine contains type b capsular polysaccharide (polyribosylribitol phosphate) conjugated to diphtheria toxoid or other protein. Given between 2 and 18 months of age.

Does not cause the flu (influenza virus does). Treatment: amoxicillin +/- clavulanate for mucosal infections; ceftriaxone for meningitis; rifampin prophylaxis for close contacts.

Acinetobacter baumannii

Gram \ominus , strictly aerobic, oxidase \ominus coccobacillus. Commensal opportunist but increasingly associated with resistant hospital-acquired infections, especially in ICU. Can cause ventilator-associated pneumonia and septicemia in immunocompromised patients.

FAS1_2019_03-Microbiology.indd 142 11/14/19 12:20 PM

Bordetella pertussis

Gram ⊝, aerobic coccobacillus. Virulence factors include pertussis toxin (disables G_i), adenylate cyclase toxin († cAMP), and tracheal cytotoxin. Three clinical stages:

- Catarrhal—low-grade fevers, Coryza.
- Paroxysmal—paroxysms of intense cough followed by inspiratory "whooP" ("whooping cough"),
 posttussive vomiting.
- Convalescent—gradual recovery of chronic cough.

Prevented by Tdap, DTaP vaccines. May be mistaken as viral infection due to lymphocytic infiltrate resulting from immune response.

Treatment: macrolides; if allergic use TMP-SMX.

Brucella

Gram ⊖, aerobic coccobacillus. Transmitted via ingestion of contaminated animal products (eg, unpasteurized milk). Survives in macrophages in the reticuloendothelial system. Can form non-caseating granulomas. Typically presents with undulant fever, night sweats, and arthralgia. Treatment: doxycycline + rifampin or streptomycin.

Legionella pneumophila



Gram ⊖ rod. Gram stains poorly—use silver stain. Grow on charcoal yeast extract medium with iron and cysteine. Detected by presence of antigen in urine. Labs may show hyponatremia.

Aerosol transmission from environmental water source habitat (eg, air conditioning systems, hot water tanks). No person-to-person transmission.

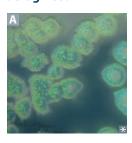
Treatment: macrolide or quinolone.

Think of a French legionnaire (soldier) with his silver helmet, sitting around a campfire (charcoal) with his iron dagger—he is no sissy (cysteine).

Legionnaires' disease—severe pneumonia (often unilateral and lobar A), fever, GI and CNS symptoms. Common in smokers and in chronic lung disease.

Pontiac fever—mild flu-like syndrome.

Pseudomonas aeruginosa





Aeruginosa—aerobic; motile, catalase ⊕, gram ⊝ rod. Non-lactose fermenting.
Oxidase ⊕. Frequently found in water. Has a grape-like odor.

PSEUDOMONAS is associated with:
Pneumonia, Sepsis, Ecthyma gangrenosum,
UTIs, Diabetes, Osteomyelitis, Mucoid
polysaccharide capsule, Otitis externa
(swimmer's ear), Nosocomial infections (eg,
catheters, equipment), Addicts (drug abusers),
Skin infections (eg, hot tub folliculitis, wound
infection in burn victims).

Mucoid polysaccharide capsule may contribute to chronic pneumonia in cystic fibrosis patients due to biofilm formation.

Produces PEEP: Phospholipase C (degrades cell membranes); Endotoxin (fever, shock); Exotoxin A (inactivates EF-2); Pigments: pyoverdine and pyocyanin (blue-green pigment A; also generates reactive oxygen species).

Corneal ulcers/keratitis in contact lens wearers/ minor eye trauma.

Ecthyma gangrenosum—rapidly progressive, necrotic cutaneous lesion **B** caused by *Pseudomonas* bacteremia. Typically seen in immunocompromised patients.

Treatments include "CAMPFIRE" drugs:

- Carbapenems
- Aminoglycosides
- Monobactams
- Polymyxins (eg, polymyxin B, colistin)
- Fluoroquinolones (eg, ciprofloxacin, levofloxacin)
- ThIRd- and fourth-generation cephalosporins (eg, ceftazidime, cefepime)
- Extended-spectrum penicillins (eg, piperacillin, ticarcillin)

FAS1_2019_03-Microbiology.indd 143 11/14/19 12:20 PM

Salmonella vs Shigella Both Salmonella and Shigella are gram ⊖ rods, non-lactose fermenters, oxidase ⊖, and can invade the GI tract via M cells of Peyer patches.

	Salmonella typhi (ty-Vi)	Salmonella spp. (except S typhi)	Shigella
RESERVOIRS	Humans only	Humans and animals	Humans only
SPREAD	Can disseminate hematogenously	Can disseminate hematogenously	Cell to cell; no hematogenous spread
H ₂ S PRODUCTION	Yes	Yes	No
FLAGELLA	Yes (salmon swim)	Yes (salmon swim)	No
VIRULENCE FACTORS	Endotoxin; Vi capsule	Endotoxin	Endotoxin; Shiga toxin (enterotoxin)
INFECTIOUS DOSE (ID ₅₀)	High—large inoculum required; acid-labile (inactivated by gastric acids)	High	Low—very small inoculum required; acid stable (resistant to gastric acids)
EFFECT OF ANTIBIOTICS ON FECAL EXCRETION	Prolongs duration	Prolongs duration	Shortens duration
IMMUNE RESPONSE	Primarily monocytes	PMNs in disseminated disease	Primarily PMN infiltration
GI MANIFESTATIONS	Constipation, followed by diarrhea	Diarrhea (possibly bloody)	Crampy abdominal pain → tenesmus, bloody mucoid stools (bacillary dysentery)
VACCINE	Oral vaccine contains live attenuated <i>S typhi</i> IM vaccine contains Vi capsular polysaccharide	No vaccine	No vaccine
UNIQUE PROPERTIES	 Causes typhoid fever (rose spots on abdomen, constipation, abdominal pain, fever; later GI ulceration and hemorrhage); treat with ceftriaxone or fluoroquinolone Carrier state with gallbladder colonization 	 Poultry, eggs, pets, and turtles are common sources Antibiotics not indicated Gastroenteritis is usually caused by non-typhoidal Salmonella 	 4 F's: Fingers, Flies, Food, Feces In order of decreasing severity (less toxin produced): <i>S dysenteriae</i>, <i>S flexneri</i>, <i>S boydii</i>, <i>S sonnei</i> Invasion of M cells is key to pathogenicity: organisms that produce little toxin can cause disease

Yersinia enterocolitica

Gram ⊖ pleomorphic rod/coccobacillus. Usually transmitted from pet feces (eg, puppies), contaminated milk, or pork. Can cause acute bloody diarrhea, pseudoappendicitis (right lower abdominal pain due to mesenteric adenitis and/or terminal ileitis), reactive arthritis in adults.

Lactose-fermenting enteric bacteria

Fermentation of lactose → pink colonies on MacConkey agar. Examples include *E coli*, *Enterobacter*, *Klebsiella*. *E coli* produces β-galactosidase, which breaks down lactose into glucose and galactose.

Lactose is key.

EMB agar—lactose fermenters grow as purple/black colonies. *E coli* grows colonies with a green sheen.

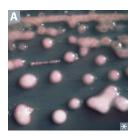
FAS1_2019_03-Microbiology.indd 144 11/14/19 12:20 PM

Escherichia coli

Gram \bigcirc , indole \oplus rod. *E coli* virulence factors: fimbriae—cystitis and pyelonephritis (P pili); K capsule—pneumonia, neonatal meningitis; LPS endotoxin—septic shock.

STRAIN	TOXIN AND MECHANISM	PRESENTATION
Enteroinvasive <i>E coli</i>	Microbe invades intestinal mucosa and causes necrosis and inflammation.	EIEC is Invasive; dysentery. Clinical manifestations similar to <i>Shigella</i> .
Enterotoxigenic <i>E coli</i>	Produces heat-labile and heat-stable enteroToxins. No inflammation or invasion.	ETEC; Traveler's diarrhea (watery).
Enteropathogenic <i>E coli</i>	No toxin produced. Adheres to apical surface, flattens villi, prevents absorption.	Diarrhea, usually in children (think E P EC and P ediatrics).
Enterohemorrhagic E coli	O157:H7 is most common serotype in US. Often transmitted via undercooked meat, raw leafy vegetables. Shiga-like toxin causes hemolytic-uremic syndrome: triad of anemia, thrombocytopenia, and acute kidney injury due to microthrombi forming on damaged endothelium → mechanical hemolysis (with schistocytes on peripheral blood smear), platelet consumption, and ↓ renal blood flow.	Dysentery (toxin alone causes necrosis and inflammation). Does not ferment sorbitol (vs other <i>E coli</i>). Hemorrhagic, Hamburgers, Hemolytic-uremic syndrome.

Klebsiella



Gram ⊖ rod; intestinal flora that causes lobar pneumonia in alcoholics and diabetics when aspirated. Very mucoid colonies A caused by abundant polysaccharide capsules. Dark red "currant jelly" sputum (blood/mucus).

Also cause of nosocomial UTIs. Associated with evolution of multidrug resistance (MDR).

ABCDE's of Klebsiella:

Aspiration pneumonia

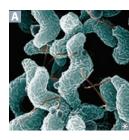
aBscess in lungs and liver

"Currant jelly" sputum

Diabetes

EtOH abuse

Campylobacter jejuni



Gram ⊖, comma or S shaped (with polar flagella) ♠, oxidase ⊕, grows at 42°C ("Campylobacter likes the hot campfire").

Major cause of bloody diarrhea, especially in children. Fecal-oral transmission through person-to-person contact or via ingestion of undercooked contaminated poultry or meat, unpasteurized milk. Contact with infected animals (dogs, cats, pigs) is also a risk factor.

Common antecedent to Guillain-Barré syndrome and reactive arthritis.

FAS1_2019_03-Microbiology.indd 145 11/14/19 12:20 PM

Vibrio cholerae



Gram \ominus , flagellated, comma shaped A, oxidase \oplus , grows in alkaline media. Endemic to developing countries. Produces profuse rice-water diarrhea via enterotoxin that permanently activates G_s , \uparrow cAMP. Sensitive to stomach acid (acid labile); requires large inoculum (high ID₅₀) unless host has \downarrow gastric acidity. Transmitted via ingestion of contaminated water or uncooked food (eg, raw shellfish). Treat promptly with oral rehydration solution.

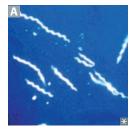
Helicobacter pylori



Curved, flagellated (motile), gram ⊖ rod A that is **triple** ⊕: catalase ⊕, oxidase ⊕, and urease ⊕ (can use urea breath test or fecal antigen test for diagnosis). Urease produces ammonia, creating an alkaline environment, which helps *H pylori* survive in acidic mucosa. Colonizes mainly antrum of stomach; causes gastritis and peptic ulcers (especially duodenal). Risk factor for peptic ulcer disease, gastric adenocarcinoma, and MALT lymphoma.

Most common initial treatment is **triple** therapy: Amoxicillin (metronidazole if penicillin allergy) + Clarithromycin + Proton pump inhibitor; Antibiotics Cure Pylori. Bismuth-based quadruple therapy if concerned about macrolide resistance.

Spirochetes



Spiral-shaped bacteria A with axial filaments. Includes Borrelia (big size), Leptospira, and Treponema. Only Borrelia can be visualized using aniline dyes (Wright or Giemsa stain) in light microscopy due to size. Treponema is visualized by dark-field microscopy or direct fluorescent antibody (DFA) microscopy.

BLT.

Borrelia is Big.

Lyme disease





Caused by *Borrelia burgdorferi*, which is transmitted by the *Ixodes* deer tick (also vector for *Anaplasma* spp. and protozoa *Babesia*). Natural reservoir is the mouse; deer are essential to tick life cycle but do not harbor *Borrelia*.

Common in northeastern United States. Stage 1—early localized: erythema migrans (typical "bulls-eye" configuration **B** is pathognomonic but not always present), flu-like symptoms.

Stage 2—early disseminated: secondary lesions, carditis, AV block, facial nerve (Bell) palsy, migratory myalgias/transient arthritis.

Stage 3—late disseminated: encephalopathy,

chronic arthritis.

A Key Lyme pie to the FACE:

Facial nerve palsy (typically bilateral)

Arthritis

Cardiac block

Erythema migrans

Treatment: doxycycline (1st line); amoxicillin and, if severe illness, CNS signs, or heart block, ceftriaxone

FAS1_2019_03-Microbiology.indd 146 11/14/19 12:20 PM

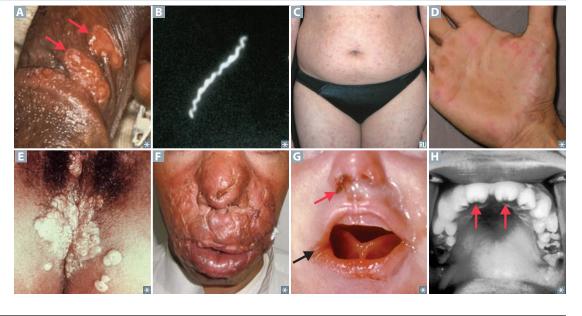
Leptospira interrogans

Spirochete with hook-shaped ends found in water contaminated with animal urine.

Leptospirosis—flu-like symptoms, myalgias (classically of calves), jaundice, photophobia with conjunctival suffusion (erythema without exudate). Prevalent among surfers and in tropics (eg, Hawaii).

Weil disease (icterohemorrhagic leptospirosis)—severe form with jaundice and azotemia from liver and kidney dysfunction, fever, hemorrhage, and anemia.

Syphilis	Caused by spirochete <i>Treponema pallidum</i> . Treatment: penicillin G.
Primary syphilis	Localized disease presenting with painless chancre \blacksquare . Use fluorescent or dark-field microscopy to visualize treponemes in fluid from chancre \blacksquare . VDRL \oplus in \sim 80%.
Secondary syphilis	Disseminated disease with constitutional symptoms, maculopapular rash (including palms and soles), condylomata lata (smooth, painless, wart-like white lesions on genitals), lymphadenopathy, patchy hair loss; also confirmable with dark-field microscopy. Serologic testing: VDRL/RPR (nonspecific), confirm diagnosis with specific test (eg, FTA-ABS). Secondary syphilis = Systemic. Latent syphilis (⊕ serology without symptoms) may follow.
Tertiary syphilis	Gummas (chronic granulomas), aortitis (vasa vasorum destruction), neurosyphilis (tabes dorsalis, "general paresis"), Argyll Robertson pupil (constricts with accommodation but is not reactive to light; also called "prostitute's pupil" since it accommodates but does not react). Signs: broad-based ataxia, ⊕ Romberg, Charcot joint, stroke without hypertension. For neurosyphilis: test spinal fluid with VDRL, FTA-ABS, and PCR.
Congenital syphilis	Presents with facial abnormalities such as rhagades (linear scars at angle of mouth, black arrow in G), snuffles (nasal discharge, red arrow in G), saddle nose, notched (Hutchinson) teeth H , mulberry molars, and short maxilla; saber shins; CN VIII deafness. To prevent, treat mother early in pregnancy, as placental transmission typically occurs after first trimester.



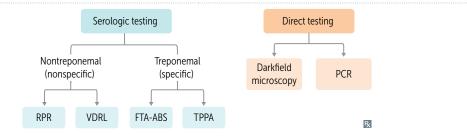
FAS1_2019_03-Microbiology.indd 147 11/14/19 12:20 PM

VDRL false positives

VDRL detects nonspecific antibody that reacts with beef cardiolipin. Quantitative, inexpensive, and widely available test for syphilis (sensitive but not specific).

False-Positive results on VDRL with:

- Pregnancy
- Viral infection (eg, EBV, hepatitis)
- Drugs (eg, chlorpromazine, procainamide)
- Rheumatic fever (rare)
- Lupus and leprosy



Jarisch-Herxheimer reaction

Flu-like syndrome (fever, chills, headache, myalgia) after antibiotics are started; due to killed bacteria (usually spirochetes) releasing toxins.

Gardnerella vaginalis



A pleomorphic, gram-variable rod involved in bacterial vaginosis. Presents as a gray vaginal discharge with a **fishy** smell; nonpainful (vs vaginitis). Associated with sexual activity, but not sexually transmitted. Bacterial **vagin**osis is also characterized by overgrowth of certain anaerobic bacteria in vagina (due to ↓ lactobacilli). **Clue** cells (vaginal epithelial cells covered with **Gardnerella**) have stippled appearance along outer margin (arrow in ▲).

I don't have a **clue** why I smell **fish** in the **vagina** garden!

Amine whiff test—mixing discharge with 10% KOH enhances fishy odor.

Treatment: metronidazole or clindamycin.

Chlamydiae



Chlamydiae cannot make their own ATP. They are obligate intracellular organisms that cause mucosal infections. 2 forms:

- Elementary body (small, dense)
 is "Enfectious" and Enters cell via
 Endocytosis; transforms into reticulate body.
- Reticulate body Replicates in cell by fission;
 Reorganizes into elementary bodies.

Chlamydia trachomatis causes neonatal and follicular adult conjunctivitis A, nongonococcal urethritis, PID, and reactive arthritis.

Chlamydophila pneumoniae and Chlamydophila psittaci cause atypical pneumonia; transmitted by aerosol.

Chlamydial cell wall lacks classic peptidoglycan (due to reduced muramic acid), rendering β -lactam antibiotics ineffective.

Chlamys = cloak (intracellular).

C psittaci—has an avian reservoir (parrots), causes atypical pneumonia.

Lab diagnosis: PCR, nucleic acid amplification test. Cytoplasmic inclusions (reticulate bodies) seen on Giemsa or fluorescent antibody—stained smear.

Treatment: azithromycin (favored because one-time treatment) or doxycycline. Add ceftriaxone for possible concomitant gonorrhea.

FAS1_2019_03-Microbiology.indd 148 11/14/19 12:20 PM

Chlamydia trachomatis serotypes

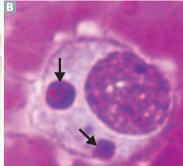
Types A, B, and C	Chronic infection, cause blindness due to follicular conjunctivitis in Africa.	ABC = A frica, B lindness, C hronic infection.
Types D-K	Urethritis/PID, ectopic pregnancy, neonatal pneumonia (staccato cough) with eosinophilia, neonatal conjunctivitis (1–2 weeks after birth).	D–K = everything else. Neonatal disease can be acquired during passage through infected birth canal.
Types L1, L2, and L3	Lymphogranuloma venereum—small, painless ulcers on genitals → swollen, painful inguinal lymph nodes that ulcerate (buboes). Treat with doxycycline.	
Zoonotic bacteria	Zoonosis—infectious disease transmitted between	n animals and humans.
SPECIES	DISEASE	TRANSMISSION AND SOURCE
Anaplasma spp	Anaplasmosis	Ixodes ticks (live on deer and mice)
Bartonella spp	Cat scratch disease, bacillary angiomatosis	Cat scratch
Borrelia burgdorferi	Lyme disease	Ixodes ticks (live on deer and mice)
Borrelia recurrentis	Relapsing fever	Louse (recurrent due to variable surface antigens)
Brucella spp	Brucellosis/undulant fever	Unpasteurized dairy
Campylobacter	Bloody diarrhea	Feces from infected pets/animals; contaminated meats/foods/hands
Chlamydophila psittaci	Psittacosis	Parrots, other birds
Coxiella burnetii	Q fever	Aerosols of cattle/sheep amniotic fluid
Ehrlichia chaffeensis	Ehrlichiosis	Amblyomma (Lone Star tick)
Francisella tularensis	Tularemia	Ticks, rabbits, deer flies
Leptospira spp	Leptospirosis	Animal urine in water; recreational water use
Mycobacterium leprae	Leprosy	Humans with lepromatous leprosy; armadillo (rare)
Pasteurella multocida	Cellulitis, osteomyelitis	Animal bite, cats, dogs
Rickettsia prowazekii	Epidemic typhus	Human to human via human body louse
Rickettsia rickettsii	Rocky Mountain spotted fever	Dermacentor (dog tick)
Rickettsia typhi	Endemic typhus	Fleas
Salmonella spp (except S typhi)	Diarrhea (which may be bloody), vomiting, fever, abdominal cramps	Reptiles and poultry
Yersinia pestis	Plague	Fleas (rats and prairie dogs are reservoirs)

FAS1_2019_03-Microbiology.indd 149 11/14/19 12:20 PM

Rickettsial diseases and vector-borne

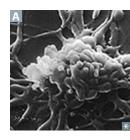
illnesses	Treatment: doxycycline.		
RASH COMMON			
Rocky Mountain spotted fever	Rickettsia rickettsii, vector is tick. Despite its name, disease occurs primarily in the South Atlantic states, especially North Carolina. Rash typically starts at wrists A and ankles and then spreads to trunk, palms, and soles.	Classic triad—headache, fever, rash (vasculitis). Palms and soles rash is seen in Coxsackievirus A infection (hand, foot, and mouth disease), Rocky Mountain spotted fever, and 2° Syphilis (you drive CARS using your palms and soles).	
Typhus	Endemic (fleas)— <i>R typhi</i> . Epidemic (human body louse)— <i>R prowazekii</i> . Rash starts centrally and spreads out, sparing palms and soles.	Rickettsii on the wRists, Typhus on the Trunk.	
RASH RARE			
Ehrlichiosis	Ehrlichia, vector is tick. Monocytes with morulae B (mulberry-like inclusions) in cytoplasm.	MEGA berry— Monocytes = Ehrlichiosis Granulocytes = Anaplasmosis	
Anaplasmosis	Anaplasma, vector is tick. Granulocytes with morulae c in cytoplasm.		
Q fever	Coxiella burnetii, no arthropod vector. Spores inhaled as aerosols from cattle/sheep amniotic fluid. Presents with headache, cough, influenza-like symptoms, pneumonia, possibly in combination with hepatitis. Common cause of culture ⊖ endocarditis.	Q fever is caused by a Quite Complicated Bug because it has no rash or vector and its causative organism can survive outside in its endospore form. Not in the <i>Rickettsia</i> genus, but closely related.	
	Λ	C	







Mycoplasma pneumoniae



Classic cause of atypical "walking pneumonia" (insidious onset, headache, nonproductive cough, patchy or diffuse interstitial infiltrate). Occurs frequently in those <30 years old; outbreaks in military recruits, prisons, colleges. X-ray looks worse than patient. High titer of cold agglutinins (IgM), which can agglutinate RBCs.

Treatment: macrolides, doxycycline, or fluoroquinolone (penicillin ineffective since *Mycoplasma* has no cell wall).

Not seen on Gram stain. Pleomorphic A. Bacterial membrane contains sterols for stability. Grown on Eaton agar.

Mycoplasma gets cold without a coat (no cell wall). Can cause atypical variant of Stevens-Johnson syndrome, typically in children and adolescents.

FAS1_2019_03-Microbiology.indd 150 11/14/19 12:21 PM

► MICROBIOLOGY — MYCOLOGY

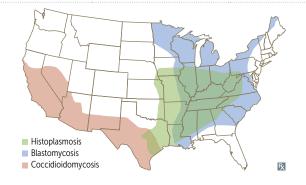
Systemic mycoses

All of the following can cause pneumonia and can disseminate.

All are caused by dimorphic fungi: $cold (20^{\circ}C) = mold$; heat $(37^{\circ}C) = yeast$. Only exception is *Coccidioides*, which is a spherule (not yeast) in tissue.

Systemic mycoses can form granulomas (like TB); cannot be transmitted person-to-person (unlike TB). Treatment: fluconazole or itraconazole for **local** infection; amphotericin B for **systemic** infection.

			, 1	,
DISEASE	ENDEMIC LOCATION	PATHOLOGIC FEATURES	UNIQUE SIGNS/SYMPTOMS	NOTES
Histoplasmosis A	Mississippi and Ohio River Valleys	Macrophage filled with <i>Histoplasma</i> (smaller than RBC)	Palatal/tongue ulcers, splenomegaly, pancytopenia	Histo hides (within macrophages) Associated with bird or bat droppings (eg, spelunking) Diagnosis via urine/serum antigen
Blastomycosis	Eastern and Central US, Great Lakes	Broad -based budding of <i>Blastomyces</i> (same size as RBC)	Inflammatory lung disease Disseminates to bone/ skin (may mimic SCC) Forms granulomatous nodules	Blasto buds broadly
Coccidioidomycosis	Southwestern US, California	Spherule (much larger than RBC) filled with endospores of Coccidioides	Disseminates to skin/ bone Erythema nodosum (desert bumps) or multiforme Arthralgias (desert rheumatism) Can cause meningitis	Associated with dust exposure in endemic areas (eg, archeological excavations, earthquakes)
Para-coccidioidomycosis	Latin America	Budding yeast of Paracoccidioides with "captain's wheel" formation (much larger than RBC) D	Similar to blastomycosis, males > females	Paracoccidio parasails with the captain's wheel all the way to Latin America



FAS1_2019_03-Microbiology.indd 151 11/14/19 12:21 PM

Cutaneous mycoses

Tinea (dermatophytes)	Clinical name for dermatophyte (cutaneous fungal) infections. Dermatophytes include <i>Microsporum</i> , <i>Trichophyton</i> , and <i>Epidermophyton</i> . Branching septate hyphae visible on KOH preparation with blue fungal stain A. Associated with pruritus.
Tinea capitis	Occurs on head, scalp. Associated with lymphadenopathy, alopecia, scaling B.
Tinea corporis	Occurs on body (usually torso). Characterized by enlarging erythematous, scaly rings ("ringworm" with central clearing C . Can be acquired from contact with infected pets or farm animals.
Tinea cruris	Occurs in inguinal area D. Often does not show the central clearing seen in tinea corporis.
Tinea pedis	Three varieties: Interdigital E; most common Moccasin distribution E Vesicular type
Tinea unguium	Onychomycosis; occurs on nails.
Tinea (pityriasis) versicolor	Caused by <i>Malassezia</i> spp. (<i>Pityrosporum</i> spp.), a yeast-like fungus (not a dermatophyte despite being called tinea). Degradation of lipids produces acids that inhibit tyrosinase (involved in melanin synthesis) → hypopigmentation ⑤; hyperpigmentation and/or pink patches can also occur due to inflammatory response. Less pruritic than dermatophytes. Can occur any time of year, but more common in summer (hot, humid weather). "Spaghetti and meatballs" appearance on microscopy ℍ. Treatment: selenium sulfide, topical and/or oral antifungal medications.



FAS1_2019_03-Microbiology.indd 152 11/14/19 12:21 PM

Opportunistic fungal infections

Candida albicans

alba = white. Dimorphic; forms pseudohyphae and budding yeasts at 20° C A, germ tubes at 37° C B.

Systemic or superficial fungal infection. Causes oral and esophageal thrush in immunocompromised (neonates, steroids, diabetes, AIDS), vulvovaginitis (diabetes, use of antibiotics), diaper rash, endocarditis (IV drug users), disseminated candidiasis (especially in neutropenic patients), chronic mucocutaneous candidiasis.

Treatment: oral fluconazole/topical azoles for vaginal; nystatin, azoles, or, rarely, echinocandins for oral; fluconazole, echinocandins, or amphotericin B for esophageal or systemic disease.

Aspergillus fumigatus

Septate hyphae that branch at 45° Acute Angle D E.

Causes invasive aspergillosis in immunocompromised patients, neutrophil dysfunction (eg, chronic granulomatous disease).

Can cause aspergillomas **F** in pre-existing lung cavities, especially after TB infection. Some species of *Aspergillus* produce **A**flatoxins (associated with hepatocellular carcinoma). Treatment: voriconazole or echinocandins (2nd-line).

Allergic bronchopulmonary aspergillosis (ABPA)—hypersensitivity response to Aspergillus growing in lung mucus. Associated with asthma and cystic fibrosis; may cause bronchiectasis and eosinophilia.

Cryptococcus neoformans

 $5{\text -}10~\mu{\rm m}$ with narrow budding. Heavily encapsulated yeast. Not dimorphic.

Found in soil, pigeon droppings. Acquired through inhalation with hematogenous dissemination to meninges. Highlighted with India ink (clear halo) and mucicarmine (red inner capsule). Latex agglutination test detects polysaccharide capsular antigen and is more sensitive and specific. Causes cryptococcosis, cryptococcal meningitis, cryptococcal encephalitis ("soap bubble" lesions

Causes cryptococcosis, cryptococcal meningitis, cryptococcal encephalitis ("soap bubble" lesions in brain), primarily in immunocompromised.

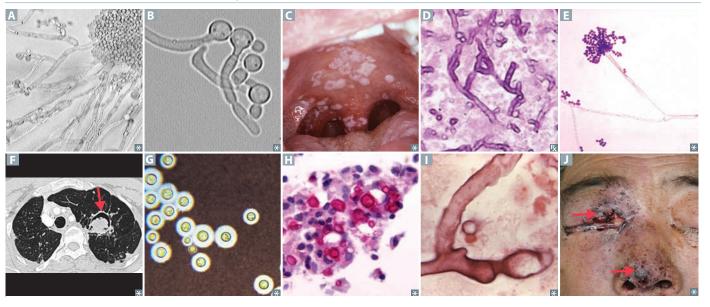
Treatment: amphotericin B + flucytosine followed by fluconazole for cryptococcal meningitis.

Mucor and Rhizopus spp

Irregular, broad, nonseptate hyphae branching at wide angles 1.

Causes mucormycosis, mostly in ketoacidotic diabetic and/or neutropenic patients (eg, leukemia). Inhalation of spores → fungi proliferate in blood vessel walls, penetrate cribriform plate, and enter brain. Rhinocerebral, frontal lobe abscess; cavernous sinus thrombosis. Headache, facial pain, black necrotic eschar on face □; may have cranial nerve involvement.

Treatment: surgical debridement, amphotericin B or isavuconazole.



FAS1_2019_03-Microbiology.indd 153 11/14/19 12:21 PM

Pneumocystis jirovecii

Causes *Pneumocystis* pneumonia (PCP), a diffuse interstitial pneumonia A. Yeast-like fungus (originally classified as protozoan). Most infections are asymptomatic. Immunosuppression (eg, AIDS) predisposes to disease. Diffuse, bilateral ground-glass opacities on chest imaging, with pneumatoceles B. Diagnosed by bronchoalveolar lavage or lung biopsy. Disc-shaped yeast seen on methenamine silver stain of lung tissue C or with fluorescent antibody.

Treatment/prophylaxis: TMP-SMX, pentamidine, dapsone (prophylaxis as single agent, or treatment in combination with TMP), atovaquone. Start prophylaxis when CD4+ count drops to < 200 cells/mm³ in HIV patients.



Sporothrix schenckii



Causes sporotrichosis. Dimorphic fungus. Exists as a **cigar**-shaped yeast at 37 °C in the human body and as hyphae with spores in soil (conidia). Lives on vegetation. When spores are traumatically introduced into the skin, typically by a thorn ("**rose gardener**'s disease"), causes local pustule or ulcer with nodules along draining lymphatics (ascending lymphangitis A). Disseminated disease possible in immunocompromised host.

Treatment: itraconazole or **pot**assium iodide (only for cutaneous/lymphocutaneous). Think of a **rose gardener** who smokes a **cigar** and **pot**.

FAS1_2019_03-Microbiology.indd 154 11/14/19 12:21 PM

► MICROBIOLOGY—PARASITOLOGY

Protozoa—gastrointestinal infections

ORGANISM	DISEASE	TRANSMISSION	DIAGNOSIS	TREATMENT
Giardia lamblia	Giardiasis—bloating, flatulence, foul-smelling, fatty diarrhea (often seen in campers/hikers)—think fat-rich Ghirardelli chocolates for fatty stools of Giardia	Cysts in water	Multinucleated trophozoites A or cysts B in stool, antigen detection	Metronidazole
Entamoeba histolytica	Amebiasis—bloody diarrhea (dysentery), liver abscess ("anchovy paste" exudate), RUQ pain; histology of colon biopsy shows flask-shaped ulcers	Cysts in water	Serology, antigen testing, and/or trophozoites (with engulfed RBCs c in the cytoplasm) or cysts with up to 4 nuclei in stool p; Entamoeba Eats Erythrocytes	Metronidazole; paromomycin or iodoquinol for asymptomatic cyst passers
Cryptosporidium	Severe diarrhea in AIDS Mild disease (watery diarrhea) in immunocompetent hosts	Oocysts in water	Oocysts on acid-fast stain E , antigen detection	Prevention (by filtering city water supplies); nitazoxanide in immunocompetent hosts
A	B			8

11/14/19 12:21 PM FAS1_2019_03-Microbiology.indd 155

Protozoa—CNS infections

ORGANISM	DISEASE	TRANSMISSION	DIAGNOSIS	TREATMENT
Toxoplasma gondii	Immunocompetent: mononucleosis-like symptoms, ⊝ heterophile antibody test Reactivation in AIDS → brain abscesses usually seen as multiple ring-enhancing lesions on MRI A Congenital toxoplasmosis: classic triad of chorioretinitis, hydrocephalus, and intracranial calcifications	Cysts in meat (most common); oocysts in cat feces; crosses placenta (pregnant women should avoid cats)	Serology, biopsy (tachyzoite)	Sulfadiazine + pyrimethamine
Naegleria fowleri	Rapidly fatal meningoencephalitis	Swimming in warm freshwater; enters via cribriform plate	Amoebas in CSF C	Amphotericin B has been effective for a few survivors
Trypanosoma brucei	African sleeping sickness— enlarged lymph nodes, recurring fever (due to antigenic variation), somnolence, coma	Tsetse fly, a painful bite	Trypomastigote in blood smear D	Suramin for blood- borne disease or melarsoprol for CNS penetration ("I sure am mellow when I'm sleeping")
	A B	∠	*	*

FAS1_2019_03-Microbiology.indd 156 11/14/19 12:21 PM

Protozoa—hematologic infections

ORGANISM	DISEASE	TRANSMISSION	DIAGNOSIS	TREATMENT
Plasmodium P vivax/ovale P falciparum P malariae	Malaria—fever, headache, anemia, splenomegaly P vivax/ovale—48-hr cycle (tertian; includes fever on first day and third day, thus fevers are actually 48 hr apart); dormant form (hypnozoite) in liver P falciparum—severe; irregular fever patterns; parasitized RBCs occlude capillaries in brain (cerebral malaria), kidneys, lungs P malariae—72-hr cycle (quartan)		Blood smear: trophozoite ring form within RBC A, schizont containing merozoites; red granules (Schüffner stippling) B throughout RBC cytoplasm seen with P vivax/ovale	Chloroquine (for sensitive species); if resistant, use mefloquine or atovaquone/ proguanil If life-threatening, use intravenous quinidine or artesunate (test for G6PD deficiency) For <i>P vivax/ovale</i> , add primaquine for hypnozoite (test for G6PD deficiency)
Babesia C 2	Babesiosis—fever and hemolytic anemia; predominantly in northeastern United States; asplenia † risk of severe disease	Ixodes tick (also vector for Borrelia burgdorferi and Anaplasma spp)	Blood smear: ring form C1, "Maltese cross" C2; PCR	Atovaquone + azithromycin

FAS1_2019_03-Microbiology.indd 157 11/14/19 12:21 PM

Protozoa—others

ORGANISM	DISEASE	TRANSMISSION	DIAGNOSIS	TREATMENT
Visceral infections				
Trypanosoma cruzi	Chagas disease—dilated cardiomyopathy with apical atrophy, megacolon, megaesophagus; predominantly in South America Unilateral periorbital swelling (Romaña sign) characteristic of acute stage	Triatomine insect (kissing bug) bites and defecates around the mouth or eyes; fecal transmission into bite site or mucosa	Trypomastigote in blood smear A	Benznidazole or nifurtimox; cruzing in my Benz, with a fur coat on
Leishmania spp	Visceral leishmaniasis (kala-azar)—spiking fevers, hepatosplenomegaly, pancytopenia Cutaneous leishmaniasis—skin ulcers B	Sandfly	Macrophages containing amastigotes C	Amphotericin B, sodium stibogluconate
Sexually transmitted	d infections			
Trichomonas vaginalis	Vaginitis—foul-smelling, greenish discharge; itching and burning; do not confuse with <i>Gardnerella vaginalis</i> , a gram-variable bacterium associated with bacterial vaginosis	Sexual (cannot exist outside human because it cannot form cysts)	Trophozoites (motile) on wet mount; punctate cervical hemorrhages ("strawberry cervix")	Metronidazole for patient and partner (prophylaxis; check for STI)
	A B	C	D.	×

Nematode routes of infection

Ingested—Enterobius, Ascaris, Toxocara,
Trichinella, Trichuris
Cutappous Strongyloides Angylostoma

Cutaneous—Strongyloides, Ancylostoma, Necator

Bites—Loa loa, Onchocerca volvulus, Wuchereria bancrofti You'll get sick if you **EATTT** these!

These get into your feet from the **SAN**d

Lay **LOW** to avoid getting bitten

FAS1_2019_03-Microbiology.indd 158 11/14/19 12:21 PM

Nematodes (roundworms)

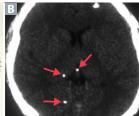
ORGANISM ORGANISM	DISEASE	TRANSMISSION	TREATMENT
Intestinal			
Enterobius vermicularis (pinworm)	Causes anal pruritus (diagnosed by seeing egg A via the tape test).	Fecal-oral.	Bendazoles (bendy worms), pyrantel pamoate.
Ascaris lumbricoides (giant roundworm)	May cause obstruction at ileocecal valve, biliary obstruction, intestinal perforation, migrates from nose/mouth.	Fecal-oral; knobby-coated, oval eggs seen in feces under microscope B .	Bendazoles.
Strongyloides stercoralis (threadworm)	GI (eg, duodenitis), pulmonary (eg, dry cough, hemoptysis), and cutaneous (eg, pruritus) symptoms. Hyperinfection syndrome caused by autoinfection (larvae enter bloodstream).	Larvae in soil penetrate skin; rhabditiform larvae seen in feces under microscope.	Ivermectin or bendazoles.
Ancylostoma spp, Necator americanus (hookworms)	Cause microcytic anemia by sucking blood from intestinal wall. Cutaneous larva migrans—pruritic, serpiginous rash from walking barefoot on contaminated beach.	Larvae penetrate skin.	Bendazoles or pyrantel pamoate.
Trichinella spiralis	Larvae enter bloodstream, encyst in striated muscle □ → myositis. Trichinosis—fever, vomiting, nausea, periorbital edema, myalgia.	Undercooked meat (especially pork); fecal-oral (less likely).	Bendazoles.
Trichuris trichiura (whipworm)	Often asymptomatic; loose stools, anemia, rectal prolapse in children.	Fecal-oral.	Bendazoles.
Tissue			
Toxocara canis	Visceral larva migrans—nematodes migrate to blood through intestinal wall → inflammation affecting liver, eyes (visual impairment, blindness), CNS (seizures, coma), heart (myocarditis).	Fecal-oral.	Bendazoles.
Onchocerca volvulus	Skin changes, loss of elastic fibers, river blindness (black skin nodules, "black sight"); allergic reaction possible.	Female black fly.	Ivermectin (ivermectin for river blindness).
Loa loa	Swelling in skin, worm in conjunctiva.	Deer fly, horse fly, mango fly.	Diethylcarbamazine.
Wuchereria bancrofti	Lymphatic filariasis (elephantiasis)— worms invade lymph nodes. → inflammation → lymphedema E ; symptom onset after 9 mo−1 yr.	Female mosquito.	Diethylcarbamazine.
A	B C C	D n	To the second se

FAS1_2019_03-Microbiology.indd 159 11/14/19 12:21 PM

Cestodes (tapeworms)

ORGANISM	DISEASE	TRANSMISSION	TREATMENT
Taenia solium A	Intestinal tapeworm	Ingestion of larvae encysted in undercooked pork	Praziquantel
	Cysticercosis, neurocysticercosis (cystic CNS lesions, seizures)	Ingestion of eggs in food contaminated with human feces	Praziquantel; albendazole for neurocysticercosis
Diphyllobothrium latum	Vitamin B ₁₂ deficiency (tapeworm competes for B ₁₂ in intestine) → megaloblastic anemia	Ingestion of larvae in raw freshwater fish	Praziquantel
Echinococcus granulosus	Hydatid cysts D ("eggshell calcification") in liver E ; cyst rupture can cause anaphylaxis	Ingestion of eggs in food contaminated with dog feces Sheep are an intermediate host	Albendazole











Trematodes (flukes)

ORGANISM	DISEASE	TRANSMISSION	TREATMENT
Schistosoma A B B	Liver and spleen enlargement (<i>S mansoni</i> , egg with lateral spine A), fibrosis, inflammation, portal hypertension Chronic infection with <i>S haematobium</i> (egg with terminal spine B) can lead to squamous cell carcinoma of the bladder (painless hematuria) and pulmonary hypertension	Snails are intermediate host; cercariae penetrate skin of humans in contact with contaminated fresh water (eg, swimming or bathing)	Praziquantel
Clonorchis sinensis	Biliary tract inflammation → pigmented gallstones Associated with cholangiocarcinoma	Undercooked fish	Praziquantel

FAS1_2019_03-Microbiology.indd 160 11/14/19 12:21 PM

Ectoparasites

Sarcoptes scabiei

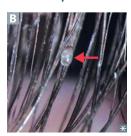


Mites burrow into stratum corneum and cause scabies-pruritus (worse at night) and serpiginous burrows (lines) often between fingers and toes A.

Common in children, crowded populations (jails, nursing homes); transmission through skin-to-skin contact (most common) or via fomites.

Treatment: permethrin cream, washing/drying all clothing/bedding, treat close contacts.

Pediculus humanus/ Phthirus pubis



Blood-sucking lice that cause intense pruritus with associated excoriations, commonly on scalp and neck (head lice), waistband and axilla (body lice), or pubic and perianal regions (pubic lice).

Body lice can transmit Rickettsia prowazekii (epidemic typhus), Borrelia recurrentis (relapsing fever), Bartonella quintana (trench fever).

Treatment: pyrethroids, malathion, or ivermectin lotion, and nit B combing. Children with head lice can be treated at home without interrupting school attendance.

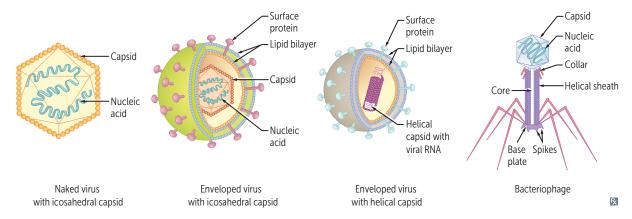
Parasite hints

ASSOCIATIONS	ORGANISM
Biliary tract disease, cholangiocarcinoma	Clonorchis sinensis
Brain cysts, seizures	Taenia solium (neurocysticercosis)
Hematuria, squamous cell bladder cancer	Schistosoma haematobium
Liver (hydatid) cysts	Echinococcus granulosus
Microcytic anemia	Ancylostoma, Necator
Myalgias, periorbital edema	Trichinella spiralis
Perianal pruritus	Enterobius
Portal hypertension	Schistosoma mansoni, Schistosoma japonicum
Vitamin B ₁₂ deficiency	Diphyllobothrium latum

FAS1_2019_03-Microbiology.indd 161 11/14/19 12:21 PM

► MICROBIOLOGY — VIROLOGY

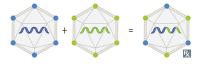
Viral structure—general features



Viral genetics

Recombination

Exchange of genes between 2 chromosomes by crossing over within regions of significant base sequence homology.



Reassortment

When viruses with segmented genomes (eg, influenza virus) exchange genetic material. For example, the 2009 novel H1N1 influenza A pandemic emerged via complex viral reassortment of genes from human, swine, and avian viruses. Has potential to cause antigenic shift.



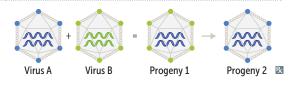
Complementation

When 1 of 2 viruses that infect the cell has a mutation that results in a nonfunctional protein, the nonmutated virus "complements" the mutated one by making a functional protein that serves both viruses. For example, hepatitis D virus requires the presence of replicating hepatitis B virus to supply HBsAg, the envelope protein for HDV.



Phenotypic mixing

Occurs with simultaneous infection of a cell with 2 viruses. For progeny 1, genome of virus A can be partially or completely coated (forming pseudovirion) with the surface proteins of virus B. Type B protein coat determines the tropism (infectivity) of the hybrid virus. Progeny from subsequent infection of a cell by progeny 1 will have a type A coat that is encoded by its type A genetic material.



FAS1_2019_03-Microbiology.indd 162 11/14/19 12:21 PM

SECTION II

DNA viral genomes

All DNA viruses have dsDNA genomes except Parvoviridae (ssDNA).

All are linear except papilloma-, polyoma-, and hepadnaviruses (circular).

All are dsDNA (like our cells), except "part-of-a-virus" (parvovirus) is ssDNA.

Parvus = small.

RNA viral genomes

All RNA viruses have ssRNA genomes except Reoviridae (dsRNA).

⊕ stranded RNA viruses: I went to a retro (retrovirus) toga (togavirus) party, where I drank flavored (flavivirus) Corona (coronavirus) and ate hippie (hepevirus) California (calicivirus) pickles (picornavirus).

All are ssRNA, except "repeato-virus" (reovirus) is dsRNA.

Naked viral genome infectivity

Purified nucleic acids of most dsDNA viruses (except poxviruses and HBV) and ⊕ strand ssRNA (≈ mRNA) viruses are infectious. Naked nucleic acids of ⊝ strand ssRNA and dsRNA viruses are not infectious. They require polymerases contained in the complete virion.

Viral envelopes

Generally, enveloped viruses acquire their envelopes from plasma membrane when they exit from cell. Exceptions include herpesviruses, which acquire envelopes from nuclear membrane.

Naked (nonenveloped) viruses include Papillomavirus, Adenovirus, Parvovirus, Polyomavirus, Calicivirus, Picornavirus, Reovirus, and Hepevirus. DNA = PAPP; RNA = CPR and hepevirus. Give PAPP smears and CPR to a naked hippie (hepevirus).

Enveloped DNA viruses Have Helpful Protection (Herpesvirus, Hepadnavirus, Poxvirus).

DNA virus characteristics

Some general rules—all DNA viruses:

GENERAL RULE	COMMENTS	
Are HHAPPPP y viruses	Hepadna, Herpes, Adeno, Pox, Parvo, Papilloma, Polyoma.	
Are double stranded Except parvo (single stranded).		
Have linear genomes	Except papilloma and polyoma (circular, supercoiled) and hepadna (circular, incomplete).	
Are icosahedral	Except pox (complex).	
Replicate in the nucleus	Except pox (carries own DNA-dependent RNA polymerase).	

FAS1_2019_03-Microbiology.indd 163 11/14/19 12:21 PM

VIRAL FAMILY	ENVELOPE	DNA STRUCTURE	MEDICAL IMPORTANCE
Herpesviruses	Yes	DS and linear	See Herpesviruses entry
Poxvirus	Yes	DS and linear (largest DNA virus)	Smallpox eradicated world wide by use of the live- attenuated vaccine Cowpox ("milkmaid blisters") Molluscum contagiosum—flesh-colored papule with central umbilication
Hepadnavirus	Yes	Partially DS and circular	HBV:Acute or chronic hepatitisNot a retrovirus but has reverse transcriptase
Adenovirus	No	DS and linear	Febrile pharyngitis A—sore throat
A			Acute hemorrhagic cystitis Pneumonia Conjunctivitis—"pink eye" Gastroenteritis Myocarditis
Papillomavirus	No	DS and circular	HPV–warts (serotypes 1, 2, 6, 11), CIN, cervical cancer (most commonly 16, 18)
Polyomavirus	No	DS and circular	JC virus—progressive multifocal leukoencephalopathy (PML) in HIV BK virus—transplant patients, commonly targets kidney JC: Junky Cerebrum; BK: Bad Kidney
Parvovirus	No	SS and linear (smallest DNA virus)	B19 virus—aplastic crises in sickle cell disease, "slapped cheek" rash in children (erythema infectiosum, or fifth disease); infects RBC precursors

Herpesviruses	Enveloped, DS, and	d linear viruses	
VIRUS	ROUTE OF TRANSMISSION	CLINICAL SIGNIFICANCE	NOTES
Herpes simplex virus-1	Respiratory secretions, saliva	Gingivostomatitis, keratoconjunctivitis A, herpes labialis (cold sores) B, herpetic whitlow on finger, temporal lobe encephalitis, esophagitis, erythema multiforme	Most commonly latent in trigeminal ganglia Most common cause of sporadic encephalitis, can present as altered mental status, seizures, and/or aphasia
Herpes simplex virus-2	Sexual contact, perinatal	Herpes genitalis C , neonatal herpes	Most commonly latent in sacral ganglia Viral meningitis more common with HSV-2 than with HSV-1

and endothelial cells → RBC destruction → hydrops fetalis and death in fetus, pure RBC aplasia and rheumatoid arthritis–like symptoms in adults

FAS1_2019_03-Microbiology.indd 164 11/14/19 12:21 PM

Herpesviruses (continued)

VIRUS	ROUTE OF TRANSMISSION	CLINICAL SIGNIFICANCE	NOTES
Varicella- Zoster virus (HHV-3)	Respiratory secretions, contact with fluid from vesicles	Varicella-zoster (chickenpox D, shingles E), encephalitis, pneumonia Most common complication of shingles is postherpetic neuralgia	Latent in dorsal root or trigeminal ganglia; CN V ₁ branch involvement can cause herpes zoster ophthalmicus
Epstein-Barr virus (HHV-4)	Respiratory secretions, saliva; aka "kissing disease," (common in teens, young adults)	Mononucleosis—fever, hepatosplenomegaly F , pharyngitis, and lymphadenopathy (especially posterior cervical nodes); avoid contact sports until resolution due to risk of splenic rupture Associated with lymphomas (eg, endemic Burkitt lymphoma), nasopharyngeal carcinoma (especially Asian adults), lymphoproliferative disease in transplant patients	Infects B cells through CD21, "Must be 21 to drink Beer in a Barr" Atypical lymphocytes on peripheral blood smear ☐—not infected B cells but reactive cytotoxic T cells ⊕ Monospot test—heterophile antibodies detected by agglutination of sheep or horse RBCs Use of amoxicillin in mononucleosis can cause characteristic maculopapular rash
Cytomegalo- virus (HHV-5)	Congenital, transfusion, sexual contact, saliva, urine, transplant	Mononucleosis (⊖ Monospot) in immunocompetent patients; infection in immunocompromised, especially pneumonia in transplant patients; esophagitis; AIDS retinitis ("sightomegalovirus"): hemorrhage, cotton-wool exudates, vision loss Congenital CMV	Infected cells have characteristic "owl eye" intranuclear inclusions [1] Latent in mononuclear cells
Human herpes- viruses 6 and 7	Saliva	Roseola infantum (exanthem subitum): high fevers for several days that can cause seizures, followed by diffuse macular rash (starts on trunk then spreads to extremities)	Roseola: fever first, Rosy (rash) later. HHV-7—less common cause of roseola
Human herpesvirus 8	Sexual contact	Kaposi sarcoma (neoplasm of endothelial cells). Seen in HIV/AIDS and transplant patients. Dark/violaceous plaques or nodules representing vascular proliferations	Can also affect GI tract and lungs
F Liv	B G G G G G G G G G G G G G G G G G G G	T T T T T T T T T T T T T T T T T T T	RU

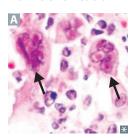
FAS1_2019_03-Microbiology.indd 165 11/14/19 12:22 PM

166

SECTION II

MICROBIOLOGY → MICROBIOLOGY — VIROLOGY

HSV identification



Viral culture for skin/genitalia.

CSF PCR for herpes encephalitis.

Tzanck test—a smear of an opened skin vesicle to detect multinucleated giant cells A commonly seen in HSV-1, HSV-2, and VZV infection. PCR of skin lesions is test of choice.

Tzanck heavens I do not have herpes.

Intranuclear eosinophilic Cowdry A inclusions also seen with HSV-1, HSV-2, VZV.

Receptors used by viruses

VIRUS	RECEPTORS
CMV	Integrins (heparan sulfate)
EBV	CD21
HIV	CD4, CXCR4, CCR5
Parvovirus B19	P antigen on RBCs
Rabies	Nicotinic AChR
Rhinovirus	ICAM-1 (I came to see the rhino)

FAS1_2019_03-Microbiology.indd 166 11/14/19 12:22 PM

VIRAL FAMILY	ENVELOPE	RNA STRUCTURE	CAPSID SYMMETRY	MEDICAL IMPORTANCE	
Reoviruses	No	DS linear Multisegmented	Icosahedral (double)	Coltivirus ^a —Colorado tick fever Rotavirus—cause of fatal diarrhea in children	
Picornaviruses	No	SS ⊕ linear	Icosahedral	Poliovirus—polio-Salk/Sabin vaccines—IPV/OPV Echovirus—aseptic meningitis Rhinovirus—"common cold" Coxsackievirus—aseptic meningitis; herpangina (mouth blisters, fever); hand, foot, and mouth disease; myocarditis; pericarditis HAV—acute viral hepatitis PERCH	
Hepevirus	No	SS ⊕ linear	Icosahedral	HEV	
Caliciviruses	No	SS ⊕ linear	Icosahedral	Norovirus—viral gastroenteritis	
Flaviviruses	Yes	SS ⊕ linear	Icosahedral	HCV Yellow fever ^a Dengue ^a St. Louis encephalitis ^a West Nile virus ^a —meningoencephalitis, flaccid paralysis Zika virus ^a	
Togaviruses	Yes	SS ⊕ linear	Icosahedral	Toga CREW—Chikungunya virus ^a (co-infection with dengue virus can occur), Rubella, Eastern and Western equine encephalitis	
Retroviruses	Yes	SS ⊕ linear 2 copies	Icosahedral (HTLV), complex and conical (HIV)	Have reverse transcriptase HTLV—T-cell leukemia HIV—AIDS	
Coronaviruses	Yes	SS ⊕ linear	Helical	"Common cold," SARS, MERS	
Orthomyxoviruses	Yes	SS ⊝ linear 8 segments	Helical	Influenza virus	
Paramyxoviruses	Yes	SS ⊝ linear Nonsegmented	Helical	PaRaMyxovirus: Parainfluenza—croup RSV—bronchiolitis in babies Measles, Mumps	
Rhabdoviruses	Yes	$SS \ominus linear$	Helical	Rabies	
Filoviruses	Yes	$SS \ominus linear$	Helical	Ebola/Marburg hemorrhagic fever—often fatal.	
Arenaviruses	Yes	SS ⊕ and ⊖ circular 2 segments	Helical	LCMV—lymphocytic choriomeningitis virus Lassa fever encephalitis—spread by rodents	
Bunyaviruses	Yes	SS ⊖ circular 3 segments	Helical	California encephalitis ^a Sandfly/Rift Valley fevers ^a Crimean-Congo hemorrhagic fever ^a Hantavirus—hemorrhagic fever, pneumonia	
Delta virus	Yes	SS ⊖ circular	Uncertain	HDV is a "defective" virus that requires the presence of HBV to replicate	

SS, single-stranded; DS, double-stranded; \oplus , positive sense; \ominus , negative sense; a = **arbov**irus, **ar**thropod **bor**ne (mosquitoes, ticks).

FAS1_2019_03-Microbiology.indd 167 11/14/19 12:22 PM

168

SECTION II

MICROBIOLOGY ► MICROBIOLOGY — VIROLOGY

Negative-stranded viruses

Must transcribe ⊝ strand to ⊕. Virion brings its own RNA-dependent RNA polymerase. They include Arenaviruses, Bunyaviruses, Paramyxoviruses, Orthomyxoviruses, Filoviruses, and Rhabdoviruses.

Always Bring Polymerase Or Fail Replication.

Segmented viruses

All are RNA viruses. They include

Bunyaviruses (3 segments), Orthomyxoviruses
(influenza viruses) (8 segments), Arenaviruses
(2 segments), and Reoviruses (10-12 segments).

BOARding flight 382 in 10-12 minutes.

Picornavirus

Includes Poliovirus, Echovirus, Rhinovirus, Coxsackievirus, and HAV. RNA is translated into 1 large polypeptide that is cleaved by virus-encoded proteases into functional viral proteins. Can cause aseptic (viral) meningitis (except rhinovirus and HAV). All are enteroviruses except rhinovirus and HAV.

PicoRNAvirus = small RNA virus. PERCH on a "peak" (pico).

Rhinovirus

A picornavirus. Nonenveloped RNA virus. Cause of common cold; > 100 serologic types. Acid labile—destroyed by stomach acid; therefore, does not infect the GI tract (unlike the other picornaviruses).

Rhino has a runny nose.

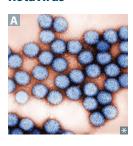
Yellow fever virus

A flavivirus (also an arbovirus) transmitted by *Aedes* mosquitoes. Virus has a monkey or human reservoir.

Symptoms: high fever, black vomitus, and jaundice. May see Councilman bodies (eosinophilic apoptotic globules) on liver biopsy.

Flavi = yellow, jaundice.

Rotavirus



Segmented dsRNA virus (a reovirus) A.

Most important global cause of infantile
gastroenteritis. Major cause of acute diarrhea
in the United States during winter, especially
in day care centers, kindergartens.

Villous destruction with atrophy leads to ↓ absorption of Na⁺ and loss of K⁺. ROTAvirus = Right Out The Anus. CDC recommends routine vaccination of all infants except those with a history of intussusception or SCID.

FAS1_2019_03-Microbiology.indd 168 11/14/19 12:22 PM

Influenza viruses

Orthomyxoviruses. Enveloped, ⊜ ssRNA viruses with 8-segment genome. Contain hemagglutinin (binds sialic acid and promotes viral entry) and neuraminidase (promotes progeny virion release) antigens. Patients at risk for fatal bacterial superinfection, most commonly *S aureus*, *S pneumoniae*, and *H influenzae*.

Reformulated vaccine ("the flu shot") contains viral strains most likely to appear during the flu season, due to the virus' rapid genetic change. Killed viral vaccine is most frequently used. Live attenuated vaccine contains temperature-sensitive mutant that replicates in the nose but not in the lung; administered intranasally. Treatment: supportive +/- neuraminidase inhibitor (eg, oseltamivir, zanamivir).

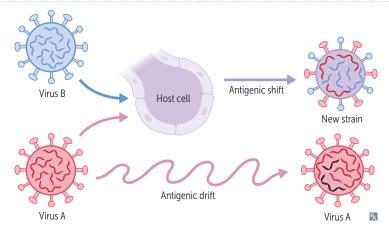
Genetic/antigenic shift

Infection of 1 cell by 2 different segmented viruses (eg, swine influenza and human influenza viruses) → RNA segment reassortment → dramatically different virus (genetic shift)

Sudden shift is more deadly than gradual drift.

- → major global outbreaks (pandemics).
- Genetic/antigenic drift

Random mutation in hemagglutinin or neuraminidase genes → minor changes (antigenic drift) → local outbreaks (epidemics).



Rubella virus



A togavirus. Causes rubella, once known as German (3-day) measles. Fever, postauricular and other lymphadenopathy, arthralgias, and fine, maculopapular rash that starts on face and spreads centrifugally to involve trunk and extremities A.

Causes mild disease in children but serious congenital disease (a TORCH infection). Congenital rubella findings include "blueberry muffin" appearance due to dermal extramedullary hematopoiesis.

Paramyxoviruses

Paramyxoviruses cause disease in children. They include those that cause parainfluenza (croup), mumps, measles, RSV, and human metapneumovirus, which causes respiratory tract infection (bronchiolitis, pneumonia) in infants. All contain surface F (fusion) protein, which causes respiratory epithelial cells to fuse and form multinucleated cells. Palivizumab (monoclonal antibody against F protein) prevents pneumonia caused by RSV infection in premature infants. Palivizumab for Paramyxovirus (RSV) Prophylaxis in Preemies.

FAS1_2019_03-Microbiology.indd 169 11/14/19 12:22 PM

Acute laryngotracheobronchitis



Also called croup. Caused by parainfluenza viruses. Virus membrane contains hemagglutinin (binds sialic acid and promotes viral entry) and neuraminidase (promotes progeny virion release) antigens. Results in a "seal-like" barking cough and inspiratory stridor. Narrowing of upper trachea and subglottis leads to characteristic steeple sign on x-ray A. Severe croup can result in pulsus paradoxus 2° to upper airway obstruction.

Measles (rubeola) virus





Usual presentation involves prodromal fever with cough, coryza, and conjunctivitis, then eventually Koplik spots (bright red spots with blue-white center on buccal mucosa A), followed 1–2 days later by a maculopapular rash B that starts at the head/neck and spreads downward.

Lymphadenitis with Warthin-Finkeldey giant cells (fused lymphocytes) in a background of paracortical hyperplasia. Possible sequelae:

- Subacute sclerosing panencephalitis (SSPE): personality changes, dementia, autonomic dysfunction, death (occurs years later)
- Encephalitis (1:1000): symptoms appear within few days of rash
- Giant cell pneumonia (rare except in immunosuppressed)

4 C's of measles:

Cough

Coryza

Conjunctivitis

"C"oplik spots

Vitamin A supplementation can reduce morbidity and mortality from measles, particularly in malnourished children.

Pneumonia is the most common cause of measles-associated death in children.

Mumps virus



Uncommon due to effectiveness of MMR vaccine.

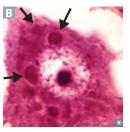
Symptoms: Parotitis A, Orchitis (inflammation of testes), aseptic Meningitis, and Pancreatitis. Can cause sterility (especially after puberty).

Mumps makes your parotid glands and testes as big as **POM-P**oms.

FAS1_2019_03-Microbiology.indd 170 11/14/19 12:22 PM

Rabies virus





Bullet-shaped virus A. Negri bodies (cytoplasmic inclusions B) commonly found in Purkinje cells of cerebellum and in hippocampal neurons. Rabies has long incubation period (weeks to months) before symptom onset. Postexposure prophylaxis is wound cleaning plus immunization with killed vaccine and rabies immunoglobulin. Example of passive-active immunity.

Travels to the CNS by migrating in a retrograde fashion (via dynein motors) up nerve axons after binding to ACh receptors.

Progression of disease: fever, malaise → agitation, photophobia, hydrophobia, hypersalivation → paralysis, coma → death. Infection more commonly from bat, raccoon, and skunk bites than from dog bites in the United States; aerosol transmission (eg, bat caves) also possible.

Ebola virus



A filovirus A that targets endothelial cells, phagocytes, hepatocytes. Following an incubation period of up to 21 days, presents with abrupt onset of flu-like symptoms, diarrhea/vomiting, high fever, myalgia. Can progress to DIC, diffuse hemorrhage, shock. Diagnosed with RT-PCR within 48 hr of symptom onset. High mortality rate.

Transmission requires direct contact with bodily fluids, fomites (including dead bodies), infected bats or primates (apes/monkeys); high incidence of nosocomial infection.

Supportive care, no definitive treatment. Strict isolation of infected individuals and barrier practices for health care workers are key to preventing transmission.

Zika virus

A flavivirus most commonly transmitted by Aedes mosquito bites.

Causes conjunctivitis, low-grade pyrexia, and itchy rash in 20% of cases. Can lead to congenital microcephaly or miscarriage if transmitted in utero.

Diagnose with RT-PCR or serology.

Sexual and vertical transmission possible. Outbreaks more common in tropical and subtropical climates. Supportive care, no definitive treatment.

FAS1_2019_03-Microbiology.indd 171 11/14/19 12:22 PM

Hepatitis viruses

Signs and symptoms of all hepatitis viruses: episodes of fever, jaundice, † ALT and AST. Naked viruses (HAV and HEV) lack an envelope and are not destroyed by the gut: the vowels hit your bowels.

HBV DNA polymerase has DNA- and RNA-dependent activities. Upon entry into nucleus, the polymerase completes the partial dsDNA. Host RNA polymerase transcribes mRNA from viral DNA to make viral proteins. The DNA polymerase then reverse transcribes viral RNA to DNA, which is the genome of the progeny virus.

HCV lacks 3′-5′ exonuclease activity → no proofreading ability → antigenic variation of HCV envelope proteins. Host antibody production lags behind production of new mutant strains of HCV.

Virus	HAV	HBV	HCV	HDV	HEV
FAMILY	RNA picornavirus	DNA hepadnavirus	RNA flavivirus	RNA deltavirus	RNA hepevirus
TRANSMISSION	Fecal-oral (shellfish, travelers, day care)	Parenteral (Blood), sexual (Baby- making), perinatal (Birthing)	Primarily blood (IVDU, post- transfusion)	Parenteral, sexual, perinatal	Fecal-oral, especially waterborne
INCUBATION	Short (weeks)	Long (months)	Long	Superinfection (HDV after HBV) = short Coinfection (HDV with HBV) = long	Short
CLINICAL COURSE	Acute and self limiting (adults), Asymptomatic (children)	Initially like serum sickness (fever, arthralgias, rash); may progress to carcinoma	May progress to Cirrhosis or Carcinoma	Similar to HBV	Fulminant hepatitis in Expectant (pregnant) women
PROGNOSIS	Good	Adults → mostly full resolution; neonates → worse prognosis	Majority develop stable, Chronic hepatitis C	Superinfection → worse prognosis	High mortality in pregnant women
HCC RISK	No	Yes	Yes	Yes	No
LIVER BIOPSY	Hepatocyte swelling, monocyte infiltration, Councilman bodies	Granular eosinophilic "ground glass" appearance; cytotoxic T cells mediate damage	Lymphoid aggregates with focal areas of macrovesicular steatosis	Similar to HBV	Patchy necrosis
NOTES	No carrier state	Carrier state common	Carrier state very common	Defective virus, Depends on HBV HBsAg coat for entry into hepatocytes	Enteric, Epidemic (eg, in parts of Asia, Africa, Middle East), no carrier state

FAS1_2019_03-Microbiology.indd 172 11/14/19 12:22 PM

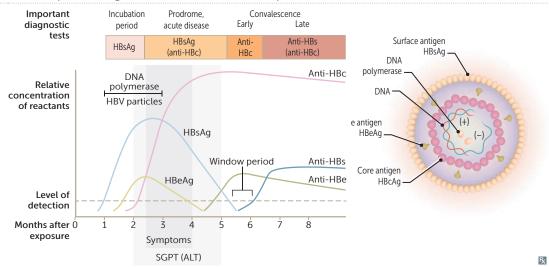
Extrahepatic manifestations of hepatitis B and C

	Hepatitis B	Hepatitis C
HEMATOLOGIC	Aplastic anemia	Essential mixed cryoglobulinemia, † risk B-cell NHL, ITP, autoimmune hemolytic anemia
RENAL	Membranous GN > membranoproliferative GN	
VASCULAR	Polyarteritis nodosa	Leukocytoclastic vasculitis
DERMATOLOGIC		Sporadic porphyria cutanea tarda, lichen planus
ENDOCRINE		† risk of diabetes mellitus, autoimmune hypothyroidism

FAS1_2019_03-Microbiology.indd 173 11/14/19 12:22 PM

Hepatitis serologic markers

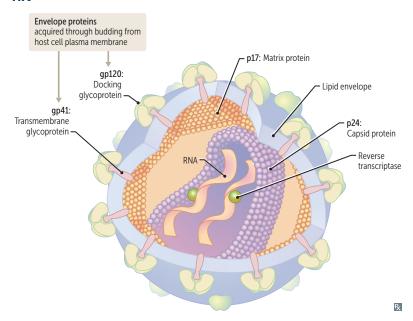
Anti-HAV (IgM)	IgM antibody to HAV; best test to detect acute hepatitis A.	
Anti-HAV (IgG)	IgG antibody indicates prior HAV infection and/or prior vaccination; protects against reinfection	
HBsAg	Antigen found on surface of HBV; indicates hepatitis B infection.	
Anti-HBs	Antibody to HBsAg; indicates immunity to hepatitis B due to vaccination or recovery from infection.	
HBcAg	Antigen associated with core of HBV.	
Anti-HBc	Antibody to HBcAg; IgM = acute/recent infection; IgG = prior exposure or chronic infection. IgM anti-HBc may be the sole ⊕ marker of infection during window period.	
HBeAg	Secreted by infected hepatocyte into circulation. Not part of mature HBV virion. Indicates active viral replication and therefore high transmissibility and poorer prognosis.	
Anti-HBe	Antibody to HBeAg; indicates low transmissibility.	



HBsAg	Anti-HBs	HBeAg	Anti-HBe	Anti-HBc
✓		✓		IgM
			✓	IgM
✓		✓		IgG
✓			✓	IgG
	✓		✓	IgG
	✓			
	HBsAg ✓	HBsAg Anti-HBs ✓ ✓ ✓ ✓ ✓	HBsAg Anti-HBs HBeAg	HBsAg Anti-HBs HBeAg Anti-HBe / / / / / / / / / / / / /

FAS1_2019_03-Microbiology.indd 174 11/14/19 12:22 PM

HIV



Diploid genome (2 molecules of RNA). The 3 structural genes (protein coded for):

- *env* (gp120 and gp41):
 - Formed from cleavage of gp160 to form envelope glycoproteins.
 - gpl20—attachment to host CD4+ T cell.
 - gp4l—fusion and entry.
- gag (p24 and p17)—capsid and matrix proteins, respectively.
- pol—Reverse transcriptase, Integrase, Protease; RIP "Pol" (Paul)

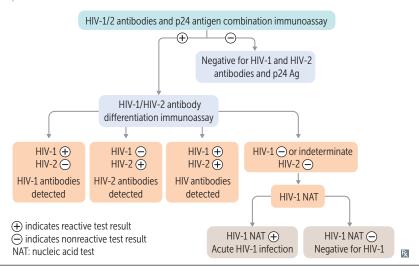
Reverse transcriptase synthesizes dsDNA from genomic RNA; dsDNA integrates into host genome.

Virus binds CD4 as well as a coreceptor, either CCR5 on macrophages (early infection) or CXCR4 on T cells (late infection).

Homozygous CCR5 mutation = immunity. Heterozygous CCR5 mutation = slower course.

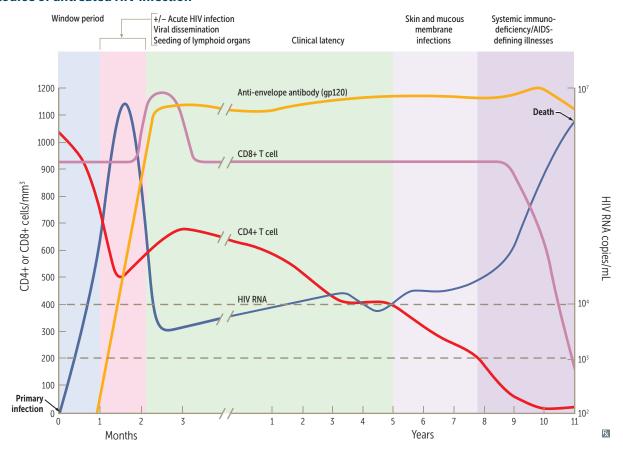
HIV diagnosis

Presumptive diagnosis made with HIV-1/2 Ag/ Ab immunoassays. These immunoassays detect viral p24 Ag capsid protein and IgG Abs to HIV-1/2. Very high sensitivity/specificity. Viral load tests determine the amount of viral RNA in the plasma. High viral load associated with poor prognosis. Also use viral load to monitor effect of drug therapy. Use HIV genotyping to determine appropriate therapy. AIDS diagnosis: ≤ 200 CD4+ cells/mm³ (normal: 500–1500 cells/mm³) or HIV ⊕ with AIDS-defining condition (eg, *Pneumocystis* pneumonia). Western blot tests are no longer recommended by the CDC for confirmatory testing.
HIV-1/2 Ag/Ab testing is not recommended in babies with suspected HIV due to maternally transferred antibody. Use HIV viral load instead.



FAS1_2019_03-Microbiology.indd 175 11/14/19 12:22 PM

Time course of untreated HIV infection



Dashed lines on CD4+ count axis indicate moderate immunocompromise (< 400 CD4+ cells/mm³) and when AIDS-defining illnesses emerge (< 200 CD4+ cells/mm³).

Most patients who do not receive treatment eventually die of complications of HIV infection.

Four stages of untreated infection:

- 1. Flu-like (acute)
- 2. Feeling fine (latent)
- 3. Falling count
- 4. Final crisis

During clinical latency phase, virus replicates in lymph nodes

FAS1_2019_03-Microbiology.indd 176 11/14/19 12:22 PM

Common diseases of HIV-positive adults

↓ CD4+ cell count → reactivation of past infections (eg, TB, HSV, shingles), dissemination of bacterial infections and fungal infections (eg, coccidioidomycosis), and non-Hodgkin lymphomas.

PATHOGEN	PRESENTATION	FINDINGS
CD4+ cell count < 500/	mm³	
Candida albicans	Oral thrush	Scrapable white plaque, pseudohyphae on microscopy
EBV	Oral hairy leukoplakia	Unscrapable white plaque on lateral tongue
HHV-8	Kaposi sarcoma	Biopsy with lymphocytic inflammation
HPV	Squamous cell carcinoma, commonly of anus (men who have sex with men) or cervix	
CD4+ cell count < 200/	mm ³	
Histoplasma capsulatum	Fever, weight loss, fatigue, cough, dyspnea, nausea, vomiting, diarrhea	Oval yeast cells within macrophages
HIV	Dementia	Cerebral atrophy on neuroimaging
JC virus (reactivation)	Progressive multifocal leukoencephalopathy	Nonenhancing areas of demyelination on MR
Pneumocystis jirovecii	Pneumocystis pneumonia	"Ground-glass" opacities on chest imaging
CD4+ cell count < 100/	mm ³	
Aspergillus fumigatus	Hemoptysis, pleuritic pain	Cavitation or infiltrates on chest imaging
Bartonella spp	Bacillary angiomatosis	Biopsy with neutrophilic inflammation
Candida albicans	Esophagitis	White plaques on endoscopy; yeast and pseudohyphae on biopsy
CMV	Colitis, Retinitis, Esophagitis, Encephalitis, Pneumonitis (CREEP)	Linear ulcers on endoscopy, cotton-wool spots on fundoscopy Biopsy reveals cells with intranuclear (owl eye) inclusion bodies
Cryptococcus neoformans	Meningitis	Encapsulated yeast on India ink stain or capsular antigen ⊕
Cryptosporidium spp	Chronic, watery diarrhea	Acid-fast oocysts in stool
EBV	B-cell lymphoma (eg, non-Hodgkin lymphoma, CNS lymphoma)	CNS lymphoma—ring enhancing, may be solitary (vs <i>Toxoplasma</i>)
Mycobacterium avium–intracellulare, Mycobacterium avium complex	Nonspecific systemic symptoms (fever, night sweats, weight loss) or focal lymphadenitis	Most common if CD4+ cell count < 50/mm ³
Toxoplasma gondii	Brain abscesses	Multiple ring-enhancing lesions on MRI

FAS1_2019_03-Microbiology.indd 177 11/14/19 12:22 PM 178 **SECTION II**

MICROBIOLOGY ► MICROBIOLOGY—SYSTEMS

Prions

Prion diseases are caused by the conversion of a normal (predominantly α -helical) protein termed prion protein (PrPc) to a β-pleated form (PrPsc), which is transmissible via CNS-related tissue (iatrogenic CJD) or food contaminated by BSE-infected animal products (variant CJD). PrPsc resists protease degradation and facilitates the conversion of still more PrPc to PrPsc. Resistant to standard sterilizing procedures, including standard autoclaving. Accumulation of PrPsc results in spongiform encephalopathy and dementia, ataxia, and death.

Creutzfeldt-Jakob disease—rapidly progressive dementia, typically sporadic (some familial forms).

Bovine spongiform encephalopathy—also called "mad cow disease."

Kuru—acquired prion disease noted in tribal populations practicing human cannibalism.

► MICROBIOLOGY—SYSTEMS

Normal flora: dominant

Neonates delivered by C-section have no flora but are rapidly colonized after birth.

LOCATION	MICROORGANISM	
Skin	S epidermidis	
Nose	S epidermidis; colonized by S aureus	
Oropharynx	Viridans group streptococci	
Dental plaque	S mutans	
Colon	B fragilis > E coli	
Vagina	Lactobacillus; colonized by E coli and group B strep	

Bugs causing foodborne illness

S aureus and *B cereus* food poisoning starts quickly and ends quickly.

SOURCE OF INFECTION	
Reheated rice. "Food poisoning from reheated rice? Be serious !" (<i>B cereus</i>)	
Improperly canned foods (toxins), raw honey (spores)	
Reheated meat	
Undercooked meat	
Deli meats, soft cheeses	
Poultry, meat, and eggs	
Meats, mayonnaise, custard; preformed toxin	
Raw/undercooked seafood	

FAS1_2019_03-Microbiology.indd 178 11/14/19 12:22 PM

Bugs causing diarrhea

Bloody diarrhea	
Campylobacter	Comma- or S-shaped organisms; growth at 42°C
E histolytica	Protozoan; amebic dysentery; liver abscess
Enterohemorrhagic <i>E coli</i>	O157:H7; can cause HUS; makes Shiga-like toxin
Enteroinvasive <i>E coli</i>	Invades colonic mucosa
Salmonella (non- typhoidal)	Lactose ⊖; flagellar motility; has animal reservoir, especially poultry and eggs
Shigella	Lactose ⊖; very low ID50; produces Shiga toxin; human reservoir only; bacillary dysentery
Y enterocolitica	Day care outbreaks; pseudoappendicitis
Watery diarrhea	
C difficile	Pseudomembranous colitis; associated with antibiotics and PPIs; occasionally bloody diarrhea
C perfringens	Also causes gas gangrene
Enterotoxigenic <i>E coli</i>	Travelers' diarrhea; produces heat-labile (LT) and heat-stable (ST) toxins
Protozoa	Giardia, Cryptosporidium
V cholerae	Comma-shaped organisms; rice-water diarrhea; often from infected seafood
Viruses	Rotavirus, norovirus, enteric adenovirus

Common causes of pneumonia

NEONATES (< 4 WK)	CHILDREN (4 WK-18 YR)	ADULTS (18-40 YR)	ADULTS (40-65 YR)	ELDERLY	
Group B streptococci	Viruses (RSV)	Mycoplasma	S pneumoniae	S pneumoniae	
E coli	M ycoplasma	C pneumoniae	H influenzae	Influenza virus	
	C trachomatis	S pneumoniae	Anaerobes	Anaerobes	
	(infants-3 yr)	Viruses (eg, influenza)	Viruses	H influenzae	
	C pneumoniae		Mycoplasma	Gram ⊝ rods	
	(school-aged				
	children)				
	S p neumoniae				
	Runts May Cough				
	Chunky Sputum				
Special groups					
Alcoholic	<i>Klebsiella</i> , anaerobes usually due to aspiration (eg, <i>Peptostreptococcus</i> , <i>Fusobacterium</i> , <i>Prevotella</i> , <i>Bacteroides</i>)				
IV drug users	S pneumoniae, S aureus				
Aspiration	Anaerobes				
Atypical	Mycoplasma, Chlamydophila, Legionella, viruses (RSV, CMV, influenza, adenovirus)				
Cystic fibrosis	Pseudomonas, S aureus, S pneumoniae, Burkholderia cepacia				
Immunocompromised	S aureus, enteric gram ⊖ rods, fungi, viruses, P jirovecii (with HIV)				
	S aureus, Pseudomonas, other enteric gram \ominus rods				
Nosocomial (hospital acquired)	s daredo, i ocacomona				

FAS1_2019_03-Microbiology.indd 179 11/14/19 12:22 PM

Common causes of meningitis

NEWBORN (0-6 MO)	CHILDREN (6 MO-6 YR)	6-60 YR	60 YR +
Group B Streptococcus	S pneumoniae	N meningitidis	S pneumoniae
E coli	N meningitidis	S pneumoniae	N meningitidis
Listeria	H influenzae type b	Enteroviruses	H influenzae type b
	Group B Streptococcus	HSV	Group B Streptococcus
	Enteroviruses		Listeria

Give ceftriaxone and vancomycin empirically (add ampicillin if *Listeria* is suspected).

Viral causes of meningitis: enteroviruses (especially coxsackievirus), HSV-2 (HSV-1 = encephalitis), HIV, West Nile virus (also causes encephalitis), VZV.

In HIV: Cryptococcus spp.

Note: Incidence of Group B streptococcal meningitis in neonates has ↓ greatly due to screening and antibiotic prophylaxis in pregnancy. Incidence of *H influenzae* meningitis has ↓ greatly due to conjugate *H influenzae* vaccinations. Today, cases are usually seen in unimmunized children.

Cerebrospinal fluid findings in meningitis

	OPENING PRESSURE	CELL TYPE	PROTEIN	GLUCOSE
Bacterial	†	† PMNs	†	†
Fungal/TB	1	† lymphocytes	†	ţ
Viral	Normal/†	↑ lymphocytes	Normal/†	Normal

Infections causing brain abscess

Most commonly viridans streptococci and *Staphylococcus aureus*. If dental infection or extraction precedes abscess, oral anaerobes commonly involved.

Multiple abscesses are usually from bacteremia; single lesions from contiguous sites: otitis media and mastoiditis → temporal lobe and cerebellum; sinusitis or dental infection → frontal lobe. *Toxoplasma* reactivation in AIDS.

Osteomyelitis



ASSOCIATED INFECTION
S aureus (most common overall)
Neisseria gonorrhoeae (rare), septic arthritis more common
Salmonella and S aureus
S aureus and S epidermidis
S aureus, M tuberculosis (Pott disease)
Pasteurella multocida
S aureus; also Pseudomonas, Candida

Elevated ESR and CRP sensitive but not specific.

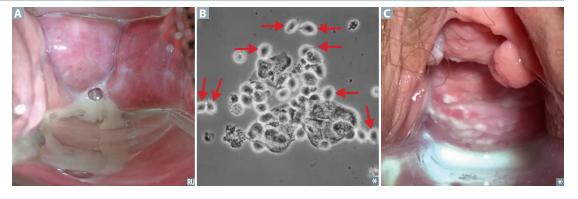
Radiographs are insensitive early but can be useful in chronic osteomyelitis (A, left). MRI is best for detecting acute infection and detailing anatomic involvement (A, right).

FAS1_2019_03-Microbiology.indd 180 11/14/19 12:22 PM

Urinary tract infections	Cystitis presents with dysuria, frequency, urgency, suprapubic pain, and WBCs (but not WBC casts) in urine. Primarily caused by ascension of microbes from urethra to bladder. Ascension to kidney results in pyelonephritis, which presents with fever, chills, flank pain, costovertebral angle tenderness, hematuria, and WBC casts. Ten times more common in women (shorter urethras colonized by fecal flora).		
	Risk factors: obstruction (eg, kidney stones, enlarged prostate), kidney surgery, catheterization, congenital GU malformation (eg, vesicoureteral reflux), diabetes, pregnancy.		
SPECIES	FEATURES	COMMENTS	
Escherichia coli	Leading cause of UTI. Colonies show strong pink lactose-fermentation on MacConkey agar.	Diagnostic markers: ① Leukocyte esterase = evidence of WBC activity.	
Staphylococcus saprophyticus	2nd leading cause of UTI in sexually active women.	 ⊕ Nitrite test = reduction of urinary nitrates by gram ⊝ bacterial species (eg, E coli). 	
Klebsiella pneumoniae	3rd leading cause of UTI. Large mucoid capsule and viscous colonies.	 ⊕ Urease test = urease-producing bugs (eg, S saprophyticus, Proteus, Klebsiella). 	
Serratia marcescens	Some strains produce a red pigment; often nosocomial and drug resistant.		
Enterococcus	Often nosocomial and drug resistant.		
Proteus mirabilis	Motility causes "swarming" on agar; associated with struvite stones.		
Pseudomonas aeruginosa	Blue-green pigment and fruity odor; usually nosocomial and drug resistant.		

Common vaginal infections

	Bacterial vaginosis	Trichomonas vaginitis	Candida vulvovaginitis
SIGNS AND SYMPTOMS	No inflammation Thin, white discharge A with fishy odor	Inflammation ("strawberry cervix") Frothy, yellow-green, foul- smelling discharge	Inflammation Thick, white, "cottage cheese" discharge
LAB FINDINGS	Clue cells pH > 4.5 ⊕ KOH whiff test	Motile pear-shaped trichomonads B pH > 4.5	Pseudohyphae pH normal (4.0–4.5)
TREATMENT	Metronidazole or clindamycin	Metronidazole Treat sexual partner(s)	Azoles



FAS1_2019_03-Microbiology.indd 181 11/14/19 12:22 PM

TORCH infections

Microbes that may pass from mother to fetus. Transmission is transplacental in most cases, or via delivery (especially HSV-2). Nonspecific signs common to many **ToRCHHeS** infections include hepatosplenomegaly, jaundice, thrombocytopenia, and growth retardation.

Other important infectious agents include *Streptococcus agalactiae* (group B streptococci), *E coli*, and *Listeria monocytogenes*—all causes of meningitis in neonates. Parvovirus B19 causes hydrops fetalis.

AGENT	MODES OF MATERNAL TRANSMISSION	MATERNAL MANIFESTATIONS	NEONATAL MANIFESTATIONS
Toxoplasma gondii	Cat feces or ingestion of undercooked meat	Usually asymptomatic; lymphadenopathy (rarely)	Classic triad: chorioretinitis, hydrocephalus, and intracranial calcifications, +/- "blueberry muffin" rash A
Rubella	Respiratory droplets	Rash, lymphadenopathy, polyarthritis, polyarthralgia	Classic triad: abnormalities of eye (cataracts ■) and ear (deafness) and congenital heart disease (PDA); +/- "blueberry muffin" rash. "I (eye) ▼ ruby (rubella) earrings"
Cytomegalovirus	Sexual contact, organ transplants	Usually asymptomatic; mononucleosis-like illness	Hearing loss, seizures, petechial rash, "blueberry muffin" rash, chorioretinitis, periventricular calcifications
HIV	Sexual contact, needlestick	Variable presentation depending on CD4+ cell count	Recurrent infections, chronic diarrhea
Herpes simplex virus-2	Skin or mucous membrane contact	Usually asymptomatic; herpetic (vesicular) lesions	Meningoencephalitis, herpetic (vesicular) lesions
Syphilis	Sexual contact	Chancre (1°) and disseminated rash (2°) are the two stages likely to result in fetal infection	Often results in stillbirth, hydrops fetalis; if child survives, presents with facial abnormalities (eg, notched teeth, saddle nose, short maxilla), saber shins, CN VIII deafness







FAS1_2019_03-Microbiology.indd 182 11/14/19 12:22 PM

Red rashes of childhood

AGENT	ASSOCIATED SYNDROME/DISEASE	CLINICAL PRESENTATION
Coxsackievirus type A	Hand-foot-mouth disease	Oval-shaped vesicles on palms and soles A; vesicles and ulcers in oral mucosa (herpangina)
Human herpesvirus 6	Roseola (exanthem subitum)	Asymptomatic rose-colored macules appear on body after several days of high fever; can present with febrile seizures; usually affects infants
Measles virus	Measles (rubeola)	Confluent rash beginning at head and moving down; preceded by cough, coryza, conjunctivitis, and blue-white (Koplik) spots on buccal mucosa
Parvovirus B19	Erythema infectiosum (fifth disease)	"Slapped cheek" rash on face B (can cause hydrops fetalis in pregnant women)
Rubella virus	Rubella	Pink macules and papules begin at head and move down, remain discrete → fine desquamating truncal rash; postauricular lymphadenopathy
Streptococcus pyogenes	Scarlet fever	Flushed cheeks and circumoral pallor on face; erythematous, sandpaper-like rash from neck to trunk and extremities; fever, sore throat, strawberry tongue
Varicella-Zoster virus	Chickenpox	Vesicular rash begins on trunk; spreads to face and extremities with lesions of different stages









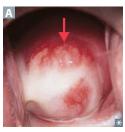
FAS1_2019_03-Microbiology.indd 183 11/14/19 12:22 PM

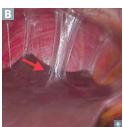
Sexually transmitted infections

DISEASE	CLINICAL FEATURES	ORGANISM
AIDS	Opportunistic infections, Kaposi sarcoma, lymphoma	HIV
Chancroid A	Painful genital ulcer with exudate, inguinal adenopathy A	Haemophilus ducreyi (it's so painful, you "do cry")
Chlamydia	Urethritis, cervicitis, epididymitis, conjunctivitis, reactive arthritis, PID	Chlamydia trachomatis (D–K)
Condylomata acuminata	Genital warts, koilocytes	HPV-6 and -11
Genital herpes	Painful penile, vulvar, or cervical vesicles and ulcers; can cause systemic symptoms such as fever, headache, myalgia	HSV-2, less commonly HSV-1
Gonorrhea	Urethritis, cervicitis, PID, prostatitis, epididymitis, arthritis, creamy purulent discharge	Neisseria gonorrhoeae
Granuloma inguinale (Donovanosis) B	Painless, beefy red ulcer that bleeds readily on contact Uncommon in US	Klebsiella (Calymmatobacterium) granulomatis; cytoplasmic Donovan bodies (bipolar staining) seen on microscopy
Hepatitis B	Jaundice	HBV
Lymphogranuloma venereum	Infection of lymphatics; painless genital ulcers, painful lymphadenopathy (ie, buboes)	C trachomatis (L1–L3)
Primary syphilis	Painless chancre	Treponema pallidum
Secondary syphilis	Fever, lymphadenopathy, skin rashes, condylomata lata	
Tertiary syphilis	Gummas, tabes dorsalis, general paresis, aortitis, Argyll Robertson pupil	
Trichomoniasis	Vaginitis, strawberry cervix, motile in wet prep	Trichomonas vaginalis

FAS1_2019_03-Microbiology.indd 184 11/14/19 12:22 PM

Pelvic inflammatory disease





Top bugs—*Chlamydia trachomatis* (subacute, often undiagnosed), *Neisseria gonorrhoeae* (acute).

C trachomatis—most common bacterial STI in the United States.

Signs include cervical motion tenderness, adnexal tenderness, purulent cervical discharge A.

PID may include salpingitis, endometritis, hydrosalpinx, and tubo-ovarian abscess.

Salpingitis is a risk factor for ectopic pregnancy, infertility, chronic pelvic pain, and adhesions. Can lead to perihepatitis (Fitz-Hugh-Curtis syndrome)—infection and inflammation of liver capsule and "violin string" adhesions of peritoneum to liver **B**.

RISK FACTOR	PATHOGEN	UNIQUE SIGNS/SYMPTOMS
Antibiotic use	Clostridium difficile	Watery diarrhea, leukocytosis
Aspiration (2° to altered mental status, old age)	Polymicrobial, gram ⊖ bacteria, often anaerobes	Right lower lobe infiltrate or right upper/ middle lobe (patient recumbent); purulent malodorous sputum
Decubitus ulcers, surgical wounds, drains	S aureus (including MRSA), gram \ominus anaerobes (Bacteroides, Prevotella, Fusobacterium)	Erythema, tenderness, induration, drainage from surgical wound sites
Intravascular catheters	S aureus (including MRSA), S epidermidis (long term), Enterobacter	Erythema, induration, tenderness, drainage from access sites
Mechanical ventilation, endotracheal intubation	Late onset: P aeruginosa, Klebsiella, Acinetobacter, S aureus	New infiltrate on CXR, † sputum production sweet odor (<i>Pseudomonas</i>)
Renal dialysis unit, needlestick	HBV, HCV	
Urinary catheterization	Proteus spp, E coli, Klebsiella (infections in your PEcKer)	Dysuria, leukocytosis, flank pain or costovertebral angle tenderness
Water aerosols	Legionella	Signs of pneumonia, GI symptoms (diarrhea, nausea, vomiting), neurologic abnormalities

FAS1_2019_03-Microbiology.indd 185 11/14/19 12:22 PM

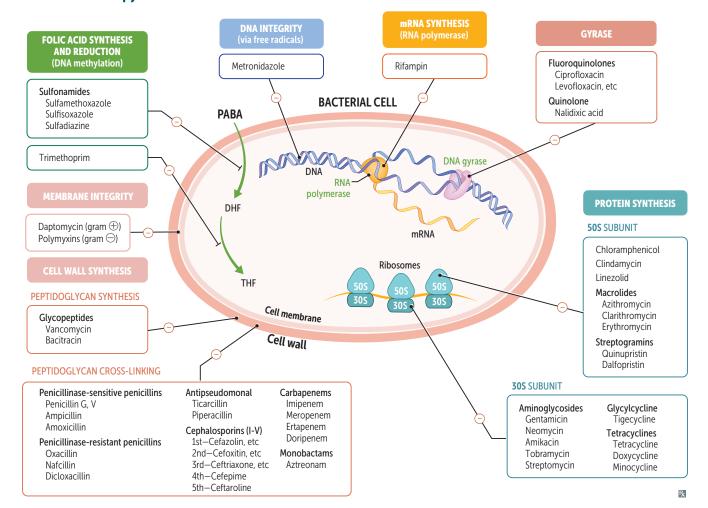
Bugs affecting unvaccinated children

CLINICAL PRESENTATION	FINDINGS/LABS	PATHOGEN
Dermatologic		
Rash	Beginning at head and moving down with postauricular lymphadenopathy	Rubella virus
	Beginning at head and moving down; preceded by cough, coryza, conjunctivitis, and Koplik spots	Measles virus
Neurologic		
Meningitis	Microbe colonizes nasopharynx	H influenzae type b
	Can also lead to myalgia and paralysis	Poliovirus
Tetanus	Muscle spasms and spastic paralysis (eg, lockjaw, opisthotonus)	Clostridium tetani
Respiratory		
Epiglottitis	Fever with dysphagia, drooling, and difficulty breathing due to edema	H influenzae type b (also capable of causing epiglottitis in fully immunized children)
Pertussis	Low-grade fevers, coryza → whooping cough, post-tussive vomiting → gradual recovery	Bordetella pertussis
Pharyngitis	Grayish pseudomembranes (may obstruct airways)	Corynebacterium diphtheriae
ug hints	CHARACTERISTIC	ORGANISM
	Asplenic patients	Encapsulated microbes, especially SHiN (S pneumoniae >> H influenzae type b > N meningitidis)
	Branching rods in oral infection, sulfur granules	Actinomyces israelii
	Chronic granulomatous disease	Catalase \oplus microbes, especially S aureus
	"Currant jelly" sputum	Klebsiella
	Dog or cat bite	Pasteurella multocida
	Facial nerve palsy (typically bilateral)	Borrelia burgdorferi (Lyme disease)
	Human bite	Human oral flora (eg, Eikenella, Fusobacterium
	Neutropenic patients	Candida albicans (systemic), Aspergillus
	Organ transplant recipient	CMV
	PAS ⊕	Tropheryma whipplei (Whipple disease)
	Pediatric infection	Haemophilus influenzae (including epiglottitis)
	Pneumonia in cystic fibrosis, burn infection	Pseudomonas aeruginosa
	Puncture wound, lockjaw	Clostridium tetani
	Pus, empyema, abscess	S aureus
	Rash on hands and feet	Coxsackie A, R rickettsii, Syphilis (CARS)
	Sepsis/meningitis in newborn	Group B strep
	Sinus/CNS infection in diabetics	Mucor or Rhizopus spp.
	Surgical wound	S aureus
	Traumatic open wound	Clostridium perfringens

FAS1_2019_03-Microbiology.indd 186 11/14/19 12:22 PM

► MICROBIOLOGY — ANTIMICROBIALS

Antimicrobial therapy



Penicillin G, V	Penicillin G (IV and IM form), penicillin V (oral). Prototype β -lactam antibiotics.	
MECHANISM	D-Ala-D-Ala structural analog. Bind penicillin-binding proteins (transpeptidases). Block transpeptidase cross-linking of peptidoglycan in cell wall. Activate autolytic enzymes.	
CLINICAL USE	Mostly used for gram \oplus organisms (<i>S pneumoniae</i> , <i>S pyogenes</i> , <i>Actinomyces</i>). Also used for gram \ominus cocci (mainly <i>N meningitidis</i>) and spirochetes (mainly <i>T pallidum</i>). Bactericidal for gram \oplus cocci, gram \ominus cocci, and spirochetes. β -lactamase sensitive.	
ADVERSE EFFECTS	Hypersensitivity reactions, direct Coombs \oplus hemolytic anemia, drug-induced interstitial nephritis.	
RESISTANCE	β -lactamase cleaves the β -lactam ring. Mutations in PBPs.	

FAS1_2019_03-Microbiology.indd 187 11/14/19 12:22 PM

penicillins	Amoxicillin, ampicillin; aminopenicillins.	
MECHANISM	Same as penicillin. Wider spectrum; penicillinase sensitive. Also combine with clavulanic acid to protect against destruction by β-lactamase.	AMinoPenicillins are AMPed-up penicillin. AmOxicillin has greater Oral bioavailability than ampicillin.
CLINICAL USE	Extended-spectrum penicillin— <i>H</i> influenzae, <i>H</i> pylori, <i>E</i> coli, <i>L</i> isteria monocytogenes, <i>Proteus mirabilis</i> , <i>Salmonella</i> , <i>Shigella</i> , enterococci.	Coverage: ampicillin/amoxicillin HHELPSS kill enterococci.
ADVERSE EFFECTS	Hypersensitivity reactions, rash, pseudomembranous colitis.	
MECHANISM OF RESISTANCE	Penicillinase (a type of β -lactamase) cleaves β -lactam ring.	
Penicillinase-resistant penicillins	Dicloxacillin, nafcillin, oxacillin.	
MECHANISM	Same as penicillin. Narrow spectrum; penicillinase resistant because bulky R group blocks access of β-lactamase to β-lactam ring.	
	S aureus (except MRSA).	"Use naf (nafcillin) for staph ."
CLINICAL USE		
ADVERSE EFFECTS	Hypersensitivity reactions, interstitial nephritis.	
ADVERSE EFFECTS MECHANISM OF RESISTANCE Antipseudomonal	Hypersensitivity reactions, interstitial nephritis. MRSA has altered penicillin-binding protein target site.	
ADVERSE EFFECTS MECHANISM OF RESISTANCE Antipseudomonal penicillins	Hypersensitivity reactions, interstitial nephritis. MRSA has altered penicillin-binding protein target site. Piperacillin, ticarcillin.	nase sensitive: use with β-lactamase inhibitors
ADVERSE EFFECTS	Hypersensitivity reactions, interstitial nephritis. MRSA has altered penicillin-binding protein target site.	nase sensitive; use with β-lactamase inhibitors.

FAS1_2019_03-Microbiology.indd 188 11/14/19 12:22 PM

_			•
(er	าทลเ	Insn	orins
	J	OSP	011113

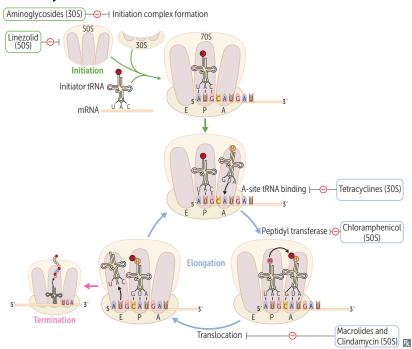
MECHANISM	β-lactam drugs that inhibit cell wall synthesis but are less susceptible to penicillinases. Bactericidal.	Organisms typically not covered by 1st–4th generation cephalosporins are LAME: Listeria, Atypicals (Chlamydia, Mycoplasma), MRSA, and Enterococci.
CLINICAL USE	lst generation (cefazolin, cephalexin)—gram ⊕ cocci, <i>Proteus mirabilis</i> , <i>E coli</i> , <i>Klebsiella pneumoniae</i> . Cefazolin used prior to surgery to prevent <i>S aureus</i> wound infections.	lst generation—⊕ PEcK.
	2nd generation (cefaclor, cefoxitin, cefuroxime, cefotetan)—gram ⊕ cocci, H influenzae, Enterobacter aerogenes, Neisseria spp., Serratia marcescens, Proteus mirabilis, E coli, Klebsiella pneumoniae.	2nd graders wear fake fox fur to tea parties.2nd generation—⊕ HENS PEcK.
	3rd generation (ceftriaxone, cefotaxime, cefpodoxime, ceftazidime)—serious gram ⊝ infections resistant to other β-lactams.	Can cross blood-brain barrier. Ceftriaxone—meningitis, gonorrhea, disseminated Lyme disease. Ceftazidime— <i>Pseudomonas</i> .
	4th generation (cefepime)—gram ⊖ organisms, with ↑ activity against <i>Pseudomonas</i> and gram ⊕ organisms.	
	5th generation (ceftaroline)—broad gram ⊕ and gram ⊝ organism coverage; unlike 1st–4th generation cephalosporins, ceftaroline covers MRSA, and Enterococcus faecalis—does not cover Pseudomonas.	
ADVERSE EFFECTS	Hypersensitivity reactions, autoimmune hemolytic anemia, disulfiram-like reaction, vitamin K deficiency. Low rate of cross-reactivity even in penicillin-allergic patients. † nephrotoxicity of aminoglycosides.	
MECHANISM OF RESISTANCE	Inactivated by cephalosporinases (a type of β-lactamase). Structural change in penicillin-binding proteins (transpeptidases).	
β-lactamase inhibitors	Include Clavulanic acid, Avibactam, Sulbactam, Tazobactam. Often added to penicillin antibiotics to protect the antibiotic from destruction by β -lactamase.	CAST (eg, amoxicillin-clavulanate, ceftazidime-avibactam, ampicillin-sulbactam piperacillin-tazobactam).

190

SECTION II MICROBIOLOGY ➤ MICROBIOLOGY—ANTIMICROBIALS

Carbapenems	Doripenem, Imipenem, Meropenem, Ertapener 10/10 [life-threatening] infection).	m (DIME antibiotics are given when there is a
MECHANISM	Imipenem is a broad-spectrum, β-lactamase– resistant carbapenem. Always administered with cilastatin (inhibitor of renal dehydropeptidase I) to ↓ inactivation of drug in renal tubules.	With imipenem, "the kill is lastin' with cilastatin." Newer carbapenems include ertapenem (limited Pseudomonas coverage) and doripenem.
CLINICAL USE	Gram ⊕ cocci, gram ⊝ rods, and anaerobes. Wide spectrum and significant side effects limit use to life-threatening infections or after other drugs have failed. Meropenem has a ↓ risk of seizures and is stable to dehydropeptidase I.	
ADVERSE EFFECTS	GI distress, rash, and CNS toxicity (seizures) at high plasma levels.	
MECHANISM OF RESISTANCE	Inactivated by carbapenemases produced by, eg, <i>K pneumoniae</i> , <i>E coli</i> , <i>E aerogenes</i> .	
Monobactams	Aztreonam	
MECHANISM	Less susceptible to β -lactamases. Prevents peptidoglycan cross-linking by binding to penicillin-binding protein 3. Synergistic with aminoglycosides. No cross-allergenicity with penicillins.	
CLINICAL USE	Gram \ominus rods only—no activity against gram \oplus rods or anaerobes. For penicillin-allergic patients and those with renal insufficiency who cannot tolerate aminoglycosides.	
ADVERSE EFFECTS	Usually nontoxic; occasional GI upset.	
Vancomycin		
MECHANISM	Inhibits cell wall peptidoglycan formation by binding D-Ala-D-Ala portion of cell wall precursors. Bactericidal against most bacteria (bacteriostatic against <i>C difficile</i>). Not susceptible to β-lactamases.	
CLINICAL USE	Gram ⊕ bugs only—for serious, multidrug-resistant organisms, including MRSA, <i>S epidermidis</i> , sensitive <i>Enterococcus</i> species, and <i>Clostridium difficile</i> (oral dose for pseudomembranous colitis).	
ADVERSE EFFECTS A **	Well tolerated in general but NOT trouble Free. Nephrotoxicity, Ototoxicity, Thrombophlebitis, diffuse Flushing (red man syndrome A idiopathic reaction largely preventable by pretreatment with antihistamines), DRESS syndrome.	
MECHANISM OF RESISTANCE	Occurs in bacteria (eg, <i>Enterococcus</i>) via amino a "If you Lac k a D-Ala (dollar), you can't ride the	acid modification of D-Ala-D-Ala to <mark>D-Ala</mark> -D -Lac . e van (vancomycin)."

Protein synthesis inhibitors



Specifically target smaller bacterial ribosome (70S, made of 30S and 50S subunits), leaving human ribosome (80S) unaffected.

All are bacteriostatic, except aminoglycosides (bactericidal) and linezolid (variable).

30S inhibitors

Aminoglycosides
Tetracyclines

50S inhibitors

Chloramphenicol, Clindamycin Erythromycin (macrolides) Linezolid

"Buy **AT 30, CCEL** (sell) at **50**."

Aminoglycosides	Gentamicin, Neomycin, Amikacin, Tobramycin, Streptomycin.	"Mean" (aminoglycoside) GNATS caNNOT kill anaerobes.
MECHANISM	Bactericidal; irreversible inhibition of initiation complex through binding of the 30S subunit. Can cause misreading of mRNA. Also block translocation. Require O ₂ for uptake; therefore ineffective against anaerobes.	
CLINICAL USE	Severe gram \ominus rod infections. Synergistic with β-lactam antibiotics. Neomycin for bowel surgery.	
ADVERSE EFFECTS	Nephrotoxicity, Neuromuscular blockade (absolute contraindication with myasthenia gravis), Ototoxicity (especially with loop diuretics), Teratogenicity.	
MECHANISM OF RESISTANCE	Bacterial transferase enzymes inactivate the drug by acetylation, phosphorylation, or adenylation.	

FAS1_2019_03-Microbiology.indd 191 11/14/19 12:22 PM

Tetracyclines	Tetracycline, doxycycline, minocycline.	
MECHANISM	-	
CLINICAL USE	Borrelia burgdorferi, M pneumoniae. Drugs' ability to accumulate intracellularly makes them very effective against <i>Rickettsia</i> and <i>Chlamydia</i> . Also used to treat acne. Doxycycline effective against community-acquired MRSA.	
ADVERSE EFFECTS	GI distress, discoloration of teeth and inhibitio Contraindicated in pregnancy.	n of bone growth in children, photosensitivity.
MECHANISM OF RESISTANCE	↓ uptake or ↑ efflux out of bacterial cells by plasmid-encoded transport pumps.	
Figecycline		
MECHANISM	Tetracycline derivative. Binds to 30S, inhibiting protein synthesis. Generally bacteriostatic.	
CLINICAL USE	Broad-spectrum anaerobic, gram ⊖, and gram ⊕ coverage. Multidrug-resistant organisms (MRSA, VRE) or infections requiring deep tissue penetration.	
ADVERSE EFFECTS	GI symptoms: nausea, vomiting.	
Chloramphenicol		
MECHANISM	Blocks peptidyltransferase at 50S ribosomal sul	ounit. Bacteriostatic.
CLINICAL USE	Meningitis (Haemophilus influenzae, Neisseria rickettsial diseases (eg, Rocky Mountain spott Limited use due to toxicity but often still used	red fever [Rickettsia rickettsii]).
ADVERSE EFFECTS	Anemia (dose dependent), aplastic anemia (dos infants because they lack liver UDP-glucuron	re independent), gray baby syndrome (in premature osyltransferase).
MECHANISM OF RESISTANCE	Plasmid-encoded acetyltransferase inactivates t	he drug.
Clindamycin		
MECHANISM	Blocks peptide transfer (translocation) at 50S ribosomal subunit. Bacteriostatic.	
CLINICAL USE	Anaerobic infections (eg, <i>Bacteroides</i> spp., <i>Clostridium perfringens</i>) in aspiration pneumonia, lung abscesses, and oral infections. Also effective against invasive group A streptococcal infection.	Treats anaerobic infections above the diaphragm vs metronidazole (anaerobic infections below diaphragm).
ADVERSE EFFECTS	Pseudomembranous colitis (<i>C difficile</i> overgrowth), fever, diarrhea.	

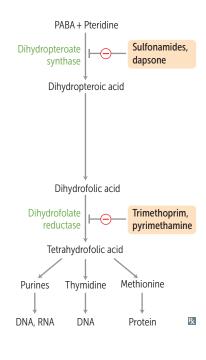
MECHANISM	Inhibits protein synthesis by binding to 50S subunit and preventing formation of the initiation complex.
CLINICAL USE	Gram \oplus species including MRSA and VRE.
ADVERSE EFFECTS	Bone marrow suppression (especially thrombocytopenia), peripheral neuropathy, serotonin syndrome (due to partial MAO inhibition).
MECHANISM OF RESISTANCE	Point mutation of ribosomal RNA.
Macrolides	Azithromycin, clarithromycin, erythromycin.
MECHANISM	Inhibit protein synthesis by blocking translocation ("macroslides"); bind to the 23S rRNA of the 50S ribosomal subunit. Bacteriostatic.
CLINICAL USE	Atypical pneumonias (<i>Mycoplasma</i> , <i>Chlamydia</i> , <i>Legionella</i>), STIs (<i>Chlamydia</i>), gram ⊕ cocci (streptococcal infections in patients allergic to penicillin), and <i>B pertussis</i> .
ADVERSE EFFECTS	MACRO: Gastrointestinal Motility issues, Arrhythmia caused by prolonged QT interval, acute Cholestatic hepatitis, Rash, eOsinophilia. Increases serum concentration of theophylline, oral anticoagulants. Clarithromycin and erythromycin inhibit cytochrome P-450.
MECHANISM OF RESISTANCE	Methylation of 23S rRNA-binding site prevents binding of drug.
Polymyxins	Colistin (polymyxin E), polymyxin B.
MECHANISM	Cation polypeptides that bind to phospholipids on cell membrane of gram ⊖ bacteria. Disrupt cell membrane integrity → leakage of cellular components → cell death.
CLINICAL USE	Salvage therapy for multidrug-resistant gram \ominus bacteria (eg, P aeruginosa, E coli, K pneumoniae). Polymyxin B is a component of a triple antibiotic ointment used for superficial skin infections.
ADVERSE EFFECTS	Nephrotoxicity, neurotoxicity (eg, slurred speech, weakness, paresthesias), respiratory failure.

FAS1_2019_03-Microbiology.indd 193 11/14/19 12:22 PM

Sulfonamides	Sulfamethoxazole (SMX), sulfisoxazole, sulfadiazine.
MECHANISM	Inhibit dihydropteroate synthase, thus inhibiting folate synthesis. Bacteriostatic (bactericidal when combined with trimethoprim).
CLINICAL USE	Gram ⊕, gram ⊖, <i>Nocardia.</i> TMP-SMX for simple UTI.
ADVERSE EFFECTS	Hypersensitivity reactions, hemolysis if G6PD deficient, nephrotoxicity (tubulointerstitial nephritis), photosensitivity, Stevens-Johnson syndrome, kernicterus in infants, displace other drugs from albumin (eg, warfarin).
MECHANISM OF RESISTANCE	Altered enzyme (bacterial dihydropteroate synthase), ↓ uptake, or ↑ PABA synthesis.

Dapsone	
MECHANISM	Similar to sulfonamides, but structurally distinct agent.
CLINICAL USE	Leprosy (lepromatous and tuberculoid), <i>Pneumocystis jirovecii</i> prophylaxis, or treatment when used in combination with TMP.
ADVERSE EFFECTS	Hemolysis if G6PD deficient, methemoglobinemia, agranulocytosis.

MECHANISM	Inhibits bacterial dihydrofolate reductase. Bacteriostatic.
CLINICAL USE	Used in combination with sulfonamides (trimethoprim-sulfamethoxazole [TMP-SMX]), causing sequential block of folate synthesis. Combination used for UTIs, Shigella, Salmonella, Pneumocystis jirovecii pneumonia treatment and prophylaxis, toxoplasmosis prophylaxis.
ADVERSE EFFECTS	Hyperkalemia (high doses), megaloblastic anemia, leukopenia, granulocytopenia, which may be avoided with coadministration of leucovorin (folinic acid). TMP Treats Marrow Poorly.

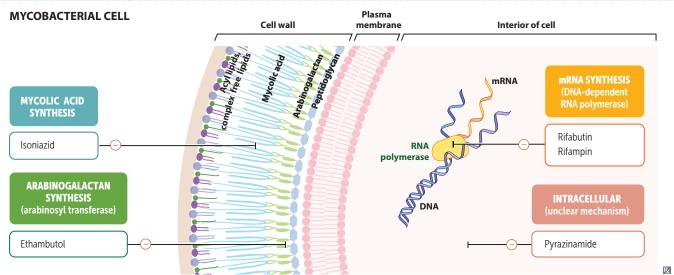


FAS1_2019_03-Microbiology.indd 194 11/14/19 12:22 PM

Fluoroquinolones	Ciprofloxacin, enoxacin, norfloxacin, ofloxacin; re levofloxacin, moxifloxacin.	espiratory fluoroquinolones—gemifloxacin,
MECHANISM	Inhibit prokaryotic enzymes topoisomerase II (DNA gyrase) and topoisomerase IV. Bactericidal. Must not be taken with antacids.	
CLINICAL USE	Gram \ominus rods of urinary and GI tracts (including <i>Pseudomonas</i>), some gram \oplus organisms, otitis externa.	
ADVERSE EFFECTS	GI upset, superinfections, skin rashes, headache, dizziness. Less commonly, can cause leg cramps and myalgias. Contraindicated in pregnant women, nursing mothers, and children < 18 years old due to possible damage to cartilage. Some may prolong QT interval. May cause tendonitis or tendon rupture in people > 60 years old and in patients taking prednisone. Ciprofloxacin inhibits cytochrome P-450.	Fluoroquinolones hurt attachments to your bones.
MECHANISM OF RESISTANCE	Chromosome-encoded mutation in DNA gyrase, plasmid-mediated resistance, efflux pumps.	
Daptomycin		
MECHANISM	Lipopeptide that disrupts cell membranes of gram ⊕ cocci by creating transmembrane channels.	
CLINICAL USE	S aureus skin infections (especially MRSA), bacteremia, endocarditis, VRE.	Not used for pneumonia (avidly binds to and is inactivated by surfactant). "Daptomyskin" is used for skin infections.
ADVERSE EFFECTS	Myopathy, rhabdomyolysis.	
Metronidazole		
MECHANISM	Forms toxic free radical metabolites in the bacterial cell that damage DNA. Bactericidal, antiprotozoal.	
CLINICAL USE	Treats <i>Giardia</i> , <i>Entamoeba</i> , <i>Trichomonas</i> , <i>Gardnerella vaginalis</i> , <i>A</i> naerobes (<i>Bacteroides</i> , <i>C difficile</i>). Can be used in place of amoxicillin in <i>H pylori</i> "triple therapy" in case of penicillin allergy.	GET GAP on the Metro with metronidazole! Treats anaerobic infection below the diaphragm vs clindamycin (anaerobic infections above diaphragm).
ADVERSE EFFECTS	Disulfiram-like reaction (severe flushing, tachycardia, hypotension) with alcohol; headache, metallic taste.	

Antimycobacterial therapy

BACTERIUM	PROPHYLAXIS	TREATMENT
M tuberculosis	Isoniazid	Rifampin, Isoniazid, Pyrazinamide, Ethambutol (RIPE for treatment)
M avium–intracellulare	Azithromycin, rifabutin	Azithromycin or clarithromycin + ethambutol Can add rifabutin or ciprofloxacin
M leprae	N/A	Long-term treatment with dapsone and rifampin for tuberculoid form Add clofazimine for lepromatous form



Rifamycins	Rifampin, rifabutin.	
MECHANISM	Inhibit DNA-dependent RNA polymerase.	Rifampin's 4 R's:
CLINICAL USE	Mycobacterium tuberculosis; delay resistance to dapsone when used for leprosy. Used for meningococcal prophylaxis and chemoprophylaxis in contacts of children with H influenzae type b.	RNA polymerase inhibitor Ramps up microsomal cytochrome P-450 Red/orange body fluids Rapid resistance if used alone Rifampin ramps up cytochrome P-450, but
ADVERSE EFFECTS	Minor hepatotoxicity and drug interactions († cytochrome P-450); orange body fluids (nonhazardous side effect). Rifabutin favored over rifampin in patients with HIV infection due to less cytochrome P-450 stimulation.	rifa <mark>but</mark> in does not.
MECHANISM OF RESISTANCE	Mutations reduce drug binding to RNA polymerase. Monotherapy rapidly leads to resistance.	

FAS1_2019_03-Microbiology.indd 196 11/14/19 12:22 PM

Isoniazid

MECHANISM	↓ synthesis of mycolic acids. Bacterial catalase- peroxidase (encoded by KatG) needed to convert INH to active metabolite.	
CLINICAL USE	Mycobacterium tuberculosis. The only agent used as solo prophylaxis against TB. Also used as monotherapy for latent TB.	Different INH half-lives in fast vs slow acetylators.
ADVERSE EFFECTS	Hepatotoxicity, cytochrome P-450 inhibition, drug-induced SLE, anion gap metabolic acidosis, vitamin B ₆ deficiency (peripheral neuropathy, sideroblastic anemia), seizures (in high doses, refractory to benzodiazepines). Administer with pyridoxine (B ₆).	INH Injures Neurons and Hepatocytes.
MECHANISM OF RESISTANCE	Mutations leading to underexpression of KatG.	
Pyrazinamide		
MECHANISM	Mechanism uncertain. Pyrazinamide is a prodrug pyrazinoic acid. Works best at acidic pH (eg, in	2
CLINICAL USE	Mycobacterium tuberculosis.	
ADVERSE EFFECTS	Hyperuricemia, hepatotoxicity.	
Ethambutol		
MECHANISM	↓ carbohydrate polymerization of mycobacterium	cell wall by blocking arabinosyltransferase.
CLINICAL USE	Mycobacterium tuberculosis.	
ADVERSE EFFECTS	Optic neuropathy (red-green color blindness, usu	nally reversible). Pronounce <mark>"eye</mark> thambutol."
Streptomycin		
MECHANISM	Interferes with 30S component of ribosome.	
CLINICAL LICE	Mycobacterium tuberculosis (2nd line).	
CLINICAL USE		

Antimicrobial prophylaxis

CLINICAL SCENARIO	MEDICATION
Exposure to meningococcal infection	Ceftriaxone, ciprofloxacin, or rifampin
High risk for endocarditis and undergoing surgical or dental procedures	Amoxicillin
History of recurrent UTIs	TMP-SMX
Malaria prophylaxis for travelers	Atovaquone-proguanil, mefloquine, doxycycline, primaquine, or chloroquine (for areas with sensitive species)
Pregnant woman carrying group B strep	Intrapartum penicillin G or ampicillin
Prevention of gonococcal conjunctivitis in newborn	Erythromycin ointment on eyes
Prevention of postsurgical infection due to S aureus	Cefazolin
Prophylaxis of strep pharyngitis in child with prior rheumatic fever	Benzathine penicillin G or oral penicillin V

Prophylaxis in HIV/AIDS patients

	•	
CELL COUNT	PROPHYLAXIS	INFECTION
CD4 < 200 cells/mm ³	TMP-SMX	Pneumocystis pneumonia
CD4 < 100 cells/mm ³	TMP-SMX	Pneumocystis pneumonia and toxoplasmosis
CD4 < 50 cells/mm ³	Azithromycin or clarithromycin	Mycobacterium avium complex

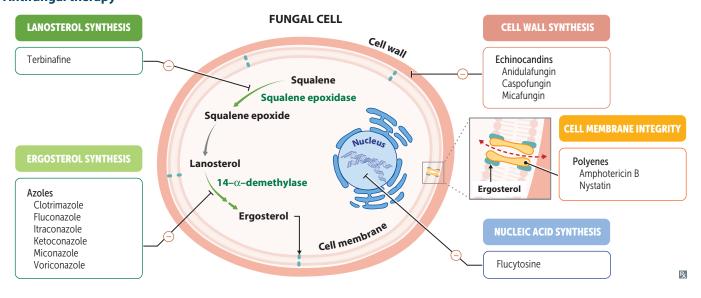
Treatment of highly resistant bacteria

MRSA: vancomycin, daptomycin, linezolid, tigecycline, ceftaroline, doxycycline.

VRE: linezolid, tigecycline, and streptogramins (quinupristin, dalfopristin).

Multidrug-resistant P aeruginosa, multidrug-resistant Acinetobacter baumannii: polymyxins B and E (colistin).

Antifungal therapy



FAS1_2019_03-Microbiology.indd 198 11/14/19 12:22 PM

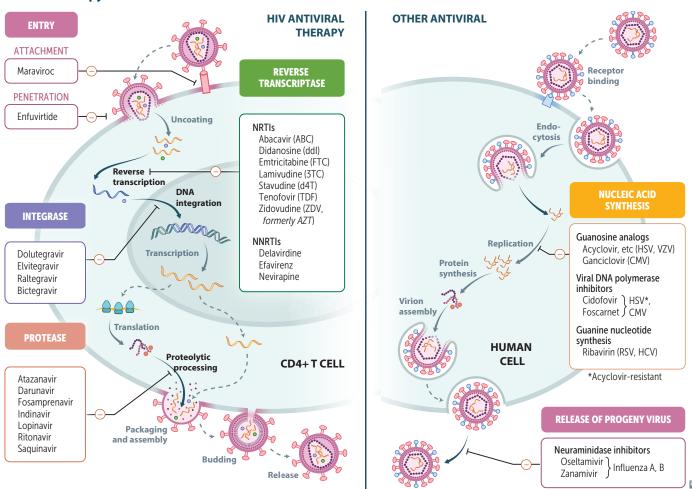
MECHANISM	Binds ergosterol (unique to fungi); forms membrane pores that allow leakage of electrolytes.	Amphotericin "tears" holes in the fungal membrane by forming pores.
CLINICAL USE	Serious, systemic mycoses. <i>Cryptococcus</i> (amphotericin B with +/– without flucytosine for cryptococcal meningitis), <i>Blastomyces</i> , <i>Coccidioides</i> , <i>Histoplasma</i> , <i>Candida</i> , <i>Mucor</i> . Intrathecally for coccidioidal meningitis.	Supplement K ⁺ and Mg ²⁺ because of altered renal tubule permeability.
ADVERSE EFFECTS	Fever/chills ("shake and bake"), hypotension, nephrotoxicity, arrhythmias, anemia, IV phlebitis ("amphoterrible"). Hydration ↓ nephrotoxicity. Liposomal amphotericin ↓ toxicity.	
Nystatin		
MECHANISM	Same as amphotericin B. Topical use only as too	toxic for systemic use.
CLINICAL USE	"Swish and swallow" for oral candidiasis (thrush)	; topical for diaper rash or vaginal candidiasis.
Flucytosine		
MECHANISM	Inhibits DNA and RNA biosynthesis by conversion to 5-fluorouracil by cytosine deaminase.	
CLINICAL USE	Systemic fungal infections (especially meningitis amphotericin B.	caused by <i>Cryptococcus</i>) in combination with
ADVERSE EFFECTS	Bone marrow suppression.	
Azoles	Clotrimazole, fluconazole, isavuconazole, itraco	nazole, ketoconazole, miconazole, voriconazole.
MECHANISM	Inhibit fungal sterol (ergosterol) synthesis by inhi lanosterol to ergosterol.	biting the cytochrome P-450 enzyme that convert
CLINICAL USE	Local and less serious systemic mycoses. Flucona meningitis in AIDS patients and candidal infect Blastomyces, Coccidioides, Histoplasma, Sporota topical fungal infections. Voriconazole for Aspe serious Aspergillus and Mucor infections.	stions of all types. Itraconazole may be used for hrix schenckii. Clotrimazole and miconazole for
ADVERSE EFFECTS	Testosterone synthesis inhibition (gynecomastia, (inhibits cytochrome P-450).	especially with ketoconazole), liver dysfunction
Terbinafine		
MECHANISM	Inhibits the fungal enzyme squalene epoxidase.	
CLINICAL USE	Dermatophytoses (especially onychomycosis—fu	ngal infection of finger or toe nails).
ADVERSE EFFECTS	GI upset, headaches, hepatotoxicity, taste disturb	ance.

200

SECTION II MICROBIOLOGY ➤ MICROBIOLOGY—ANTIMICROBIALS

Echinocandins	Anidulafungin, caspofungin, micafungin.		
MECHANISM	Inhibit cell wall synthesis by inhibiting synthesis of β -glucan.		
CLINICAL USE	Invasive aspergillosis, Candida.		
ADVERSE EFFECTS	GI upset, flushing (by histamine release).		
Griseofulvin			
MECHANISM	Interferes with microtubule function; disrupts mitosis. Deposits in keratin-containing tissues (eg, nails).		
CLINICAL USE	Oral treatment of superficial infections; inhibits growth of dermatophytes (tinea, ringworm).		
ADVERSE EFFECTS	Teratogenic, carcinogenic, confusion, headaches, disulfiram-like reaction, † cytochrome P-450 and warfarin metabolism.		
Antiprotozoal therapy	Pyrimethamine (toxoplasmosis), suramin and melarsoprol (<i>Trypanosoma brucei</i>), nifurtimox (<i>T cruzi</i>), sodium stibogluconate (leishmaniasis).		
Anti-mite/louse therapy	Permethrin (inhibits Na ⁺ channel deactivation \rightarrow neuronal membrane depolarization), malathion (acetylcholinesterase inhibitor), topical +/- oral ivermectin. Used to treat scabies (<i>Sarcoptes scabiei</i>) and lice (<i>Pediculus</i> and <i>Pthirus</i>).		
Chloroquine			
MECHANISM	Blocks detoxification of heme into hemozoin. Heme accumulates and is toxic to plasmodia.		
CLINICAL USE	Treatment of plasmodial species other than <i>P falciparum</i> (frequency of resistance in <i>P falciparum</i> is too high). Resistance due to membrane pump that \$\ddot\$ intracellular concentration of drug. Treat <i>P falciparum</i> with artemether/lumefantrine or atovaquone/proguanil. For life-threatening malaria, use quinidine in US (quinine elsewhere) or artesunate.		
ADVERSE EFFECTS	Retinopathy; pruritus (especially in dark-skinned individuals).		
Antihelminthic therapy	Pyrantel pamoate, Ivermectin, Mebendazole (microtubule inhibitor), Praziquantel († Ca ²⁺ permeability, † vacuolization), Diethylcarbamazine. Helminths get PIMP'D.		

Antiviral therapy



Oseltamivir, zanamivir

MECHANISM	Inhibit influenza neuraminidase → ↓ release of progeny virus.
CLINICAL USE	Treatment and prevention of influenza A and B. Beginning therapy within 48 hours of symptom onset may shorten duration of illness.

Acyclovir, famciclovir, valacyclovir

MECHANISM	Guanosine analogs. Monophosphorylated by HSV/VZV thymidine kinase and not phosphorylated in uninfected cells → few adverse effects. Triphosphate formed by cellular enzymes. Preferentially inhibit viral DNA polymerase by chain termination.
CLINICAL USE	HSV and VZV. Weak activity against EBV. No activity against CMV. Used for HSV-induced mucocutaneous and genital lesions as well as for encephalitis. Prophylaxis in immunocompromised patients. No effect on latent forms of HSV and VZV. Valacyclovir, a prodrug of acyclovir, has better oral bioavailability. For herpes zoster, use famciclovir.
ADVERSE EFFECTS	Obstructive crystalline nephropathy and acute kidney injury if not adequately hydrated.
MECHANISM OF RESISTANCE	Mutated viral thymidine kinase.

FAS1_2019_03-Microbiology.indd 201 11/14/19 12:22 PM

Ganciclovir		
MECHANISM	5'-monophosphate formed by a CMV viral kinase. Guanosine analog. Triphosphate formed by cellular kinases. Preferentially inhibits viral DNA polymerase.	
CLINICAL USE	CMV, especially in immunocompromised patients. Valganciclovir, a prodrug of ganciclovir, has better oral bioavailability.	
ADVERSE EFFECTS	Bone marrow suppression (leukopenia, neutropenia, thrombocytopenia), renal toxicity. More toxic to host enzymes than acyclovir.	
MECHANISM OF RESISTANCE	Mutated viral kinase.	
Foscarnet		
MECHANISM	Viral DNA/RNA polymerase inhibitor and HIV reverse transcriptase inhibitor. Binds to pyrophosphate-binding site of enzyme. Does not require any kinase activation. Foscarnet = pyrofosphate analog.	
CLINICAL USE	CMV retinitis in immunocompromised patients when ganciclovir fails; acyclovir-resistant HSV.	
ADVERSE EFFECTS	Nephrotoxicity, electrolyte abnormalities (hypo- or hypercalcemia, hypo- or hyperphosphatemia, hypokalemia, hypomagnesemia) can lead to seizures.	
MECHANISM OF RESISTANCE	Mutated DNA polymerase.	
Cidofovir		
MECHANISM	Preferentially inhibits viral DNA polymerase. Does not require phosphorylation by viral kinase.	
CLINICAL USE	CMV retinitis in immunocompromised patients; acyclovir-resistant HSV. Long half-life.	
ADVERSE EFFECTS	Nephrotoxicity (coadminister with probenecid and IV saline to ↓ toxicity).	

HIV therapy

Antiretroviral therapy (ART): often initiated at the time of HIV diagnosis.

	Strongest indication for use with patients presentic counts (< 500 cells/mm³), or high viral load. Reg 2 NRTIs and preferably an integrase inhibitor. All ARTs are active against HIV-1 and HIV-2 with	ing with AIDS-defining illness, low CD4+ cell gimen consists of 3 drugs to prevent resistance:
DRUG	MECHANISM	TOXICITY
NRTIs		
Abacavir (ABC) Didanosine (ddl) Emtricitabine (FTC) Lamivudine (3TC) Stavudine (d4T) Tenofovir (TDF) Zidovudine (ZDV, formerly AZT)	Competitively inhibit nucleotide binding to reverse transcriptase and terminate the DNA chain (lack a 3' OH group). Tenofovir is a nucleoTide; the others are nucleosides. All need to be phosphorylated to be active. ZDV can be used for general prophylaxis and during pregnancy to \$\dagger\$ risk of fetal transmission. Have you dined (vudine) with my nuclear (nucleosides) family?	Bone marrow suppression (can be reversed with granulocyte colony-stimulating factor [G-CSF] and erythropoietin), peripheral neuropathy, lactic acidosis (nucleosides), anemia (ZDV), pancreatitis (didanosine). Abacavir contraindicated if patient has HLA-B*5701 mutation due to † risk of hypersensitivity.
NNRTIs		
Delavirdine Efavirenz Nevirapine	Bind to reverse transcriptase at site different from NRTIs. Do not require phosphorylation to be active or compete with nucleotides.	Rash and hepatotoxicity are common to all NNRTIs. Vivid dreams and CNS symptoms are common with efavirenz.
Integrase inhibitors		
Bictegravir Dolutegravir Elvitegravir Raltegravir	Inhibits HIV genome integration into host cell chromosome by reversibly inhibiting HIV integrase.	† creatine kinase.
Protease inhibitors		
Atazanavir Darunavir Fosamprenavir Indinavir Lopinavir Ritonavir Saquinavir	Assembly of virions depends on HIV-l protease (pol gene), which cleaves the polypeptide products of HIV mRNA into their functional parts. Thus, protease inhibitors prevent maturation of new viruses. Ritonavir can "boost" other drug concentrations by inhibiting cytochrome P-450. Navir (never) tease a protease.	Hyperglycemia, GI intolerance (nausea, diarrhea), lipodystrophy (Cushing-like syndrome). Nephropathy, hematuria, thrombocytopenia (indinavir). Rifampin (potent CYP/UGT inducer) reduces protease inhibitor concentrations; use rifabutin instead.
Entry inhibitors		
Enfuvirtide	Binds gp41, inhibiting viral entry.	Skin reaction at injection sites. En fu virtide inhibits fu sion.
Maraviroc	Binds CCR-5 on surface of T cells/monocytes, inhibiting interaction with gpl20.	Maraviroc inhibits docking.

FAS1_2019_03-Microbiology.indd 203 11/14/19 12:22 PM

Paule	replication cycle (HCV-encoded proteins). Exam	·
DRUG	MECHANISM	TOXICITY
NS5A inhibitors	I 1:1: NCFA : 1 1 1 1	II 1 1 1: 1
Ledipasvir Ombitasvir	Inhibits NS5A, a viral phosphoprotein that plays a key role in RNA replication	Headache, diarrhea
Velpatasvir	Exact mechanism unknown	
NS5B inhibitors		
Sofosbuvir	Inhibits NS5B, an RNA-dependent RNA	Fatigue, headache
Dasabuvir	polymerase acting as a chain terminator	
NC2/4A 1 - b 1b 1c	Prevents viral RNA replication	
NS3/4A inhibitors	I 1:1: NG2/44	
Grazoprevir Simeprevir	Inhibits NS3/4A, a viral protease, preventing viral replication	Grazoprevir: headache, fatigue Simeprevir: photosensitivity reactions, rash
Alternative drugs	1	1 1 / /
Ribavirin	Inhibits synthesis of guanine nucleotides by	Hemolytic anemia, severe teratogen
	competitively inhibiting IMP dehydrogenase	
	Used as adjunct in cases refractory to newer medications	
	medications	
Disinfection and sterilization	Goals include the reduction of pathogenic organi	
Autoclave	inactivation of all microbes including spores (sterilization). Pressurized steam at > 120°C. Sporicidal. May not reliably inactivate prions.	
Alcohols	Denature proteins and disrupt cell membranes. Not sporicidal.	
Chlorhexidine	Denatures proteins and disrupts cell membranes. Not sporicidal.	
Chlorine	Oxidizes and denatures proteins. Sporicidal.	
Ethylene oxide	Alkylating agent. Sporicidal.	
Hydrogen peroxide	Free radical oxidation. Sporicidal.	
lodine and iodophors	Halogenation of DNA, RNA, and proteins. May be sporicidal.	
Quaternary amines	Impair permeability of cell membranes. Not sporicidal.	
Antimicrobials to	ANTIMICROBIAL	ADVERSE EFFECT
avoid in pregnancy	Sulfonamides	Kernicterus
	Aminoglycosides	Ototoxicity
	Fluoroquinolones	Cartilage damage
	Clarithromycin	Embryotoxic
	Tetracyclines	Discolored teeth, inhibition of bone growth
	Ribavirin	Teratogenic
		101410801110
	Griseofulvin	Teratogenic

HIGH-YIELD PRINCIPLES IN

Pathology

"Digressions, objections, delight in mockery, carefree mistrust are signs of health; everything unconditional belongs in pathology."

-Friedrich Nietzsche

"You cannot separate passion from pathology any more than you can separate a person's spirit from his body."

-Richard Selzer

The fundamental principles of pathology are key to understanding diseases in all organ systems. Major topics such as inflammation and neoplasia appear frequently in questions across different organ systems, and such topics are definitely high yield. For example, the concepts of cell injury and inflammation are key to understanding the inflammatory response that follows myocardial infarction, a very common subject of board questions. Similarly, a familiarity with the early cellular changes that culminate in the development of neoplasias—for example, esophageal or colon cancer—is critical. Finally, make sure you recognize the major tumor-associated genes and are comfortable with key cancer concepts such as tumor staging and metastasis.

► Cellular Injury 206 ► Inflammation 213

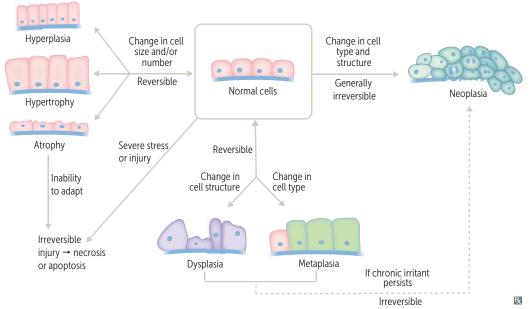
▶ Neoplasia 219

205

FAS1_2019_04-Pathol.indd 205 11/7/19 4:02 PM

▶ PATHOLOGY—CELLULAR INJURY

Cellular adaptations Reversible changes that can be physiologic (eg, uterine enlargement during pregnancy) or pathologic (eg, myocardial hypertrophy 2° to systemic HTN). If stress is excessive or persistent, adaptations can progress to cell injury (eg, significant LV hypertrophy → injury to myofibrils → HF). ↑ structural proteins and organelles → ↑ in size of cells. Example: cardiac hypertrophy. **Hypertrophy** Hyperplasia Controlled proliferation of stem cells and differentiated cells → ↑ in number of cells. Excessive stimulation → pathologic hyperplasia (eg, endometrial hyperplasia), which may progress to dysplasia and cancer. Example: benign prostatic hyperplasia. **Atrophy** ↓ in tissue mass due to ↓ in size († cytoskeleton degradation via ubiquitin-proteasome pathway and autophagy; I protein synthesis) and/or number of cells (apoptosis). Causes include disuse, denervation, loss of blood supply, loss of hormonal stimulation, poor nutrition. Metaplasia Reprogramming of stem cells → replacement of one cell type by another that can adapt to a new stress. Usually due to exposure to an irritant, such as gastric acid (→ Barrett esophagus) or cigarette smoke (→ respiratory ciliated columnar epithelium replaced by stratified squamous epithelium). May progress to dysplasia → malignant transformation with persistent insult (eg, Barrett esophagus → esophageal adenocarcinoma). Metaplasia of connective tissue can also occur (eg, myositis ossificans, the formation of bone within muscle after trauma). Dysplasia Disordered, precancerous epithelial cell growth; not considered a true adaptive response. Characterized by loss of uniformity of cell size and shape (pleomorphism); loss of tissue orientation; nuclear changes (eg, † nuclear:cytoplasmic ratio and clumped chromatin). Mild and moderate dysplasias (ie, do not involve entire thickness of epithelium) may regress with alleviation of inciting cause. Severe dysplasia often becomes irreversible and progresses to carcinoma in situ. Usually preceded by persistent metaplasia or pathologic hyperplasia.



FAS1 2019 04-Pathol.indd 206 11/7/19 4:02 PM

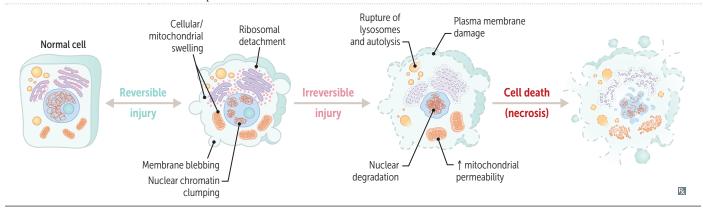
Cell injury

Reversible cell injury

- ↓ ATP → ↓ activity of Ca²⁺ and Na⁺/K⁺ pumps → cellular swelling (earliest morphologic manifestation), mitochondrial swelling
- Ribosomal/polysomal detachment → ↓ protein synthesis
- Plasma membrane changes (eg, blebbing)
- Nuclear changes (eg, chromatin clumping)
- Rapid loss of function (eg, myocardial cells are noncontractile after 1-2 minutes of ischemia)
- Myelin figures (aggregation of peroxidized lipids)

Irreversible cell injury

- Breakdown of plasma membrane → cytosolic enzymes (eg, troponin) leak outside of cell, influx of Ca²⁺ → activation of degradative enzymes
- Mitochondrial damage/dysfunction → loss of electron transport chain → ↓ ATP
- Cytoplasmic vacuolization accompanies programmed cell death (apoptosis)
- Rupture of lysosomes → autolysis
- Nuclear degradation: pyknosis (nuclear condensation) → karyorrhexis (nuclear fragmentation caused by endonuclease-mediated cleavage) → karyolysis (nuclear dissolution)
- Amorphous densities/inclusions in mitochondria



FAS1_2019_04-Pathol.indd 207 11/7/19 4:02 PM

Apoptosis

ATP-dependent programmed cell death.

Intrinsic and extrinsic pathways; both pathways activate caspases (cytosolic proteases) → cellular breakdown including cell shrinkage, chromatin condensation, membrane blebbing, and formation of apoptotic bodies, which are then phagocytosed.

Characterized by deeply eosinophilic cytoplasm and basophilic nucleus, pyknosis, and karyorrhexis. Cell membrane typically remains intact without significant inflammation (unlike necrosis). DNA laddering (fragments in multiples of 180 bp) is a sensitive indicator of apoptosis.

Intrinsic (mitochondrial) pathway

Involved in tissue remodeling in embryogenesis. Occurs when a regulating factor is withdrawn from a proliferating cell population (eg, ↓ IL-2 after a completed immunologic reaction → apoptosis of proliferating effector cells). Also occurs after exposure to injurious stimuli (eg, radiation, toxins, hypoxia).

Regulated by Bcl-2 family of proteins. BAX and BAK are proapoptotic, while Bcl-2 and Bcl-xL are antiapoptotic.

BAX and BAK form pores in the mitochondrial membrane → release of cytochrome C from inner mitochondrial membrane into the cytoplasm → activation of caspases.

Bcl-2 keeps the mitochondrial membrane impermeable, thereby preventing cytochrome C release. Bcl-2 overexpression (eg, follicular lymphoma t[14;18]) → ↓ caspase activation → tumorigenesis.

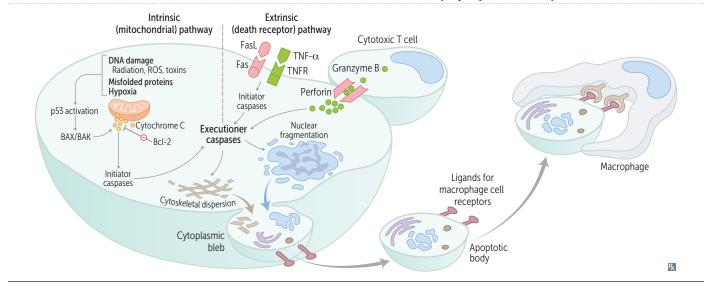
Extrinsic (death receptor) pathway

2 pathways:

- Ligand receptor interactions (FasL binding to Fas [CD95] or TNF-α binding to its receptor)
- Immune cell (cytotoxic T-cell release of perforin and granzyme B)

Fas-FasL interaction is necessary in thymic medullary negative selection.

Fas mutations † numbers of circulating self-reacting lymphocytes due to failure of clonal deletion. Defective Fas-FasL interactions cause autoimmune lymphoproliferative syndrome.



FAS1_2019_04-Pathol.indd 208 11/7/19 4:02 PM

Necrosis	Exogenous injury → plasma membrane damage → cell undergoes enzymatic degradation and protein denaturation, intracellular components leak → local inflammatory reaction (unlike apoptosis).		
ТҮРЕ	SEEN IN	DUE TO	HISTOLOGY
Coagulative	Ischemia/infarcts in most tissues (except brain)	Ischemia or infarction; injury denatures enzymes → proteolysis blocked	Preserved cellular architecture (cell outlines seen), but nuclei disappear; † cytoplasmic binding of eosin stain (→ † eosinophilia; red/pink color)
Liquefactive	Bacterial abscesses, brain infarcts	Neutrophils release lysosomal enzymes that digest the tissue B	Early: cellular debris and macrophages Late: cystic spaces and cavitation (brain) Neutrophils and cell debris seen with bacterial infection
Caseous	TB, systemic fungi (eg, Histoplasma capsulatum), Nocardia	Macrophages wall off the infecting microorganism → granular debris 【	Fragmented cells and debris surrounded by lymphocytes and macrophages (granuloma)
Fat	Enzymatic: acute pancreatitis (saponification of peripancreatic fat) Nonenzymatic: traumatic (eg, injury to breast tissue)	Damaged pancreatic cells release lipase, which breaks down triglycerides; liberated fatty acids bind calcium → saponification (chalkywhite appearance)	Outlines of dead fat cells without peripheral nuclei; saponification of fat (combined with Ca ²⁺) appears dark blue on H&E stain D
Fibrinoid	Immune vascular reactions (eg, PAN) Nonimmune vascular reactions (eg, hypertensive emergency, preeclampsia)	Immune complex deposition (type III hypersensitivity reaction) and/or plasma protein (eg, fibrin) leakage from damaged vessel	Vessel walls are thick and pink E
Gangrenous	Distal extremity and GI tract, after chronic	Dry: ischemia F	Coagulative
	ischemia	Wet: superinfection	Liquefactive superimposed on coagulative
	D. C. C. C. C. C. C. C. C. C. C. C. C. C.	E E	

FAS1_2019_04-Pathol.indd 209 11/7/19 4:02 PM

Ischemia



Inadequate blood supply to meet demand. Mechanisms include ↓ arterial perfusion (eg, atherosclerosis), ↓ venous drainage (eg, testicular torsion, Budd-Chiari syndrome), shock. Regions most vulnerable to hypoxia/ischemia and subsequent infarction:

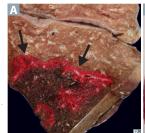
ORGAN	REGION
Brain	ACA/MCA/PCA boundary areas ^{a,b}
Heart	Subendocardium (LV) 🖪
Kidney	Straight segment of proximal tubule (medulla) Thick ascending limb (medulla)
Liver	Area around central vein (zone III)
Colon	Splenic flexure (Griffith point), ^a rectosigmoid junction (Sudeck point) ^a

^aWatershed areas (border zones) receive blood supply from most distal branches of 2 arteries with limited collateral vascularity. These areas are susceptible to ischemia from hypoperfusion.

Types of infarcts

Red infarct

Occurs in venous occlusion and tissues with multiple blood supplies (eg, liver, lung A, intestine, testes), and with reperfusion (eg, after angioplasty). Reperfusion injury is due to damage by free radicals.





Pale infarct

Occurs in solid organs with a single (endarterial) blood supply (eg, heart, kidney **B**).

Free radical injury

Free radicals damage cells via membrane lipid peroxidation, protein modification, DNA breakage. Initiated via radiation exposure (eg, cancer therapy), metabolism of drugs (phase I), redox reactions, nitric oxide (eg, inflammation), transition metals, WBC (eg, neutrophils, macrophages) oxidative burst.

Free radicals can be eliminated by scavenging enzymes (eg, catalase, superoxide dismutase, glutathione peroxidase), spontaneous decay, antioxidants (eg, vitamins A, C, E), and certain metal carrier proteins (eg, transferrin, ceruloplasmin).

Examples:

- Oxygen toxicity: retinopathy of prematurity (abnormal vascularization), bronchopulmonary dysplasia, reperfusion injury after thrombolytic therapy
- Drug/chemical toxicity: acetaminophen overdose (hepatotoxicity), carbon tetrachloride (converted by cytochrome P-450 into CCl₃ free radical → fatty liver [cell injury
- → ↓ apolipoprotein synthesis → fatty change], centrilobular necrosis)
- Metal storage diseases: hemochromatosis (iron) and Wilson disease (copper)

FAS1_2019_04-Pathol.indd 210 11/7/19 4:02 PM

^bNeurons most vulnerable to hypoxic-ischemic insults include Purkinje cells of the cerebellum and pyramidal cells of the hippocampus and neocortex (zones 3, 5, 6).

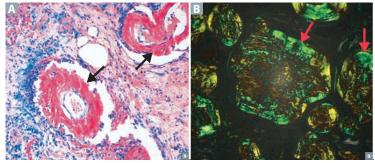
Types of calcification

	Dystrophic calcification	Metastatic calcification
Ca ²⁺ DEPOSITION	In abnormal (Diseased) tissues	In normal tissues
EXTENT	Tends to be localized (eg, calcific aortic stenosis)	Widespread (ie, diffuse, metastatic)
ASSOCIATED CONDITIONS A **	TB (lung and pericardium) and other granulomatous infections, liquefactive necrosis of chronic abscesses, fat necrosis, infarcts, thrombi, schistosomiasis, congenital CMV, toxoplasmosis, rubella, psammoma bodies, CREST syndrome, atherosclerotic plaques can become calcified	Predominantly in interstitial tissues of kidney, lung, and gastric mucosa (these tissues lose acid quickly; † pH favors Ca ²⁺ deposition) Nephrocalcinosis of collecting ducts may lead to nephrogenic diabetes insipidus and renal failure
ETIOLOGY	2° to injury or necrosis	2° to hypercalcemia (eg, 1° hyperparathyroidism, sarcoidosis, hypervitaminosis D) or high calcium-phosphate product levels (eg, chronic kidney disease with 2° hyperparathyroidism, long-term dialysis, calciphylaxis, multiple myeloma)
SERUM Ca ²⁺ LEVELS	Normal	Usually abnormal
Lipofuscin A	A yellow-brown "wear and tear" pigment A associated with normal aging. Composed of polymers of lipids and phospholipids complexed with protein. May be derived through lipid peroxidation of polyunsaturated lipids of subcellular membranes. Autopsy of elderly person will reveal deposits in heart, colon, liver, kidney, eye, and other organs.	

Calcium deposits appear deeply basophilic (arrow in A) on H&E stain.

FAS1_2019_04-Pathol.indd 211 11/7/19 4:02 PM

Amyloidosis	fibrils → cellular damage a (red/orange on nonpolarize	eteins (or their fragments) into β-pleate and apoptosis. Amyloid deposits visuali and light [arrows in A]), (apple-green bi cain (shows deposits in glomerular mean an light microscopy.	zed by Congo red stain refringence on polarized light
COMMON TYPES	FIBRIL PROTEIN	DESCRIPTION	
Systemic			
Primary amyloidosis	AL (from Ig Light chains)	Seen in Plasma cell disorders (eg, multiple myeloma)	Manifestations include: • Cardiac (eg, restrictive
Secondary amyloidosis	Serum A myloid A (AA)	Seen in chronic inflammatory conditions, (eg, rheumatoid arthritis, IBD, familial Mediterranean fever, protracted infection)	cardiomyopathy) GI (eg, macroglossia, hepatomegaly) Renal (eg, nephrotic syndrome)
Dialysis-related amyloidosis	eta_2 -microglobulin	Seen in patients with ESRD and/or on long-term dialysis	 Hematologic (eg, easy bruising, splenomegaly) Neurologic (eg, neuropathy) Musculoskeletal (eg, carpal tunnel syndrome)
Localized			
Alzheimer disease	β-amyloid protein	Cleaved from amyloid precursor protein (APP)	
Type 2 diabetes mellitus	Islet amyloid polypeptide (IAPP)	Caused by deposition of amylin in pancreatic islets	
Medullary thyroid cancer	Calcitonin		
Isolated atrial amyloidosis	ANP	Common in normal aging † risk of atrial fibrillation	
Systemic senile (age- related) amyloidosis	Normal (wild-type) transthyretin (TTR)	Seen predominantly in cardiac ventricles	Cardiac dysfunction more insidious than in AL amyloidosis
Hereditary			
Familial amyloid cardiomyopathy	Mutated transthyretin (ATTR)	Ventricular endomyocardium deposition → restrictive cardiomyopathy, arrhythmias	5% of African Americans are carriers of mutant allele
Familial amyloid polyneuropathies	Mutated transthyretin (ATTR)	Due to transthyretin gene mutation	
	A	В	



FAS1_2019_04-Pathol.indd 212 11/7/19 4:02 PM

nflammation	Response to eliminate initial cause of cell injury, to remove necrotic cells resulting from original insult, and to initiate tissue repair. Divided into acute and chronic. The inflar response itself can be harmful to the host if the reaction is excessive (eg, septic shock), (eg, persistent infections such as TB), or inappropriate (eg, autoimmune diseases such			
Cardinal signs	MECHANICA	MEDIATORS		
SIGN Declaration and a second section	MECHANISM	MEDIATORS		
Rubor (redness), calor (warmth)	Vasodilation (relaxation of arteriolar smooth muscle) → ↑ blood flow	Histamine, prostaglandins, bradykinin, NO		
Tumor (swelling)	Endothelial contraction/disruption (eg, from tissue damage) → ↑ vascular permeability → leakage of protein-rich fluid from postcapillary venules into interstitial space (exudate) → ↑ interstitial oncotic pressure	Endothelial contraction: leukotrienes (C_4 , D_4 , E_4), histamine, serotonin		
Dolor (pain)	Sensitization of sensory nerve endings	Bradykinin, PGE ₂ , histamine		
Functio laesa (loss of function)	Cardinal signs above impair function (eg, inability to make fist with hand that has cellulitis)			
Systemic manifestations	(acute-phase reaction)			
Fever	Pyrogens (eg, LPS) induce macrophages to release IL-1 and TNF → ↑ COX activity in perivascular cells of hypothalamus → ↑ PGE ₂ → ↑ temperature set point			
Leukocytosis	Elevation of WBC count; type of cell that is predominantly elevated depends on the inciting agent or injury (eg, bacteria → ↑ neutrophils)			
† plasma acute-phase proteins	Factors whose serum concentrations change significantly in response to inflammation Produced by the liver in both acute and chronic inflammatory states	Notably induced by IL-6		
Acute phase reactants	More FFiSH in the C (sea).			
POSITIVE (UPREGULATED)				
Ferritin	Binds and sequesters iron to inhibit microbial iron			
Fibrinogen	Coagulation factor; promotes endothelial repair;	correlates with ESR.		
Serum amyloid A	Prolonged elevation can lead to amyloidosis.			
Hepcidin	↓ iron absorption (by degrading ferroportin) and ↓ iron release (from macrophages) → anemia of chronic disease.			
C-reactive protein	Opsonin; fixes complement and facilitates phagocytosis. Measured clinically as a nonspecific sign of ongoing inflammation.			
NEGATIVE (DOWNREGULATED)	n 1			
Albumin	Reduction conserves amino acids for positive reac	etants.		
Transferrin	Internalized by macrophages to sequester iron.			

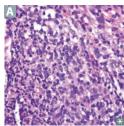
FAS1_2019_04-Pathol.indd 213 11/7/19 4:02 PM

Erythrocyte sedimentation rate

RBCs normally remain separated via ⊖ charges. Products of inflammation (eg, fibrinogen) coat RBCs → ↓ ⊖ charge → ↑ RBC aggregation. Denser RBC aggregates fall at a faster rate within a pipette tube → ↑ ESR. Often co-tested with CRP (more specific marker of inflammation).

† ESR	↓ ESR
Most anemias	Sickle cell anemia (altered shape)
Infections	Polycythemia († RBCs "dilute" aggregation
Inflammation (eg, giant cell [temporal] arteritis,	factors)
polymyalgia rheumatica)	HF
Cancer (eg, metastases, multiple myeloma)	Microcytosis
Renal disease (end-stage or nephrotic syndrome)	Hypofibrinogenemia
Pregnancy	

Acute inflammation



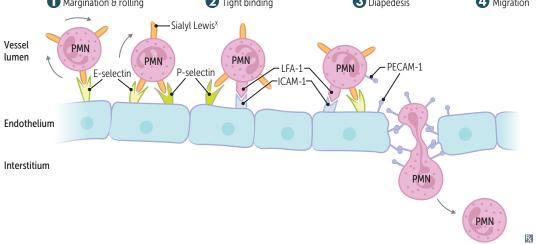
Transient and early response to injury or infection. Characterized by neutrophils in tissue A, often with associated edema. Rapid onset (seconds to minutes) and short duration (minutes to days). Represents a reaction of the innate immune system (ie, less specific response than chronic inflammation).

STIMULI	Infections, trauma, necrosis, foreign bodies.	
MEDIATORS	Toll-like receptors, arachidonic acid metabolites, neutrophils, eosinophils, antibodies (preexisting), mast cells, basophils, complement, Hageman factor (factor XII).	Inflammasome—Cytoplasmic protein complex that recognizes products of dead cells, microbial products, and crystals (eg, uric acid crystals) → activation of IL-l and inflammatory response.
COMPONENTS	 Vascular: vasodilation (→ ↑ blood flow and stasis) and ↑ endothelial permeability Cellular: extravasation of leukocytes (mainly neutrophils) from postcapillary venules and accumulation in the focus of injury followed by leukocyte activation 	To bring cells and proteins to site of injury or infection. Leukocyte extravasation has 4 steps: margination and rolling, adhesion, transmigration, and migration (chemoattraction).
OUTCOMES	 Resolution and healing (IL-10, TGF-β) Persistent acute inflammation (IL-8) Abscess (acute inflammation walled off by fibrosis) Chronic inflammation (antigen presentation by macrophages and other APCs → activation of CD4⁺ Th cells) Scarring 	Macrophages predominate in the late stages of acute inflammation (peak 2–3 days after onset) and influence outcome by secreting cytokines.

FAS1_2019_04-Pathol.indd 214 11/7/19 4:02 PM

Leukocyte extravasation

EP .	VASCULATURE/STROMA	LEUKOCYTE
Margination and rolling— defective in leukocyte adhesion	E-selectin (upregulated by TNF and IL-1)	Sialyl Lewis ^X
deficiency type 2 (‡ Sialyl Lewis ^X)	P-selectin (released from Weibel-Palade bodies)	Sialyl Lewis ^X
	GlyCAM-1, CD34	L-selectin
Tight binding (adhesion)— defective in leukocyte adhesion	ICAM-1 (CD54)	CD11/18 integrins (LFA-1, Mac-1)
deficiency type 1 (\$\ddagger\$ CD18 integrin subunit)	VCAM-1 (CD106)	VLA-4 integrin
Diapedesis (transmigration)— WBC travels between endothelial cells and exits blood vessel	PECAM-1 (CD31)	PECAM-1 (CD31)
Migration—WBC travels through interstitium to site of injury or infection guided by chemotactic signals	Chemotactic factors: C5a, IL-8, LTB ₄ , kallikrein, platelet-activating factor	Various
■ Margination & rolling	2 Tight binding 3 Diapedesis	4 Migration
ressel PMN	wis ^x	



FAS1_2019_04-Pathol.indd 215 11/7/19 4:02 PM

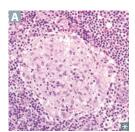
Chronic inflammation	Prolonged inflammation characterized by mononuclear infiltration (macrophages, lymphocytes, plasma cells), which leads to simultaneous tissue destruction and repair (including angiogenesis and fibrosis). May be preceded by acute inflammation.		
STIMULI	Persistent infections (eg, TB, <i>T pallidum</i> , certain fungi and viruses) → type IV hypersensitivity, autoimmune diseases, prolonged exposure to toxic agents (eg, silica) and foreign material.		
MEDIATORS	 Macrophages are the dominant cells. Interaction of macrophages and T lymphocytes → chronic inflammation. Th1 cells secrete IFN-γ → macrophage classical activation (proinflammatory) Th2 cells secrete IL-4 and IL-13 → macrophage alternative activation (repair and anti-inflammatory) 		
OUTCOMES	Scarring, amyloidosis, and neoplastic transformation (eg, chronic HCV infection → chronic inflammation → hepatocellular carcinoma; <i>Helicobacter pylori</i> infection → chronic gastritis → gastric adenocarcinoma).		
Wound healing			
Tissue mediators	MEDIATOR	ROLE	
	FGF	Stimulates angiogenesis	
	TGF-β	Angiogenesis, fibrosis	
	VEGF	Stimulates angiogenesis	
	PDGF	Secreted by activated platelets and macrophages Induces vascular remodeling and smooth muscle cell migration Stimulates fibroblast growth for collagen synthesis	
	Metalloproteinases	Tissue remodeling	
	EGF	Stimulates cell growth via tyrosine kinases (eg, EGFR/ <i>ErbB1</i>)	
PHASE OF WOUND HEALING	EFFECTOR CELLS	CHARACTERISTICS	
Inflammatory (up to 3 days after wound)	Platelets, neutrophils, macrophages	Clot formation, † vessel permeability and neutrophil migration into tissue; macrophages clear debris 2 days later	
Proliferative (day 3–weeks after wound)	Fibroblasts, myofibroblasts, endothelial cells, keratinocytes, macrophages	Deposition of granulation tissue and type III collagen, angiogenesis, epithelial cell proliferation, dissolution of clot, and wound contraction (mediated by myofibroblasts) Delayed second phase of wound healing in vitamin C and copper deficiency	
Remodeling (1 week–6+ months after wound)	Fibroblasts	Type III collagen replaced by type I collagen, ↑ tensile strength of tissue Collagenases (require zinc to function) break down type III collagen Zinc deficiency → delayed wound healing	

FAS1_2019_04-Pathol.indd 216 11/7/19 4:02 PM

Granulomatous inflammation

A pattern of chronic inflammation. Can be induced by persistent T-cell response to certain infections (eg, TB), immune-mediated diseases, and foreign bodies. Granulomas "wall off" a resistant stimulus without completely eradicating or degrading it → persistent inflammation→ fibrosis, organ damage.

HISTOLOGY



Focus of epithelioid cells (activated macrophages with abundant pink cytoplasm) surrounded by lymphocytes and multinucleated giant cells (formed by fusion of several activated macrophages). Two types:

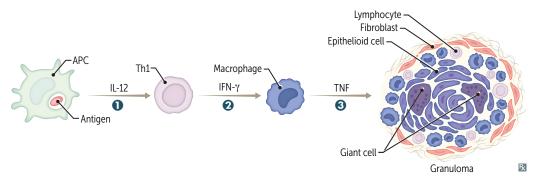
Caseating: associated with Central necrosis. Seen with infectious etiologies (eg, TB, fungal). Noncaseating A: no central necrosis. Seen with autoimmune diseases (eg, sarcoidosis, Crohn disease).

MECHANISM

- APCs present antigens to CD4+ Th cells and secrete IL-12 → CD4+ Th cells differentiate into Th1 cells
- 2 Thl secretes IFN- $\gamma \rightarrow$ macrophage activation
- Macrophages ↑ cytokine secretion (eg, TNF) → formation of epithelioid macrophages and giant cells

Anti-TNF therapy can cause sequestering granulomas to break down → disseminated disease. Always test for latent TB before starting anti-TNF therapy.

Associated with hypercalcemia due to $\uparrow 1\alpha$ -hydroxylase activity in activated macrophages, resulting in \uparrow vitamin D activity.



ETIOLOGIES

INFECTIOUS

Bacterial: *Mycobacteria* (tuberculosis, leprosy), *Bartonella henselae* (cat scratch disease; stellate necrotizing granulomas), *Listeria monocytogenes* (granulomatosis infantiseptica), *Treponema pallidum* (3° syphilis)

Fungal: endemic mycoses (eg, histoplasmosis) Parasitic: schistosomiasis

NONINFECTIOUS

Immune-mediated: sarcoidosis, Crohn disease, 1° biliary cholangitis, subacute (de Quervain/granulomatous) thyroiditis

Vasculitis: granulomatosis with polyangiitis (Wegener), eosinophilic granulomatosis with polyangiitis (Churg-Strauss), giant cell (temporal) arteritis, Takayasu arteritis

Foreign bodies: berylliosis, talcosis, hypersensitivity pneumonitis

Chronic granulomatous disease

FAS1_2019_04-Pathol.indd 217 11/7/19 4:02 PM

PATHOLOGY ► PATHOLOGY—INFLAMMATION

Scar formation	Occurs when repair cannot be accomplished by cell regeneration alone. Nonregenerated cells (2° to severe acute or chronic injury) are replaced by connective tissue. 70–80% of tensile strength regained at 3 months; little tensile strength regained thereafter. Associated with excess TGF-β.		
SCAR TYPE	Hypertrophic A	Keloid B	
COLLAGEN SYNTHESIS	↑ (type III collagen)	<pre>††† (types I and III collagen)</pre>	
COLLAGEN ORGANIZATION	Parallel	Disorganized	
EXTENT OF SCAR	Confined to borders of original wound	Extends beyond borders of original wound with "claw-like" projections typically on earlobes, face, upper extremities	
RECURRENCE	Infrequent	Frequent	
PREDISPOSITION	None	↑ incidence in ethnic groups with darker skin	



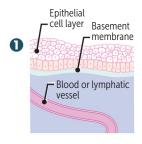


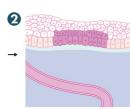
FAS1_2019_04-Pathol.indd 218 11/7/19 4:02 PM

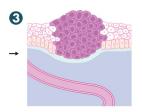
▶ PATHOLOGY—NEOPLASIA

Neoplasia and neoplastic progression

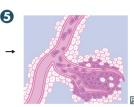
Uncontrolled, monoclonal proliferation of cells. Can be benign or malignant. Any neoplastic growth has two components: parenchyma (neoplastic cells) and supporting stroma (nonneoplastic; eg, blood vessels, connective tissue).











Normal cells

Normal cells with basal → apical polarity. See cervical example A, which shows normal cells and spectrum of dysplasia, as discussed below.

Dysplasia

Loss of uniformity in cell size and shape (pleomorphism); loss of tissue orientation; nuclear changes (eg, † nuclear:cytoplasmic ratio) A.

Carcinoma in situ/ preinvasive

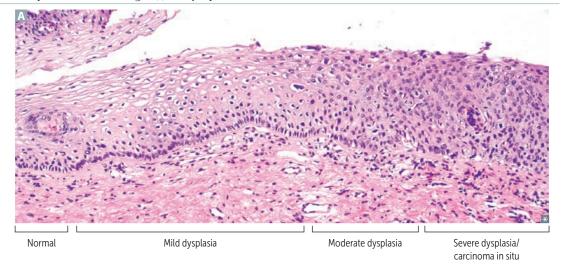
3 Irreversible severe dysplasia that involves the entire thickness of epithelium but does not penetrate the intact basement membrane A.

Invasive carcinoma

4 Cells have invaded basement membrane using collagenases and hydrolases (metalloproteinases). Cell-cell contacts lost by inactivation of E-cadherin.

Metastasis

Spread to distant organ(s) via lymphatics or blood.



FAS1_2019_04-Pathol.indd 219 11/7/19 4:02 PM 220

SECTION II

PATHOLOGY ► PATHOLOGY—NEOPLASIA

Tumor nomenclature	 Carcinoma implies epithelial origin, whereas sarcoma denotes mesenchymal origin. Both terms generally imply malignancy. Benign tumors are usually well-differentiated and well-demarcated, with low mitotic activity, no metastases, and no necrosis. Malignant tumors (cancers) may show poor differentiation, erratic growth, local invasion, metastasis, and ↓ apoptosis. Terms for non-neoplastic malformations include hamartoma (disorganized overgrowth of tissues in their native location, eg, Peutz-Jeghers polyps) and choristoma (normal tissue in a foreign location, eg, gastric tissue located in distal ileum in Meckel diverticulum). 		
CELL TYPE	BENIGN	MALIGNANT	
Epithelium	Adenoma, papilloma	Adenocarcinoma, papillary carcinoma	
Mesenchyme			
Blood cells		Leukemia, lymphoma	
Blood vessels	Hemangioma	Angiosarcoma	
Smooth muscle	Leiomyoma	Leiomyosarcoma	
Striated muscle	Rhabdomyoma	Rhabdomyosarcoma	
Connective tissue	Fibroma	Fibrosarcoma	
Bone	Osteoma	Osteosarcoma	
Fat	Lipoma	Liposarcoma	
Melanocyte	Nevus/mole Melanoma		
Tumor grade vs stage		bles its tissue of origin. Well-differentiated tumors sue of origin, whereas poorly differentiated tumors ells in a malignant neoplasm.	
Grade	Degree of cellular differentiation and mitotic activity on histology. Ranges from low grade (well-differentiated) to high grade (poorly differentiated, undifferentiated, or anaplastic).	Low grade High grade 🕟	
Stage	Degree of localization/spread based on site and size of 1° lesion, spread to regional lymph nodes, presence of metastases. Based on clinical (c) or pathologic (p) findings. Stage generally has more prognostic value than grade (eg, a high-stage yet low-grade tumor is usually worse than a low-stage yet high-grade tumor). Stage determines Survival. TNM staging system (Stage = Spread): T = Tumor size/invasiveness, N = Node involvement, M = Metastases, eg, cT3N1M0. Each TNM factor has independent prognostic value; N and M are often most important.	Lymph node N M Blood or lymphatic vessel Spread to other organs and tissues	

FAS1_2019_04-Pathol.indd 220 11/7/19 4:02 PM

CTION II		,
	,	,

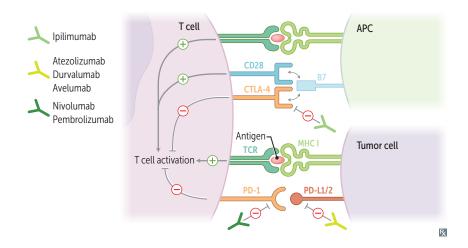
Hallmarks of cancer	Cancer is caused by (mostly acquired) DNA mutations that affect fundamental cellular processes (eg, growth, DNA repair, survival).
HALLMARK	MECHANISM
Growth signal self-sufficiency	Mutations in genes encoding: Proto-oncogenes → ↑ growth factors → autocrine loop (eg, ↑ PDGF in brain tumors) Growth factor receptors → constitutive signalling (eg, HER2/neu in breast cancer) Signaling molecules (eg, RAS) Transcription factors (eg, MYC) Cell cycle regulators (eg, cyclins, CDKs)
Anti-growth signal insensitivity	 Mutations in tumor suppressor genes (eg, Rb) Loss of E-cadherin function → loss of contact inhibition (eg, NF2 mutations)
Evasion of apoptosis	Mutations in genes that regulate apoptosis (eg, TP53, BCL2 → follicular B cell lymphoma).
Limitless replicative potential	Reactivation of telomerase → maintenance and lengthening of telomeres → prevention of chromosome shortening and cell aging.
Sustained angiogenesis	↑ pro-angiogenic factors (eg, VEGF) or ↓ inhibitory factors. Factors may be produced by tumor or stromal cells. Vessels can sprout from existing capillaries (neoangiogenesis) or endothelial cells are recruited from bone marrow (vasculogenesis). Vessels may be leaky and/or dilated.
Tissue invasion	Loss of E-cadherin function → loosening of intercellular junctions → metalloproteinases degrade basement membrane and ECM → cells attach to ECM proteins (eg, laminin, fibronectin) → cells migrate through degraded ECM ("locomotion") → vascular dissemination.
Metastasis	Tumor cells or emboli spread via lymphatics or blood → adhesion to endothelium → extravasation and homing. Site of metastasis can be predicted by site of 1° tumor, as the target organ is often the first-encountered capillary bed. Some cancers show organ tropism (eg, lung cancers commonly metastasize to adrenals).
Warburg effect	Shift of glucose metabolism away from mitochondrial oxidative phosphorylation toward glycolysis.
Immune evasion in cancer	 Normally, immune cells can recognize and attack tumor cells. For successful tumorigenesis, tumor cells must evade the immune system. Multiple escape mechanisms exist: ↓ MHC class I expression by tumor cells → cytotoxic T cells are unable to recognize tumor cells. Tumor cells secrete immunosuppressive factors (eg, TGF-β) and recruit regulatory T cells to down regulate immune response. Tumor cells up regulate immune checkpoint molecules, which inhibit immune response.

11/7/19 4:02 PM FAS1_2019_04-Pathol.indd 221

Immune checkpoint interactions

Signals that modulate T cell activation and function → ↓ immune response against tumor cells. Targeted by several cancer immunotherapies. Examples:

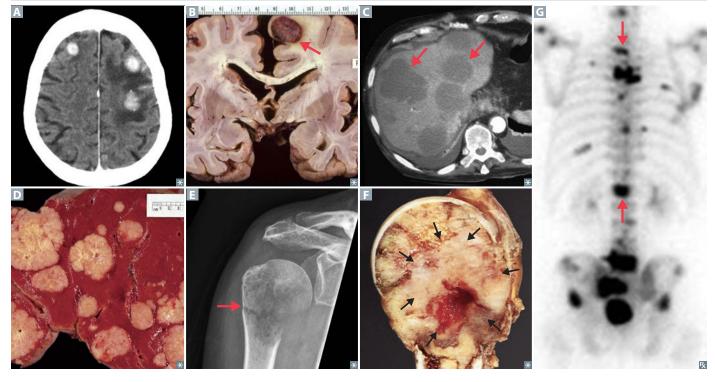
- Interaction between PD-1 (on T cells) and PD-L1/2 (on tumor cells or immune cells in tumor microenvironment) → T cell dysfunction (exhaustion). Inhibited by antibodies against PD-1 (eg, pembrolizumab, nivolumab) or PD-L1 (eg, atezolizumab, durvalumab, avelumab).
- CTLA-4 on T cells outcompetes CD28 for B7 on APCs → loss of T cell costimulatory signal. Inhibited by ipilimumab (anti-CTLA-4 antibody).



Cancer epidemiology	Skin cancer (basal > squamous >> melanoma) is the most common cancer (not included below).			
	MEN	WOMEN	CHILDREN (AGE 0-14)	NOTES
Cancer incidence	 Prostate Lung Colon/rectum 	 Breast Lung Colon/rectum 	1. Leukemia 2. CNS 3. Neuroblastoma	Lung cancer incidence has ‡ in men, but has not changed significantly in women.
Cancer mortality	 Lung Prostate Colon/rectum 	 Lung Breast Colon/rectum 	1. Leukemia 2. CNS 3. Neuroblastoma	Cancer is the 2nd leading cause of death in the United States (heart disease is 1st).

FAS1_2019_04-Pathol.indd 222 11/7/19 4:02 PM

Common metastases	Most sarcomas spread hematogenously; most carcinomas spread via lymphatics. However, Four Carcinomas Route Hematogenously: Follicular thyroid carcinoma, Choriocarcinoma, Renal cell carcinoma, and Hepatocellular carcinoma.		
SITE OF METASTASIS	1º TUMOR	NOTES	
Brain	Lung > breast > melanoma, colon, kidney	50% of brain tumors are from metastases A B Commonly seen as multiple well-circumscribed tumors at gray/white matter junction	
Liver	Colon >>> Stomach > Pancreas (Cancer Sometimes Penetrates liver)	Liver and lung are the most common sites of metastasis after the regional lymph nodes	
Bone	Prostate, Breast > Kidney, Thyroid, Lung (Painful Bones Kill The Lungs)	Bone metastasis	



FAS1_2019_04-Pathol.indd 223 11/7/19 4:02 PM

SECTION II PATHOLOGY → PATHOLOGY—NEOPLASIA

	Gain of function mutation converts proto-oncogene (normal gene) to oncogene → ↑ cancer risk. Requires damage to only one allele of a proto-oncogene.		
GENE	GENE PRODUCT	ASSOCIATED NEOPLASM	
ALK	Receptor tyrosine Kinase	Lung Adenocarcinoma (Adenocarcinoma of the Lung Kinase)	
BCR-ABL	Non-receptor tyrosine kinase	CML, ALL	
BCL-2	Antiapoptotic molecule (inhibits apoptosis)	Follicular and diffuse large B Cell Lymphomas	
BRAF	Serine/threonine kinase	Melanoma, non-Hodgkin lymphoma, papillary thyroid carcinoma, hairy cell leukemia	
c-KIT	CytoKIne receptor	Gastrointestinal stromal tumor (GIST)	
c-MYC	Transcription factor	Burkitt lymphoma	
HER2/neu (c-erbB2)	Receptor tyrosine kinase	Breast and gastric carcinomas	
JAK2	Tyrosine kinase	Chronic myeloproliferative disorders	
KRAS	GTPase	Colon cancer, lung cancer, pancreatic cancer	
MYCL1	Transcription factor	Lung tumor	
N-myc (MYCN)	Transcription factor	Neuroblastoma	
RET	Receptor tyrosine kinase	MEN 2A and 2B, papillary thyroid carcinoma, pheochromocytoma	
Tumor suppressor genes	Loss of function → ↑ cancer risk; both (two) allelexpression of disease.	es of a tu mor suppressor gene must be lost for	
genes	expression of disease.		
genes GENE	expression of disease. GENE PRODUCT	ASSOCIATED CONDITION	
genes GENE APC	expression of disease.	ASSOCIATED CONDITION Colorectal cancer (associated with FAP)	
genes GENE APC BRCA1/BRCA2	expression of disease. GENE PRODUCT Negative regulator of β-catenin/WNT pathway BRCA1/BRCA2 proteins	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers	
genes GENE APC BRCA1/BRCA2 CDKN2A	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4)	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein)	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1	
GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2	expression of disease. GENE PRODUCT Negative regulator of β-catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks G ₁ → S phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1 Neurofibromatosis type 2	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2 PTEN	expression of disease. GENE PRODUCT Negative regulator of β-catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks G ₁ → S phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein Negative regulator of PI3k/AKT pathway	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2 PTEN	expression of disease. GENE PRODUCT Negative regulator of β-catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks G ₁ → S phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1 Neurofibromatosis type 2 Prostate, breasT, and ENdometrial cancers Retinoblastoma, osteosarcoma (bone cancer) Most human cancers, Li-Fraumeni syndrome (multiple malignancies at early age, aka, SBLA)	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2 PTEN Rb	expression of disease. GENE PRODUCT Negative regulator of β-catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks G ₁ → S phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein Negative regulator of PI3k/AKT pathway Inhibits E2F; blocks G ₁ → S phase	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1 Neurofibromatosis type 2 Prostate, breasT, and ENdometrial cancers Retinoblastoma, osteosarcoma (bone cancer) Most human cancers, Li-Fraumeni syndrome (multiple malignancies at early age, aka, SBLA cancer syndrome: Sarcoma, Breast, Leukemia,	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2 PTEN Rb TP53	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins p16, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein Negative regulator of PI3k/AKT pathway Inhibits E2F; blocks $G_1 \rightarrow S$ phase p53, activates p21, blocks $G_1 \rightarrow S$ phase	ASSOCIATED CONDITION Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1 Neurofibromatosis type 2 Prostate, breasT, and ENdometrial cancers Retinoblastoma, osteosarcoma (bone cancer) Most human cancers, Li-Fraumeni syndrome (multiple malignancies at early age, aka, SBLA cancer syndrome: Sarcoma, Breast, Leukemia, Adrenal gland)	
genes GENE APC BRCA1/BRCA2 CDKN2A DCC SMAD4 (DPC4) MEN1 NF1 NF2 PTEN Rb TP53	expression of disease. GENE PRODUCT Negative regulator of β -catenin/WNT pathway BRCA1/BRCA2 proteins pl6, blocks $G_1 \rightarrow S$ phase DCC—Deleted in Colon Cancer DPC—Deleted in Pancreatic Cancer Menin Neurofibromin (Ras GTPase activating protein) Merlin (schwannomin) protein Negative regulator of PI3k/AKT pathway Inhibits E2F; blocks $G_1 \rightarrow S$ phase p53, activates p21, blocks $G_1 \rightarrow S$ phase	Colorectal cancer (associated with FAP) Breast, ovarian, and pancreatic cancers Melanoma, pancreatic cancer Colon cancer Pancreatic cancer Multiple Endocrine Neoplasia type 1 Neurofibromatosis type 1 Neurofibromatosis type 2 Prostate, breasT, and ENdometrial cancers Retinoblastoma, osteosarcoma (bone cancer) Most human cancers, Li-Fraumeni syndrome (multiple malignancies at early age, aka, SBLA cancer syndrome: Sarcoma, Breast, Leukemia, Adrenal gland) Tuberous sclerosis	

FAS1_2019_04-Pathol.indd 224 11/7/19 4:02 PM

Carcinogens

TOXIN	EXPOSURE	ORGAN	IMPACT
Aflatoxins (Aspergillus)	Stored grains and nuts	Liver	Hepatocellular carcinoma
Alkylating agents	Oncologic chemotherapy	Blood	Leukemia/lymphoma
Aromatic amines (eg, benzidine, 2-naphthylamine)	Textile industry (dyes), cigarette smoke (2-naphthylamine)	Bladder	Transitional cell carcinoma
Arsenic	Herbicides (vineyard workers), metal smelting	Liver Lung Skin	Angiosarcoma Lung cancer Squamous cell carcinoma
Asbestos	Old roofing material, shipyard workers	Lung	Bronchogenic carcinoma > mesothelioma
Cigarette smoke		Bladder Cervix Esophagus Kidney Larynx Lung Oropharynx Pancreas	Transitional cell carcinoma Squamous cell carcinoma Squamous cell carcinoma/ adenocarcinoma Renal cell carcinoma Squamous cell carcinoma Squamous cell and small cell carcinoma Oropharyngeal cancer Pancreatic adenocarcinoma
Ethanol		Esophagus Liver	Squamous cell carcinoma Hepatocellular carcinoma
lonizing radiation		Thyroid	Papillary thyroid carcinoma, leukemias
Nickel, chromium, beryllium, silica	Occupational exposure	Lung	Lung cancer
Nitrosamines	Smoked foods	Stomach	Gastric cancer
Radon	Byproduct of uranium decay, accumulates in basements	Lung	Lung cancer (2nd leading cause after cigarette smoke)
Vinyl chloride	Used to make P V C pipes (plumbers)	Liver	Angiosarcoma

11/7/19 4:02 PM FAS1_2019_04-Pathol.indd 225

Oncogenic microbes

	Microbe	Associated cancer
	EBV	Burkitt lymphoma, Hodgkin lymphoma, nasopharyngeal carcinoma, 1° CNS lymphoma (in immunocompromised patients)
	HBV, HCV	Hepatocellular carcinoma
	HHV-8	Kaposi sarcoma
	HPV	Cervical and penile/anal carcinoma (types 16, 18), head and neck cancer
	H pylori	Gastric adenocarcinoma and MALT lymphoma
	HTLV-1	Adult T -cell L eukemia/ L ymphoma
	Liver fluke (Clonorchis sinensis)	Cholangiocarcinoma
	Schistosoma haematobium	Squamous cell bladder cancer
Serum tumor markers	Tumor markers should not be used as the 1° tool used to monitor tumor recurrence and response biopsy. Some can be associated with non-neopla IMPORTANT ASSOCIATIONS	to therapy, but definitive diagnosis is made via
Alkaline phosphatase	Metastases to bone or liver, Paget disease of	Exclude hepatic origin by checking LFTs and
Alkaline phosphatase	bone, seminoma (placental ALP).	GGT levels.
α-fetoprotein	Hepatocellular carcinoma, Endodermal sinus (yolk sac) tumor, Mixed germ cell tumor, Ataxia-telangiectasia, Neural tube defects. (HE-MAN is the alpha male!)	Normally made by fetus. Transiently elevated in pregnancy. High levels associated with neural tube and abdominal wall defects, low levels associated with Down syndrome.
hCG	Hydatidiform moles and Choriocarcinomas (Gestational trophoblastic disease), testicular cancer, mixed germ cell tumor.	Produced by syncytiotrophoblasts of the placenta.
CA 15-3/CA 27-29	Breast cancer.	
CA 19-9	Pancreatic adenocarcinoma.	
CA 125	Ovarian cancer.	
Calcitonin	Medullary thyroid carcinoma (alone and in MEN2A, MEN2B).	
CEA	Colorectal and pancreatic cancers. Minor associations: gastric, breast, and medullary thyroid carcinomas.	Carcinoembryonic antigen. Very nonspecific.
Chromogranin	Neuroendocrine tumors.	
LDH	Testicular germ cell tumors, ovarian dysgerminoma, other cancers.	Can be used as an indicator of tumor burden.
Neuron-specific enolase	Neuroendocrine tumors (eg, small cell lung cancer, carcinoid tumor, neuroblastoma)	
PSA	Prostate cancer.	Prostate-specific antigen. Also elevated in BPH and prostatitis. Questionable risk/benefit for

FAS1_2019_04-Pathol.indd 226 11/7/19 4:02 PM

Important immunohistochemical stains

Determine primary site of origin for metastatic tumors and characterize tumors that are difficult to classify. Can have prognostic and predictive value.

STAIN	TARGET	TUMORS IDENTIFIED
Chromogranin and synaptophysin	Neuroendocrine cells	Small cell carcinoma of the lung, carcinoid tumor
Cytokeratin	Epithelial cells	Epithelial tumors (eg, squamous cell carcinoma)
DesMin	M uscle	Muscle tumors (eg, rhabdomyosarcoma)
GFAP	NeuroGlia (eg, astrocytes, Schwann cells, oligodendrocytes)	Astrocytoma, Glioblastoma
Neurofilament	Neurons	Neuronal tumors (eg, neuroblastoma)
PSA	Prostatic epithelium	Prostate cancer
S-100	Neural crest cells	Melanoma, schwannoma, Langerhans cell histiocytosis
TRAP	Tartrate-resistant acid phosphatase	Hairy cell leukemia
Vimentin	Me senchymal tissue (eg, fibroblasts, endothelial cells, macrophages)	Mesenchymal tumors (eg, sarcoma), but also many other tumors (eg, endometrial carcinoma, renal cell carcinoma, meningioma)

P-glycoprotein

Also known as multidrug resistance protein 1 (MDR1). Classically seen in adrenocortical carcinoma but also expressed by other cancer cells (eg, colon, liver). Used to pump out toxins, including chemotherapeutic agents (one mechanism of ↓ responsiveness or resistance to chemotherapy over time).

Psammoma bodies

Laminated, concentric spherules with dystrophic calcification A, PSaMMOMa bodies are seen in:

- Papillary carcinoma of thyroid
- Somatostatinoma
- Meningioma
- Malignant Mesothelioma
- Ovarian serous papillary cystadenocarcinoma
- Prolactinoma (Milk)

Cachexia

Weight loss, muscle atrophy, and fatigue that occur in chronic disease (eg, cancer, AIDS, heart failure, COPD). Mediated by TNF-α, IFN-γ, IL-1, and IL-6.

FAS1_2019_04-Pathol.indd 227 11/7/19 4:02 PM

Paraneoplastic syndromes

MANIFESTATION	DESCRIPTION/MECHANISM	MOST COMMONLY ASSOCIATED TUMOR(S)	
Musculoskeletal and cuta	aneous		
Dermatomyositis	Progressive proximal muscle weakness, Gottron papules, heliotrope rash	Adenocarcinomas, especially ovarian	
Acanthosis nigricans	Hyperpigmented velvety plaques in axilla and neck	Gastric adenocarcinoma and other visceral malignancies	
Sign of Leser-Trélat	Sudden onset of multiple seborrheic keratoses	GI adenocarcinomas and other visceral malignancies	
Hypertrophic osteoarthropathy	Abnormal proliferation of skin and bone at distal extremities → clubbing, arthralgia, joint effusions, periostosis of tubular bones	Adenocarcinoma of the lung	
Endocrine			
Hypercalcemia	PTHrP	Squamous cell carcinomas of lung, head, and neck; renal, bladder, breast, and ovarian carcinomas	
	↑ 1,25-(OH) ₂ vitamin D ₃ (calcitriol)	Lymphoma	
Cushing syndrome	† ACTH	Small cell lung cancer	
Hyponatremia (SIADH)	↑ ADH	oman cen lung cancel	
Hematologic			
Polycythemia	↑ Erythropoietin Paraneoplastic rise to high hematocrit levels	Pheochromocytoma, renal cell carcinoma, HCC, hemangioblastoma, leiomyoma	
Pure red cell aplasia	Anemia with low reticulocytes	ml	
Good syndrome	Hypogammaglobulinemia	Thymoma	
Trousseau syndrome	Migratory superficial thrombophlebitis		
Nonbacterial thrombotic (marantic) endocarditis	Deposition of sterile platelet thrombi on heart valves	Adenocarcinomas, especially pancreatic	
Neuromuscular			
Anti-NMDA receptor encephalitis	Psychiatric disturbance, memory deficits, seizures, dyskinesias, autonomic instability, language dysfunction	Ovarian teratoma	
Opsoclonus- myoclonus ataxia syndrome	"Dancing eyes, dancing feet"	Neuroblastoma (children), small cell lung cancer (adults)	
Paraneoplastic cerebellar degeneration	Antibodies against antigens in Purkinje cells	Small cell lung cancer (anti-Hu), gynecologic and breast cancers (anti-Yo), and Hodgkin lymphoma (anti-Tr)	
Paraneoplastic encephalomyelitis	Antibodies against Hu antigens in neurons	S	
Lambert-Eaton myasthenic syndrome	Antibodies against presynaptic (P/Q-type) Ca ²⁺ channels at NMJ	Small cell lung cancer	
Myasthenia gravis	Antibodies against postsynaptic ACh receptors at NMJ	Thymoma	

FAS1_2019_04-Pathol.indd 228 11/7/19 4:02 PM

HIGH-YIELD PRINCIPLES IN

Pharmacology

"One pill makes you larger, and one pill makes you small."

-Grace Slick

"I was under medication when I made the decision not to burn the tapes."

—Richard Nixon

"I wondher why ye can always read a doctor's bill an' ye niver can read his purscription."

-Finley Peter Dunne

"One of the first duties of the physician is to educate the masses not to take medicine."

-William Osler

Preparation for pharmacology questions is straightforward. Know all the mechanisms, clinical use, and important adverse effects of key drugs and their major variants. Obscure derivatives are low-yield. Learn their classic and distinguishing toxicities as well as major drug-drug interactions. Reviewing associated biochemistry, physiology, and microbiology concepts can be useful while studying pharmacology. The exam has a strong emphasis on ANS, CNS, antimicrobial, and cardiovascular agents as well as on NSAIDs, which are covered throughout the text. Specific drug dosages or trade names are generally not testable. The exam may use graphs to test various pharmacology content, so make sure you are comfortable interpreting them.

- ▶ Pharmacokinetics and Pharmacodynamics 230
- ▶ Autonomic Drugs 236
- ► Toxicities and Side Effects
- 248
- ► Miscellaneous 253

229

▶ PHARMACOLOGY—PHARMACOKINETICS AND PHARMACODYNAMICS

Enzyme kinetics

Michaelis-Menten kinetics

 $K_{\rm m}$ is inversely related to the affinity of the enzyme for its substrate.

 $V_{\text{max}} \mbox{ is directly proportional to the enzyme} \\ \mbox{concentration.}$

Most enzymatic reactions follow a hyperbolic curve (ie, Michaelis-Menten kinetics); however, enzymatic reactions that exhibit a sigmoid curve usually indicate cooperative kinetics (eg, hemoglobin).

[S] = concentration of substrate; V = velocity.



Effects of enzyme inhibition



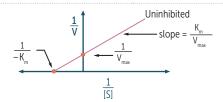
Lineweaver-Burk plot

The closer to 0 on the Y-axis, the higher the $\ensuremath{V_{\text{max}}}.$

The closer to 0 on the X-axis, the higher the K_m . The higher the K_m , the lower the affinity.

Competitive inhibitors cross each other, whereas noncompetitive inhibitors do not.

Kompetitive inhibitors increase K_m .



Effects of enzyme inhibition



	Competitive inhibitors, reversible	Competitive inhibitors, irreversible	Noncompetitive inhibitors
Resemble substrate	Yes	Yes	No
Overcome by † [S]	Yes	No	No
Bind active site	Yes	Yes	No
Effect on V _{max}	Unchanged	Ţ	†
Effect on K _m	1	Unchanged	Unchanged
Pharmacodynamics	↓ potency	↓ efficacy	↓ efficacy

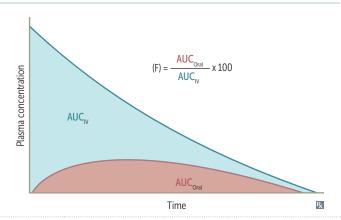
FAS1_2019_05-Pharmacology.indd 230 11/7/19 4:08 PM

Pharmacokinetics

Bioavailability (F)

Fraction of administered drug reaching systemic circulation unchanged. For an IV dose, F = 100%.

Orally: F typically < 100% due to incomplete absorption and first-pass metabolism. Can be calculated from the area under the curve in a plot of plasma concentration over time.



Volume of distribution (V_d)

Theoretical volume occupied by the total amount of drug in the body relative to its plasma concentration. Apparent V_d of plasma protein–bound drugs can be altered by liver and kidney disease (\downarrow protein binding, $\uparrow V_d$). Drugs may distribute in more than one compartment.

 $V_d = \frac{\text{amount of drug in the body}}{\text{plasma drug concentration}}$

V _d	COMPARTMENT	DRUG TYPES
Low	Intravascular	Large/charged molecules; plasma protein bound
Medium	ECF	Small hydrophilic molecules
High	All tissues including fat	Small lipophilic molecules, especially if bound to tissue protein

Clearance (CL)

The volume of plasma cleared of drug per unit time. Clearance may be impaired with defects in cardiac, hepatic, or renal function.

$$CL = \frac{rate~of~elimination~of~drug}{plasma~drug~concentration} = V_d \times K_e~(elimination~constant)$$

Half-life (t_{1/2})

The time required to change the amount of drug in the body by $\frac{1}{2}$ during elimination.

In first-order kinetics, a drug infused at a constant rate takes 4–5 half-lives to reach steady state. It takes 3.3 half-lives to reach 90% of the steady-state level.

$$t_{1/2} = \frac{0.7 \times V_d}{CL}$$
 in first-order elimination

# of half-lives	1	2	3	4
% remaining	50%	25%	12.5%	6.25%

Dosage calculations

$$Loading \ dose = \frac{C_p \times V_d}{F}$$

$$Maintenance \; dose = \frac{C_p \times CL \times \tau}{F}$$

 C_p = target plasma concentration at steady state τ = dosage interval (time between doses), if not administered continuously

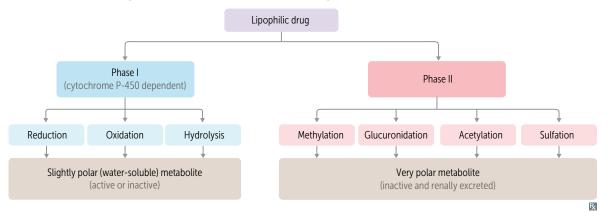
In renal or liver disease, maintenance dose ↓ and loading dose is usually unchanged.

Time to steady state depends primarily on $t_{1/2}$ and is independent of dose and dosing frequency.

FAS1_2019_05-Pharmacology.indd 231

Drug metabolism

Geriatric patients lose phase I first. Patients who are slow acetylators have † side effects from certain drugs because of ‡ rate of metabolism (eg, isoniazid).



Elimination of drugs

Zero-order elimination

Rate of elimination is constant regardless of C_p (ie, constant **amount** of drug eliminated per unit time). $C_p \downarrow$ linearly with time. Examples of drugs—Phenytoin, Ethanol, and Aspirin (at high or toxic concentrations).

Capacity-limited elimination.

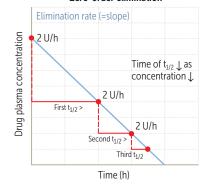
PEA (a pea is round, shaped like the "0" in zero-order).

First-order elimination

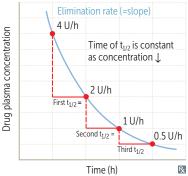
Rate of **F**irst-order elimination is directly proportional to the drug concentration (ie, constant **F**raction of drug eliminated per unit time). $C_p \downarrow$ exponentially with time. Applies to most drugs.

Flow-dependent elimination.

Zero-order elimination



First-order elimination



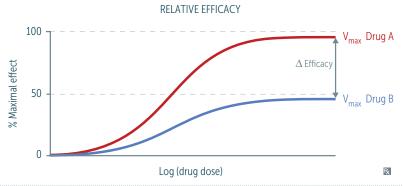
FAS1_2019_05-Pharmacology.indd 232 11/7/19 4:08 PM

Urine pH and drug elimination	Ionized species are trapped in urine and cleared quickly. Neutral forms can be reabsorbed.		
Weak acids	Examples: phenobarbital, methotrexate, aspirin (salicylates). Trapped in basic environments. Treat overdose with sodium bicarbonate to alkalinize urine.		
	$\begin{array}{ccc} RCOOH & \rightleftharpoons & RCOO^- + H^+ \\ \text{(lipid soluble)} & & \text{(trapped)} \end{array}$		
Weak bases	Examples: TCAs, amphetamines. Trapped in acidic environments. Treat overdose with ammonium chloride to acidify urine.		
	$RNH_3^+ \rightleftharpoons RNH_2 + H^+$		
	(trapped) (lipid soluble)		
	TCA toxicity is generally treated with sodium bicarbonate to overcome the sodium channel-blocking activity of TCAs, but not for accelerating drug elimination.		
рКа	pH at which drugs (weak acid or base) are 50% ionized and 50% nonionized. The pKa represents the strength of the weak acid or base.		

Efficacy vs potency

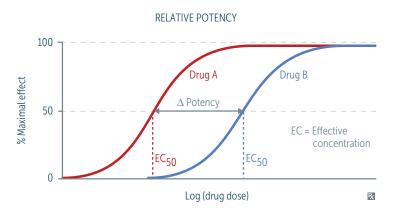
Efficacy

Maximal effect a drug can produce. Represented by the y-value (V_{max}) . † y-value = † V_{max} = † efficacy. Unrelated to potency (ie, efficacious drugs can have high or low potency). Partial agonists have less efficacy than full agonists.



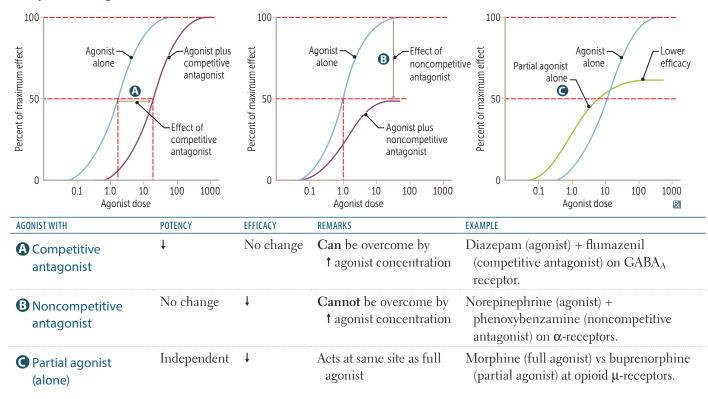
Potency

Amount of drug needed for a given effect. Represented by the x-value (EC₅₀). Left shifting = \downarrow EC₅₀ = \uparrow potency = \downarrow drug needed. Unrelated to efficacy (ie, potent drugs can have high or low efficacy).



FAS1_2019_05-Pharmacology.indd 233 11/7/19 4:08 PM

Receptor binding



Therapeutic index

Measurement of drug safety.

 $\frac{TD_{50}}{ED_{50}} = \frac{\text{median toxic dose}}{\text{median effective dose}}$

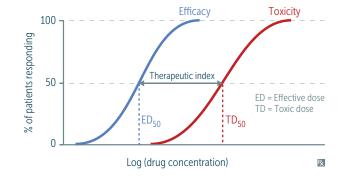
Therapeutic window—dosage range that can safely and effectively treat disease.

TITE: Therapeutic Index = TD₅₀ / ED₅₀.

Safer drugs have higher TI values. Drugs with lower TI values frequently require monitoring (eg, Warfarin, Theophylline, Digoxin, Antiepileptic drugs, Lithium; Warning! These Drugs Are Lethal!).

LD₅₀ (lethal median dose) often replaces TD₅₀.

 LD_{50} (lethal median dose) often replaces TD_{50} in animal studies.



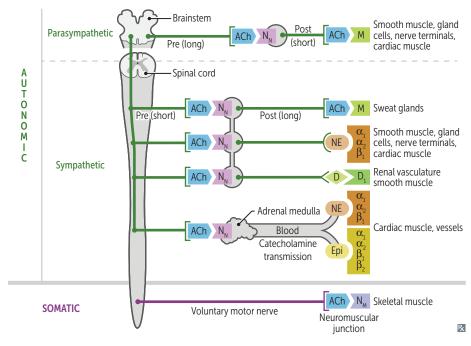
Types of drug interactions

TERM	DEFINITION	EXAMPLE
Additive	Effect of substances A and B together is equal to the sum of their individual effects	Aspirin and acetaminophen $2 + 2 = 4$ "
Permissive	Presence of substance A is required for the full effects of substance B	Cortisol on catecholamine responsiveness
Synergistic	Effect of substances A and B together is greater than the sum of their individual effects	Clopidogrel with aspirin "2 + 2 > 4"
Potentiation	Similar to synergism, but drug B with no therapeutic action enhances the therapeutic action of drug A	Carbidopa only blocks enzyme to prevent peripheral conversion of levodopa "2 + 0 > 2"
Antagonistic	Effect of substances A and B together is less than the sum of their individual effects	Ethanol antidote for methanol toxicity $"2 + 2 < 4"$
Tachyphylactic	Acute decrease in response to a drug after initial/repeated administration	Nitrates, niacin, phenylephrine, LSD, MDMA

FAS1_2019_05-Pharmacology.indd 235 11/7/19 4:08 PM

▶ PHARMACOLOGY—AUTONOMIC DRUGS

Autonomic receptors



Pelvic splanchnic nerves and CNs III, VII, IX and X are part of the parasympathetic nervous system. Adrenal medulla is directly innervated by preganglionic sympathetic fibers.

Sweat glands are part of the sympathetic pathway but are innervated by cholinergic fibers (sympathetic nervous system results in a "chold" sweat).

Acetylcholine receptors

Nicotinic ACh receptors are ligand-gated Na^+/K^+ channels. Two subtypes: N_N (found in autonomic ganglia, adrenal medulla) and N_M (found in neuromuscular junction of skeletal muscle). Muscarinic ACh receptors are G-protein–coupled receptors that usually act through 2nd messengers. 5 subtypes: M_{1-5} found in heart, smooth muscle, brain, exocrine glands, and on sweat glands (cholinergic sympathetic).

FAS1_2019_05-Pharmacology.indd 236 11/7/19 4:08 PM

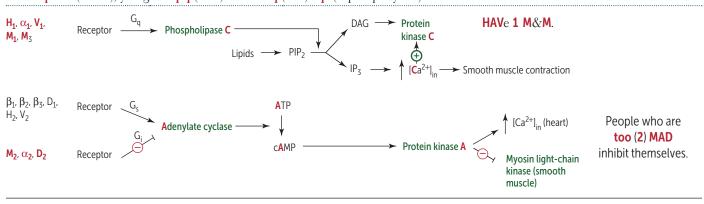
Micturition control	Micturition center in pons regulates involuntary bladder function via coordination of sympathetic and parasympathetic nervous systems. ■ ⊕ sympathetic → ↑ urinary retention ■ ⊕ parasympathetic → ↑ urine voiding. Some autonomic drugs act on smooth muscle receptors to treat bladder dysfunction.	Pelvic nerve (parasympathetic input) Hypogastric nerve (sympathetic input) Pudendal nerve (somatic input) Pudendal nerve (somatic input) Nicotinic receptor Detrusor muscle β ₃ -receptor Internal urethral sphincter External urethral sphincter
DRUGS	MECHANISM	USE
• Muscarinic antagonists (eg, oxybutynin)	⊕ M ₃ receptor → relaxation of detrusor smooth muscle → ↓ detrusor overactivity	Urgency incontinence
Muscarinic agonists (eg, bethanechol)	 ⊕ M₃ receptor → contraction of detrusor smooth muscle → ↑ bladder emptying 	Urinary retention
2 Sympathomimetics (eg, mirabegron)	⊕ β₃ receptor → relaxation of detrusor smooth muscle → ↑ bladder capacity	Urgency incontinence
3 α ₁ -blockers (eg, tamsulosin)	 ⇔ α₁-receptor → relaxation of smooth muscle (bladder neck, prostate) → ↓ urinary obstruction 	ВРН

11/7/19 4:08 PM FAS1_2019_05-Pharmacology.indd 237

G-protein-linked second messengers

RECEPTOR	G-PROTEIN CLASS	MAJOR FUNCTIONS	
Adrenergic			
α_1	q	† vascular smooth muscle contraction, † pupillary dilator muscle contraction (mydriasis), † intestinal and bladder sphincter muscle contraction	
$lpha_2$	i	↓ sympathetic (adrenergic) outflow, ↓ insulin release, ↓ lipolysis, ↑ platelet aggregation, ↓ aqueous humor production	
β ₁	S	† heart rate, † contractility (one heart), † renin release, † lipolysis	
β_2	S	Vasodilation, bronchodilation (two lungs), ↑ lipolysis, ↑ insulin release, ↑ glycogenolysis, ↓ uterine tone (tocolysis), ↑ aqueous humor production ↑ cellular K ⁺ uptake	
β ₃	S	↑ lipolysis, ↑ thermogenesis in skeletal muscle, ↑ bladder relaxation	
Cholinergic			
M_1	q	Mediates higher cognitive functions, stimulates enteric nervous system	
M ₂	i	↓ heart rate and contractility of atria	
M ₃	q	† exocrine gland secretions (eg, lacrimal, sweat, salivary, gastric acid), † gut peristalsis, † bladder contraction, bronchoconstriction, † pupillary sphincter muscle contraction (miosis), ciliary muscle contraction (accommodation), † insulin release, endothelium-mediated vasodilation	
Dopamine			
D ₁	S	Relaxes renal vascular smooth muscle, activates direct pathway of striatum	
D ₂	i	Modulates transmitter release, especially in brain, inhibits indirect pathway of striatum	
Histamine			
H ₁	q	† nasal and bronchial mucus production, † vascular permeability, bronchoconstriction, pruritus, pain	
H ₂	S	† gastric acid secretion	
Vasopressin			
\mathbf{V}_1	q	† vascular smooth muscle contraction	
V ₂	S	† H ₂ O permeability and reabsorption via upregulating aquaporin-2 in collecting twobules (tubules) of kidney, † release of vWF	

"After qisses (kisses), you get a qiq (kick) out of siq (sick) sqs (super qinky sex)."



FAS1_2019_05-Pharmacology.indd 238 11/7/19 4:08 PM

Autonomic drugs

Release of norepinephrine from a sympathetic nerve ending is modulated by NE itself, acting on presynaptic α₂-autoreceptors → negative feedback.

Amphetamines use the NE transporter (NET) to enter the presynaptic terminal, where they utilize the vesicular monoamine transporter (VMAT) to enter neurosecretory vesicles. This displaces NE from the vesicles. Once NE reaches a concentration threshold within the presynaptic terminal, the action of NET is reversed, and NE is expelled into the synaptic cleft, contributing to the characteristics and effects of † NE observed in patients taking amphetamines.

CHOLINERGIC NORADRENERGIC AXON AXON Tyrosine Choline Tyrosine Choline+ DOPA Acetyl-CoA Dopamine ChAT **VMAT** Reserpine Release-modulating ACh 📷 receptors II TA Amphetamine, ephedrine Reuptake Botulinum Negative feedback Cocaine, TCAs, Choline + amphetamine NE 🔾 acetate Diffusion, metabolism ACh receptor **AChE** inhibitors **AChE** Adrenore ceptors α or β POSTSYNAPTIC MEMBRANE **POSTSYNAPTIC MEMBRANE** Ŗ

represents transporters.

FAS1_2019_05-Pharmacology.indd 239 11/7/19 4:08 PM

DRUG	ACTION	APPLICATIONS
Direct agonists		
Bethanechol	Activates bladder smooth muscle; resistant to AChE. No nicotinic activity. "Bethany, call me to activate your bladder."	Urinary retention.
Carbachol	Carbon copy of acetylcholine (but resistant to AChE). Constricts pupil and relieves int pressure in open-angle glaucor	
<mark>M</mark> ethacholine	Stimulates muscarinic receptors in airway when inhaled.	Challenge test for diagnosis of asthma.
Pilo carpine	Contracts ciliary muscle of eye (open-angle glaucoma), pupillary sphincter (closed-angle glaucoma); resistant to AChE, can cross bloodbrain barrier (tertiary amine). "You cry, drool, and sweat on your 'pilow."	Potent stimulator of sweat, tears, and saliva Open-angle and closed-angle glaucoma, xerostomia (Sjögren syndrome).
Indirect agonists (anti-	cholinesterases)	
Donepezil, rivastigmine, galantamine	† ACh.	lst line for Alzheimer disease (Dona Riva dances at the gala).
Edrophonium	↑ ACh.	Historically used to diagnose myasthenia gravis replaced by anti-AChR Ab (anti-acetylcholine receptor antibody) test.
Neostigmine	† ACh. Neo CNS = No CNS penetration (quaternary amine).	Postoperative and neurogenic ileus and urinary retention, myasthenia gravis, reversal of neuromuscular junction blockade (postoperative).
Physostigmine Physical Physical	↑ ACh. Phreely (freely) crosses blood-brain barrier → CNS (tertiary amine).	Antidote for anticholinergic toxicity; physostigmine "phyxes" atropine overdose.
Pyridostigmine	↑ ACh; ↑ muscle strength. Used with glycopyrrolate, hyoscyamine, or propantheline to control pyridostigmine side effects. Pyridostigmine gets rid of myasthenia gravis.	Myasthenia gravis (long acting); does not penetrate CNS (quaternary amine).
Anticholinesterase poisoning	Often due to organophosphates (eg, parathion) that irreversibly inhibit AChE. Organophosphates commonly used as insecticides; poisoning usually seen in farmers.	
Muscarinic effects	Diarrhea, Urination, Miosis, Bronchospasm, Bradycardia, Emesis, Lacrimation, Sweating, Salivation.	DUMBBELSS. Reversed by atropine, a competitive inhibitor. Atropine can cross BBB to relieve CNS symptoms.
Nicotinic effects	Neuromuscular blockade (mechanism similar to succinylcholine).	Reversed by pralidoxime, regenerates AChE via dephosphorylation if given early. Pralidoxime (quaternary amine) does not readil cross BBB.

11/7/19 4:08 PM FAS1_2019_05-Pharmacology.indd 240

Muscarinic antagonists

DRUGS	ORGAN SYSTEMS	APPLICATIONS
Atropine, homatropine, tropicamide	Eye	Produce mydriasis and cycloplegia.
Benztropine, trihexyphenidyl	CNS	Parkinson disease ("park my Benz"). Acute dystonia.
Glycopyrrolate	GI, respiratory	Parenteral: preoperative use to reduce airway secretions. Oral: drooling, peptic ulcer.
Hyoscyamine, dicyclomine	GI	Antispasmodics for irritable bowel syndrome.
Ipratropium, tiotropium	Respiratory	COPD, asthma ("I pray I can breathe soon!").
Oxybutynin, solifenacin, tolterodine	Genitourinary	Reduce bladder spasms and urge urinary incontinence (overactive bladder).
Scopolamine	CNS	Motion sickness.
Atropine	Muscarinic antagonist. Used to treat bradycardia	and for ophthalmic applications.
ORGAN SYSTEM	ACTION	NOTES
Eye	† pupil dilation, cycloplegia	Blocks muscarinic effects (DUMBBELSS)
Airway	Bronchodilation, ↓ secretions	of anticholinesterases, but not the nicotinic
All way	· · · · · · · · · · · · · · · · · · ·	
Stomach	↓ acid secretion	effects.
		ettects.
Stomach	↓ acid secretion	effects.

FAS1_2019_05-Pharmacology.indd 241 11/7/19 4:08 PM

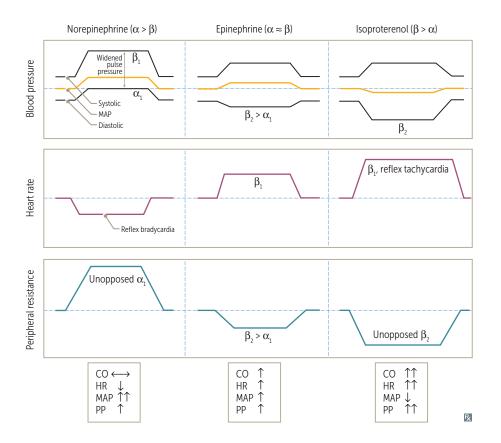
Sympathomimetics

DRUG	ACTION	HEMODYNAMIC CHANGES	APPLICATIONS
Direct sympathomimeti	CS		
Albuterol, salmeterol, terbutaline	$\beta_2 > \beta_1$	† HR (little effect)	Albuterol for Acute asthma/COPD. Salmeterol for Serial (long-term) asthma/COPD. Terbutaline for acute bronchospasm in asthma and tocolysis.
Dobutamine	$\beta_1>\beta_2,\alpha$	↔/↓ BP, ↑ HR, ↑ CO	Heart failure (HF), cardiogenic shock (inotropic > chronotropic), cardiac stress testing.
Dopamine	$D_1 = D_2 > \beta > \alpha$	† BP (high dose), † HR, † CO	Unstable bradycardia, HF, shock; inotropic and chronotropic effects at lower doses due to β effects; vasoconstriction at high doses due to α effects.
Epinephrine	$\beta > \alpha$	† BP (high dose), † HR, † CO	Anaphylaxis, asthma, open-angle glaucoma; α effects predominate at high doses. Significantly stronger effect at β_2 -receptor than norepinephrine.
Fenoldopam	D_1	↓ BP (vasodilation), ↑ HR,↑ CO	Postoperative hypertension, hypertensive crisis. Vasodilator (coronary, peripheral, renal, and splanchnic). Promotes natriuresis. Can cause hypotension and tachycardia.
Isoproterenol	$\beta_1 = \beta_2$	↓ BP (vasodilation), ↑ HR,↑ CO	Electrophysiologic evaluation of tachyarrhythmias. Can worsen ischemia. Has negligible α effect.
Midodrine	$lpha_{ m l}$	↑ BP (vasoconstriction), ↓ HR, ↔/↓ CO	Autonomic insufficiency and postural hypotension. May exacerbate supine hypertension.
Mirabegron	β_3		Urinary urgency or incontinence or overactive bladder. Think "mirab3gron."
Norepinephrine	$\alpha_l>\alpha_2>\beta_l$	† BP, † HR, ↔/† CO	Hypotension, septic shock.
Phenylephrine	$\alpha_1>\alpha_2$	† BP (vasoconstriction), ↓ HR, ↔/↓ CO	Hypotension (vasoconstrictor), ocular procedures (mydriatic), rhinitis (decongestant), ischemic priapism.
Indirect sympathomime	etics		
Amphetamine	Indirect general agonist, reuptake inhibitor, also releases stored catecholamines		Narcolepsy, obesity, ADHD.
Cocaine	Indirect general agonist, reuptake inhibitor		Causes vasoconstriction and local anesthesia. Caution when giving β-blockers if cocaine intoxication is suspected (can lead to unopposed α₁ activation → extreme hypertension, coronary vasospasm).
Ephedrine	Indirect general a catecholamines	gonist, releases stored	Nasal decongestion (pseudoephedrine), urinary incontinence, hypotension.

FAS1_2019_05-Pharmacology.indd 242 11/7/19 4:08 PM

Norepinephrine vs isoproterenol

NE \uparrow systolic and diastolic pressures as a result of α_1 -mediated vasoconstriction $\rightarrow \uparrow$ mean arterial pressure \rightarrow reflex bradycardia. However, isoproterenol (rarely used) has little α effect but causes β_2 -mediated vasodilation, resulting in \downarrow mean arterial pressure and \uparrow heart rate through β_1 and reflex activity.



Sympatholytics (α₂-agonists)

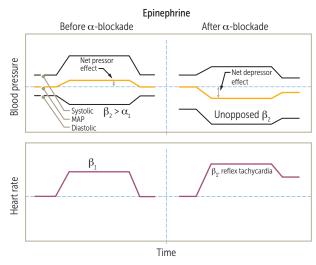
DRUG	APPLICATIONS	ADVERSE EFFECTS	
Clonidine, guanfacine	Hypertensive urgency (limited situations), ADHD, Tourette syndrome, symptom control in opioid withdrawal	CNS depression, bradycardia, hypotension, respiratory depression, miosis, rebound hypertension with abrupt cessation	
α -methyldopa	Hypertension in pregnancy	Direct Coombs ⊕ hemolysis, drug-induced lupus, hyperprolactinemia	
Tizanidine	Relief of spasticity	Hypotension, weakness, xerostomia	

FAS1_2019_05-Pharmacology.indd 243 11/7/19 4:08 PM

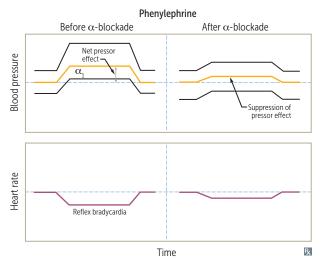
α-blockers

DRUG	APPLICATIONS	ADVERSE EFFECTS	
Nonselective			
Phenoxybenzamine Irreversible. Pheochromocytoma (used preoperatively) to prevent catecholamine (hypertensive) crisis			
Phentolamine	Reversible. Given to patients on MAO inhibitors who eat tyramine-containing foods and for severe cocaine-induced hypertension (2nd line)	Orthostatic hypotension, reflex tachycardia	
α_1 selective (-osin endir	ng)		
Prazosin, terazosin, Urinary symptoms of BPH; PTSD (prazosin); doxazosin, hypertension (except tamsulosin) tamsulosin		lst-dose orthostatic hypotension, dizziness, headache	
α_2 selective			
Mirtazapine	Depression	Sedation, † serum cholesterol, † appetite	

zapine Depression Sedation, † serum cholesterol, † appetite



Epinephrine response exhibits reversal of mean arterial pressure from a net increase (the α response) to a net decrease (the β_2 response).



Phenylephrine response is suppressed but not reversed because it is a "pure" α -agonist (lacks β -agonist properties).

FAS1_2019_05-Pharmacology.indd 244 11/7/19 4:08 PM

β-blockers	Acebutolol, atenolol, betaxolol, bisoprolol, carvedilol, esmolol, labetalol, metoprolol, nadolol, nebivolol, pindolol, propranolol, timolol.		
APPLICATION	ACTIONS	NOTES/EXAMPLES	
Angina pectoris	↓ heart rate and contractility → ↓ O ₂ consumption		
Glaucoma	↓ production of aqueous humor	Timolol	
Heart failure	↓ mortality	Bisoprolol, Carvedilol, Metoprolol (β-blockers Curb Mortality)	
Hypertension	↓ cardiac output, ↓ renin secretion (due to β₁- receptor blockade on JG cells)		
Hyperthyroidism/ thyroid storm	Symptom control (↓ heart rate, ↓ tremor)	Propranolol	
Hypertrophic cardiomyopathy	↓ heart rate → ↑ filling time, relieving obstruction		
Myocardial infarction	↓ O ₂ demand (short-term), ↓ mortality (long-term)		
Supraventricular tachycardia	↓ AV conduction velocity (class II antiarrhythmic)	Metoprolol, esmolol	
Variceal bleeding	↓ hepatic venous pressure gradient and portal hypertension (prophylactic use)	Nadolol, propranolol, carvedilol	
ADVERSE EFFECTS	Erectile dysfunction, cardiovascular (bradycardia, AV block, HF), CNS (seizures, sleep alterations), dyslipidemia (metoprolol), and asthma/COPD exacerbations	Use of β-blockers for acute cocaine-associated chest pain remains controversial due to unsubstantiated concern for unopposed α-adrenergic stimulation	
SELECTIVITY	β_1 -selective antagonists ($\beta_1 > \beta_2$)—acebutolol (partial agonist), atenolol, betaxolol, bisoprolol, esmolol, metoprolol	Selective antagonists mostly go from A to M $(\beta_l$ with lst half of alphabet)	
	Nonselective antagonists $(\beta_1 = \beta_2)$ —nadolol, pindolol (partial agonist), propranolol, timolol	NonZelective antagonists mostly go from N to Z (β_2 with 2nd half of alphabet)	
	Nonselective α - and β -antagonists—carvedilol, labetalol	Nonselective α - and β -antagonists have modified suffixes (instead of "-olol")	
	Nebivolol combines cardiac-selective β ₁ -adrenergic blockade with stimulation of β ₃ -receptors (activate nitric oxide synthase in the vasculature and ↓ SVR)	Nebivolol increases NO	

11/7/19 4:08 PM FAS1_2019_05-Pharmacology.indd 245

Phosphodiesterase inhibitors

Phosphodiesterase (PDE) inhibitors inhibit PDE, which catalyzes the hydrolysis of cAMP and/or cGMP, and thereby increase cAMP and/or cGMP. These inhibitors have varying specificity for PDE isoforms and thus have different clinical uses.

TYPE OF INHIBITOR	MECHANISM OF ACTION	CLINICAL USES	ADVERSE EFFECTS
Nonspecific PDE inhibitor Theophylline	↓ cAMP hydrolysis → ↑ cAMP → bronchial smooth muscle relaxation → bronchodilation	COPD/asthma (rarely used)	Cardiotoxicity (eg, tachycardia, arrhythmia), neurotoxicity (eg, headache), abdominal pain
PDE-5 inhibitors Sildenafil, vardenafil, tadalafil, avanafil	 I hydrolysis of cGMP → ↑ cGMP → ↑ smooth muscle relaxation by enhancing NO activity → pulmonary vasodilation and ↑ blood flow in corpus cavernosum fills the penis 	Erectile dysfunction Pulmonary hypertension BPH (tadalafil only)	Facial flushing, headache, dyspepsia, hypotension in patients taking nitrates; "Hot and sweaty," then Headache, Heartburn, Hypotension Sildenafil only: cyanopia (bluetinted vision) via inhibition of PDE-6 in retina
PDE-4 inhibitor Roflumilast	† cAMP in neutrophils, granulocytes, and bronchial epithelium	Severe COPD	Abdominal pain, weight loss, mental disorders (eg, depression)
PDE-3 inhibitor Milrinone	In cardiomyocytes: ↑ cAMP → ↑ Ca ²⁺ influx → ↑ ionotropy and chronotropy In vascular smooth muscle: ↑ cAMP → MLCK inhibition → vasodilation → ↓ preload and afterload	Acute decompensated HF with cardiogenic shock	Tachycardia, ventricular arrhythmias (thus not for chronic use), hypotension
"Platelet inhibitors" Cilostazol ^a Dipyridamole ^b	In platelets: ↑ cAMP → inhibition of platelet aggregation	Intermittent claudication Stroke or TIA prevention (with aspirin) Cardiac stress testing (dipyridamole only, due to coronary vasodilation) Prevention of coronary stent restenosis	Nausea, headache, facial flushing, hypotension, abdominal pain

^aCilostazol is a PDE-3 inhibitor, but due to its indications is categorized as a platelet inhibitor together with dipyridamole.

FAS1_2019_05-Pharmacology.indd 246 11/7/19 4:08 PM

^bDipyridamole is a nonspecific PDE inhibitor, leading to inhibition of platelet aggregation. It also prevents adenosine reuptake by platelets → ↑ extracellular adenosine → ↑ vasodilation.

Ingested seafood toxins

Toxin actions include **H**istamine release, **T**otal block of Na⁺ channels, or opening of Na⁺ channels to Cause depolarization.

TOXIN	SOURCE	ACTION	SYMPTOMS	TREATMENT
Histamine (scombroid poisoning)	Spoiled dark-meat fish such as tuna, mahi- mahi, mackerel, and bonito	Bacterial histidine decarboxylase converts histidine to histamine Frequently misdiagnosed as fish allergy	Mimics anaphylaxis: acute burning sensation of mouth, flushing of face, erythema, urticaria, itching May progress to bronchospasm, angioedema, hypotension	Antihistamines Albuterol and epinephrine if needed
Tetrodotoxin	Pufferfish	Highly potent toxin; binds fast voltage-gated Na ⁺ channels in nerve tissue, preventing depolarization	Nausea, diarrhea, paresthesias, weakness, dizziness, loss of reflexes	Supportive
Ciguatoxin	Reef fish such as barracuda, snapper, and moray eel	Opens Na ⁺ channels, causing depolarization	Nausea, vomiting, diarrhea; perioral numbness; reversal of hot and cold sensations; bradycardia, heart block, hypotension	Supportive

Beers criteria

Widely used criteria developed to reduce potentially inappropriate prescribing and harmful polypharmacy in the geriatric population. Includes > 50 medications that should be avoided in elderly patients due to \$\ddot\$ efficacy and/or \$\ddot\$ risk of adverse events. Examples:

- α-blockers († risk of hypotension)
- Anticholinergics, antidepressants, antihistamines, opioids († risk of delirium, sedation, falls, constipation, urinary retention)
- Benzodiazepines († risk of delirium, sedation, falls)
- NSAIDs († risk of GI bleeding, especially with concomitant anticoagulation)
- PPIs († risk of *C difficile* infection)

FAS1_2019_05-Pharmacology.indd 247 11/7/19 4:08 PM

► PHARMACOLOGY—TOXICITIES AND SIDE EFFECTS

Specific toxicity treatments

TOXIN	TREATMENT	
Acetaminophen	N-acetylcysteine (replenishes glutathione)	
AChE inhibitors, organophosphates	Atropine > pralidoxime	
Antimuscarinic, anticholinergic agents	Physostigmine (crosses BBB), control hyperthermia	
Arsenic	Dimercaprol, succimer	
Benzodiazepines	Flumazenil	
β-blockers	Atropine, glucagon, saline	
Carbon monoxide	100% O ₂ , hyperbaric O ₂	
Copper	"Penny"cillamine (penicillamine), trientine (copper penny × 3)	
Cyanide	Hydroxocobalamin, nitrites + sodium thiosulfate	
Digitalis (digoxin)	Digoxin-specific antibody fragments	
Heparin	Protamine sulfate	
Iron (Fe)	Deferoxamine, deferasirox, deferiprone	
Lead	Calcium disodium EDTA, dimercaprol, succimer, penicillamine	
Mercury	Di <mark>mer</mark> caprol, succi <mark>mer</mark>	
Methanol, ethylene glycol (antifreeze)	Fomepizole > ethanol, dialysis	
Meth emoglobin	Methylene blue, vitamin C (reducing agent)	
OpiO ids	NalOx <mark>O</mark> ne	
Salicylates	NaHCO3 (alkalinize urine), dialysis	
TCAs	NaHCO3 (stabilizes cardiac cell membrane)	
Warfarin	Vitamin K (delayed effect), PCC (prothrombin complex concentrate)/FFP (immediate effect)	

Drug reactions—cardiovascular

DRUG REACTION	CAUSAL AGENTS	
Coronary vasospasm	Cocaine, Amphetamines, Sumatriptan, Ergot alkaloids (CASE)	
Cutaneous flushing	Vancomycin, Adenosine, Niacin, Ca ²⁺ channel blockers, Echinocandins, Nitrates (flushed from VANCEN [dancing])	
	Red man syndrome—rate-dependent infusion reaction to vancomycin causing widespread prurition erythema due to histamine release. Manage with diphenhydramine, slower infusion rate.	
Dilated cardiomyopathy	Anthracyclines (eg, Doxorubicin, Daunorubicin); prevent with Dexrazoxane	
Torsades de pointes	Agents that prolong QT interval: antiArrhythmics (class IA, III), antiBiotics (eg, macrolides), anti"C"ychotics (eg, ziprasidone), antiDepressants (eg, TCAs), antiEmetics (eg, ondansetron) (ABCDE)	

FAS1_2019_05-Pharmacology.indd 248 11/7/19 4:08 PM

Drug reactions—endocrine/reproductive

DRUG REACTION	CAUSAL AGENTS	NOTES
Adrenocortical insufficiency	HPA suppression 2° to glucocorticoid withdrawal	
Diabetes insipidus	Lithium, demeclocycline	
Hot flashes	SERMs (eg, tamoxifen, clomiphene, raloxifene)	
Hyperglycemia	Tacrolimus, Protease inhibitors, Niacin, HCTZ, Corticosteroids	The People Need Hard Candies
Hyperprolactinemia	Typical antipsychotics (eg, haloperidol), atypical antipsychotics (eg, risperidone), metoclopramide, methyldopa, reserpine	Presents with hypogonadism (eg, infertility, amenorrhea, erectile dysfunction) and galactorrhea
Hyperthyroidism	Amiodarone, iodine	
Hypothyroidism	AMiodarone, SUlfonamides, Lithium	I AM SU ddenly L ethargic
SIADH	Carbamazepine, Cyclophosphamide, SSRIs	Can't Concentrate Serum Sodium

Drug reactions—gastrointestinal

DRUG REACTION	CAUSAL AGENTS	NOTES
Acute cholestatic hepatitis, jaundice	Macrolides (eg, erythromycin)	
Diarrhea	Acamprosate, antidiabetic agents (acarbose, metformin, pramlintide), colchicine, cholinesterase inhibitors, lipid-lowering agents (eg, ezetimibe, orlistat), macrolides (eg, erythromycin), SSRIs, chemotherapy (eg, irinotecan)	
Focal to massive hepatic necrosis	Halothane, Amanita phalloides (death cap mushroom), Valproic acid, Acetaminophen	Liver "HAVAc"
Hepatitis	Rifampin, isoniazid, pyrazinamide, statins, fibrates	
Pancreatitis	Didanosine, Corticosteroids, Alcohol, Valproic acid, Azathioprine, Diuretics (eg, furosemide, HCTZ)	Drugs Causing A Violent Abdominal Distress
Pill-induced esophagitis	Bisphosphonates, ferrous sulfate, NSAIDs, potassium chloride, tetracyclines	Caustic effect minimized with upright posture and adequate water ingestion
Pseudomembranous colitis	Ampicillin, cephalosporins, clindamycin, fluoroquinolones, PPIs	Antibiotics predispose to superinfection by resistant <i>C difficile</i>

FAS1_2019_05-Pharmacology.indd 249 11/7/19 4:08 PM

Drug reactions—hematologic

DRUG REACTION	CAUSAL AGENTS	NOTES
Agranulocytosis	Dapsone, Clozapine, Carbamazepine, Propylthiouracil, Methimazole, Colchicine, Ganciclovir	Drugs Can Cause Pretty Major Collapse of Granulocytes
Aplastic anemia	Carbamazepine, Methimazole, NSAIDs, Benzene, Chloramphenicol, Propylthiouracil	Can't Make New Blood Cells Properly
Direct Coombs ⊕ hemolytic anemia	Penicillin, methylDopa, Cephalosporins	P Diddy Coombs
Drug reaction with eosinophilia and systemic symptoms (DRESS)	Allopurinol, anticonvulsants, antibiotics, sulfa drugs	Potentially fatal delayed hypersensitivity reaction. Latency period (2- 8 weeks), then fever, morbilliform skin rash, frequent multiorgan involvement. Treatment: withdrawal of offending drug, corticosteroids
Gray baby syndrome	Chloramphenicol	
Hemolysis in G6PD deficiency	Isoniazid, Sulfonamides, Dapsone, Primaquine, Aspirin, Ibuprofen, Nitrofurantoin	Hemolysis IS D PAIN
Megaloblastic anemia	Hydrox <mark>yur</mark> ea, P henytoin, M ethotrexate, S ulfa drugs	You're having a mega blast with PMS
Thrombocytopenia	Heparin, vancomycin, linezolid, quinidine, indinavir, ganciclovir, abciximab	
Thrombotic complications	Combined oral contraceptives, hormone replacement therapy, SERMs (eg, tamoxifen)	Estrogen-mediated side effect

Drug reactions—musculoskeletal/skin/connective tissue

DRUG REACTION	CAUSAL AGENTS	NOTES
Drug-induced <mark>lupus</mark>	Methyldopa, Minocycline, Hydralazine, Isoniazid, Phenytoin, Sulfa drugs, Etanercept, Procainamide	Lupus Makes My HIPS Extremely Painful
Fat redistribution	Protease inhibitors, Glucocorticoids	Fat PiG
Gingival hyperplasia	Cyclosporine, Ca ²⁺ channel blockers, Phenytoin	Can Cause Puffy gums
Hyperuricemia (gout)	Pyrazinamide, Thiazides, Furosemide, Niacin, Cyclosporine	Painful Tophi and Feet Need Care
Myopathy	Statins, fibrates, niacin, colchicine, daptomycin, hydroxychloroquine, interferon-α, penicillamine, glucocorticoids	
Osteoporosis	Corticosteroids, depot medroxyprogesterone acetate, GnRH agonists, aromatase inhibitors, anticonvulsants, heparin, PPIs	
Photosensitivity	Sulfonamides, Amiodarone, Tetracyclines, 5-FU	SAT For Photo
Rash (Stevens-Johnson syndrome)	Anti-epileptic drugs (especially lamotrigine), allopurinol, sulfa drugs, penicillin	Steven Johnson has epileptic allergy to sulfa drugs and penicillin
Teeth discoloration	Tet racyclines	Teethracyclines
Tendon/cartilage damage	Fluoroquinolones	

FAS1_2019_05-Pharmacology.indd 250 11/7/19 4:08 PM

Drug reactions—neurologic

DRUG REACTION	CAUSAL AGENTS	NOTES
Cinchonism	Quinidine, quinine	Can present with tinnitus, hearing/vision loss, psychosis, and cognitive impairment
Parkinson-like syndrome	Antipsychotics, Reserpine, Metoclopramide	Cogwheel rigidity of ARM
Peripheral neuropathy	Isoniazid, phenytoin, platinum agents (eg, cisplatin), vincristine	
Idiopathic intracranial hypertension	Growth hormones, tetracyclines, vitamin A	
Seizures	Isoniazid, Bupropion, Imipenem/cilastatin, Tramadol, Enflurane	With seizures, I BITE my tongue
Tardive dyskinesia	Antipsychotics, metoclopramide	
Visual disturbance	Topiramate (blurred vision/diplopia, haloes), Digoxin (yellow-tinged vision), Isoniazid (optic neuritis), Vigabatrin (bilateral visual field defects), PDE-5 inhibitors (blue-tinged vision), Ethambutol (color vision changes)	These Drugs Irritate Very Precious Eyes

Drug reactions—renal/genitourinary

DRUG REACTION	CAUSAL AGENTS	NOTES
Fanconi syndrome	e Cisplatin, ifosfamide, expired tetracyclines, tenofovir	
Hemorrhagic cystitis	Cyclophosphamide, ifosfamide	Prevent by coadministering with mesna
Interstitial nephritis	Diuretics (Pee), NSAIDs (Pain-free), Penicillins and cephalosporins, PPIs, rifamPin, and sulfa drugs	Remember the 5 P 's

Drug reactions—respiratory

	<u> </u>	
DRUG REACTION	CAUSAL AGENTS	NOTES
Dry cough	ACE inhibitors	
Pulmonary fibrosis	Methotrexate, Nitrofurantoin, Carmustine, Bleomycin, Busulfan, Amiodarone	My Nose Cannot Breathe Bad Air

Drug reactions—multiorgan

DRUG REACTION	CAUSAL AGENTS	NOTES
Antimuscarinic	Atropine, TCAs, H ₁ -blockers, antipsychotics	
Disulfiram-like reaction	lst-generation Sulfonylureas, Procarbazine, certain Cephalosporins, Griseofulvin, Metronidazole	Sorry Pals, Can't Go Mingle
Nephrotoxicity/ ototoxicity	Loop diuretics, Aminoglycosides, cisPlatin, Vancomycin, amphoTERicin B	Listen And Pee Very TERriBly Cisplatin toxicity may respond to amifostine

FAS1_2019_05-Pharmacology.indd 251 11/7/19 4:08 PM

Drugs affecting pupil size

† pupil size	↓ pupil size
Anticholinergics (eg, atropine, TCAs, tropicamide, scopolamine, antihistamines)	Sympatholytics (eg, α_2 -agonists)
Drugs of abuse (eg, amphetamines, cocaine, LSD), meperidine	Drugs of abuse (eg, heroin/opioids)
Sympathomimetics	Parasympathomimetics (eg, pilocarpine), organophosphates

Cytochrome P-450 interactions (selected)

Inducers (+)	Substrates	Inhibitors (–)
Mo dafinil	War farin	Sodium valproate
Chronic alcohol use	Anti-epileptics	Isoniazid
St. John's wort	The ophylline	Cimetidine
Phen ytoin	OCPs	K etoconazole
Phen obarbital		Fluconazole
Nev irapine		Acute alcohol abuse
R ifampin		Chloramphenicol
Griseofulvin		Erythromycin/clarithromycin
Carb amazepine		S ulfonamides
		Ciprofloxacin
		Omeprazole
		M etronidazole
		Am iodarone
		Ritonavir
		Grapefruit juice
Most chronic alcoholics Steal Phen-Phen and Never Refuse Greasy Carbs	War Against The OCPs	SICKFACES.COM (when I Am Really drinking Grapefruit juice)

Sulfa drugs

Sulfonamide antibiotics, Sulfasalazine, Probenecid, Furosemide, Acetazolamide, Celecoxib, Thiazides, Sulfonylureas.
Patients with sulfa allergies may develop fever, urinary tract infection, Stevens-Johnson syndrome, hemolytic anemia, thrombocytopenia, agranulocytosis, acute interstitial nephritis, and urticaria (hives).

Scary Sulfa Pharm FACTS

FAS1_2019_05-Pharmacology.indd 252 11/7/19 4:08 PM

▶ PHARMACOLOGY — MISCELLANEOUS

ENDING	CATEGORY	EXAMPLE
Antimicrobial		
-bendazole	Antiparasitic/antihelminthic	Mebendazole
-cillin	Transpeptidase inhibitor	Ampicillin
-conazole	Ergosterol synthesis inhibitor	Ketoconazole
-cycline	Protein synthesis inhibitor	Tetracycline
-ivir	Neuraminidase inhibitor	Oseltamivir
-navir	Protease inhibitor	Ritonavir
-ovir	Viral DNA polymerase inhibitor	Acyclovir
-tegravir	Integrase inhibitor	Elvitegravir, raltegravir
-thromycin	Macrolide antibiotic	Azithromycin
CNS		
-apine, -idone	Atypical antipsychotic	Quetiapine, risperidone
-azine	Typical antipsychotic	Thioridazine
-barbital	Barbiturate	Phenobarbital
-ipramine, -triptyline	TCA	Imipramine, amitriptyline
-triptan	5-HT _{IB/ID} agonist	Sumatriptan
-zepam, -zolam	Benzodiazepine	Diazepam, alprazolam
Autonomic		
-chol	Cholinergic agonist	Bethanechol, carbachol
-olol	β-blocker	Propranolol
-stigmine	AChE inhibitor	Neostigmine
-terol	β ₂ -agonist	Albuterol
-zosin	α ₁ -blocker	Prazosin
Cardiovascular		
-afil	PDE-5 inhibitor	Sildenafil
-dipine	Dihydropyridine Ca ²⁺ channel blocker	Amlodipine
-pril	ACE inhibitor	Captopril
-sartan	Angiotensin-II receptor blocker	Losartan
-xaban	Direct factor Xa inhibitor	Api <mark>xa</mark> ban, edo <mark>xa</mark> ban, rivaro <mark>xa</mark> ban
Metabolic		
-gliflozin	SGLT-2 inhibitor	Dapagliflozin, canagliflozin
-glinide	Meglitinide	Repaglinide, nateglinide
-gliptin	DPP-4 inhibitor	Sitagliptin
		V 1

FAS1_2019_05-Pharmacology.indd 253 11/7/19 4:08 PM

Rosiglitazone

Liraglutide, albiglutide

PPAR-γ activator

GLP-1 analog

-glitazone -glutide 254 SECTION II

PHARMACOLOGY → PHARMACOLOGY—MISCELLANEOUS

Drug names (continued)

ENDING	CATEGORY	EXAMPLE	
Other			
-dronate	Bisphosphonate	Alendronate	
-prazole	Proton pump inhibitor	Omeprazole	
-prost	Prostaglandin analog	Latanoprost	
-sentan	Endothelin receptor antagonist	Bosentan	
-tidine	H ₂ -antagonist	Cimetidine	
-vaptan	ADH antagonist	Tolvaptan	

Biologic agents

ENDING	CATEGORY	EXAMPLE
Monoclonal ant	ibodies (-mab)—target overexpressed cell surface rece	ptors
-ximab	Chimeric human-mouse monoclonal antibody	Rituximab
- <mark>zu</mark> mab	Humanized mouse monoclonal antibody	Bevacizumab
-umab	Human monoclonal antibody	Denosumab
Small molecule	inhibitors (-ib)—target intracellular molecules	
-tinib	Tyrosine kinase inhibitor	Imatinib
-zomib	Proteasome inhibitor	Bortezomib
-ciclib	Cyclin-dependent kinase inhibitor	Palbociclib
Receptor fusion	proteins (-cept)	
-cept	TNF- α antagonist	Etanercept
Interleukin rece	ptor modulators (-kin)—agonists and antagonists of inf	terleukin receptors
-leukin	IL-2 agonist/analog	Aldesleukin
-kinra	Interleukin receptor antagonist	Anakinra

FAS1_2019_05-Pharmacology.indd 254 11/7/19 4:08 PM

HIGH-YIELD PRINCIPLES IN

Public Health Sciences

"Medicine is a science of uncertainty and an art of probability."

-William Osler

"There are two kinds of statistics: the kind you look up and the kind you make up."

-Rex Stout

"On a long enough timeline, the survival rate for everyone drops to zero."

—Chuck Palahniuk

"There are three kinds of lies: lies, damned lies, and statistics."

-Mark Twain

A heterogenous mix of epidemiology, biostatistics, ethics, law, healthcare delivery, patient safety, quality improvement, and more falls under the heading of public health sciences. Biostatistics and epidemiology are the foundations of evidence-based medicine and are very high yield. Make sure you can quickly apply biostatistical equations such as sensitivity, specificity, and predictive values in a problem-solving format. Also, know how to set up your own 2 × 2 tables. Quality improvement and patient safety topics were introduced a few years ago on the exam and represent trends in health system science. Medical ethics questions often require application of principles. Typically, you are presented with a patient scenario and then asked how you would respond.

► Epidemiology and Biostatistics 25

256

▶ Ethics

265

270

▶ The Well Patient

▶ Healthcare Delivery 270

▶ Quality and Safety 273

255

FAS1_2019_06-PubHealth.indd 255 11/7/19 4:16 PM

Observational studies		
STUDY TYPE	DESIGN	MEASURES/EXAMPLE
Cross-sectional study	Frequency of disease and frequency of risk- related factors are assessed in the present. Asks, "What is happening?"	Disease prevalence. Can show risk factor association with disease, bu does not establish causality.
Case-control study	Compares a group of people with disease to a group without disease. Looks to see if odds of prior exposure or risk factor differ by disease state. Asks, "What happened?"	Odds ratio (OR). Patients with COPD had higher odds of a smoking history than those without COPD.
Cohort study	Compares a group with a given exposure or risk factor to a group without such exposure. Looks to see if exposure or risk factor is associated with later development of disease. Can be prospective or retrospective.	Relative risk (RR). Smokers had a higher risk of developing COPD than nonsmokers. Cohort = relative risk.
Crossover study	Compares the effect of a series of ≥2 treatments on a participant. Order in which participants receive treatments is randomized. Washout period occurs between each treatment.	Allows participants to serve as their own controls.
Twin concordance study	Compares the frequency with which both monozygotic twins vs both dizygotic twins develop the same disease.	Measures heritability and influence of environmental factors ("nature vs nurture").
Adoption study	Compares siblings raised by biological vs adoptive parents.	Measures heritability and influence of environmental factors.
Clinical trial	Experimental study involving humans. Compare treatment and placebo. Study quality improves blinded (ie, neither patient nor doctor knows wl group). Triple-blind refers to the additional blin Four phases ("Does the drug SWIM?").	when study is randomized, controlled, and double- nether the patient is in the treatment or control
DRUG TRIALS	TYPICAL STUDY SAMPLE	PURPOSE
Phase I	Small number of either healthy volunteers or patients with disease of interest.	"Is it Safe?" Assesses safety, toxicity, pharmacokinetics, and pharmacodynamics.
Phase II	Moderate number of patients with disease of interest.	"Does it Work?" Assesses treatment efficacy, optimal dosing, and adverse effects.
Phase III	Large number of patients randomly assigned either to the treatment under investigation or to the standard of care (or placebo).	"Is it as good or better?" Compares the new treatment to the current standard of care (any Improvement?).
Phase IV	Postmarketing surveillance of patients after treatment is approved.	"Can it stay?" Detects rare or long-term adverse effects (eg, black box warnings). Can result in treatment being withdrawn from Market.

11/7/19 4:16 PM FAS1_2019_06-PubHealth.indd 256

Sensitivity and specificity are fixed properties Disease **Evaluation of (+)** Θ of a test. PPV and NPV vary depending on diagnostic tests PPV disease prevalence in population being tested. TP FP = TP/(TP + FP) NPV Θ FN TN = TN/(TN + FN) Prevalence TP + FN (TP + FN + FP + TN) Specificity Sensitivity =TN/(TN + FP Proportion of all people with disease who test = TP / (TP + FN)Sensitivity (truepositive rate) positive, or the probability that when the = 1 - FN rate disease is present, the test is positive. **SN-N-OUT** = highly **SeN**sitive test, when Value approaching 100% is desirable for ruling Negative, rules **OUT** disease out disease and indicates a low false-negative High sensitivity test used for screening rate. Specificity (true-Proportion of all people without disease who = TN / (TN + FP)negative rate) test negative, or the probability that when the = 1 - FP rate disease is absent, the test is negative. **SP-P-IN** = highly **SP**ecific test, when **P**ositive, Value approaching 100% is desirable for ruling rules IN disease in disease and indicates a low false-positive High specificity test used for confirmation after a positive screening test rate Positive predictive Probability that a person who has a positive test PPV = TP / (TP + FP)PPV varies directly with pretest probability result actually has the disease. value (baseline risk, such as prevalence of disease): high pretest probability → high PPV NPV = TN / (TN + FN)**Negative predictive** Probability that a person with a negative test value result actually does not have the disease. NPV varies inversely with prevalence or pretest probability Possible cutoff values for (+) vs (-) test result Disease Disease A = 100% sensitivity cutoff value Number of people absent present **B** = practical compromise between specificity and sensitivity = 100% specificity cutoff value ΤP TN Lowering the cutoff value: ↑ Sensitivity ↑ NPV $\mathbf{B} \rightarrow \mathbf{A} (\uparrow \mathsf{FP} \downarrow \mathsf{FN})$ ↓ Specificity ↓ PPV FN ↑ Specificity ↑ PPV Raising the cutoff value: В $\mathbf{B} \rightarrow \mathbf{C} (\uparrow \mathsf{FN} \downarrow \mathsf{FP})$ ↓ Sensitivity ↓ NPV Test results $LR^{+} = \frac{sensitivity}{1 - specificity}$ Likelihood ratio Likelihood that a given test result would be TP rate expected in a patient with the target disorder compared to the likelihood that the same result would be expected in a patient without the $LR^{-} = \frac{1 - sensitivity}{specificity} = \frac{FN \text{ rate}}{TN \text{ rate}}$ target disorder. LR⁺ > 10 indicates a highly specific test, while LR⁻ < 0.1 indicates a highly sensitive test.

FAS1_2019_06-PubHealth.indd 257 11/7/19 4:16 PM

LRs can be multiplied with pretest odds of disease to estimate posttest odds.

Quantifying risk

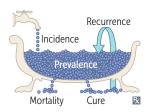
Definitions and formulas are based on the classic 2×2 or contingency table.

Ξ.	Disease or	outcome
Exposure intervention \bigcirc \bigcirc	a	b
r inter	С	d

TERM	DEFINITION	EXAMPLE	FORMULA
Odds ratio	Typically used in case-control studies. Represents the odds of exposure among cases (a/c) vs odds of exposure among controls (b/d).	If in a case-control study, 20/30 lung cancer patients and 5/25 healthy individuals report smoking, the OR is 8; so the lung cancer patients are 8 times more likely to have a history of smoking.	$OR = \frac{a/c}{b/d} = \frac{ad}{bc}$ $\begin{vmatrix} a & b & \\ 20 & 5 \\ c & d & \\ 10 & 20 & \end{vmatrix}$
Relative risk	Typically used in cohort studies. Risk of developing disease in the exposed group divided by risk in the unexposed group. RR = 1 → no association between exposure and disease. RR > 1 → exposure associated with † disease occurrence. RR < 1 → exposure associated with ↓ disease occurrence.	If 5/10 people exposed to radiation are diagnosed with cancer, and 1/10 people not exposed to radiation are diagnosed with cancer, the RR is 5; so people exposed to radiation have a 5 times greater risk of developing cancer. For rare diseases (low prevalence), OR approximates RR.	$RR = \frac{a/(a+b)}{c/(c+d)}$ $\begin{bmatrix} a & b & 5 \\ 5 & 5 \\ c & d \end{bmatrix}$
Relative risk reduction	The proportion of risk reduction attributable to the intervention as compared to a control.	If 2% of patients who receive a flu shot develop the flu, while 8% of unvaccinated patients develop the flu, then RR = 2/8 = 0.25, and RRR = 0.75.	RRR = 1 – RR
Attributable risk	The difference in risk between exposed and unexposed groups.	If risk of lung cancer in smokers is 21% and risk in nonsmokers is 1%, then the attributable risk is 20%.	$AR = \frac{a}{a+b} - \frac{c}{c+d}$ $AR\% = \frac{RR-1}{RR} \times 100$
Absolute risk reduction	The difference in risk (not the proportion) attributable to the intervention as compared to a control.	If 8% of people who receive a placebo vaccine develop the flu vs 2% of people who receive a flu vaccine, then ARR = $8\%-2\% = 6\% = 0.06$.	$ARR = \frac{c}{c+d} - \frac{a}{a+b}$
Number needed to treat	Number of patients who need to be treated for 1 patient to benefit. Lower number = better treatment.		NNT = I/ARR
Number needed to harm	Number of patients who need to be exposed to a risk factor for 1 patient to be harmed. Higher number = safer exposure.		NNH = 1/ <mark>AR</mark>
Case fatality rate	Percentage of deaths occurring among those with disease.	If 4 patients die among 10 cases of meningitis, case fatality rate is 40%.	$CFR\% = \frac{\text{deaths}}{\text{cases}} \times 100$

FAS1_2019_06-PubHealth.indd 258 11/7/19 4:16 PM

Incidence vs prevalence



of new cases
of people at risk Incidence =

(per unit of time)

of existing cases
Total # of people (at a point in Prevalence = time) in a population

Prevalence looks at all current cases.

Incidence looks at new cases (incidents).

= Incidence rate × average duration Prevalence l – prevalence

> Prevalence ~ pretest probability. ↑ prevalence → ↑ PPV and ↓ NPV.

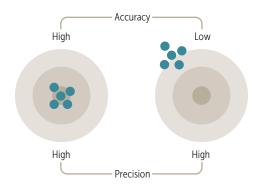
Prevalence ≈ incidence for short duration disease (eg, common cold).

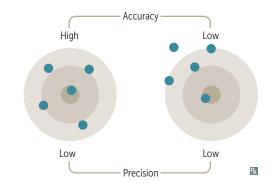
Prevalence > incidence for chronic diseases, due to large # of existing cases (eg, diabetes).

SITUATION	INCIDENCE	PREVALENCE
† survival time	_	†
† mortality	_	ţ
Faster recovery time	_	ţ
Extensive vaccine administration	<u> </u>	ţ
↓ risk factors	↓	ţ

Precision vs accuracy

,		
Precision (reliability)	The consistency and reproducibility of a test. The absence of random variation in a test.	Random error ↓ precision in a test. ↑ precision → ↓ standard deviation. ↑ precision → ↑ statistical power (1 – β).
Accuracy (validity)	The closeness of test results to the true values. The absence of systematic error or bias in a test.	Systematic error ↓ accuracy in a test.



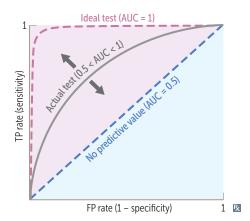


FAS1_2019_06-PubHealth.indd 259 11/7/19 4:16 PM

Receiving operating characteristic curve

ROC curve demonstrates how well a diagnostic test can distinguish between 2 groups (eg, disease vs healthy). Plots the true-positive rate (sensitivity) against the false-positive rate (1 – specificity).

The better performing test will have a higher area under the curve (AUC), with the curve closer to the upper left corner.



Bias and study errors

ТҮРЕ	DEFINITION	EXAMPLES	STRATEGIES TO REDUCE BIAS
Recruiting participants			
Selection bias	Nonrandom sampling or treatment allocation of subjects such that study population is not representative of target population. Most commonly a sampling bias.	Berkson bias—cases and/ or controls selected from hospitals are less healthy and have different exposures than general population Attrition bias—participants lost to follow up have a different prognosis than those who complete the study	Randomization Ensure the choice of the right comparison/reference group
Performing study			
Recall bias	Awareness of disorder alters recall by subjects; common in retrospective studies	Patients with disease recall exposure after learning of similar cases	Decrease time from exposure to follow-up
Measurement bias	Information is gathered in a systemically distorted manner	Using a faulty automatic sphygmomanometer to measure BP Hawthorne effect—participants change behavior upon awareness of being observed	Use objective, standardized, and previously tested methods of data collection that are planned ahead of time Use placebo group
Procedure bias	Subjects in different groups are not treated the same	Patients in treatment group spend more time in highly specialized hospital units	Blinding (masking) and use of placebo reduce influence of participants and
Observer-expectancy bias	Researcher's belief in the efficacy of a treatment changes the outcome of that treatment (aka, Pygmalion effect)	An observer expecting treatment group to show signs of recovery is more likely to document positive outcomes	researchers on procedures and interpretation of outcomes as neither are aware of group assignments

FAS1_2019_06-PubHealth.indd 260 11/7/19 4:16 PM

Bias and study errors (continued)

TYPE	DEFINITION	EXAMPLES	STRATEGY TO REDUCE BIAS				
Interpreting results							
Confounding bias	Factor related to both exposure and outcome (but not on causal path) distorts effect of exposure on outcome (vs effect modification, in which the exposure leads to different outcomes in subgroups stratified by the factor)	An uncontrolled study shows an association between drinking coffee and lung cancer. However, coffee drinkers also smoke more, which can account for the association	Multiple/repeated studies Crossover studies (subjects act as their own controls) Matching (patients with similar characteristics in both treatment and control groups)				
Lead-time bias	Early detection is confused with † survival	Early detection makes it seem like survival has increased, but the disease's natural history has not changed	Measure "back-end" survival (adjust survival according to the severity of disease at the time of diagnosis)				
Length-time bias	Screening test detects diseases with long latency period, while those with shorter latency period become symptomatic earlier	A slowly progressive cancer is more likely detected by a screening test than a rapidly progressive cancer	A randomized controlled trial assigning subjects to the screening program or to no screening				

11/7/19 4:16 PM FAS1_2019_06-PubHealth.indd 261

Measures of central	Mean = (sum of values)/(total number of values).	Most affected by outliers (extreme values).			
tendency	Median = middle value of a list of data sorted from least to greatest.	If there is an even number of values, the median will be the average of the middle two values.			
	Mode = most common value.	Least affected by outliers.			
Measures of dispersion	Standard deviation = how much variability exists in a set of values, around the mean of these values. Standard error = an estimate of how much variability exists in a (theoretical) set of sample means around the true population mean.	$\sigma = SD$; $n = sample size$. Variance = $(SD)^2$. $SE = \sigma/\sqrt{n}$. $SE \downarrow as n \uparrow$.			
Normal distribution	Gaussian, also called bell-shaped. Mean = median = mode.	-3σ -1σ +1σ +2σ +3σ 68% 95% 99.7%			
Nonnormal distribution	ons				
Bimodal	Suggests two different populations (eg, metabolic polymorphism such as fast vs slow acetylators; age at onset of Hodgkin lymphoma; suicide rate by age).				
Positive skew	Typically, mean > median > mode. Asymmetry with longer tail on right.	Mode Median Mean			
Negative skew	Typically, mean < median < mode. Asymmetry with longer tail on left.	Median Mode Mean			
Statistical hypotheses					
Null (H ₀)	Hypothesis of no difference or relationship (eg, there is no association between the disease and the risk factor in the population).				
Alternative (H ₁)	Hypothesis of some difference or relationship (eg, there is some association between the disease and the risk factor in the population).				

11/7/19 4:16 PM FAS1_2019_06-PubHealth.indd 262

Outcomes of statistical hypothesis testing

Correct result

Stating that there is an effect or difference when one exists (null hypothesis rejected in favor of alternative hypothesis).

Stating that there is no effect or difference when none exists (null hypothesis not rejected).

Incorrect result

Type I error (α)

Stating that there is an effect or difference when none exists (null hypothesis incorrectly rejected in favor of alternative hypothesis).

 α is the probability of making a type I error. p is judged against a preset α level of significance (usually 0.05). If p < 0.05 for a study outcome, the probability of obtaining that result purely by chance is < 5%.

Statistical significance ≠ clinical significance.

Also called false-positive error.

 α = you accused an innocent man.

You can never "prove" the alternate hypothesis, but you can reject the null hypothesis as being very unlikely.

Type II error (β)

Stating that there is not an effect or difference when one exists (null hypothesis is not rejected when it is in fact false).

 β is the probability of making a type II error. β is related to statistical power $(1-\beta)$, which is the probability of rejecting the null hypothesis when it is false.

↑ power and \downarrow β by:

- † sample size
- † expected effect size
- † precision of measurement

Also called false-negative error.

β = you blindly let the guilty man go free.
 If you † sample size, you † power. There is power in numbers.

Confidence interval

Range of values within which the true mean of the population is expected to fall, with a specified probability.

CI for sample mean = $\bar{x} \pm Z(SE)$

The 95% CI (corresponding to $\alpha = .05$) is often used. As sample size increases, CI narrows.

For the 95% CI, Z = 1.96. For the 99% CI, Z = 2.58. If the 95% CI for a mean difference between 2 variables includes 0, then there is no significant difference and H_0 is not rejected.

If the 95% CI for odds ratio or relative risk includes 1, H_0 is not rejected.

If the CIs between 2 groups do not overlap

→ statistically significant difference exists.

If the CIs between 2 groups overlap → usually no significant difference exists.

FAS1_2019_06-PubHealth.indd 263 11/7/19 4:16 PM

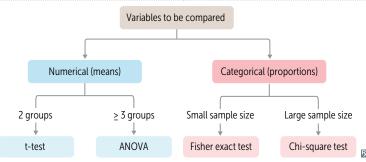
Meta-analysis

A method of statistical analysis that pools summary data (eg, means, RRs) from multiple studies for a more precise estimate of the size of an effect. Also estimates heterogeneity of effect sizes between studies.

Improves power, strength of evidence, and generalizability of study findings. Limited by quality of individual studies and bias in study selection.

Common statistical tests

<i>t</i> -test	Checks differences between means of 2 groups.	Tea is meant for 2. Example: comparing the mean blood pressure between men and women.
ANOVA	Checks differences between means of 3 or more groups.	3 words: ANalysis Of VAriance. Example: comparing the mean blood pressure between members of 3 different ethnic groups.
Chi-square (χ²)	Checks differences between 2 or more percentages or proportions of categorical outcomes (not mean values).	Pronounce Chi-tegorical. Example: comparing the percentage of members of 3 different ethnic groups who have essential hypertension.
Fisher's exact test	Checks differences between 2 percentages or proportions of categorical, nominal outcomes. Use instead of chi-square test with small populations.	Example: comparing the percentage of 20 men and 20 women with hypertension.



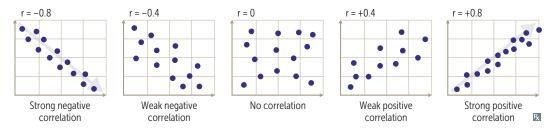
Pearson correlation coefficient

r is always between -1 and +1. The closer the absolute value of *r* is to 1, the stronger the linear correlation between the 2 variables. Variance is how much the measured values differ from the average value in a data set.

Positive *r* value \rightarrow positive correlation (as one variable \uparrow), the other variable \uparrow).

Negative *r* value \rightarrow negative correlation (as one variable †, the other variable ‡).

Coefficient of determination = r^2 (amount of variance in one variable that can be explained by variance in another variable).



FAS1_2019_06-PubHealth.indd 264 11/7/19 4:16 PM

▶ PUBLIC HEALTH SCIENCES—ETHICS Core ethical principles **Autonomy** Obligation to respect patients as individuals (truth-telling, confidentiality), to create conditions necessary for autonomous choice (informed consent), and to honor their preference in accepting or not accepting medical care. **Beneficence** Physicians have a special ethical (fiduciary) duty to act in the patient's best interest. May conflict with autonomy (an informed patient has the right to decide) or what is best for society (eg, mandatory TB treatment). Traditionally, patient interest supersedes. Nonmaleficence "Do no harm." Must be balanced against beneficence; if the benefits outweigh the risks, a patient may make an informed decision to proceed (most surgeries and medications fall into this category). **Justice** To treat persons fairly and equitably. This does not always imply equally (eg, triage). **Informed consent** A process (not just a document/signature) that Exceptions to informed consent (WIPE it away): Waiver—patient explicitly waives the right of requires: Disclosure: discussion of pertinent informed consent information (using medical interpreter, if Legally Incompetent—patient lacks decisionmaking capacity (obtain consent from legal needed) Understanding: ability to comprehend surrogate) Capacity: ability to reason and make one's Therapeutic Privilege—withholding own decisions (distinct from competence, a information when disclosure would severely harm the patient or undermine informed legal determination) Voluntariness: freedom from coercion and decision-making capacity manipulation Emergency situation—implied consent may Patients must have an intelligent understanding apply of their diagnosis and the risks/benefits of proposed treatment and alternative options, including no treatment. Patient must be informed that he or she can revoke written consent at any time, even orally. **Consent for minors** A minor is generally any person < 18 years old. Situations in which parental consent is usually not required:

A minor is generally any person < 18 years old. Parental consent laws in relation to healthcare vary by state. In general, parental consent should be obtained, but exceptions exist for emergency treatment (eg, blood transfusions) or if minor is legally emancipated (eg, married, self-supporting, or in the military).

- Sex (contraception, STIs, pregnancy)
- Drugs (substance abuse)
- Rock and roll (emergency/trauma)

Physicians should always encourage healthy minor-guardian communication.

Physician should seek a minor's assent even if their consent is not required.

FAS1_2019_06-PubHealth.indd 265 11/7/19 4:16 PM

266

SECTION II

PUBLIC HEALTH SCIENCES → PUBLIC HEALTH SCIENCES—ETHICS

Decision-making capacity

Physician must determine whether the patient is psychologically and legally capable of making a particular healthcare decision. Note that decisions made with capacity cannot be revoked simply if the patient later loses capacity. Intellectual disability alone (eg, Down syndrome, autism) is not an exclusion criterion for informed decision-making.

Capacity is determined by a physician for a specific healthcare-related decision (eg, to refuse medical care). Competency is determined by a judge and usually refers to more global categories of decision making (eg, legally unable to make any healthcare-related decision).

Components (think **GIEMSA**):

- Decision is consistent with patient's values and Goals
- Patient is Informed (knows and understands)
- Patient Expresses a choice
- Decision is not a result of altered Mental status (eg, delirium, psychosis, intoxication), Mood disorder
- Decision remains Stable over time
- Patient is ≥ 18 years of Age or otherwise legally emancipated

Advance directives	Instructions given by a patient in anticipation of the need for a medical decision. Details vary per state law.
Oral advance directive	Incapacitated patient's prior oral statements commonly used as guide. Problems arise from variance in interpretation. If patient was informed, directive was specific, patient made a choice, and decision was repeated over time to multiple people, then the oral directive is more valid.
Written advance directive	Specifies specific healthcare interventions that a patient anticipates he or she would accept or reject during treatment for a critical or life-threatening illness. A living will is an example.
Medical power of attorney	Patient designates an agent to make medical decisions in the event that he/she loses decision-making capacity. Patient may also specify decisions in clinical situations. Can be revoked by patient if decision-making capacity is intact. More flexible than a living will.
Do not resuscitate order	DNR order prohibits cardiopulmonary resuscitation (CPR). Other resuscitative measures that may follow (eg, feeding tube) are also typically avoided.
Surrogate decision- maker	If a patient loses decision-making capacity and has not prepared an advance directive, individuals (surrogates) who know the patient must determine what the patient would have done. Priority of surrogates: spouse → adult Children → Parents → Siblings → other relatives (the spouse ChiPS in).

FAS1_2019_06-PubHealth.indd 266 11/7/19 4:16 PM

Confidentiality

Confidentiality respects patient privacy and autonomy. If the patient is incapacitated or the situation is emergent, disclosing information to family and friends should be guided by professional judgment of patient's best interest. The patient may voluntarily waive the right to confidentiality (eg, insurance company request).

General principles for exceptions to confidentiality:

- Potential physical harm to others is serious and imminent
- Alternative means to warn or protect those at risk is not possible
- Self-harm is likely
- Steps can be taken to prevent harm

Examples of exceptions to patient confidentiality (many are state specific) include the following ("The physician's good judgment **SAVED** the day"):

- Suicidal/homicidal patients.
- Abuse (children, elderly, and/or prisoners).
- Duty to protect—state-specific laws that sometimes allow physician to inform or somehow protect potential Victim from harm.
- Epileptic patients and other impaired automobile drivers.
- Reportable Diseases (eg, STIs, hepatitis, food poisoning); physicians may have a duty to warn
 public officials, who will then notify people at risk. Dangerous communicable diseases, such as
 TB or Ebola, may require involuntary treatment.

FAS1_2019_06-PubHealth.indd 267 11/7/19 4:16 PM

Ethical situations

SITUATION	APPROPRIATE RESPONSE
Patient is not adherent.	Attempt to identify the reason for nonadherence and determine his/her willingness to change; do not coerce the patient into adhering and do not refer him/her to another physician.
Patient desires an unnecessary procedure.	Attempt to understand why the patient wants the procedure and address underlying concerns. Do not refuse to see the patient and do not refer him/her to another physician. Avoid performing unnecessary procedures.
Patient has difficulty taking medications.	Provide written instructions; attempt to simplify treatment regimens; use teach-back method (ask patient to repeat regimen back to physician) to ensure comprehension.
Family members ask for information about patient's prognosis.	Avoid discussing issues with relatives without the patient's permission.
A patient's family member asks you not to disclose the results of a test if the prognosis is poor because the patient will be "unable to handle it."	Attempt to identify why the family member believes such information would be detrimental to the patient's condition. Explain that as long as the patient has decision making capacity and does not indicate otherwise, communication of information concerning his/her care will not be withheld. However, if you believe the patient might seriously harm himself/herself or others if informed, then you may invoke therapeutic privilege and withhold the information.
A 17-year-old girl is pregnant and requests an abortion.	Many states require parental notification or consent for minors for an abortion. Unless there are specific medical risks associated with pregnancy, a physician should not sway the patient's decision for, or against, an elective abortion (regardless of maternal age or fetal condition).
A 15-year-old girl is pregnant and wants to keep the child. Her parents want you to tell her to give the child up for adoption.	The patient retains the right to make decisions regarding her child, even if her parents disagree. Provide information to the teenager about the practical issues of caring for a baby. Discuss the options, if requested. Encourage discussion between the teenager and her parents to reach the best decision.
A terminally ill patient requests physician assistance in ending his/ her own life.	Overwhelming majority of states refuse involvement in any form of physician-assisted death. Physicians may, however, prescribe medically appropriate analgesics even if they shorten the patient's life.
Patient is suicidal.	Assess the seriousness of the threat. If it is serious, suggest that the patient remain in the hospital voluntarily; patient can be hospitalized involuntarily if he/she refuses.
Patient states that he/she finds you attractive.	Ask direct, closed-ended questions and use a chaperone if necessary. Romantic relationships with patients are never appropriate. It may be necessary to transition care to another physician.
A woman who had a mastectomy says she now feels "ugly."	Find out why the patient feels this way. Do not offer falsely reassuring statements (eg, "You still look good").
Patient is angry about the long time he/she spent in the waiting room.	Acknowledge the patient's anger, but do not take a patient's anger personally. Apologize for any inconvenience. Stay away from efforts to explain the delay.
Patient is upset with the way he/she was treated by another doctor.	Suggest that the patient speak directly to that physician regarding his/her concerns. If the problem is with a member of the office staff, tell the patient you will speak to that person.
An invasive test is performed on the wrong patient.	Regardless of the outcome, a physician is ethically obligated to inform a patient that a mistake has been made.

FAS1_2019_06-PubHealth.indd 268 11/7/19 4:16 PM

Ethical situations (continued)

SITUATION	APPROPRIATE RESPONSE
A patient requires a treatment not covered by his/her insurance.	Never limit or deny care because of the expense in time or money. Discuss all treatment options with patients, even if some are not covered by their insurance companies.
A 7-year-old boy loses a sister to cancer and now feels responsible.	At ages 5–7, children begin to understand that death is permanent, that all life functions end completely at death, and that everything that is alive eventually dies. Provide a direct, concrete description of his sister's death. Avoid clichés and euphemisms. Reassure the boy that he is not responsible. Identify and normalize fears and feelings. Encourage play and healthy coping behaviors (eg, remembering her in his own way).
Patient is victim of intimate partner violence.	Ask if patient is safe and has an emergency plan. Do not necessarily pressure patient to leave his or her partner, or disclose the incident to the authorities (unless required by state law).
Patient wants to try alternative or holistic medicine.	Explore any underlying reasons with the patient in a supportive, nonjudgmental manner. Advise the patient of known benefits and risks of treatment, including adverse effects, contraindications, and medication interactions.
Physician colleague presents to work impaired.	If impaired or incompetent, colleague is a threat to patient safety. Report the situation to local supervisory personnel. Should the organization fail to take action, alert the state licensing board.
Patient is officially determined to suffer brain death. Patient's family insists on maintaining life support indefinitely because patient is still moving when touched.	Gently explain to family that there is no chance of recovery, and that brain death is equivalent to death. Movement is due to spinal arc reflex and is not voluntary. Bring case to appropriate ethics board regarding futility of care and withdrawal of life support.
A pharmaceutical company offers you a sponsorship in exchange for advertising its new drug.	Reject this offer. Generally, decline gifts and sponsorships to avoid any appearance of conflict of interest. The AMA Code of Ethics does make exceptions for gifts directly benefitting patients; gifts of minimal value; special funding for medical education of students, residents, fellows; grants whose recipients are chosen by independent institutional criteria; and funds that are distributed without attribution to sponsors.
Patient requests a nonemergent procedure that is against your personal or religious beliefs.	Provide accurate and unbiased information so patients can make an informed decision. Explain to the patient that you do not perform the procedure but offer to refer him/her to another physician.
Mother and 15-year-old daughter are unresponsive following a car accident and are bleeding internally. Father says do not transfuse because they are Jehovah's Witnesses.	Transfuse daughter, but do not transfuse mother. Emergent care can be refused by the healthcare proxy for an adult, particularly when patient preferences are known or reasonably inferred, but not for a minor based solely on faith.
A child presents with injuries inconsistent with parental story.	Contact child protective services and ensure child is in a safe location. Physicians are required by law to report any reasonable suspicion of child abuse or endangerment.

11/7/19 4:16 PM FAS1_2019_06-PubHealth.indd 269

▶ PUBLIC HEALTH SCIENCES—THE WELL PATIENT

Changes in the elderly

Sexual changes:

- Men—slower erection/ejaculation, longer refractory period, but unchanged libido.
- Women—vaginal shortening, thinning, and dryness

Sleep patterns: ↓ REM and slow-wave sleep, ↑ sleep latency, ↑ early awakenings

1 suicide rate

- ↓ vision and hearing
- ↓ immune response
- ↓ renal, pulmonary, and GI function
- ↓ muscle mass, ↑ fat

Intelligence does not decrease

▶ PUBLIC HEALTH SCIENCES—HEALTHCARE DELIVERY

Prevent disease before it occurs (eg, HPV vaccination)
Screen early for and manage existing but asymptomatic disease (eg, Pap smear for cervical cancer)
Treatment to reduce complications from disease that is ongoing or has long-term effects (eg, chemotherapy)
Quit (avoid) unnecessary medical interventions to minimize incidental harm (eg, imaging studies, optimizing medications to reduce polypharmacy).

FAS1_2019_06-PubHealth.indd 270 11/7/19 4:16 PM

Major medical insurance plans

PLAN	PROVIDERS	PAYMENTS	SPECIALIST CARE
Exclusive provider organization	Restricted to limited panel (except emergencies)		No referral required
Health maintenance organization	Restricted to limited panel (except emergencies)	Denied for any service that does not meet established, evidence-based guidelines	Requires referral from primary care provider
Point of service	Patient can see providers outside network	Higher copays and deductibles for out-of- network services	Requires referral from primary care provider
Preferred provider organization	Patient can see providers outside network	Higher copays and deductibles for all services	No referral required
Accountable care organization	Providers voluntarily enroll	Medicare	Specialists voluntarily enroll

Healthcare payment models

Bundled payment	Healthcare organization receives a set amount per service, regardless of ultimate cost, to be divided among all providers and facilities involved.
Capitation	Physicians receive a set amount per patient assigned to them per period of time, regardless of how much the patient uses the healthcare system. Used by some HMOs.
Discounted fee-for- service	Patient pays for each individual service at a discounted rate predetermined by providers and payers (eg, PPOs).
Fee-for-service	Patient pays for each individual service.
Global payment	Patient pays for all expenses associated with a single incident of care with a single payment. Most commonly used during elective surgeries, as it covers the cost of surgery as well as the necessary pre- and postoperative visits.

FAS1_2019_06-PubHealth.indd 271 11/7/19 4:16 PM

272

SECTION II

PUBLIC HEALTH SCIENCES ▶ PUBLIC HEALTH SCIENCES—HEALTHCARE DELIVERY

Medicare and Medicaid

Medicare and Medicaid—federal social healthcare programs that originated from amendments to the Social Security Act.

Medicare is available to patients ≥ 65 years old, < 65 with certain disabilities, and those with end-stage renal disease.

Medicaid is joint federal and state health assistance for people with limited income and/or resources.

Medicar**E** is for **E**lderly. Medicai**D** is for **D**estitute.

The 4 parts of Medicare:

- Part A: HospitAl insurance, home hospice care
- Part B: Basic medical bills (eg, doctor's fees, diagnostic testing)
- Part C: (parts A + B = Combo) delivered by approved private companies
- Part D: Prescription Drugs

Hospice care

Medical care focused on providing comfort and palliation instead of definitive cure. Available to patients on Medicare or Medicaid and in most private insurance plans whose life expectancy is < 6 months.

During end-of-life care, priority is given to improving the patient's comfort and relieving pain (often includes opioid, sedative, or anxiolytic medications). Facilitating comfort is prioritized over potential side effects (eg, respiratory depression). This prioritization of positive effects over negative effects is called the principle of double effect.

Common causes of death (US) by age

	< 1 YR	1–14 YR	15-34 YR	35-44 YR	45-64 YR	65+ YR
#1	Congenital malformations	Unintentional injury	Unintentional injury	Unintentional injury	Cancer	Heart disease
#2	Preterm birth	Cancer	Suicide	Cancer	Heart disease	Cancer
#3	Maternal pregnancy complications	Congenital malformations	Homicide	Heart disease	Unintentional injury	Chronic respiratory disease

Conditions with frequent hospital readmissions

Readmissions may be reduced by discharge planning and outpatient follow-up appointments. The table below is based on readmission for any reason within 30 days of discharge.

	MEDICARE	MEDICAID	PRIVATE INSURANCE	UNINSURED
#1	Congestive HF	Mood disorders	Maintenance of chemotherapy or radiotherapy	Mood disorders
#2	Septicemia	Schizophrenia/ psychotic disorders	Mood disorders	Alcohol-related disorders
#3	Pneumonia	Diabetes mellitus with complications	Complications of surgical procedures or medical care	Diabetes mellitus with complications

FAS1_2019_06-PubHealth.indd 272 11/7/19 4:16 PM

▶ PUBLIC HEALTH SCIENCES—QUALITY AND SAFETY

Safety culture

Organizational environment in which everyone can freely bring up safety concerns without fear of censure. Facilitates error identification.

Event reporting systems collect data on errors for internal and external monitoring.

Human factors design

Forcing functions (those that prevent undesirable actions [eg, connecting feeding syringe to IV tubing]) are the most effective.

Standardization improves process reliability (eg, clinical pathways, guidelines, checklists).

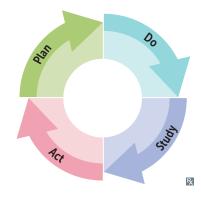
Simplification reduces wasteful activities (eg, consolidating electronic medical records).

Deficient designs hinder workflow and lead to staff workarounds that bypass safety features (eg, patient ID barcodes affixed to computers due to unreadable wristbands).

PDSA cycle

Process improvement model to test changes in real clinical setting. Impact on patients:

- Plan—define problem and solution
- Do—test new process
- Study—measure and analyze data
- Act—integrate new process into workflow

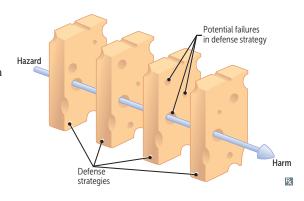


Quality measurements

	MEASURE	EXAMPLE
Structural	Physical equipment, resources, facilities	Number of diabetes educators
Process	Performance of system as planned	Percentage of diabetic patients whose ${ m HbA_{lc}}$ was measured in the past 6 months
Outcome	Impact on patients	Average $\mathrm{HbA}_{\mathrm{lc}}$ of patients with diabetes
Balancing	Impact on other systems/outcomes	Incidence of hypoglycemia among patients who tried an intervention to lower HbA_{lc}

Swiss cheese model

Focuses on systems and conditions rather than an individual's error. The risk of a threat becoming a reality is mitigated by differing layers and types of defenses. Patient harm can occur despite multiple safeguards when "the holes in the cheese line up."



FAS1_2019_06-PubHealth.indd 273 11/7/19 4:16 PM

SECTION II PUBLIC HEALTH SCIENCES → PUBLIC HEALTH SCIENCES—QUALITY AND SAFETY

Types of medical errors	May involve patient identification, diagnosis, monitoring, nosocomial infection, medications, procedures, devices, documentation, handoffs. Medical errors should be disclosed to patients, independent of immediate outcome (harmful or not).	
Active error	Occurs at level of frontline operator (eg, wrong IV pump dose programmed).	Immediate impact.
Latent error	Occurs in processes indirect from operator but impacts patient care (eg, different types of IV pumps used within same hospital).	Accident waiting to happen.
Never event	Adverse event that is identifiable, serious, and usually preventable (eg, scalpel retained in a surgical patient's abdomen).	Major error that should never occur.
Burnout vs fatigue		
Burnout	Prolonged, excessive stress → cynicism, detachment, ↓ motivation and interest, sense of failure and helplessness, ↓ immunity. Medical errors due to lack of concern.	
Fatigue	Sleep deprivation → ↓ energy and motivation, cognitive impairment. Medical errors due to compromised intellectual function.	
Medical error analysis		
	DESIGN	METHODS
Root cause analysis	Retrospective approach. Applied after failure event to prevent recurrence.	Uses records and participant interviews to identify all the underlying problems (eg, process, people, environment, equipment, materials, management) that led to an error.
Failure mode and effects analysis	Forward-looking approach. Applied before process implementation to prevent failure occurrence.	Uses inductive reasoning to identify all the ways a process might fail and prioritizes them by their probability of occurrence and impact on patients.

11/7/19 4:16 PM FAS1_2019_06-PubHealth.indd 274

SECTION III

High-Yield Organ Systems

"Symptoms, then, are in reality nothing but the cry from suffering organs."

—Jean-Martin Charcot

"Man is an intelligence in servitude to his organs."

-Aldous Huxley

"When every part of the machine is correctly adjusted and in perfect harmony, health will hold dominion over the human organism by laws as natural and immutable as the laws of gravity."

-Andrew T. Still

▶ Approaching the	
Organ Systems	276
▶ Cardiovascular	279
▶ Endocrine	325
▶ Gastrointestinal	357
▶ Hematology and	400
Oncology	403
► Musculoskeletal, Skin, and Connective	
Tissue	445
▶ Neurology and	
Special Senses	489
▶ Psychiatry	553
▶ Renal	577
▶ Reproductive	611
▶ Respiratory	659

275

FAS1_2019_07-Cardio.indd 275 11/7/19 4:24 PM

▶ APPROACHING THE ORGAN SYSTEMS

In this section, we have divided the High-Yield Facts into the major Organ Systems. Within each Organ System are several subsections, including Embryology, Anatomy, Physiology, Pathology, and Pharmacology. As you progress through each Organ System, refer back to information in the previous subsections to organize these basic science subsections into a "vertically integrated" framework for learning. Below is some general advice for studying the organ systems by these subsections.

Embryology

Relevant embryology is included in each organ system subsection. Embryology tends to correspond well with the relevant anatomy, especially with regard to congenital malformations.

Anatomy

Several topics fall under this heading, including gross anatomy, histology, and neuroanatomy. Do not memorize all the small details; however, do not ignore anatomy altogether. Review what you have already learned and what you wish you had learned. Many questions require two or more steps. The first step is to identify a structure on anatomic cross section, electron micrograph, or photomicrograph. The second step may require an understanding of the clinical significance of the structure.

When studying, stress clinically important material. For example, be familiar with gross anatomy and radiologic anatomy related to specific diseases (eg, Pancoast tumor, Horner syndrome), traumatic injuries (eg, fractures, sensory and motor nerve deficits), procedures (eg, lumbar puncture), and common surgeries (eg, cholecystectomy). There are also many questions on the exam involving x-rays, CT scans, and neuro MRI scans. Many students suggest browsing through a general radiology atlas, pathology atlas, and histology atlas. Focus on learning basic anatomy at key levels in the body (eg, sagittal brain MRI; axial CT of the midthorax, abdomen, and pelvis). Basic neuroanatomy (especially pathways, blood supply, and functional anatomy), associated neuropathology, and neurophysiology have good yield. Please note that many of the photographic images in this book are for illustrative purposes and are not necessarily reflective of Step I emphasis.

Physiology

The portion of the examination dealing with physiology is broad and concept oriented and thus does not lend itself as well to fact-based review. Diagrams are often the best study aids, especially given the increasing number of questions requiring the interpretation of diagrams. Learn to apply basic physiologic relationships in a variety of ways (eg, the Fick equation, clearance equations). You are seldom asked to perform complex

FAS1_2019_07-Cardio.indd 276 11/7/19 4:24 PM

calculations. Hormones are the focus of many questions, so learn their sites of production and action as well as their regulatory mechanisms.

A large portion of the physiology tested on the USMLE Step 1 is clinically relevant and involves understanding physiologic changes associated with pathologic processes (eg, changes in pulmonary function with COPD). Thus, it is worthwhile to review the physiologic changes that are found with common pathologies of the major organ systems (eg, heart, lungs, kidneys, GI tract) and endocrine glands.

Pathology

Questions dealing with this discipline are difficult to prepare for because of the sheer volume of material involved. Review the basic principles and hallmark characteristics of the key diseases. Given the clinical orientation of Step 1, it is no longer sufficient to know only the "buzzword" associations of certain diseases (eg. café-au-lait macules and neurofibromatosis); you must also know the clinical descriptions of these findings.

Given the clinical slant of the USMLE Step 1, it is also important to review the classic presenting signs and symptoms of diseases as well as their associated laboratory findings. Delve into the signs, symptoms, and pathophysiology of major diseases that have a high prevalence in the United States (eg, alcoholism, diabetes, hypertension, heart failure, ischemic heart disease, infectious disease). Be prepared to think one step beyond the simple diagnosis to treatment or complications.

The examination includes a number of color photomicrographs and photographs of gross specimens that are presented in the setting of a brief clinical history. However, read the question and the choices carefully before looking at the illustration, because the history will help you identify the pathologic process. Flip through an illustrated pathology textbook, color atlases, and appropriate Web sites in order to look at the pictures in the days before the exam. Pay attention to potential clues such as age, sex, ethnicity, occupation, recent activities and exposures, and specialized lab tests.

Pharmacology

Preparation for questions on pharmacology is straightforward. Learning all the key drugs and their characteristics (eg, mechanisms, clinical use, and important side effects) is high yield. Focus on understanding the prototype drugs in each class. Avoid memorizing obscure derivatives. Learn the "classic" and distinguishing toxicities of the major drugs. Do not bother with drug dosages or trade names. Reviewing associated biochemistry, physiology, and microbiology can be useful while studying pharmacology. There is a strong emphasis on ANS, CNS, antimicrobial, and cardiovascular agents as well as NSAIDs. Much of the material is clinically relevant. Newer drugs on the market are also fair game.

FAS1 2019 07-Cardio.indd 277 11/7/19 4:24 PM 278

SECTION III HIGH-YIELD ORGAN SYSTEMS

▶ NOTES	

FAS1_2019_07-Cardio.indd 278 11/7/19 4:24 PM

HIGH-YIELD SYSTEMS

Cardiovascular

"As for me, except for an occasional heart attack, I feel as young as I ever did."

—Robert Benchley

"Hearts will never be practical until they are made unbreakable."

—The Wizard of Oz

"As the arteries grow hard, the heart grows soft."

-H. L. Mencken

"Nobody has ever measured, not even poets, how much the heart can hold."

—Zelda Fitzgerald

"Only from the heart can you touch the sky."

—Rumi

"It is not the size of the man but the size of his heart that matters."

—Evander Holyfield

The cardiovascular system is one of the highest yield areas for the boards and, for some students, may be the most challenging. Focusing on understanding the mechanisms instead of memorizing the details can make a big difference, especially for this topic. Pathophysiology of atherosclerosis and heart failure, MOA of drugs (particular physiology interactions) and their adverse effects, ECGs of heart blocks, the cardiac cycle, and the Starling curve are some of the more high-yield topics. Differentiating between systolic and diastolic dysfunction is also very important. Heart murmurs and maneuvers that affect these murmurs have also been high yield and may be asked in a multimedia format.

▶ Embryology 280
▶ Anatomy 283
▶ Physiology 284
▶ Pathology 298
▶ Pharmacology 316

FAS1_2019_07-Cardio.indd 279 11/7/19 4:24 PM

► CARDIOVASCULAR—EMBRYOLOGY

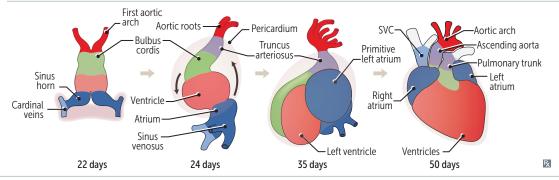
Heart morphogenesis

First functional organ in vertebrate embryos; beats spontaneously by week 4 of development.

Cardiac looping

Primary heart tube loops to establish left-right polarity; begins in week 4 of development.

Defect in left-right Dynein (involved in L/R asymmetry) can lead to Dextrocardia, as seen in Kartagener syndrome (1° ciliary Dyskinesia).

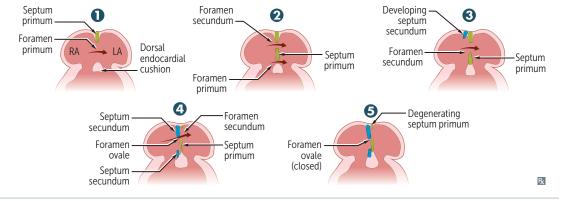


Septation of the chambers

Atria

- Septum primum grows toward endocardial cushions, narrowing foramen primum.
- **2** Foramen secundum forms in septum primum (foramen primum regresses).
- Septum secundum develops on the right side of septum primum, as foramen secundum maintains right-to-left shunt.
- Septum secundum expands and covers most of foramen secundum. The residual foramen is the foramen ovale.
- **3** Remaining portion of septum primum forms the one-way valve of the foramen ovale.
- 6. Septum primum closes against septum secundum, sealing the foramen ovale soon after birth because of ↑ LA pressure and ↓ RA pressure.
- 7. Septum secundum and septum primum fuse during infancy/early childhood, forming the atrial septum.

Patent foramen ovale—caused by failure of septum primum and septum secundum to fuse after birth; most are left untreated. Can lead to paradoxical emboli (venous thromboemboli entering the systemic arterial circulation) as can occur in ASD.



FAS1_2019_07-Cardio.indd 280 11/7/19 4:24 PM

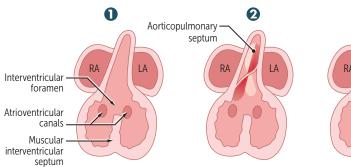
Heart morphogenesis (continued)

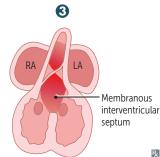
Ventricles

- Muscular interventricular septum forms.

 Opening is called interventricular foramen.
- 2 Aorticopulmonary septum rotates and fuses with muscular ventricular septum to form membranous interventricular septum, closing interventricular foramen.
- **3** Growth of endocardial cushions separates atria from ventricles and contributes to both atrial septation and membranous portion of the interventricular septum.

Ventricular septal defect—most common congenital cardiac anomaly, usually occurs in membranous septum.





Outflow tract formation

Neural crest and endocardial cell migrations

- → truncal and bulbar ridges that spiral and fuse to form aorticopulmonary septum
- → ascending aorta and pulmonary trunk.

Conotruncal abnormalities associated with failure of neural crest cells to migrate:

- Transposition of great vessels.
- Tetralogy of Fallot.
- Persistent truncus arteriosus.

Valve development

Aortic/pulmonary: derived from endocardial cushions of outflow tract.

Mitral/tricuspid: derived from fused endocardial cushions of the AV canal.

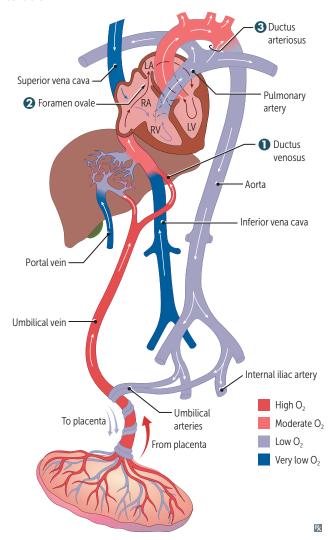
Valvular anomalies may be stenotic, regurgitant, atretic (eg, tricuspid atresia), or displaced (eg, Ebstein anomaly).

Heart embryology

EMBRYONIC STRUCTURE	GIVES RISE TO
Truncus arteriosus	Ascending aorta and pulmonary trunk
Bulbus cordis	Smooth parts (outflow tract) of left and right ventricles
Primitive ventricle	Trabeculated part of left and right ventricles
Primitive atrium	Trabeculated part of left and right atria
Left horn of sinus venosus	Coronary sinus
Right horn of sinus venosus	Smooth part of right atrium (sinus venarum)
Endocardial cushion	Atrial septum, membranous interventricular septum; AV and semilunar valves
Right common cardinal vein and right anterior cardinal vein	Superior vena cava (SVC)
Posterior, subcardinal, and supracardinal veins	Inferior vena cava (IVC)
Primitive pulmonary vein	Smooth part of left atrium

FAS1_2019_07-Cardio.indd 281 11/7/19 4:24 PM

Fetal circulation



Blood in umbilical vein has a Po_2 of ≈ 30 mm Hg and is $\approx 80\%$ saturated with O_2 . Umbilical arteries have low O_2 saturation.

3 important shunts:

- Blood entering fetus through the umbilical vein is conducted via the ductus venosus into the IVC, bypassing hepatic circulation.
- 2 Most of the highly Oxygenated blood reaching the heart via the IVC is directed through the foramen Ovale into the left atrium.
- ② Deoxygenated blood from the SVC passes through the RA → RV → main pulmonary artery → Ductus arteriosus → Descending aorta; shunt is due to high fetal pulmonary artery resistance (due partly to low O₂ tension).

At birth, infant takes a breath → ↓ resistance in pulmonary vasculature → ↑ left atrial pressure vs right atrial pressure → foramen ovale closes (now called fossa ovalis); ↑ in O₂ (from respiration) and ↓ in prostaglandins (from placental separation) → closure of ductus arteriosus.

Indomethacin helps close the patent Ductus arteriosus → ligamentum arteriosum (remnant of ductus arteriosus). Come In and close the

Prostaglandins \mathbf{E}_1 and \mathbf{E}_2 k**EE**p PDA open.

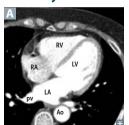
Fetal-postnatal derivatives

FETAL STRUCTURE	POSTNATAL DERIVATIVE	NOTES
Ductus arteriosus	Ligamentum arteriosum	Near the left recurrent laryngeal nerve
Ductus venosus	Ligamentum venosum	
Foramen ovale	Fossa ovalis	
Allantois → urachus	Medi <mark>an</mark> umbilical ligament	Urachus is part of allantoic duct between bladder and umbilicus
Umbilical arteries	Medi <mark>al</mark> umbilical ligaments	
Umbilical vein	Ligamentum teres hepatis (round ligament)	Contained in falciform ligament
Notochord	Nucleus pulposus	

FAS1_2019_07-Cardio.indd 282

► CARDIOVASCULAR—ANATOMY

Anatomy of the heart



LA is the most posterior part of the heart A; enlargement of the LA (eg, in mitral stenosis) can lead to compression of the esophagus (dysphagia) and/or the left recurrent laryngeal nerve, a branch of the vagus nerve, causing hoarseness (Ortner syndrome).

RV is the most anterior part of the heart and most commonly injured in trauma.

Pericardium

Consists of 3 layers (from outer to inner):

- Fibrous pericardium
- Parietal layer of serous pericardium
- Visceral layer of serous pericardium

Pericardial cavity lies between parietal and visceral layers.

Pericardium innervated by phrenic nerve.

Coronary blood supply

> PT = Pulmonary trunk PV = Pulmonary vein

LAD and its branches supply anterior 2/3 of interventricular septum, anterolateral papillary muscle, and anterior surface of LV. Most commonly occluded.

PDA supplies AV node (dependent on dominance), posterior 1/3 of interventricular septum, posterior 2/3 walls of ventricles, and posteromedial papillary muscle.

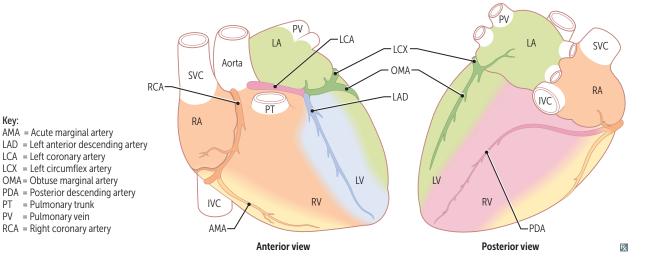
RCA supplies SA node (blood supply independent of dominance). Infarct may cause nodal dysfunction (bradycardia or heart block). Right (acute) marginal artery supplies RV.

Pericarditis can cause referred pain to the neck, arms, or one or both shoulders (often left).

Dominance:

- Right-dominant circulation (85%) = PDA arises from RCA.
- Left-dominant circulation (8%) = PDA arises from LCX.
- Codominant circulation (7%) = PDA arises from both LCX and RCA.

Coronary blood flow peaks in early diastole.



FAS1_2019_07-Cardio.indd 283 11/7/19 4:24 PM

► CARDIOVASCULAR—PHYSIOLOGY

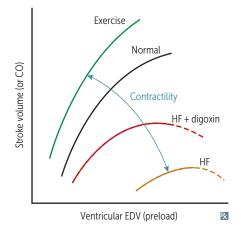
Cardiac output variable	les	
Stroke volume	Stroke Volume affected by Contractility, Afterload, and Preload. † SV with: † Contractility (eg, anxiety, exercise) † Preload (eg, early pregnancy) ‡ Afterload	SV CAP. A failing heart has ↓ SV (systolic and/or diastolic dysfunction).
Contractility	 Contractility (and SV) ↑ with: Catecholamine stimulation via β₁ receptor: Activated protein kinase A → phospholamban phosphorylation → active Ca²+ ATPase → ↑ Ca²+ storage in sarcoplasmic reticulum Activated protein kinase A → Ca²+ channel phosphorylation → ↑ Ca²+ entry → ↑ Ca²+-induced Ca²+ release ↑ intracellular Ca²+ ↓ extracellular Na+ (↓ activity of Na+/Ca²+ exchanger) Digitalis (blocks Na+/K+ pump → ↑ intracellular Na+ → ↓ Na+/Ca²+ exchanger activity → ↑ intracellular Ca²+) 	Contractility (and SV) ↓ with: ■ β ₁ -blockade (↓ cAMP) ■ HF with systolic dysfunction ■ Acidosis ■ Hypoxia/hypercapnia (↓ Po ₂ /↑ Pco ₂) ■ Non-dihydropyridine Ca ²⁺ channel blockers
Preload	Preload approximated by ventricular EDV; depends on venous tone and circulating blood volume.	Vasodilators (eg, nitroglycerin) ↓ preload.
Afterload	Afterload approximated by MAP. † wall tension per Laplace's law → † pressure → † afterload. LV compensates for † afterload by thickening (hypertrophy) in order to ↓ wall stress.	Arterial vasodilators (eg, hydralazine) ↓ Afterload. ACE inhibitors and ARBs ↓ both preload and afterload. Chronic hypertension († MAP) → LV hypertrophy.
Myocardial oxygen demand	Myocardial O ₂ demand is † by: 1 Contractility 1 Afterload (proportional to arterial pressure) 1 heart Rate 1 Diameter of ventricle († wall tension)	Wall tension follows Laplace's law: Wall tension = pressure \times radius Wall stress = $\frac{\text{pressure} \times \text{radius}}{2 \times \text{wall thickness}}$

11/7/19 4:24 PM FAS1_2019_07-Cardio.indd 284

Cardiac output equations

	EQUATION	NOTES
Stroke volume	SV = EDV - ESV	
Ejection fraction	$EF = \frac{SV}{EDV} = \frac{EDV - ESV}{EDV}$	EF is an index of ventricular contractility (\(\frac{1}{4}\) in systolic HF; usually normal in diastolic HF).
Cardiac output	$CO = SV \times HR$ Fick principle: $CO = \frac{\text{rate of } O_2 \text{ consumption}}{(\text{arterial } O_2 \text{ content} - \text{venous } O_2 \text{ content})}$	In early stages of exercise, CO maintained by † HR and † SV. In later stages, CO maintained by † HR only (SV plateaus). Diastole is shortened with †† HR (eg, ventricular tachycardia) → ↓ diastolic filling time → ↓ SV → ↓ CO.
Pulse pressure	PP = SBP – DBP	PP directly proportional to SV and inversely proportional to arterial compliance. † PP in hyperthyroidism, aortic regurgitation, aortic stiffening (isolated systolic hypertension in elderly), obstructive sleep apnea († sympathetic tone), anemia, exercise (transient). † PP in aortic stenosis, cardiogenic shock, cardiac tamponade, advanced HF.
Mean arterial pressure	$MAP = CO \times TPR$	MAP (at resting HR) = $2/3$ DBP + $1/3$ SBP = DBP + $1/3$ PP.

Starling curves



Force of contraction is proportional to enddiastolic length of cardiac muscle fiber (preload).

- † contractility with catecholamines, positive inotropes (eg, digoxin).
- ↓ contractility with loss of functional myocardium (eg, MI), β-blockers (acutely), non-dihydropyridine Ca²⁺ channel blockers, dilated cardiomyopathy.

FAS1_2019_07-Cardio.indd 285 11/7/19 4:24 PM

Resistance, pressure, flow

$$\Delta P = Q \times R$$

Similar to Ohm's law: $\Delta V = I \times R$

Volumetric flow rate (Q) = flow velocity $(v) \times cross$ -sectional area (A)

Resistance

$$= \frac{\text{driving pressure } (\Delta P)}{O} = \frac{8\eta \text{ (viscosity)} \times \text{length}}{\pi r^4}$$

Total resistance of vessels in series:

$$R_T = R_1 + R_2 + R_3 ...$$

Total resistance of vessels in parallel:

$$\frac{1}{R_{\rm T}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$$

Capillaries have highest total cross-sectional area and lowest flow velocity.

Pressure gradient drives flow from high pressure to low pressure.

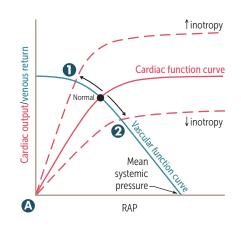
Arterioles account for most of TPR. Veins provide most of blood storage capacity.

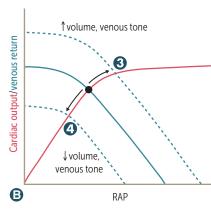
Viscosity depends mostly on hematocrit.

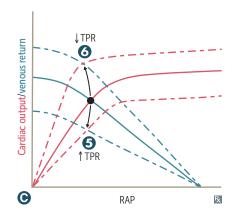
Viscosity † in hyperproteinemic states (eg, multiple myeloma), polycythemia.

Viscosity ↓ in anemia.

Cardiac and vascular function curves







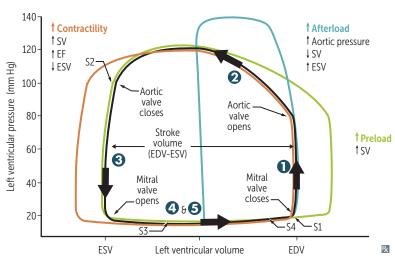
Intersection of curves = operating point of heart (ie, venous return and CO are equal, as circulatory system is a closed system).

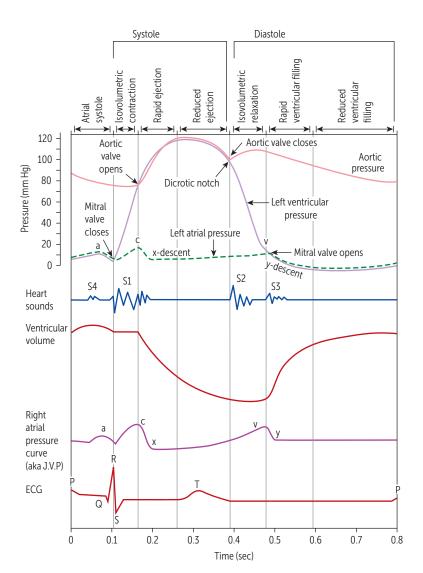
GRAPH	EFFECT	EXAMPLES	
⚠ Inotropy	Changes in contractility → altered SV → altered CO/VR and RA pressure (RAP)	 ① Catecholamines, digoxin, exercise ⊕ ② HF with reduced EF, narcotic overdose, sympathetic inhibition ⊝ 	
B Venous return Changes in circulating volume → altered SV → change in CO		tered RAP	
Total peripheral resistance	Changes in TPR → altered CO Change in RAP unpredictable.	State of the state of	

Changes often occur in tandem, and may be reinforcing (eg, exercise ↑ inotropy and ↓ TPR to maximize CO) or compensatory (eg, HF ↓ inotropy → fluid retention to ↑ preload to maintain CO).

FAS1_2019_07-Cardio.indd 286 11/7/19 4:24 PM

Pressure-volume loops and cardiac cycle





The black loop represents normal cardiac physiology.

Phases—left ventricle:

- Isovolumetric contraction—period between mitral valve closing and aortic valve opening; period of highest O₂ consumption
- 2 Systolic ejection—period between aortic valve opening and closing
- 3 Isovolumetric relaxation—period between aortic valve closing and mitral valve
- A Rapid filling—period just after mitral valve opening
- **5** Reduced filling—period just before mitral valve closing

Heart sounds:

- Sl—mitral and tricuspid valve closure. Loudest at mitral area.
- S2—aortic and pulmonary valve closure. Loudest at left upper sternal border.
- S3—in early diastole during rapid ventricular filling phase. Best heard at apex with patient in left lateral decubitus position. Associated with † filling pressures (eg, MR, AR, HF, thyrotoxicosis) and more common in dilated ventricles (but can be normal in children, young adults, athletes, and pregnancy).
- S4—in late diastole ("atrial kick"). Best heard at apex with patient in left lateral decubitus position. High atrial pressure. Associated with ventricular noncompliance (eg, hypertrophy). Left atrium must push against stiff LV wall. Considered abnormal if palpable.

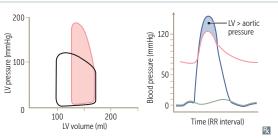
Jugular venous pulse (JVP):

- **a** wave—**a**trial contraction. Absent in atrial fibrillation (AF).
- **c** wave—RV **c**ontraction (closed tricuspid valve bulging into atrium).
- x descent—downward displacement of closed tricuspid valve during rapid ventricular ejection phase. Reduced or absent in tricuspid regurgitation and right HF because pressure gradients are reduced.
- v wave—† right atrial pressure due to filling ("villing") against closed tricuspid valve.
- y descent—RA emptying into RV. Prominent in constrictive pericarditis, absent in cardiac tamponade.

FAS1 2019 07-Cardio.indd 287 11/7/19 4:24 PM

Pressure-volume loops and valvular disease

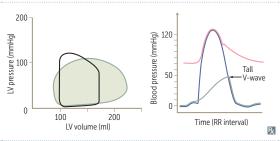
Aortic stenosis



- † LV pressure
- † ESV
- No change in EDV
- ↓ SV

Ventricular hypertrophy → ↓ ventricular compliance → ↑ EDP for given EDV

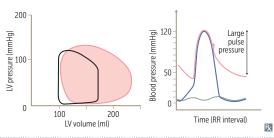
Mitral regurgitation



No true isovolumetric phase

- ↓ ESV due to ↓ resistance and↑ regurgitation into LA during systole
- ↑ EDV due to ↑ LA volume/pressure from regurgitation → ↑ ventricular filling
- † SV

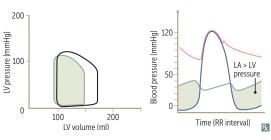
Aortic regurgitation



No true isovolumetric phase

- † EDV
- † SV

Mitral stenosis



- ↑ LA pressure
- ↓ EDV because of impaired ventricular filling
- ↓ ESV
- ↓ SV

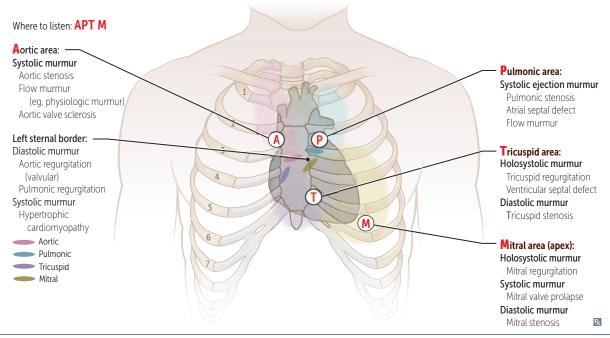
FAS1_2019_07-Cardio.indd 288 11/7/19 4:24 PM

Splitting of S2

Physiologic splitting	Inspiration → drop in intrathoracic pressure → ↑ venous return → ↑ RV filling → ↑ RV stroke volume → ↑ RV ejection time → delayed closure of pulmonic valve. ↓ pulmonary impedance (↑ capacity of the pulmonary circulation) also occurs during inspiration, which contributes to delayed closure of pulmonic valve.	E = Expiration I = Inspiration
Wide splitting	Seen in conditions that delay RV emptying (eg, pulmonic stenosis, right bundle branch block). Causes delayed pulmonic sound (especially on inspiration). An exaggeration of normal splitting.	S1 A2 P2 Abnormal delay R
Fixed splitting	Heard in ASD. ASD → left-to-right shunt → ↑ RA and RV volumes → ↑ flow through pulmonic valve → delayed pulmonic valve closure (independent of respiration).	E
Paradoxical splitting	Heard in conditions that delay aortic valve closure (eg, aortic stenosis, left bundle branch block). Normal order of semilunar valve closure is reversed so that P2 sound occurs before delayed A2 sound. On inspiration, P2 closes later and moves closer to A2, "paradoxically" eliminating the split. On expiration, the split can be heard (opposite to physiologic splitting).	E

FAS1_2019_07-Cardio.indd 289 11/7/19 4:24 PM

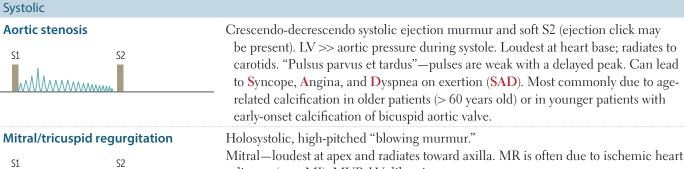
Auscultation of the heart



MANEUVER	CARDIOVASCULAR CHANGES	MURMURS THAT INCREASE WITH MANEUVER	MURMURS THAT DECREASE WITH MANEUVER
Standing Valsalva (strain phase)	↓ preload (↓ LV volume)	MVP (↓ LV volume) HCM (↓ LV volume)	Most murmurs (‡ flow through stenotic or regurgitant valve)
Passive leg raise	† preload († LV volume)	M	MX7D (4 1X7 1)
Squatting	† preload, † afterload († LV volume)	Most murmurs († flow through stenotic or regurgitant valve)	MVP († LV volume) HCM († LV volume)
Hand grip	↑↑ afterload → ↑ reverse flow across aortic valve (↑ LV volume)	Most other left-sided murmurs (AR, MR, VSD)	AS (\$\frac{1}{4}\$ transaortic valve pressure gradient) HCM (\$\frac{1}{4}\$ LV volume)
Inspiration	↑ venous return to right heart, ↓ venous return to left heart	Most right-sided murmurs	Most left-sided murmurs

FAS1_2019_07-Cardio.indd 290 11/7/19 4:24 PM

Heart murmurs



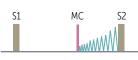




disease (post-MI), MVP, LV dilatation.

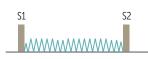
Tricuspid—loudest at tricuspid area. TR commonly caused by RV dilatation. Rheumatic fever and infective endocarditis can cause either MR or TR.

Mitral valve prolapse



Late systolic crescendo murmur with midsystolic click (MC) due to sudden tensing of chordae tendineae as mitral leaflets prolapse into the LA (Chordae cause Crescendo with Click). Most frequent valvular lesion. Best heard over apex. Loudest just before S2. Usually benign. Can predispose to infective endocarditis. Can be caused by myxomatous degeneration (1° or 2° to connective tissue disease such as Marfan or Ehlers-Danlos syndrome), rheumatic fever (particularly in developing countries), chordae rupture.

Ventricular septal defect



Holosystolic, harsh-sounding murmur. Loudest at tricuspid area. Larger VSDs have a lower intensity murmur than smaller VSDs.

Diastolic





High-pitched "blowing" early diastolic decrescendo murmur. Best heard at base (aortic root dilation) or left sternal border (valvular disease). Long diastolic murmur, hyperdynamic pulse, and head bobbing when severe and chronic. Wide pulse pressure. Causes include Bicuspid aortic valve, Endocarditis, Aortic root dilation, Rheumatic fever (BEAR). Progresses to left HF.

Mitral stenosis

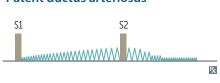


Follows opening snap (OS; due to abrupt halt in leaflet motion in diastole, after rapid opening due to fusion at leaflet tips). Delayed rumbling mid-to-late diastolic murmur (↓ interval between S2 and OS correlates with ↑ severity). LA>>> LV pressure during diastole.

Often a late (and highly specific) sequela of rheumatic fever. Chronic MS can result in pulmonary congestion/hypertension and LA dilation → atrial fibrillation and Ortner syndrome.

Continuous

Patent ductus arteriosus



Continuous machine-like murmur. Best heard at left infraclavicular area. Loudest at S2. Often due to congenital rubella or prematurity.

"PDAs (Public Displays of Affection) are continuously annoying."

FAS1 2019 07-Cardio.indd 291 11/7/19 4:24 PM

Myocardial action potential

Phase 0 = rapid upstroke and depolarization—voltage-gated Na⁺ channels open.

Phase 1 = initial repolarization—inactivation of voltage-gated Na⁺ channels. Voltage-gated K⁺ channels begin to open.

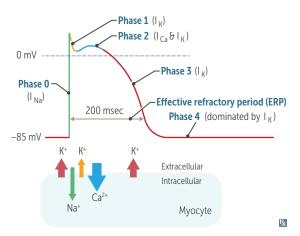
Phase 2 = plateau—Ca²⁺ influx through voltagegated Ca²⁺ channels balances K⁺ efflux. Ca²⁺ influx triggers Ca²⁺ release from sarcoplasmic reticulum and myocyte contraction.

Phase 3 = rapid repolarization—massive K⁺ efflux due to opening of voltage-gated slow delayed-rectifier K⁺ channels and closure of voltage-gated Ca²⁺ channels.

Phase 4 = resting potential—high K^+ permeability through K^+ channels.

In contrast to skeletal muscle:

- Cardiac muscle action potential has a plateau due to Ca²⁺ influx and K⁺ efflux.
- Cardiac muscle contraction requires Ca²⁺ influx from ECF to induce Ca²⁺ release from sarcoplasmic reticulum (Ca²⁺-induced Ca²⁺ release).
- Cardiac myocytes are electrically coupled to each other by gap junctions.



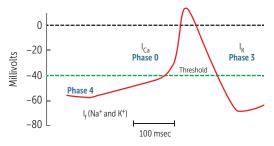
Occurs in all cardiac myocytes except for those in the SA and AV nodes.

Pacemaker action potential

Occurs in the SA and AV nodes. Key differences from the ventricular action potential include: **Phase 0** = upstroke—opening of voltage-gated Ca²⁺ channels. Fast voltage-gated Na⁺ channels are permanently inactivated because of the less negative resting potential of these cells. Results in a slow conduction velocity that is used by the AV node to prolong transmission from the atria to ventricles. Phases 1 and 2 are absent.

Phase 3 = repolarization—inactivation of the Ca²⁺ channels and \uparrow activation of K⁺ channels $\rightarrow \uparrow$ K⁺ efflux.

Phase 4 = slow spontaneous diastolic depolarization due to I_f ("funny current"). I_f channels responsible for a slow, mixed Na^+/K^+ inward current; different from I_{Na} in phase 0 of ventricular action potential. Accounts for automaticity of SA and AV nodes. The slope of phase 4 in the SA node determines HR. ACh/adenosine ↓ the rate of diastolic depolarization and ↓ HR, while catecholamines ↑ depolarization and ↑ HR. Sympathetic stimulation ↑ the chance that I_f channels are open and thus ↑ HR.



FAS1_2019_07-Cardio.indd 292 11/7/19 4:24 PM

Electrocardiogram

Conduction pathway: SA node → atria → AV node → bundle of His → right and left bundle branches → Purkinje fibers → ventricles; left bundle branch divides into left anterior and posterior fascicles.

SA node—located at junction of RA and SVC; "pacemaker" inherent dominance with slow phase of upstroke.

AV node—located in posteroinferior part of interatrial septum. Blood supply usually from RCA. 100-msec delay allows time for ventricular filling.

Pacemaker rates: SA > AV > bundle of His/ Purkinje/ventricles.

Speed of conduction: His-Purkinje > Atria > Ventricles > AV node. He Parks At Ventura Avenue.

P wave—atrial depolarization.

PR interval—time from start of atrial depolarization to start of ventricular depolarization (normally 120-200 msec).

QRS complex—ventricular depolarization (normally < 100 msec).

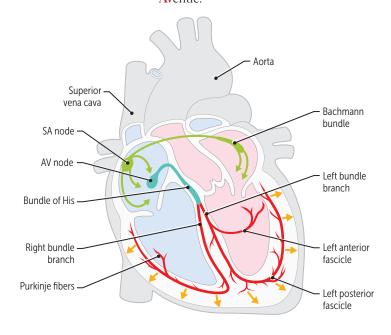
QT interval—ventricular depolarization, mechanical contraction of the ventricles, ventricular repolarization.

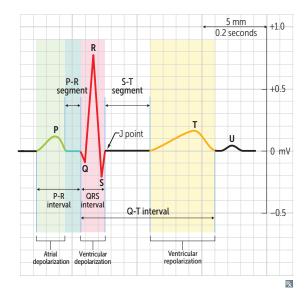
T wave—ventricular repolarization. T-wave inversion may indicate ischemia or recent MI.

J point—junction between end of QRS complex and start of ST segment.

ST segment—isoelectric, ventricles depolarized.

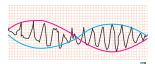
U wave—prominent in hypokalemia (think hyp"U"kalemia), bradycardia.





FAS1_2019_07-Cardio.indd 293 11/7/19 4:24 PM

Torsades de pointes



Polymorphic ventricular tachycardia, characterized by shifting sinusoidal waveforms on ECG; can progress to ventricular fibrillation (VF). Long QT interval predisposes to torsades de pointes. Caused by drugs, ↓ K⁺, ↓ Mg²⁺, ↓ Ca²⁺, congenital abnormalities. Treatment includes magnesium sulfate.

 $Drug\text{-}induced\ long\ QT\ (\textbf{ABCDE}):$

AntiArrhythmics (class IA, III)

AntiBiotics (eg, macrolides)

Anti"C"ychotics (eg, haloperidol)

AntiDepressants (eg, TCAs)

AntiEmetics (eg, ondansetron)

Torsades de pointes = twisting of the points

Congenital long QT syndrome

Inherited disorder of myocardial repolarization, typically due to ion channel defects (most commonly loss-of-function mutations affecting K⁺ channels); † risk of sudden cardiac death (SCD) due to torsades de pointes. Includes:

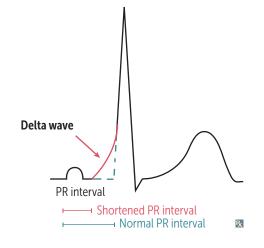
- Romano-Ward syndrome—autosomal dominant, pure cardiac phenotype (no deafness).
- Jervell and Lange-Nielsen syndrome autosomal recessive, sensorineural deafness.

Brugada syndrome

Autosomal dominant disorder most common in Asian males. ECG pattern of pseudo-right bundle branch block and ST elevations in V_1 - V_3 . † risk of ventricular tachyarrhythmias and SCD. Prevent SCD with implantable cardioverter-defibrillator (ICD).

Wolff-Parkinson-White syndrome

Most common type of ventricular preexcitation syndrome. Abnormal fast accessory conduction pathway from atria to ventricle (bundle of Kent) bypasses the rate-slowing AV node → ventricles begin to partially depolarize earlier → characteristic delta wave with widened QRS complex and shortened PR interval on ECG. May result in reentry circuit → supraventricular tachycardia.



FAS1_2019_07-Cardio.indd 294 11/7/19 4:24 PM

ECG tracings

RHYTHM	DESCRIPTION	EXAMPLE
Atrial fibrillation	Chaotic and erratic baseline with no discrete P waves in between irregularly spaced QRS complexes. Irregularly irregular heartbeat. Most common risk factors include hypertension and coronary artery disease (CAD). Occasionally seen after binge drinking ("holiday heart syndrome"). Can lead to thromboembolic events, particularly stroke. Treatment: anticoagulation, rate and rhythm control and/or cardioversion.	RR ₁ ≠ RR ₂ ≠ RR ₃ ≠ RR ₄ Irregular baseline (absent P waves)
Atrial flutter	A rapid succession of identical, back-to-back atrial depolarization waves. The identical appearance accounts for the "sawtooth" appearance of the flutter waves. Treat like atrial fibrillation +/- catheter ablation.	$RR_1 = RR_2 = RR_3$ $4.1 \text{ sawtooth pattern}$
Ventricular fibrillation	A completely erratic rhythm with no identifiable waves. Fatal arrhythmia without immediate CPR and defibrillation.	No discernible rhythm
AV block		
First-degree AV block	The PR interval is prolonged (> 200 msec). Benign and asymptomatic. No treatment required.	$PR_1 = PR_2 = PR_3 = PR_4$
Second-degree AV block		
Mobitz type I (Wenckebach)	Progressive lengthening of PR interval until a beat is "dropped" (a P wave not followed by a QRS complex). Usually asymptomatic. Variable RR interval with a pattern (regularly irregular).	PR ₁ < PR ₂ < PR ₃ P wave, absent QRS
Mobitz type II	Dropped beats that are not preceded by a change in the length of the PR interval (as in type I). May progress to 3rd-degree block. Often treated with pacemaker.	PR ₁ = PR ₂ P wave, absent QRS
Third-degree (complete) AV block	The atria and ventricles beat independently of each other. P waves and QRS complexes not rhythmically associated. Atrial rate > ventricular rate. Usually treated with pacemaker. Can be caused by Lym3 disease.	
	PP ₁ = PP ₂ = PP ₃ = PP ₄	P wave on QRS complex P wave on T wave

11/7/19 4:24 PM FAS1_2019_07-Cardio.indd 295

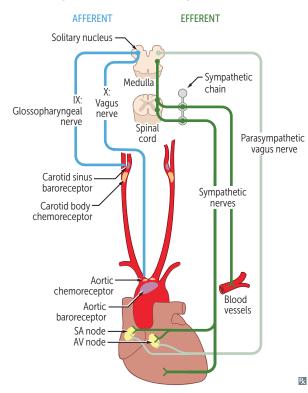
Atrial natriuretic peptide

Released from atrial myocytes in response to † blood volume and atrial pressure. Acts via cGMP. Causes vasodilation and ↓ Na⁺ reabsorption at the renal collecting tubule. Dilates afferent renal arterioles and constricts efferent arterioles, promoting diuresis and contributing to "aldosterone escape" mechanism.

B-type (brain) natriuretic peptide

Released from ventricular myocytes in response to † tension. Similar physiologic action to ANP, with longer half-life. BNP blood test used for diagnosing HF (very good negative predictive value). Available in recombinant form (nesiritide) for treatment of HF.

Baroreceptors and chemoreceptors



Receptors:

- Aortic arch transmits via vagus nerve to solitary nucleus of medulla (responds to changes in BP).
- Carotid sinus (dilated region at carotid bifurcation) transmits via glossopharyngeal nerve to solitary nucleus of medulla (responds to changes in BP).

Baroreceptors:

- Hypotension → 1 arterial pressure → 1 stretch → 1 afferent baroreceptor firing → 1 efferent sympathetic firing and 1 efferent parasympathetic stimulation → vasoconstriction, 1 HR, 1 contractility, 1 BP. Important in the response to severe hemorrhage.
- Carotid massage—↑ pressure on carotid sinus → ↑ stretch
 → ↑ afferent baroreceptor firing → ↑ AV node refractory period
 → ↓ HR.
- Component of Cushing reflex (triad of hypertension, bradycardia, and respiratory depression)—↑ intracranial pressure constricts arterioles → cerebral ischemia → ↑ pCO₂ and ↓ pH → central reflex sympathetic ↑ in perfusion pressure (hypertension) → ↑ stretch → peripheral reflex baroreceptor—induced bradycardia.

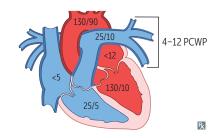
Chemoreceptors:

- Peripheral—carotid and aortic bodies are stimulated by ↑ Pco₂,
 ↓ pH of blood, and ↓ Po₂ (< 60 mm Hg).
- Central—are stimulated by changes in pH and Pco₂ of brain interstitial fluid, which in turn are influenced by arterial CO₂ as H⁺ cannot cross the blood-brain barrier. Do not directly respond to Po₂. Central chemoreceptors become less responsive with chronically ↑ Pco₂ (eg, COPD) → ↑ dependence on peripheral chemoreceptors to detect ↓ O₂ to drive respiration.

FAS1 2019 07-Cardio.indd 296 11/7/19 4:24 PM

Normal cardiac pressures

Pulmonary capillary wedge pressure (PCWP; in mm Hg) is a good approximation of left atrial pressure. In mitral stenosis, PCWP > LV end diastolic pressure. PCWP is measured with pulmonary artery catheter (Swan-Ganz catheter).



Autoregulation	How blood flow to an organ remains constant over a wide range of perfusion pressures.		
ORGAN	FACTORS DETERMINING AUTOREGULATION		
Heart	Local metabolites (vasodilatory): adenosine, NO, CO₂, ↓ O₂	The pulmonary vasculature is unique in that alveolar hypoxia causes vasoconstriction so	
Brain	Local metabolites (vasodilatory): CO ₂ (pH)	that only well-ventilated areas are perfused.	
Kidneys	Myogenic and tubuloglomerular feedback	other organs, hypoxia causes vasodilation.	
Lungs	Hypoxia causes vasoconstriction		
Skeletal muscle Local metabolites during exercise (vasodilatory): CO ₂ , H ⁺ , Adenosine, Lactate, K ⁺ At rest: sympathetic tone in arteries		CHALK	
Skin	Sympathetic vasoconstriction most important mechanism for temperature control		

Capillary fluid exchange

Starling forces determine fluid movement through capillary membranes:

- P_c = capillary hydrostatic pressure—pushes fluid out of capillary
- P_i = interstitial hydrostatic pressure—pushes fluid into capillary
- π_c = plasma colloid osmotic (oncotic) pressure—pulls fluid into capillary
- π_i = interstitial fluid colloid osmotic pressure—pulls fluid out of capillary

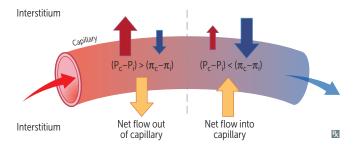
 $J_{\rm v} = net \; fluid \; flow = K_f \left[(P_c - P_i) - \sigma(\pi_c - \pi_i) \right] \label{eq:Jv}$

 K_f = capillary permeability to fluid

 σ = reflection coefficient (measure of capillary permeability to protein)

Edema—excess fluid outflow into interstitium commonly caused by:

- † capillary pressure († P_c; eg, HF)
- † capillary permeability († K_f; eg, toxins, infections, burns)
- † interstitial fluid colloid osmotic pressure († π_i ; eg, lymphatic blockage)
- \downarrow plasma proteins ($\downarrow \pi_c$; eg, nephrotic syndrome, liver failure, protein malnutrition)



FAS1_2019_07-Cardio.indd 297 11/7/19 4:24 PM

► CARDIOVASCULAR—PATHOLOGY

Congenital heart diseases

RIGHT-TO-LEFT SHUNTS

Early cyanosis—"blue babies." Often diagnosed prenatally or become evident immediately after birth. Usually require urgent surgical treatment and/or maintenance of a PDA.

The **5 T**'s:

- 1. Truncus arteriosus (1 vessel)
- 2. Transposition (2 switched vessels)
- 3. Tricuspid atresia (3 = Tri)
- **4.** Tetralogy of Fallot (**4 = Tetra**)

Persistent truncus arteriosus

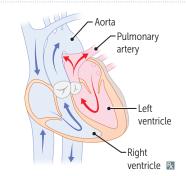
Truncus arteriosus fails to divide into pulmonary trunk and aorta due to failure of aorticopulmonary septum formation; most patients have accompanying VSD.

5. TAPVR (**5** letters in the name)

D-transposition of great vessels

Aorta leaves RV (anterior) and pulmonary trunk leaves LV (posterior) → separation of systemic and pulmonary circulations. Not compatible with life unless a shunt is present to allow mixing of blood (eg, VSD, PDA, or patent foramen ovale).

Due to failure of the aorticopulmonary septum to spiral ("egg on a string" appearance on CXR). Without surgical intervention, most infants die within the first few months of life.



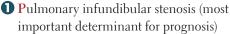
Tricuspid atresia

Tetralogy of Fallot

Absence of tricuspid valve and hypoplastic RV; requires both ASD and VSD for viability.

Caused by anterosuperior displacement of the P

infundibular septum. Most common cause of early childhood cyanosis.



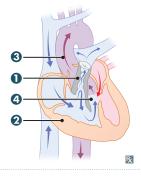
- Right ventricular hypertrophy (RVH) boot-shaped heart on CXR A
- Overriding aorta
- 4 VSD

Pulmonary stenosis forces right-to-left flow across VSD → RVH, "tet spells" (often caused by crying, fever, and exercise due to exacerbation of RV outflow obstruction).

PROVe.

Squatting: ↑ SVR, ↓ right-to-left shunt, improves cyanosis.

Associated with 22q11 syndromes.



Total anomalous pulmonary venous return

Pulmonary veins drain into right heart circulation (SVC, coronary sinus, etc); associated with ASD and sometimes PDA to allow for right-to-left shunting to maintain CO.

Ebstein anomaly

Displacement of tricuspid valve leaflets downward into RV, artificially "atrializing" the ventricle. Associated with tricuspid regurgitation, accessory conduction pathways, right-sided HF.

Can be caused by lithium exposure in utero.

FAS1_2019_07-Cardio.indd 298 11/7/19 4:24 PM

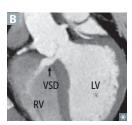
Congenital heart diseases (continued)

LEFT-TO-RIGHT SHUNTS

Acyanotic at presentation; cyanosis may occur years later. Frequency: VSD > ASD > PDA.

Right-to-Left shunts: eaRLy cyanosis. Left-to-Right shunts: "LateR" cyanosis.

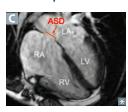
Ventricular septal defect



Asymptomatic at birth, may manifest weeks later or remain asymptomatic throughout life. Most self resolve; larger lesions **B** may lead to LV overload and HF.

O₂ saturation † in RV and pulmonary artery.

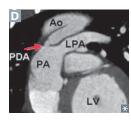
Atrial septal defect



Defect in interatrial septum **C**; wide, fixed split S2. Ostium secundum defects most common and usually an isolated finding; ostium primum defects rarer and usually occur with other cardiac anomalies. Symptoms range from none to HF. Distinct from patent foramen ovale in that septa are missing tissue rather than unfused.

O₂ saturation † in RA, RV, and pulmonary artery. May lead to paradoxical emboli (systemic venous emboli use ASD to bypass lungs and become systemic arterial emboli). Associated with Down syndrome.

Patent ductus arteriosus



In fetal period, shunt is right to left (normal). In neonatal period, ↓ pulmonary vascular resistance → shunt becomes left to right → progressive RVH and/or LVH and HF.

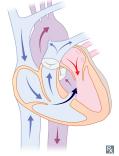
Associated with a continuous, "machine-like" murmur. Patency is maintained by PGE synthesis and low O₂ tension. Uncorrected PDA □ can eventually result in late cyanosis in the lower extremities (differential cyanosis).

PDA is normal in utero and normally closes only after birth.

Eisenmenger syndrome

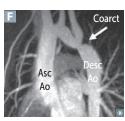


Uncorrected left-to-right shunt (VSD, ASD, PDA) → ↑ pulmonary blood flow → pathologic remodeling of vasculature → pulmonary arterial hypertension. RVH occurs to compensate → shunt becomes right to left. Causes late cyanosis, clubbing **E**, and polycythemia. Age of onset varies.



OTHER ANOMALIES

Coarctation of the aorta



Aortic narrowing **F** near insertion of ductus arteriosus ("juxtaductal"). Associated with bicuspid aortic valve, other heart defects, and Turner syndrome. Hypertension in upper extremities and weak, delayed pulse in lower extremities (brachial-femoral delay). With age, intercostal arteries enlarge due to collateral circulation; arteries erode ribs → notched appearance on CXR.

Complications include HF, † risk of cerebral hemorrhage (berry aneurysms), aortic rupture, and possible endocarditis.

FAS1_2019_07-Cardio.indd 299 11/7/19 4:24 PM

CARDIOVASCULAR ► CARDIOVASCULAR—PATHOLOGY

Congenital cardiac defect associations

DISORDER	DEFECT
Alcohol exposure in utero (fetal alcohol syndrome)	VSD, PDA, ASD, tetralogy of Fallot
Congenital rubella	PDA, pulmonary artery stenosis, septal defects
Down syndrome	AV septal defect (endocardial cushion defect), VSD, ASD
Infant of diabetic mother	Transposition of great vessels, VSD
Marfan syndrome	MVP, thoracic aortic aneurysm and dissection, aortic regurgitation
Prenatal lithium exposure	Ebstein anomaly
Turner syndrome	Bicuspid aortic valve, coarctation of aorta
Williams syndrome	Supravalvular aortic stenosis
22q11 syndromes	Truncus arteriosus, tetralogy of Fallot

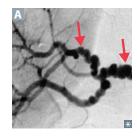
Hypertension

Persistent systolic BP \geq 130 mm Hg and/or diastolic BP \geq 80 mm Hg.

RISK FACTORS

† age, obesity, diabetes, physical inactivity, excess salt intake, excess alcohol intake, cigarette smoking, family history; African American > Caucasian > Asian.

FEATURES



PREDISPOSES TO

90% of hypertension is 1° (essential) and related to † CO or † TPR. Remaining 10% mostly 2° to renal/renovascular diseases such as fibromuscular dysplasia (characteristic "string of beads" appearance of renal artery A, usually seen in women of child-bearing age) and atherosclerotic renal artery stenosis or to 1° hyperaldosteronism.

Hypertensive urgency—severe (≥ 180/≥ 120 mm Hg) hypertension without acute end-organ damage.

Hypertensive emergency—severe hypertension with evidence of acute end-organ damage (eg, encephalopathy, stroke, retinal hemorrhages and exudates, papilledema, MI, HF, aortic dissection, kidney injury, microangiopathic hemolytic anemia, eclampsia).

CAD, LVH, HF, atrial fibrillation; aortic dissection, aortic aneurysm; stroke; CKD (hypertensive nephropathy); retinopathy.

FAS1_2019_07-Cardio.indd 300 11/7/19 4:24 PM

Hyperlipidemia signs

Xanthomas	Plaques or nodules composed of lipid-laden histiocytes in skin A, especially the eyelids (xanthelasma B).
Tendinous xanthoma	Lipid deposit in tendon C, especially Achilles.
Corneal arcus	Lipid deposit in cornea. Common in elderly (arcus senilis D), but appears earlier in life with hypercholesterolemia.



Arteriosclerosis

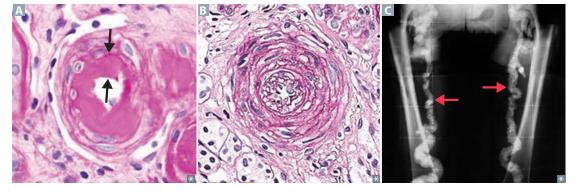
Hardening of arteries, with arterial wall thickening and loss of elasticity.

Arteriolosclerosis

Common. Affects small arteries and arterioles. Two types: hyaline (thickening of vessel walls 2° to plasma protein leak into endothelium in essential hypertension or diabetes mellitus A) and hyperplastic ("onion skinning" in severe hypertension B with proliferation of smooth muscle cells).

Mönckeberg sclerosis (Medial calcific sclerosis)

Uncommon. Affects Medium-sized arteries. Calcification of internal elastic lamina and media of arteries → vascular stiffening without obstruction. "Pipestem" appearance on x-ray . Does not obstruct blood flow; intima not involved.



FAS1_2019_07-Cardio.indd 301 11/7/19 4:24 PM

302

SECTION III

CARDIOVASCULAR ► CARDIOVASCULAR—PATHOLOGY

Atherosclerosis

Very common. Disease of elastic arteries and large- and medium-sized muscular arteries; a form of arteriosclerosis caused by buildup of cholesterol plaques in intima.

LOCATION

Abdominal aorta > Coronary artery > Popliteal artery > Carotid artery > circle of Willis. A CoPy Cat named Willis.

RISK FACTORS

Modifiable: smoking, hypertension, dyslipidemia († LDL, $\mbox{\ensuremath{\mbox{\sc t}}}$ HDL), diabetes.

Non-modifiable: age, sex († in men and postmenopausal women), family history.

SYMPTOMS

Angina, claudication, but can be asymptomatic.

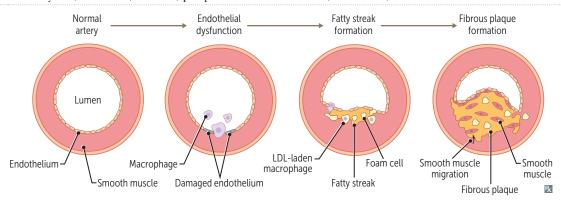
PROGRESSION



Inflammation important in pathogenesis: endothelial cell dysfunction → macrophage and LDL accumulation → foam cell formation → fatty streaks → smooth muscle cell migration (involves PDGF and FGF), proliferation, and extracellular matrix deposition → fibrous plaque → complex atheromas A → calcification (calcium content correlates with risk of complications).

COMPLICATIONS

Aneurysms, ischemia, infarcts, peripheral vascular disease, thrombus, emboli.



Aortic aneurysm

Localized pathologic dilation of the aorta. May cause abdominal and/or back pain, which is a sign of leaking, dissection, or imminent rupture.

Abdominal aortic aneurysm



Usually associated with atherosclerosis. Risk factors include history of tobacco use, † age, male sex, family history. May present as palpable pulsatile abdominal mass (arrows in A point to outer dilated calcified aortic wall, with partial crescent-shaped non-opacification of aorta due to flap/clot). Most often infrarenal (distal to origin of renal arteries).

Thoracic aortic aneurysm

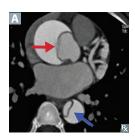
Associated with cystic medial degeneration. Risk factors include hypertension, bicuspid aortic valve, connective tissue disease (eg, Marfan syndrome). Also associated with 3° syphilis (obliterative endarteritis of the vasa vasorum). Aortic root dilatation may lead to aortic valve regurgitation.

FAS1_2019_07-Cardio.indd 302

Traumatic aortic rupture

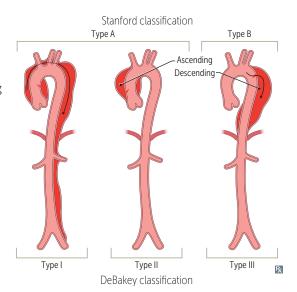
Due to trauma and/or deceleration injury, most commonly at aortic isthmus (proximal descending aorta just distal to origin of left subclavian artery). X-ray may reveal widened mediastinum.

Aortic dissection



Longitudinal intimal tear forming a false lumen. Associated with hypertension, bicuspid aortic valve, inherited connective tissue disorders (eg, Marfan syndrome). Can present with tearing, sudden-onset chest pain radiating to the back +/— markedly unequal BP in arms. CXR can show mediastinal widening. Can result in organ ischemia, aortic rupture, death. Two types:

- Stanford type A (proximal): involves
 Ascending aorta (red arrow in A). May
 extend to aortic arch or descending aorta
 (blue arrow in A). May result in acute
 aortic regurgitation or cardiac tamponade.
 Treatment: surgery.
- Stanford type B (distal): involves only descending aorta (Below left subclavian artery). Treatment: β-blockers, then vasodilators.



FAS1_2019_07-Cardio.indd 303 11/7/19 4:24 PM

Ischemic heart disease manifestations

Chest pain due to ischemic myocardium 2° to coronary artery narrowing or spasm; no myocyte **Angina** necrosis. ■ Stable—usually 2° to atherosclerosis (≥ 70% occlusion); exertional chest pain in classic distribution (usually with ST depression on ECG), resolving with rest or nitroglycerin. Vasospastic (also called Prinzmetal or Variant)—occurs at rest 2° to coronary artery spasm; transient ST elevation on ECG. Smoking is a risk factor; hypertension and hypercholesterolemia are not. Triggers include cocaine, alcohol, and triptans. Treat with Ca²⁺ channel blockers, nitrates, and smoking cessation (if applicable). Unstable—thrombosis with incomplete coronary artery occlusion; +/- ST depression and/or T-wave inversion on ECG but no cardiac biomarker elevation (unlike NSTEMI); † in frequency or intensity of chest pain or any chest pain at rest. Distal to coronary stenosis, vessels are maximally dilated at baseline. Administration of vasodilators **Coronary steal** (eg, dipyridamole, regadenoson) dilates normal vessels → blood is shunted toward well-perfused syndrome areas → ischemia in myocardium perfused by stenosed vessels. Principle behind pharmacologic stress tests with coronary vasodilators. Sudden cardiac death Death from cardiac causes within 1 hour of onset of symptoms, most commonly due to a lethal arrhythmia (eg, VF). Associated with CAD (up to 70% of cases), cardiomyopathy (hypertrophic, dilated), and hereditary ion channelopathies (eg, long QT syndrome, Brugada syndrome). Prevent with ICD. **Chronic ischemic** Progressive onset of HF over many years due to chronic ischemic myocardial damage. heart disease **Myocardial infarction** Most often due to rupture of coronary artery atherosclerotic plaque → acute thrombosis. ↑ cardiac biomarkers (CK-MB, troponins) are diagnostic. Non-ST-segment elevation MI (NSTEMI) ST-segment elevation MI (STEMI) Subendocardial infarcts Transmural infarcts Subendocardium (inner 1/3) especially Full thickness of myocardial wall involved vulnerable to ischemia ST depression on ECG ST elevation, pathologic Q waves on ECG

FAS1 2019 07-Cardio.indd 304 11/7/19 4:24 PM

Evolution of myocardial infarction

Commonly occluded coronary arteries: LAD > RCA > circumflex. Symptoms: diaphoresis, nausea, vomiting, severe retrosternal pain, pain in left arm and/or jaw, shortness of breath, fatigue.

TIME	GROSS	LIGHT MICROSCOPE	COMPLICATIONS
0–24 hr	Dark mottling Occluded artery Infarct Dark mottling; pale with tetrazolium stain	Early coagulative necrosis → cell content released into blood; edema, hemorrhage, wavy fibers Reperfusion injury → free radicals and ↑ Ca²+ influx → hypercontraction of myofibrils (dark eosinophilic stripes)	Ventricular arrhythmia, HF, cardiogenic shock
1–3 days	Hyperemia	Extensive coagulative necrosis Tissue surrounding infarct shows acute inflammation with neutrophils	Postinfarction fibrinous pericarditis
3–14 days	Hyperemic border; central yellow-brown softening	Macrophages, then granulation tissue at margins	Free wall rupture → tamponade; papillary muscle rupture → mitral regurgitation; interventricular septal rupture due to macrophage-mediated structural degradation → left- to-right shunt LV pseudoaneurysm (risk of rupture)
2 weeks to several months	Recanalized artery Gray-white scar	Contracted scar complete	Dressler syndrome, HF, arrhythmias, true ventricular aneurysm (risk of mural thrombus)

FAS1_2019_07-Cardio.indd 305 11/7/19 4:24 PM

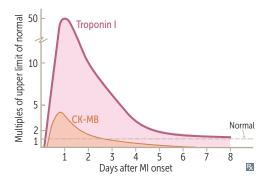
Diagnosis of myocardial infarction

In the first 6 hours, ECG is the gold standard. Cardiac troponin I rises after 4 hours (peaks at 24 hr) and is † for 7–10 days; more specific than other protein markers.

CK-MB rises after 6–12 hours (peaks at 16–24 hr) and is predominantly found in myocardium but can also be released from skeletal muscle. Useful in diagnosing reinfarction following acute MI because levels return to normal after 48 hours.

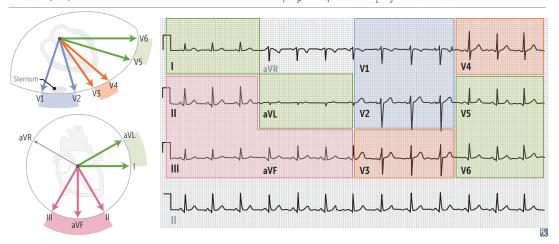
Large MIs lead to greater elevations in troponin I and CK-MB. Exact curves vary with testing procedure.

ECG changes can include ST elevation (STEMI, transmural infarct), ST depression (NSTEMI, subendocardial infarct), hyperacute (peaked) T waves, T-wave inversion, new left bundle branch block, and pathologic Q waves or poor R wave progression (evolving or old transmural infarct).



ECG localization of STEMI

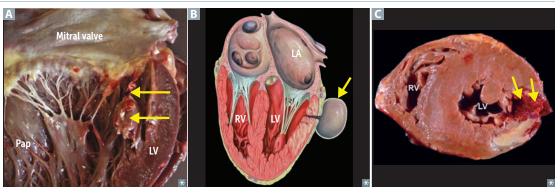
INFARCT LOCATION	LEADS WITH ST-SEGMENT ELEVATIONS OR Q WAVES
Anteroseptal (LAD)	V_1 - V_2
Anteroapical (distal LAD)	V_3 – V_4
Anterolateral (LAD or LCX)	V_5 – V_6
Lateral (LCX)	l, aV <mark>L</mark>
InFerior (RCA)	II, III, aVF
Posterior (PDA)	$V_7 - V_0$, ST depression in $V_1 - V_2$ with tall R waves



FAS1_2019_07-Cardio.indd 306 11/7/19 4:24 PM

Myocardial infarction complications

Cardiac arrhythmia	Occurs within the first few days after MI. Important cause of death before reaching the hospital and within the first 24 hours post-MI.
Postinfarction fibrinous pericarditis	1–3 days: friction rub.
Papillary muscle rupture	2–7 days: posteromedial papillary muscle rupture 🖪 † risk due to single blood supply from posterior descending artery. Can result in severe mitral regurgitation.
Interventricular septal rupture	3–5 days: macrophage-mediated degradation \rightarrow VSD \rightarrow † O_2 saturation and pressure in RV.
Ventricular pseudoaneurysm formation	3–14 days: free wall rupture contained by adherent pericardium or scar tissue □ ; ↓ CO, risk of arrhythmia, embolus from mural thrombus.
Ventricular free wall rupture	5–14 days: free wall rupture C → cardiac tamponade. LV hypertrophy and previous MI protect against free wall rupture. Acute form usually leads to sudden death.
True ventricular aneurysm	2 weeks to several months: outward bulge with contraction ("dyskinesia"), associated with fibrosis.
Dressler syndrome	Several weeks: autoimmune phenomenon resulting in fibrinous pericarditis.
LV failure and pulmonary edema	Can occur 2° to LV infarction, VSD, free wall rupture, papillary muscle rupture with mitral regurgitation.



Acute coronary syndrome treatments

Unstable angina/NSTEMI—Anticoagulation (eg, heparin), antiplatelet therapy (eg, aspirin)

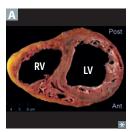
+ ADP receptor inhibitors (eg, clopidogrel), $\beta\text{-blockers},$ ACE inhibitors, statins. Symptom control with nitroglycerin and morphine.

STEMI—In addition to above, reperfusion therapy most important (percutaneous coronary intervention preferred over fibrinolysis).

FAS1_2019_07-Cardio.indd 307 11/7/19 4:24 PM

Cardiomyopathies

Dilated cardiomyopathy



Most common cardiomyopathy (90% of cases). Often idiopathic or familial (eg, due to mutation of *TTN* gene encoding the sarcomeric protein titin).

Other etiologies include drugs (eg, alcohol, cocaine, doxorubicin), infection (eg, coxsackie B virus, Chagas disease), ischemia (eg, CAD), systemic conditions (eg, hemochromatosis, sarcoidosis, thyrotoxicosis, wet beriberi), peripartum cardiomyopathy.

Findings: HF, S3, systolic regurgitant murmur, dilated heart on echocardiogram, balloon appearance of heart on CXR.

Treatment: Na⁺ restriction, ACE inhibitors, β-blockers, diuretics, mineralocorticoid receptor blockers (eg, spironolactone), digoxin, ICD, heart transplant. Leads to systolic dysfunction.

Dilated cardiomyopathy A displays eccentric hypertrophy (sarcomeres added in series).

Takotsubo cardiomyopathy: broken heart syndrome—ventricular apical ballooning likely due to increased sympathetic stimulation (eg, stressful situations).

Hypertrophic obstructive cardiomyopathy



60–70% of cases are familial, autosomal dominant (most commonly due to mutations in genes encoding sarcomeric proteins, such as myosin binding protein C and β-myosin heavy chain). Causes syncope during exercise and may lead to sudden death (eg, in young athletes) due to ventricular arrhythmia.

Findings: S4, systolic murmur. May see mitral regurgitation due to impaired mitral valve closure.

Treatment: cessation of high-intensity athletics, use of β -blocker or non-dihydropyridine Ca²⁺ channel blockers (eg, verapamil). ICD if syncope occurs.

Diastolic dysfunction ensues.

Marked ventricular concentric hypertrophy (sarcomeres added in parallel) **B**, often septal predominance. Myofibrillar disarray and fibrosis.

Physiology of HOCM—asymmetric septal hypertrophy and systolic anterior motion of mitral valve → outflow obstruction → dyspnea, possible syncope.

Other causes of concentric LV hypertrophy: chronic HTN, Friedreich ataxia.

Restrictive/infiltrative cardiomyopathy

Postradiation fibrosis, Löffler endocarditis, Endocardial fibroelastosis (thick fibroelastic tissue in endocardium of young children), Amyloidosis, Sarcoidosis, Hemochromatosis (although dilated cardiomyopathy is more common) (Puppy LEASH). Diastolic dysfunction ensues. Can have low-voltage ECG despite thick myocardium (especially in amyloidosis).

Löffler endocarditis—associated with hypereosinophilic syndrome; histology shows eosinophilic infiltrates in myocardium.

FAS1 2019 07-Cardio.indd 308 11/7/19 4:24 PM

Heart failure



Clinical syndrome of cardiac pump dysfunction → congestion and low perfusion. Symptoms include dyspnea, orthopnea, fatigue; signs include S3 heart sound, rales, jugular venous distention (JVD), pitting edema A.

Systolic dysfunction—reduced EF, † EDV; † contractility often 2° to ischemia/MI or dilated cardiomyopathy.

Diastolic dysfunction—preserved EF, normal EDV; \$\dagger\$ compliance († EDP) often 2° to myocardial hypertrophy.

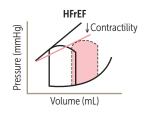
Right HF most often results from left HF. Cor pulmonale refers to isolated right HF due to pulmonary cause.

ACE inhibitors or angiotensin II receptor blockers, β-blockers (except in acute decompensated HF), and spironolactone ↓ mortality. Loop and thiazide diuretics are used mainly for symptomatic relief. Hydralazine with nitrate therapy improves both symptoms and mortality in select patients.

Left heart failure Orthopnea Shortness of breath when supine: 1 venous return from redistribution of blood (immediate gravity effect) exacerbates pulmonary vascular congestion. **Paroxysmal** Breathless awakening from sleep: † venous return from redistribution of blood, reabsorption of nocturnal dyspnea peripheral edema, etc. **Pulmonary edema** ↑ pulmonary venous pressure → pulmonary venous distention and transudation of fluid. Presence of hemosiderin-laden macrophages ("HF" cells) in lungs. Right heart failure Hepatomegaly ↑ central venous pressure → ↑ resistance to portal flow. Rarely, leads to "cardiac cirrhosis." (nutmeg liver) **Jugular venous** † venous pressure.

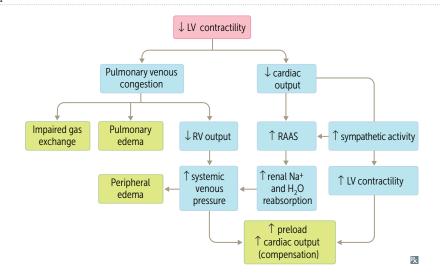
distention

↑ venous pressure → fluid transudation.



Peripheral edema





FAS1 2019 07-Cardio.indd 309 11/7/19 4:24 PM

Shock

Inadequate organ perfusion and delivery of nutrients necessary for normal tissue and cellular function. Initially may be reversible but life threatening if not treated promptly.

	CAUSED BY	SKIN	PCWP (PRELOAD)	СО	SVR (AFTERLOAD)	TREATMENT
Hypovolemic shock	Hemorrhage, dehydration, burns	Cold, clammy	++	ţ	†	IV fluids
Cardiogenic shock	Acute MI, HF, valvular dysfunction, arrhythmia	Cold,	A 1		•	Inotropes, diuresis
Obstructive shock	Cardiac tamponade, pulmonary embolism, tension pneumothorax	clammy	↑ or ↓	11	I	Relieve obstruction
Distributive shock	Sepsis, anaphylaxis CNS injury	Warm Dry	†	†	†† ††	IV fluids, pressors, epinephrine (anaphylaxis)

Cardiac tamponade





Compression of the heart by fluid (eg, blood, effusions [arrows in \blacksquare] in pericardial space) $\rightarrow \downarrow$ CO. Equilibration of diastolic pressures in all 4 chambers.

Findings: Beck triad (hypotension, distended neck veins, distant heart sounds), † HR, pulsus paradoxus. ECG shows low-voltage QRS and electrical alternans

(due to "swinging" movement of heart in large effusion).

Pulsus paradoxus—↓ in amplitude of systolic BP by > 10 mm Hg during inspiration. Seen in constrictive Pericarditis, obstructive pulmonary disease (eg, Croup, OSA, Asthma, COPD), cardiac Tamponade (Pea COAT).

FAS1_2019_07-Cardio.indd 310 11/7/19 4:24 PM

Bacterial endocarditis

Acute—*S aureus* (high virulence). Large vegetations on previously normal valves A. Rapid onset.

Subacute—viridans streptococci (low virulence). Smaller vegetations on congenitally abnormal or diseased valves. Sequela of dental procedures. Gradual onset.

Symptoms: fever (most common), new murmur, Roth spots (round white spots on retina surrounded by hemorrhage B), Osler nodes (Ouchy raised lesions on finger or toe pads due to immune complex deposition), Janeway lesions (small, painless, erythematous lesions on palm or sole) D, splinter hemorrhages E on nail bed.

Associated with glomerulonephritis, septic arterial or pulmonary emboli.

May be nonbacterial (marantic/thrombotic) 2° to malignancy, hypercoagulable state, or lupus.

FROM JANE with **♥**:

Fever

Roth spots

Osler nodes

Murmur

Janeway lesions

Anemia

Nail-bed hemorrhage

Emboli

Requires multiple blood cultures for diagnosis. If culture ⊖, most likely *Coxiella burnetii*, *Bartonella* spp.

Mitral valve is most frequently involved.

Tricuspid valve endocarditis is associated with

IV **drug** abuse (don't "tri" **drugs**). Associated with *S aureus*, *Pseudomonas*, and *Candida*.

S bovis (gallolyticus) is present in colon cancer, *S epidermidis* on prosthetic valves.

Native valve endocarditis may be due to **HACEK** organisms (*Haemophilus*, *Aggregatibacter* [formerly *Actinobacillus*], *Cardiobacterium*, *Eikenella*, *Kingella*).





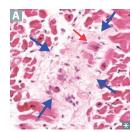






FAS1_2019_07-Cardio.indd 311 11/7/19 4:24 PM

Rheumatic fever



A consequence of pharyngeal infection with group A β-hemolytic streptococci. Late sequelae include rheumatic heart disease, which affects heart valves—mitral > aortic >> tricuspid (high-pressure valves affected most). Early lesion is mitral valve regurgitation; late lesion is mitral stenosis.

Associated with Aschoff bodies (granuloma with giant cells [blue arrows in A]), Anitschkow cells (enlarged macrophages with ovoid, wavy, rod-like nucleus [red arrow in A]), † anti-streptolysin O (ASO) and † anti-DNase B titers.

Immune mediated (type II hypersensitivity); not a direct effect of bacteria. Antibodies to M protein cross-react with self antigens, often myosin (molecular mimicry).

Treatment/prophylaxis: penicillin.

JVNES (major criteria):

Joint (migratory polyarthritis)

♥ (carditis)

Nodules in skin (subcutaneous)

Erythema marginatum (evanescent rash with ring margin)

Sydenham chorea

Syphilitic heart disease

3° syphilis disrupts the vasa vasorum of the aorta with consequent atrophy of vessel wall and dilation of aorta and valve ring. May see calcification of aortic root, ascending aortic arch, and thoracic aorta. Leads to "tree bark" appearance of aorta.

Can result in aneurysm of ascending aorta or aortic arch, aortic insufficiency.

FAS1_2019_07-Cardio.indd 312 11/7/19 4:24 PM

SECTION III

Acute pericarditis



Inflammation of the pericardium [A, red arrows]. Commonly presents with sharp pain, aggravated by inspiration, and relieved by sitting up and leaning forward. Often complicated by pericardial effusion [between yellow arrows in A]. Presents with friction rub. ECG changes include widespread ST-segment elevation and/or PR depression.

Causes include idiopathic (most common; presumed viral), confirmed infection (eg, coxsackievirus B), neoplasia, autoimmune (eg, SLE, rheumatoid arthritis), uremia, cardiovascular (acute STEMI or Dressler syndrome), radiation therapy.

Treatment: NSAIDs, colchicine, glucocorticoids, dialysis (uremia).

Myocarditis

Inflammation of myocardium → global enlargement of heart and dilation of all chambers. Major cause of SCD in adults < 40 years old.

Presentation highly variable, can include dyspnea, chest pain, fever, arrhythmias (persistent tachycardia out of proportion to fever is characteristic).

Multiple causes:

- Viral (eg, adenovirus, coxsackie B, parvovirus Bl9, HIV, HHV-6); lymphocytic infiltrate with focal necrosis highly indicative of viral myocarditis.
- Parasitic (eg, Trypanosoma cruzi, Toxoplasma gondii)
- Bacterial (eg, Borrelia burgdorferi, Mycoplasma pneumoniae, Corynebacterium diphtheriae)
- Toxins (eg, carbon monoxide, black widow venom)
- Rheumatic fever
- Drugs (eg, doxorubicin, cocaine)
- Autoimmune (eg, Kawasaki disease, sarcoidosis, SLE, polymyositis/dermatomyositis)

Complications include sudden death, arrhythmias, heart block, dilated cardiomyopathy, HF, mural thrombus with systemic emboli.

FAS1_2019_07-Cardio.indd 313 11/7/19 4:24 PM

Vasculitides

	EPIDEMIOLOGY/PRESENTATION	NOTES
Large-vessel vasculitis		
Giant cell (temporal) arteritis	Usually elderly females. Unilateral headache, possible temporal artery tenderness, jaw claudication. May lead to irreversible blindness due to ophthalmic artery occlusion. Associated with polymyalgia rheumatica.	Most commonly affects branches of carotid artery. Focal granulomatous inflammation A. † ESR. Treat with high-dose corticosteroids prior to temporal artery biopsy to prevent blindness.
Takayasu arteritis	Usually Asian females < 40 years old. "Pulseless disease" (weak upper extremity pulses), fever, night sweats, arthritis, myalgias, skin nodules, ocular disturbances.	Granulomatous thickening and narrowing of aortic arch and proximal great vessels B . † ESR. Treatment: corticosteroids.
Medium-vessel vasculitis	s	
Buerger disease (thromboangiitis obliterans)	Heavy smokers, males < 40 years old. Intermittent claudication. May lead to gangrene , autoamputation of digits, superficial nodular phlebitis. Raynaud phenomenon is often present.	Segmental thrombosing vasculitis with vein and nerve involvement. Treatment: smoking cessation.
Kawasaki disease (mucocutaneous lymph node syndrome)	Asian children < 4 years old. Conjunctival injection, Rash (polymorphous → desquamating), Adenopathy (cervical), Strawberry tongue (oral mucositis) D, Hand- foot changes (edema, erythema), fever.	CRASH and burn on a Kawasaki. May develop coronary artery aneurysms E ; thrombosis or rupture can cause death. Treatment: IV immunoglobulin and aspirin.
Polyarteritis nodosa	Usually middle-aged men. Hepatitis B seropositivity in 30% of patients. Fever, weight loss, malaise, headache. GI: abdominal pain, melena. Hypertension, neurologic dysfunction, cutaneous eruptions, renal damage.	Typically involves renal and visceral vessels, not pulmonary arteries. Different stages of transmural inflammation with fibrinoid necrosis. Innumerable renal microaneurysms and spasms on arteriogram (string of pearls appearance). Treatment: corticosteroids, cyclophosphamide.
Small-vessel vasculitis		
Behçet syndrome	High incidence in people of Turkish and eastern Mediterranean descent. Recurrent aphthous ulcers, genital ulcerations, uveitis, erythema nodosum. Can be precipitated by HSV or parvovirus. Flares last 1–4 weeks.	Immune complex vasculitis. Associated with HLA-B51.
Cutaneous small- vessel vasculitis	Occurs 7-10 days after certain medications (penicillin, cephalosporins, phenytoin, allopurinol) or infections (eg, HCV, HIV). Palpable purpura, no visceral involvement.	Immune complex—mediated leukocytoclastic vasculitis; late involvement indicates systemic vasculitis.

FAS1_2019_07-Cardio.indd 314 11/7/19 4:24 PM

Vasculitides (continued)

	EPIDEMIOLOGY/PRESENTATION	NOTES	
Small-vessel vasculitis (c	ontinued)		
Eosinophilic granulomatosis with polyangiitis (Churg- Strauss)	Asthma, sinusitis, skin nodules or purpura, peripheral neuropathy (eg, wrist/foot drop). Can also involve heart, GI, kidneys (pauciimmune glomerulonephritis).	Granulomatous, necrotizing vasculitis with eosinophilia G. MPO-ANCA/p-ANCA, † IgE level.	
Granulomatosis with polyangiitis (Wegener)	Upper respiratory tract: perforation of nasal septum, chronic sinusitis, otitis media, mastoiditis. Lower respiratory tract: hemoptysis, cough, dyspnea. Renal: hematuria, red cell casts.	 Triad: Focal necrotizing vasculitis Necrotizing granulomas in lung and upper airway Necrotizing glomerulonephritis PR3-ANCA/c-ANCA (anti-proteinase 3). CXR: large nodular densities. Treatment: cyclophosphamide, corticosteroids. 	
Immunoglobulin A vasculitis	Also called Henoch-Schönlein purpura. Most common childhood systemic vasculitis. Often follows URI. Classic triad: Skin: palpable purpura on buttocks/legs Arthralgias GI: abdominal pain (associated with intussusception)	Vasculitis 2° to IgA immune complex deposition. Associated with IgA nephropathy (Berger disease). Treatment: supportive care, possibly corticosteroids.	
Microscopic polyangiitis	Necrotizing vasculitis commonly involving lung, kidneys, and skin with pauci-immune glomerulonephritis and palpable purpura. Presentation similar to granulomatosis with polyangiitis but without nasopharyngeal involvement.	No granulomas. MPO-ANCA/p-ANCA (antimyeloperoxidase). Treatment: cyclophosphamide, corticosteroids.	
Mixed cryoglobulinemia	Often due to viral infections, especially HCV. Triad of palpable purpura, weakness, arthralgias. May also have peripheral neuropathy and renal disease (eg, glomerulonephritis).	Cryoglobulins are immunoglobulins that precipitate in the Cold. Vasculitis due to mixed IgG and IgM immune complex deposition.	
F	B RSC AAo X	E LM LAD	

FAS1_2019_07-Cardio.indd 315

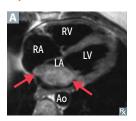
316 SECTION III

CARDIOVASCULAR ► CARDIOVASCULAR—PHARMACOLOGY

Cardiac tumors

Most common heart tumor is a metastasis (eg, melanoma).

Myxomas



Most common 1° cardiac tumor in adults (arrows in A). 90% occur in the atria (mostly left atrium). Myxomas are usually described as a "ball valve" obstruction in the left atrium (associated with multiple syncopal episodes). IL-6 production by tumor → constitutional symptoms (eg, fever, weight loss). May auscultate early diastolic "tumor plop" sound. Histology: gelatinous material, myxoma cells immersed in glycosaminoglycans.

Adults make myxed drinks.

Rhabdomyomas

Most frequent 1° cardiac tumor in children (associated with tuberous sclerosis). Histology: hamartomatous growths.

Kussmaul sign

† in JVP on inspiration instead of a normal ↓.

Inspiration → negative intrathoracic pressure not transmitted to heart → impaired filling of right ventricle → blood backs up into vena cava → JVD. May be seen with constrictive pericarditis, restrictive cardiomyopathies, right heart failure, massive pulmonary embolism, right atrial or ventricular tumors.

Hereditary hemorrhagic telangiectasia

Also called Osler-Weber-Rendu syndrome. Autosomal dominant disorder of blood vessels. Findings: blanching lesions (telangiectasias) on skin and mucous membranes, recurrent epistaxis, skin discolorations, arteriovenous malformations (AVMs), GI bleeding, hematuria.

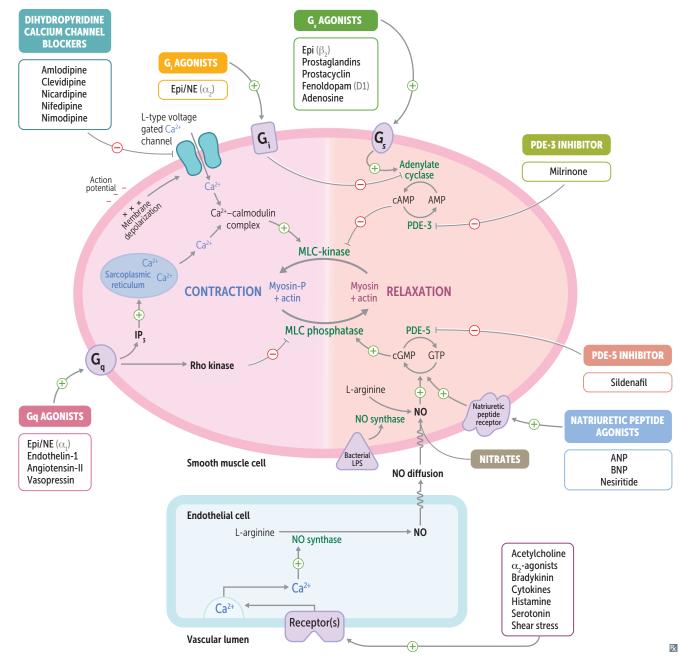
► CARDIOVASCULAR—PHARMACOLOGY

Hypertension treatment

Primary (essential) hypertension	Thiazide diuretics, ACE inhibitors, angiotensin II receptor blockers (ARBs), dihydropyridine Ca ²⁺ channel blockers.	
Hypertension with heart failure	Diuretics, ACE inhibitors/ARBs, β-blockers (compensated HF), aldosterone antagonists.	β-blockers must be used cautiously in decompensated HF and are contraindicated in cardiogenic shock. In HF, ARBs may be combined with the neprilysin inhibitor sacubitril.
Hypertension with diabetes mellitus	ACE inhibitors/ARBs, Ca^{2+} channel blockers, thiazide diuretics, β -blockers.	ACE inhibitors/ARBs are protective against diabetic nephropathy. β-blockers can mask hypoglycemia symptoms.
Hypertension in asthma	ARBs, Ca^{2+} channel blockers, thiazide diuretics, cardioselective β -blockers.	Avoid nonselective β-blockers to prevent β ₂ -receptor–induced bronchoconstriction. Avoid ACE inhibitors to prevent confusion between drug or asthma-related cough.
Hypertension in pregnancy	Hydralazine, labetalol, methyldopa, nifedipine.	"He likes my neonate."

FAS1_2019_07-Cardio.indd 316 11/7/19 4:24 PM

Cardiac therapy



FAS1_2019_07-Cardio.indd 317 11/7/19 4:24 PM

SECTION III CARDIOVASCULAR → CARDIOVASCULAR—PHARMACOLOGY

Calcium channel blockers	Amlodipine, clevidipine, nicardipine, nifedipine, nimodipine (dihydropyridines, act on vascular smooth muscle); diltiazem, verapamil (non-dihydropyridines, act on heart).		
MECHANISM	Block voltage-dependent L-type calcium channels of cardiac and smooth muscle → ↓ muscle contractility. Vascular smooth muscle—amlodipine = nifedipine > diltiazem > verapamil.		
	Heart—verapamil > diltiazem > amlodipine = nifedipine (verapamil = ventricle).		
CLINICAL USE	Dihydropyridines (except nimodipine): hypertension, angina (including vasospastic type), Rayna phenomenon. Nimodipine: subarachnoid hemorrhage (prevents cerebral vasospasm). Nicardipine, clevidipine: hypertensive urgency or emergency. Non-dihydropyridines: hypertension, angina, atrial fibrillation/flutter.		
ADVERSE EFFECTS	Gingival hyperplasia. Dihydropyridine: peripheral edema, flushing, dizziness. Non-dihydropyridine: cardiac depression, AV block, hyperprolactinemia (verapamil), constipation.		
Hydralazine			
MECHANISM	↑ cGMP → smooth muscle relaxation. Vasodilates arterioles > veins; afterload reduction.		
CLINICAL USE	Severe hypertension (particularly acute), HF (with organic nitrate). Safe to use during pregnancy Frequently coadministered with a β-blocker to prevent reflex tachycardia.		
ADVERSE EFFECTS	Compensatory tachycardia (contraindicated in angina/CAD), fluid retention, headache, angina, drug-induced lupus.		
Hypertensive emergency	Treat with labetalol, clevidipine, fenoldopam, nicardipine, nitroprusside.		
Nitroprusside	Short acting vasodilator (arteries = veins); † cGMP via direct release of NO. Can cause cyanide toxicity (releases cyanide).		
Fenoldopam	Dopamine D₁ receptor agonist—coronary, peripheral, renal, and splanchnic vasodilation. ↓ BP, ↑ natriuresis. Also used postoperatively as an antihypertensive. Can cause hypotension and tachycardia.		
Nitrates	Nitroglycerin, isosorbide dinitrate, isosorbide mononitrate.		
MECHANISM	Vasodilate by ↑ NO in vascular smooth muscle → ↑ in cGMP and smooth muscle relaxation. Dilate veins >> arteries. ↓ preload.		
CLINICAL USE	Angina, acute coronary syndrome, pulmonary edema.		
ADVERSE EFFECTS	Reflex tachycardia (treat with β-blockers), hypotension, flushing, headache, "Monday disease" in industrial exposure: development of tolerance for the vasodilating action during the work week and loss of tolerance over the weekend → tachycardia, dizziness, headache upon reexposure. Contraindicated in right ventricular infarction, hypertrophic cardiomyopathy, and with concurrent PDE-5 inhibitor use.		

11/7/19 4:24 PM FAS1_2019_07-Cardio.indd 318

Antianginal therapy

Goal is reduction of myocardial O_2 consumption (MVO₂) by \downarrow 1 or more of the determinants of MVO₂: end-diastolic volume, BP, HR, contractility.

COMPONENT	NITRATES	β-BLOCKERS	NITRATES + β-BLOCKERS
End-diastolic volume	↓	No effect or †	No effect or ↓
Blood pressure	ţ	ţ	↓
Contractility	↑ (reflex response)	†	Little/no effect
Heart rate	↑ (reflex response)	↓	No effect or ↓
Ejection time	ţ	†	Little/no effect
MVO ₂	ţ	ţ	11

Verapamil is similar to β -blockers in effect.

Pindolol and acebutolol are partial β -agonists that should be used with caution in angina.

Ranolazine

MECHANISM	Inhibits the late phase of inward sodium current thereby reducing diastolic wall tension and oxygen consumption. Does not affect heart rate or blood pressure.
CLINICAL USE	Angina refractory to other medical therapies.
ADVERSE EFFECTS	Constipation, dizziness, headache, nausea.

Sacubitril

Sacabitiii	
MECHANISM	A neprilysin inhibitor; prevents degradation of natriuretic peptides, angiotensin II, and substance P → ↑ vasodilation, ↓ ECF volume.
CLINICAL USE	Used in combination with valsartan (an ARB) to treat HFrEF.
ADVERSE EFFECTS	Hypotension, hyperkalemia, cough, dizziness; contraindicated with ACE inhibitors due to angioedema.

FAS1_2019_07-Cardio.indd 319 11/7/19 4:24 PM

320 SECTION III

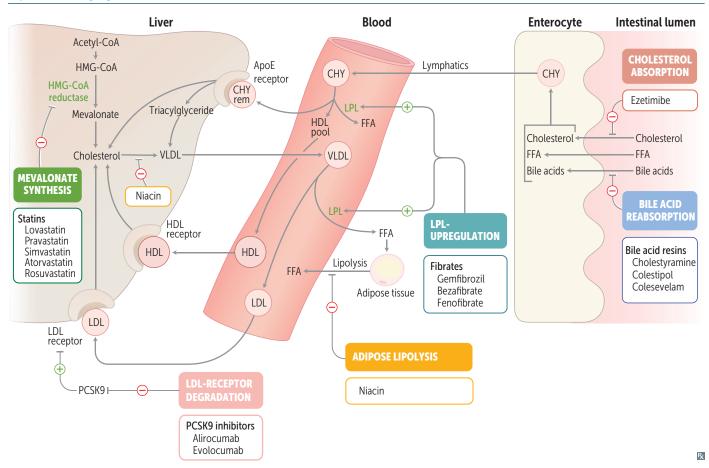
CARDIOVASCULAR ► CARDIOVASCULAR—PHARMACOLOGY

Lipid-lowering agents

DRUG	LDL	HDL	TRIGLYCERIDES	MECHANISMS OF ACTION	ADVERSE EFFECTS/PROBLEMS
HMG-CoA reductase inhibitors (eg, atorvastatin, simvastatin)	111	1	1	Inhibit conversion of HMG-CoA to mevalonate, a cholesterol precursor; † LDL recycling; ↓ mortality in CAD patients	Hepatotoxicity († LFTs), myopathy (esp when used with fibrates or niacin)
Bile acid resins Cholestyramine, colestipol, colesevelam	† †	† slightly	† slightly	Prevent intestinal reabsorption of bile acids; liver must use cholesterol to make more	GI upset, ‡ absorption of other drugs and fat-soluble vitamins
Ezetimibe	11	† /—	↓/—	Prevents cholesterol absorption at small intestine brush border	Rare † LFTs, diarrhea
Fibrates Gemfibrozil, bezafibrate, fenofibrate	1	†	111	Upregulate LPL → ↑ TG clearance Activates PPAR-α to induce HDL synthesis	Myopathy († risk with statins), cholesterol gallstones (via inhibition of cholesterol 7α-hydroxylase)
Niacin	11	††	↓	Inhibits lipolysis (hormone- sensitive lipase) in adipose tissue; reduces hepatic VLDL synthesis	Flushed face (\$\ddagger\$ by NSAIDs or long-term use) Hyperglycemia Hyperuricemia
PCSK9 inhibitors Alirocumab, evolocumab	111	†	†	Inactivation of LDL-receptor degradation → ↑ removal of LDL from bloodstream	Myalgias, delirium, dementia, other neurocognitive effects
Fish oil and marine omega-3 fatty acids	† slightly	† slightly	↓ at high doses	Believed to decrease FFA delivery to liver and decrease activity of TG-synthesizing enzymes	Nausea, fish-like taste

FAS1_2019_07-Cardio.indd 320 11/7/19 4:24 PM

Lipid-lowering agents (continued)



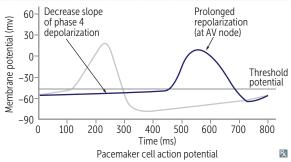
Cardiac glycosides	Digoxin.		
MECHANISM	Direct inhibition of Na ⁺ /K ⁺ ATPase \rightarrow indirect inhibition of Na ⁺ /Ca ²⁺ exchanger. † $[Ca^{2+}]_i \rightarrow$ positive inotropy. Stimulates vagus nerve $\rightarrow \downarrow$ HR.		
CLINICAL USE	HF († contractility); atrial fibrillation (↓ conduction at AV node and d	epression of SA node).	
ADVERSE EFFECTS	Cholinergic effects (nausea, vomiting, diarrhea), blurry yellow vision (think van Glow), arrhythmias, AV block. Can lead to hyperkalemia, which indicates poor prognosis. Factors predisposing to toxicity: renal failure (↓ excretion), hypokalemia (permissive for digoxin binding at K⁺-binding site on Na⁺/K⁺ ATPase), drugs that displace digoxin from tissue-binding sites, and ↓ clearance (eg, verapamil, amiodarone, quinidine).		
ANTIDOTE	Slowly normalize K ⁺ , cardiac pacer, anti-digoxin Fab fragments, Mg ²⁺ .		

FAS1_2019_07-Cardio.indd 321 11/7/19 4:24 PM

Antiarrhythmics— sodium channel blockers (class I)	Slow or block (\dagger) conduction (especially in depolar state dependent (selectively depress tissue that is	rized cells). ↓ slope of phase 0 depolarization. Are frequently depolarized [eg, tachycardia]).
Class IA	Quinidine, Procainamide, Disopyramide. "The Queen Proclaims Diso's pyramid."	0 mV
MECHANISM	Moderate Na ⁺ channel blockade. † AP duration, † effective refractory period (ERP) in ventricular action potential, † QT interval, some potassium channel blocking effects.	Slope of phase 0
CLINICAL USE	Both atrial and ventricular arrhythmias, especially re-entrant and ectopic SVT and VT.	
ADVERSE EFFECTS	Cinchonism (headache, tinnitus with quinidine), reversible SLE-like syndrome (procainamide), HF (disopyramide), thrombocytopenia, torsades de pointes due to † QT interval.	
Class IB	Lidocaine, MexileTine. "I'd Buy Liddy's Mexican Tacos."	0 mV Slope of
MECHANISM	Weak Na ⁺ channel blockade. ↓ AP duration. Preferentially affect ischemic or depolarized Purkinje and ventricular tissue. Phenytoin can also fall into the IB category.	phase 0
CLINICAL USE	Acute ventricular arrhythmias (especially post-MI), digitalis-induced arrhythmias. IB is Best post-MI.	
ADVERSE EFFECTS	CNS stimulation/depression, cardiovascular depression.	•
Class IC	Flecainide, Propafenone. "Can I have Fries, Please."	0 mV
MECHANISM	Strong Na ⁺ channel blockade. Significantly prolongs ERP in AV node and accessory bypass tracts. No effect on ERP in Purkinje and ventricular tissue. Minimal effect on AP duration.	Slope of phase 0
CLINICAL USE	SVTs, including atrial fibrillation. Only as a last resort in refractory VT.	
ADVERSE EFFECTS	Proarrhythmic, especially post-MI (contraindicated). IC is Contraindicated in structural and ischemic heart disease.	

FAS1_2019_07-Cardio.indd 322 11/7/19 4:24 PM

Antiarrhythmics— β-blockers (class II)	Metoprolol, propranolol, esmolol, atenolol, timolol, carvedilol.		
MECHANISM	Decrease SA and AV nodal activity by ↓ cAMP, ↓ Ca ²⁺ currents. Suppress abnormal pacemakers by ↓ slope of phase 4. AV node particularly sensitive—↑ PR interval. Esmolol very short acting.		
CLINICAL USE	SVT, ventricular rate control for atrial fibrillation and atrial flutter.		
ADVERSE EFFECTS	Impotence, exacerbation of COPD and asthma, cardiovascular effects (bradycardia, AV block, HF), CNS effects (sedation, sleep alterations). May mask the signs of hypoglycemia. Metoprolol can cause dyslipidemia. Propranolol can exacerbate vasospasm in vasospastic angina. β -blockers (except the nonselective α - and β -antagonists carvedilol and labetalol) cause unopposed α_l -agonism if given alone for pheochromocytoma or for cocaine toxicity (unsubstantiated). Treat β -blocker overdose with saline, atropine, glucagon.		



Antiarrhythmics—

Amiodarone, Ibutilide, Dofetilide, Sotalol.

AIDS.

Cell action potential

Ŗ

MECHANISM	↑ AP duration, ↑ ERP, ↑ QT interval.	
CLINICAL USE	Atrial fibrillation, atrial flutter; ventricular tachycardia (amiodarone, sotalol).	
ADVERSE EFFECTS	Sotalol—torsades de pointes, excessive β blockade. Ibutilide—torsades de pointes. Amiodarone—pulmonary fibrosis, hepatotoxicity, hypothyroidism or hyperthyroidism (amiodarone is 40% iodine by weight), acts as hapten (corneal deposits, blue/gray skin deposits resulting in photodermatitis), neurologic effects, constipation, cardiovascular effects (bradycardia, heart block, HF).	Remember to check PFTs, LFTs, and TFTs when using amiodarone. Amiodarone is lipophilic and has class I, II, III, and IV effects.
	0 mV	Markedly prolonged repolarization (I _K)

FAS1_2019_07-Cardio.indd 323 11/7/19 4:24 PM

−85 mV **=**

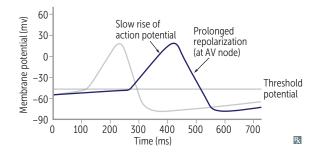
324 SECTION III

CARDIOVASCULAR → CARDIOVASCULAR—PHARMACOLOGY

Antiarrhythmics—calcium channel blockers (class IV)

Diltiazem, Verapamil

MECHANISM	Decrease conduction Velocity, † ERP, † PR interval.
CLINICAL USE	Prevention of nodal arrhythmias (eg, SVT), rate control in atrial fibrillation.
ADVERSE EFFECTS	Constipation, flushing, edema, cardiovascular effects (HF, AV block, sinus node depression).



Other antiarrhythmics

Adenosine	↑ K^+ out of cells → hyperpolarizing the cell and ↓ I_{Ca} , decreasing AV node conduction. Drug of
	choice in diagnosing/terminating certain forms of SVT. Very short acting (~ 15 sec). Effects
	blunted by the ophylline and caffeine (both are adenosine receptor antagonists). Adverse effects
	include flushing, hypotension, chest pain, sense of impending doom, bronchospasm.
Magnesium	Effective in torsades de pointes and digoxin toxicity.

Effective in coloudes de pointes und disjoint tonteit

Ivabradine

MECHANISM	IV abradine prolongs slow depolarization (phase " IV ") by selectively inhibiting "funny" sodium channels (I _f).
CLINICAL USE	Chronic stable angina in patients who cannot take β-blockers. Chronic HFrEF.
ADVERSE EFFECTS	Luminous phenomena/visual brightness, hypertension, bradycardia.

FAS1_2019_07-Cardio.indd 324 11/7/19 4:24 PM

HIGH-YIELD SYSTEMS

Endocrine

"If you skew the endocrine system, you lose the pathways to self."

—Hilary Mantel

"We have learned that there is an endocrinology of elation and despair, a chemistry of mystical insight, and, in relation to the autonomic nervous system, a meteorology and even . . . an astro-physics of changing moods."

—Aldous Huxley

"Chocolate causes certain endocrine glands to secrete hormones that affect your feelings and behavior by making you happy."

-Elaine Sherman, Book of Divine Indulgences

The endocrine system comprises widely distributed organs that work in a highly integrated manner to orchestrate a state of hormonal equilibrium within the body. Generally speaking, endocrine diseases can be classified either as diseases of underproduction or overproduction, or as conditions involving the development of mass lesions—which themselves may be associated with underproduction or overproduction of hormones. Therefore, study the endocrine system first by learning the glands, their hormones, and their regulation, and then by integrating disease manifestations with diagnosis and management. Take time to learn the multisystem connections.

▶ Embryology	326
Anatomy	327
▶ Physiology	328
▶ Pathology	338
▶ Pharmacology	352

FAS1_2019_08-Endocrine.indd 325 11/7/19 4:30 PM

► ENDOCRINE—EMBRYOLOGY

Thyroid development

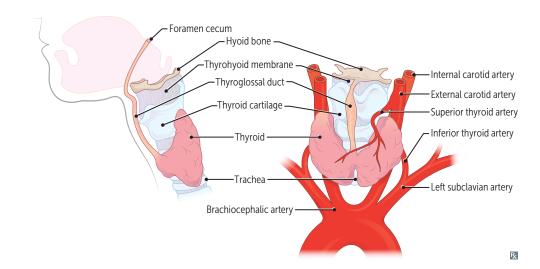


Thyroid diverticulum arises from floor of primitive pharynx and descends into neck. Connected to tongue by thyroglossal duct, which normally disappears but may persist as cysts or the pyramidal lobe of thyroid. Foramen cecum is normal remnant of thyroglossal duct.

Most common ectopic thyroid tissue site is the tongue (lingual thyroid). Removal may result in hypothyroidism if it is the only thyroid tissue present.

Thyroglossal duct cyst A presents as an anterior midline neck mass that moves with swallowing or protrusion of the tongue (vs persistent cervical sinus leading to pharyngeal cleft cyst in lateral neck).

Thyroid follicular cells derived from endoderm.



FAS1_2019_08-Endocrine.indd 326 11/7/19 4:30 PM

► ENDOCRINE—ANATOMY

Pituitary gland

Anterior pituitary (adenohypophysis)

Secretes FSH, LH, ACTH, TSH, prolactin, GH, and β -endorphin. Melanotropin (MSH) secreted from intermediate lobe of pituitary. Derived from oral ectoderm (Rathke pouch).

- α subunit—hormone subunit common to TSH, LH, FSH, and hCG.
- β subunit—determines hormone specificity.

Posterior pituitary (neurohypophysis)

Stores and releases vasopressin (antidiuretic hormone, or ADH) and oxytocin, both made in the hypothalamus (supraoptic and paraventricular nuclei) and transported to posterior pituitary via neurophysins (carrier proteins). Derived from neuroectoderm.

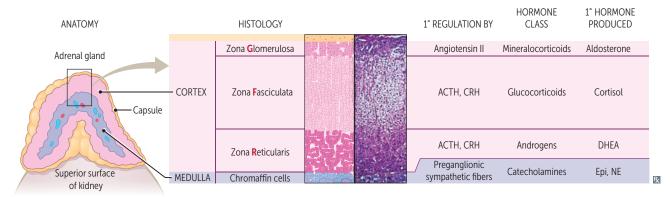
Proopiomelanocortin derivatives—β-endorphin, ACTH, and MSH. Go pro with a BAM!

FLAT PiG: FSH, LH, ACTH, TSH, PRL, GH.
B-FLAT: Basophils—FSH, LH, ACTH, TSH.

Acid PiG: Acidophils — PRL, GH.

Adrenal cortex and medulla

Adrenal cortex (derived from mesoderm) and medulla (derived from neural crest).



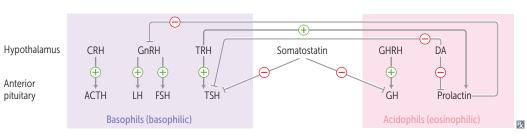
GFR corresponds with **S**alt (mineralocorticoids), **S**ugar (glucocorticoids), and **S**ex (androgens). "The deeper you go, the sweeter it gets."

FAS1_2019_08-Endocrine.indd 327 11/7/19 4:30 PM

► ENDOCRINE—PHYSIOLOGY

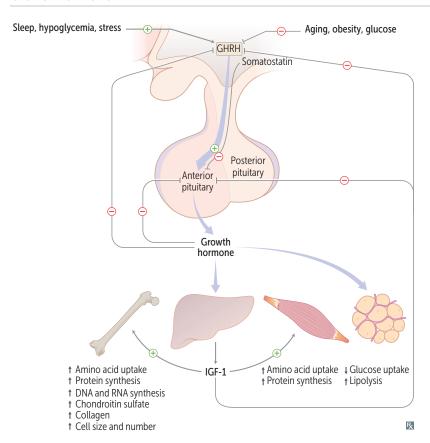
Hypothalamic-pituitary hormones

HORMONE	FUNCTION	CLINICAL NOTES
ADH	↑ water permeability of distal convoluted tubule and collecting duct cells in kidney to ↑ water reabsorption	Stimulus for secretion is ↑ plasma osmolality, except in SIADH, in which ADH is elevated despite ↓ plasma osmolality
CRH	† ACTH, MSH, β-endorphin	↓ in chronic exogenous steroid use
Dopamine	↓ prolactin, TSH	Also called prolactin-inhibiting factor Dopamine antagonists (eg, antipsychotics) can cause galactorrhea due to hyperprolactinemia
GHRH	↑ GH	Analog (tesamorelin) used to treat HIV-associated lipodystrophy
GnRH	↑ FSH, LH	Suppressed by hyperprolactinemia Tonic GnRH analog (eg, leuprolide) suppresses hypothalamic–pituitary–gonadal axis. Pulsatile GnRH leads to puberty, fertility
MSH	↑ melanogenesis by melanocytes	Causes hyperpigmentation in Cushing disease, as MSH and ACTH share the same precursor molecule, proopiomelanocortin
Oxytocin	Causes uterine contractions during labor. Responsible for milk letdown reflex in response to suckling.	Modulates fear, anxiety, social bonding, mood, and depression
Prolactin	↓ GnRH Stimulates lactogenesis.	Pituitary prolactinoma → amenorrhea, osteoporosis, hypogonadism, galactorrhea Breastfeeding → ↑ prolactin → ↓ GnRH → delayed postpartum ovulation (natural contraception)
Somatostatin	↓ GH, TSH	Also called growth hormone inhibiting hormone (GHIH) Analogs used to treat acromegaly
TRH	† TSH, prolactin	† TRH (eg, in 1°/2° hypothyroidism) may increase prolactin secretion → galactorrhea



FAS1_2019_08-Endocrine.indd 328 11/7/19 4:30 PM

Growth hormone



Also called somatotropin. Secreted by anterior pituitary.

Stimulates linear growth and muscle mass through IGF-1 (somatomedin C) secretion by liver. † insulin resistance (diabetogenic).

Released in pulses in response to growth hormone–releasing hormone (GHRH).

Secretion † during exercise, deep sleep, puberty, hypoglycemia, CKD.

Secretion ↓ by glucose, somatostatin, somatomedin (regulatory molecule secreted by liver in response to GH acting on target tissues).

Excess secretion of GH (eg, pituitary adenoma) may cause acromegaly (adults) or gigantism (children). Treatment: somatostatin analogs (eg, octreotide) or surgery.

Antidiuretic hormone	Also called vasopressin.	
SOURCE	Synthesized in hypothalamus (supraoptic and paraventricular nuclei), stored and secreted by posterior pituitary.	
FUNCTION	Regulates blood pressure (V ₁ -receptors) and serum osmolality (V ₂ -receptors). Primary function is serum osmolality regulation (ADH ↓ serum osmolality, † urine osmolality) via regulation of aquaporin channel insertion in principal cells of renal collecting duct.	ADH level is ↓ in central diabetes insipidus (DI), normal or † in nephrogenic DI. Nephrogenic DI can be caused by mutation in V ₂ -receptor. Desmopressin (ADH analog) is a treatment for central DI and nocturnal enuresis.
REGULATION	Plasma osmolality (1°); hypovolemia.	

FAS1_2019_08-Endocrine.indd 329 11/7/19 4:30 PM

Prolactin				
SOURCE	Secreted mainly by anterior pituitary.	Structurally homologous to growth hormone.		
FUNCTION	Stimulates milk production in breast; inhibits ovulation in females and spermatogenesis in males by inhibiting GnRH synthesis and release.	Excessive amounts of prolactin associated with \$\d\\$ libido.		
REGULATION	Prolactin secretion from anterior pituitary is tonically inhibited by dopamine from tuberoinfundibular pathway of hypothalamus. Prolactin in turn inhibits its own secretion by † dopamine synthesis and secretion from hypothalamus. TRH † prolactin secretion (eg, in 1° or 2° hypothyroidism).	Dopamine agonists (eg, bromocriptine) inhibit prolactin secretion and can be used in treatment of prolactinoma. Dopamine antagonists (eg, most antipsychotics, metoclopramide) and estrogens (eg, OCPs, pregnancy) stimulate prolactin secretion.		
	Sight/cry of baby —————— Higher corti	cal centers		
	Hypotha	alamus		
	Medications Chest wall injury (via ANS) Nipple stimulation Dopamine Anterior pituitary	Posterior pituitary Pestrogen Pregnancy		
	Reduced prolactin elimination	Estrogen + Pregnancy Pregnancy Ovulation		

11/7/19 4:30 PM FAS1_2019_08-Endocrine.indd 330

Prolactin

Renal failure

Ovulation

Milk production

Spermatogenesis

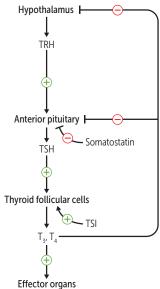
Ŗ

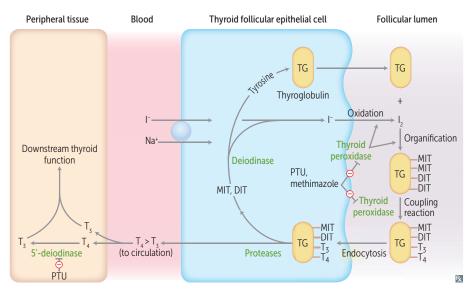
Thyroid produces triiodothyronine (T_3) and thyroxine (T_4) , iodine-containing hormones that **Thyroid hormones** control the body's metabolic rate. Follicles of thyroid. 5'-deiodinase converts T₄ (the major thyroid product) to T₃ in peripheral tissue **SOURCE** (5, 4, 3). Peripheral conversion is inhibited by glucocorticoids, β -blockers, and propylthiouracil (PTU). Reverse T₃ (rT₃) is a metabolically inactive byproduct of the peripheral conversion of T₄ and its production is increased by growth hormone and glucocorticoids. Functions of thyroid peroxidase include oxidation, organification of iodine, and coupling of monoiodotyrosine (MIT) and diiodotyrosine (DIT). Inhibited by PTU and methimazole. DIT + DIT = T_4 . DIT + MIT = T_3 . Wolff-Chaikoff effect—excess iodine temporarily turns off thyroid peroxidase $\rightarrow \ \ T_3/T_4$ production (protective autoregulatory effect). **FUNCTION** Only free hormone is active. T₃ binds nuclear receptor with greater affinity than T₄. T₃ functions **−7 B**'s: Brain maturation Bone growth (synergism with GH) ■ β-adrenergic effects. ↑ $β_1$ receptors in heart → ↑ CO, HR, SV, contractility; β-blockers alleviate adrenergic symptoms in thyrotoxicosis ■ Basal metabolic rate \uparrow (via Na⁺/K⁺-ATPase activity $\rightarrow \uparrow$ O₂ consumption, RR, body temperature) Blood sugar († glycogenolysis, gluconeogenesis) Break down lipids († lipolysis) Stimulates surfactant synthesis in Babies REGULATION TRH ⊕ TSH release → ⊕ follicular cells. Thyroid-stimulating immunoglobulin (TSI) may ⊕ follicular cells in Graves disease. Negative feedback primarily by free T_3/T_4 : Anterior pituitary → ↓ sensitivity to TRH Hypothalamus → ↓ TRH secretion

■ ↓ TBG in steroid use, nephrotic syndrome

Thyroxine-binding globulin (TBG) binds most T_3/T_4 in blood. Bound T_3/T_4 = inactive.

■ † TBG in pregnancy, OCP use (estrogen \rightarrow † TBG) \rightarrow † total T_3/T_4





FAS1 2019 08-Endocrine.indd 331 11/7/19 4:30 PM

Parathyroid hormone

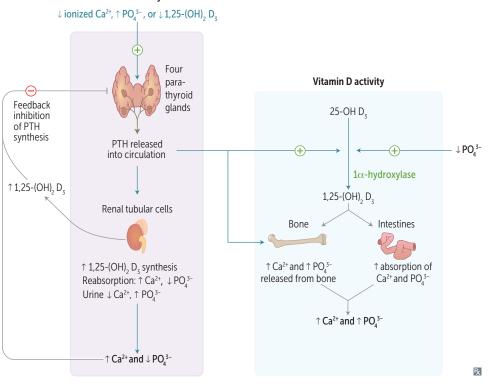
SOURCE	Chief cells of parathyroid	
FUNCTION	† free Ca ²⁺ in the blood (1° function) † Ca ²⁺ and PO ₄ ³⁻ absorption in GI system † Ca ²⁺ and PO ₄ ³⁻ from bone resorption † Ca ²⁺ reabsorption from DCT ‡ PO ₄ ³⁻ reabsorption in PCT † 1,25-(OH) ₂ D ₃ (calcitriol) production by activating 1α-hydroxylase in PCT Tri to make D ₃ in the PCT	PTH ↑ serum Ca ²⁺ , ↓ serum PO ₄ ³⁻ , ↑ urine PO ₄ ³⁻ , ↑ urine cAMP ↑ RANK-L (receptor activator of NF-κB ligand) secreted by osteoblasts and osteocytes; binds RANK (receptor) on osteoclasts and their precursors to stimulate osteoclasts and ↑ Ca ²⁺ → bone resorption (intermittent PTH release can also stimulate bone formation) PTH = Phosphate-Trashing Hormone PTH-related peptide (PTHrP) functions like PTH and is commonly increased in malignancies (eg, squamous cell carcinoma of the lung, renal cell carcinoma)

.

REGULATION

↓ serum Ca²⁺ → ↑ PTH secretion
 ↑ serum PO₄³⁻ → ↑ PTH secretion
 ↓ serum Mg²⁺ → ↑ PTH secretion
 ↓↓ serum Mg²⁺ → ↓ PTH secretion
 Common causes of ↓ Mg²⁺ include diarrhea, aminoglycosides, diuretics, alcohol abuse

PTH activity



FAS1_2019_08-Endocrine.indd 332 11/7/19 4:30 PM

► ENDOCRINE—PHYSIOLOGY **ENDOCRINE**

Calcium homeostasis

Plasma Ca²⁺ exists in three forms:

- Ionized/free (~ 45%, active form)
- Bound to albumin (~ 40%)
- Bound to anions (~ 15%)

\uparrow pH (less H ⁺) → albumin binds more	
$Ca^{2+} \rightarrow \downarrow$ ionized Ca^{2+} (eg, cramps, pain,	
paresthesias, carpopedal spasm) → ↑ PTH	
\downarrow pH (more H ⁺) → albumin binds less Ca ²⁺	
tionized Ca2+ LDTU	

SECTION III

Ionized/free Ca²⁺ is 1° regulator of PTH; changes in pH alter PTH secretion, whereas changes in albumin concentration do not

Calcitonin

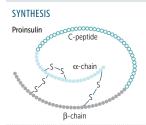
REGULATION

SOURCE	Parafollicular cells (C cells) of thyroid.	Calcitonin opposes actions of PTH. Not
FUNCTION	↓ bone resorption of Ca ²⁺ .	important in normal Ca ²⁺ homeostasis
REGULATION	↑ serum $Ca^{2+} \rightarrow \uparrow$ calcitonin secretion.	Calcitonin tones down serum Ca ²⁺ levels and keeps it in bones
Glucagon		
SOURCE SOURCE	Made by α cells of pancreas.	

Secreted in response to hypoglycemia. Inhibited by insulin, hyperglycemia, somatostatin.

FAS1_2019_08-Endocrine.indd 333 11/7/19 4:30 PM

Insulin



Preproinsulin (synthesized in RER of pancreatic β cells) \rightarrow cleavage of "presignal" \rightarrow proinsulin (stored in secretory granules) \rightarrow cleavage of proinsulin \rightarrow exocytosis of insulin and C-peptide equally. Insulin and C-peptide are \uparrow in insulinoma and sulfonylurea use, whereas exogenous insulin lacks C-peptide.

FUNCTION

Binds insulin receptors (tyrosine kinase activity ①), inducing glucose uptake (carrier-mediated transport) into insulin-dependent tissue ② and gene transcription.

Anabolic effects of insulin:

- † glucose transport in skeletal muscle and adipose tissue
- † glycogen synthesis and storage
- † triglyceride synthesis
- Na⁺ retention (kidneys)
- † protein synthesis (muscles)
- ↑ cellular uptake of K⁺ and amino acids
- ↓ glucagon release
- ↓ lipolysis in adipose tissue

Unlike glucose, insulin does not cross placenta.

Insulin-dependent glucose transporters:

 GLUT4: adipose tissue, striated muscle (exercise can also † GLUT4 expression)

Insulin-independent transporters:

- GLUT1: RBCs, brain, cornea, placenta
- GLUT2 (bidirectional): β islet cells, liver, kidney, GI tract (think 2-way street)
- GLUT3: brain, placenta
- GLUT5 (Fructose): spermatocytes, GI tract
- SGLT1/SGLT2 (Na⁺-glucose cotransporters): kidney, small intestine

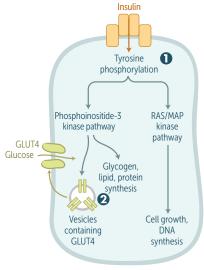
Brain prefers glucose, but may use ketone bodies during starvation. RBCs utilize glucose, as they lack mitochondria for aerobic metabolism.

BRICK LIPS (insulin-independent glucose uptake): Brain, RBCs, Intestine, Cornea, Kidney, Liver, Islet (β) cells, Placenta, Spermatocytes.

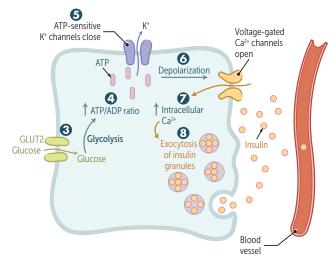
REGULATION

Glucose is the major regulator of insulin release. \uparrow insulin response with oral vs IV glucose due to incretins (eg, glucagon-like peptide 1 [GLP-1], glucose-dependent insulinotropic polypeptide [GIP]), which are released after meals and \uparrow β cell sensitivity to glucose. Release \downarrow by α_2 , \uparrow by β_2 stimulation (2 = regulates insulin)

Glucose enters β cells $\mathfrak{S} \to \uparrow$ ATP generated from glucose metabolism \mathfrak{S} closes K^+ channels (target of sulfonylureas) \mathfrak{S} and depolarizes β cell membrane \mathfrak{S} . Voltage-gated Ca^{2+} channels open $\to Ca^{2+}$ influx \mathfrak{S} and stimulation of insulin exocytosis \mathfrak{S} .



Insulin-dependent glucose uptake

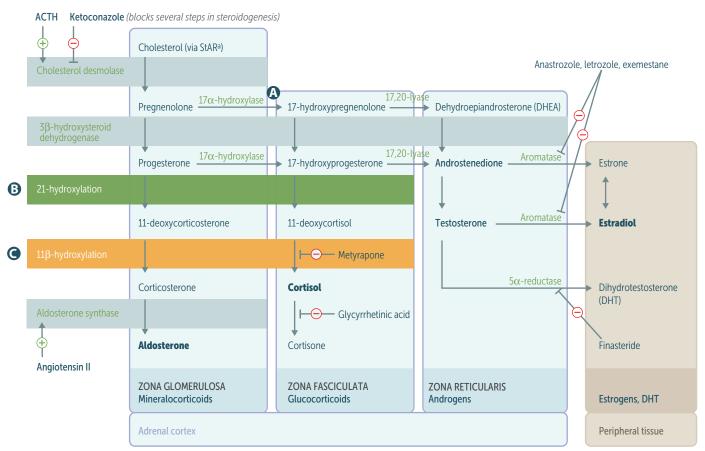


Insulin secretion by pancreatic β cells

Ŗ

FAS1_2019_08-Endocrine.indd 334 11/7/19 4:30 PM

Adrenal steroids and congenital adrenal hyperplasias



^aRate-limiting step.

ENZYME DEFICIENCY	MINERALOCORTICOIDS	[K ⁺]	ВР	CORTISOL	SEX HORMONES	LABS	PRESENTATION
A 17α-hydroxylase ^a	1	1	†	1	1	↓ androstenedione	XY: ambiguous genitalia, undescended testes XX: lacks 2° sexual development
3 21-hydroxylase ^a	1	†	1	↓	t	† renin activity † 17-hydroxy- progesterone	Most common Presents in infancy (salt wasting) or childhood (precocious puberty) XX: virilization
(11β-hydroxylase ^a	↓ aldosterone † 11-deoxycorti- costerone (results in † BP)	1	1	↓	t	↓ renin activity	Presents in infancy (severe hypertension) or childhood (precocious puberty) XX: virilization

^aAll congenital adrenal enzyme deficiencies are autosomal recessive disorders and most are characterized by skin hyperpigmentation (due to † MSH production, which is coproduced and secreted with ACTH) and bilateral adrenal gland enlargement (due to † ACTH stimulation).

If deficient enzyme starts with 1, it causes hypertension; if deficient enzyme ends with 1, it causes virilization in females.

FAS1_2019_08-Endocrine.indd 335 11/7/19 4:30 PM 336 SECTION

SECTION III ENDOCRINE → ENDOCRINE—PHYSIOLOGY

Cortisol

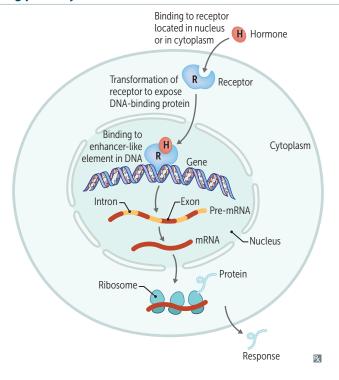
SOURCE	Adrenal zona fasciculata.	Bound to corticosteroid-binding globulin.
FUNCTION	 ↑ Appetite ↑ Blood pressure: Upregulates α₁-receptors on arterioles → ↑ sensitivity to norepinephrine and epinephrine (permissive action) At high concentrations, can bind to mineralocorticoid (aldosterone) receptors ↑ Insulin resistance (diabetogenic) ↑ Gluconeogenesis, lipolysis, and proteolysis (↓ glucose utilization) ↓ Fibroblast activity (poor wound healing, ↓ collagen synthesis, ↑ striae) ↓ Inflammatory and Immune responses: ■ Inhibits production of leukotrienes and prostaglandins ■ Inhibits WBC adhesion → neutrophilia ■ Blocks histamine release from mast cells ■ Eosinopenia, lymphopenia ■ Blocks IL-2 production ↓ Bone formation (↓ osteoblast activity) 	Cortisol is A BIG FIB. Exogenous corticosteroids can cause reactivation of TB and candidiasis (blocks IL-production). Stress Circadian rhythm Hypothalamus CRH Anterior pituitary Endorphins MSH Proopiomelanocortin ACTH Downstream cortisol function
REGULATION	CRH (hypothalamus) stimulates ACTH release (pituitary) → cortisol production in adrenal zona fasciculata. Excess cortisol ↓ CRH, ACTH, and cortisol secretion.	Chronic stress may induce prolonged cortisol secretion, cortisol resistance, impaired immunocompetency, and dysregulation of HPA axis.
Appetite regulation		
Ghrelin	Stimulates hunger (orexigenic effect) and GH restomach. Sleep deprivation, fasting, or Prader-V Ghrelin makes you hunghre and ghrow. Acts on appetite.	Willi syndrome → ↑ ghrelin production.
Leptin	Satiety hormone. Produced by adipose tissue. Moreople have ↑ leptin due to ↑ adipose tissue but effect.) Sleep deprivation or starvation → ↓ lept Leptin keeps you thin. Acts on ventromedial are	t also appear resistant to leptin's anorexigenic in production.
Endocannabinoids	Act at cannabinoid receptors in hypothalamus and homeostatic and hedonic control of food intake Exogenous cannabinoids cause "the munchies."	nd nucleus accumbens, two key brain areas for the e → ↑ appetite.

FAS1_2019_08-Endocrine.indd 336 11/7/19 4:30 PM

Signaling pathways of endocrine hormones

Signaling patriways or e	indoctific fromtones	
CAMP	FSH, LH, ACTH, TSH, CRH, hCG, ADH (V ₂ -receptor), MSH, PTH, Calcitonin, Histamine (H ₂ -receptor), Glucagon, GHRH	FLAT ChAMPs CHuGG
cGMP	BNP, ANP, EDRF (NO)	BAD GraMPa Think vasodilation and diuresis
IP ₃	GnRH, Oxytocin, ADH (V ₁ -receptor), TRH, Histamine (H ₁ -receptor), Angiotensin II, Gastrin	GOAT HAG
Intracellular receptor	Progesterone, Estrogen, Testosterone, Cortisol, Aldosterone, T ₃ /T ₄ , Vitamin D	PET CAT on TV
Receptor tyrosine kinase	IGF-1, FGF, PDGF, EGF, TGF-β, Insulin	MAP kinase pathway Get Found In the MAP
Nonreceptor tyrosine kinase	Prolactin, Immunomodulators (eg, cytokines IL-2, IL-6, IFN), GH, G-CSF, Erythropoietin, Thrombopoietin	JAK/STAT pathway Think acidophils and cytokines PIGGLET

Signaling pathways of steroid hormones



Steroid hormones are lipophilic and therefore must circulate bound to specific binding globulins, which † their solubility.

In men, † sex hormone–binding globulin (SHBG) lowers free testosterone

→ gynecomastia.

In women, ↓ SHBG raises free testosterone
→ hirsutism.

inioddisin.

↑ estrogen (eg, OCPs, pregnancy) → ↑ SHBG.

FAS1_2019_08-Endocrine.indd 337 11/7/19 4:30 PM

▶ ENDOCRINE—PATHOLOGY

Syndrome of inappropriate antidiuretic hormone secretion

Characterized by:

- Excessive free water retention
- Euvolemic hyponatremia with continued urinary Na⁺ excretion
- Urine osmolality > serum osmolality

Body responds to water retention with

- ↓ aldosterone and ↑ ANP and BNP
- → † urinary Na⁺ secretion → normalization of extracellular fluid volume → euvolemic hyponatremia. Very low serum Na⁺ levels can lead to cerebral edema, seizures. Correct slowly to prevent osmotic demyelination syndrome (formerly called central pontine myelinolysis).

SIADH causes include:

- Ectopic ADH (eg, small cell lung cancer)
- CNS disorders/head trauma
- Pulmonary disease
- Drugs (eg, SSRIs, carbamazepine, cyclophosphamide)

Treatment: fluid restriction (first line), salt tablets, IV hypertonic saline, diuretics, ADH antagonists (eg, conivaptan, tolvaptan, demeclocycline).

Diabetes insipidus

Characterized by intense thirst and polyuria with inability to concentrate urine due to lack of ADH (central) or failure of response to circulating ADH (nephrogenic).

	Central DI	Nephrogenic DI
ETIOLOGY	Pituitary tumor, autoimmune, trauma, surge ischemic encephalopathy, idiopathic	ery, Hereditary (ADH receptor mutation), 2° to hypercalcemia, hypokalemia, lithium, demeclocycline (ADH antagonist)
FINDINGS	↓ ADH	Normal or † ADH levels
	Urine osmo Serum osmo	fic gravity < 1.006 lality < 300 mOsm/kg olality > 290 mOsm/kg tic volume contraction
WATER DEPRIVATION TEST ^a	> 50% † in urine osmolality only after administration of ADH analog	Minimal change in urine osmolality, even after administration of ADH analog
TREATMENT	Desmopressin Hydration	HCTZ, indomethacin, amiloride Hydration, dietary salt restriction, avoidance of offending agent

aNo water intake for 2–3 hr followed by hourly measurements of urine volume and osmolality as well as plasma Na⁺ concentration and osmolality. ADH analog (desmopressin) is administered if serum osmolality > 295–300 mOsm/kg, plasma Na⁺ ≥ 145 mEq/L, or urine osmolality does not rise despite a rising plasma osmolality.

FAS1_2019_08-Endocrine.indd 338 11/7/19 4:30 PM

SECTION III

Hypopituitarism

Undersecretion of pituitary hormones due to:

- Nonsecreting pituitary adenoma, craniopharyngioma
- Sheehan syndrome—ischemic infarct of pituitary following postpartum bleeding; pregnancyinduced pituitary growth → ↑ susceptibility to hypoperfusion. Usually presents with failure to lactate, absent menstruation, cold intolerance
- Empty sella syndrome—atrophy or compression of pituitary (which lies in the sella turcica), often idiopathic, common in obese women; associated with idiopathic intracranial hypertension
- Pituitary apoplexy—sudden hemorrhage of pituitary gland, often in the presence of an existing pituitary adenoma. Usually presents with sudden onset severe headache, visual impairment (eg, bitemporal hemianopia, diplopia due to CN III palsy), and features of hypopituitarism
- Brain injury
- Radiation

Treatment: hormone replacement therapy (corticosteroids, thyroxine, sex steroids, human growth hormone)

Acromegaly	Excess GH in adults. Typically caused by pituitary adenoma.				
FINDINGS	Large tongue with deep furrows, deep voice, large hands and feet, coarsening of facial features with aging A, frontal bossing, diaphoresis (excessive sweating), impaired glucose tolerance (insulin resistance), hypertension. † risk of colorectal polyps and cancer.	† GH in children → gigantism († linea growth). HF most common cause of c			
DIAGNOSIS	† serum IGF-1; failure to suppress serum GH following oral glucose tolerance test; pituitary mass seen on brain MRI.	Baseline			
TREATMENT	Pituitary adenoma resection. If not cured, treat with octreotide (somatostatin analog), pegvisomant (GH receptor antagonist), or dopamine agonists (eg, cabergoline).				

ar bone death.



FAS1_2019_08-Endocrine.indd 339 11/7/19 4:30 PM

Hypothyroidism vs hyperthyroidism

FINDINGS	Hypothyroidism	Hyperthyroidism
METABOLIC	Cold intolerance, ↓ sweating, weight gain (↓ basal metabolic rate → ↓ calorigenesis), hyponatremia (↓ free water clearance)	Heat intolerance, ↑ sweating, weight loss (↑ synthesis of Na+-K+ ATPase → ↑ basal metabolic rate → ↑ calorigenesis)
SKIN/HAIR A **Example 1	Dry, cool skin (due to ↓ blood flow); coarse, brittle hair; diffuse alopecia; brittle nails; puffy facies and generalized nonpitting edema (myxedema) due to † GAGs in interstitial spaces → † osmotic pressure → water retention	Warm, moist skin (due to vasodilation); fine hair; onycholysis (A); pretibial myxedema in Graves disease
OCULAR	Periorbital edema	Ophthalmopathy in Graves disease (including periorbital edema, exophthalmos), lid lag/retraction († sympathetic stimulation of levator palpebrae superioris and superior tarsal muscle)
GASTROINTESTINAL	Constipation (↓ GI motility), ↓ appetite	Hyperdefecation/diarrhea († GI motility), † appetite
MUSCULOSKELETAL	Hypothyroid myopathy (proximal weakness, † CK), carpal tunnel syndrome, myoedema (small lump rising on the surface of a muscle when struck with a hammer)	Thyrotoxic myopathy (proximal weakness, normal CK), osteoporosis/† fracture rate (T ₃ directly stimulates bone resorption)
REPRODUCTIVE	Abnormal uterine bleeding, ↓ libido, infertility	Abnormal uterine bleeding, gynecomastia, ↓ libido, infertility
NEUROPSYCHIATRIC	Hypoactivity, lethargy, fatigue, weakness, depressed mood, ↓ reflexes (delayed/slow relaxing)	Hyperactivity, restlessness, anxiety, insomnia, fine tremors (due to † β-adrenergic activity), † reflexes (brisk)
CARDIOVASCULAR	Bradycardia, dyspnea on exertion (‡ cardiac output)	Tachycardia, palpitations, dyspnea, arrhythmias (eg, atrial fibrillation), chest pain and systolic HTN due to ↑ number and sensitivity of β-adrenergic receptors, ↑ expression of cardiac sarcolemmal ATPase and ↓ expression of phospholamban
LABS	↑ TSH (if 1°) ↓ free T ₃ and T ₄ Hypercholesterolemia (due to ↓ LDL receptor expression)	↓ TSH (if 1°) ↑ free T₃ and T₄ ↓ LDL, HDL, and total cholesterol

FAS1_2019_08-Endocrine.indd 340 11/7/19 4:30 PM

Hypothyroidism

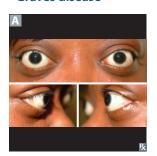
Hashimoto thyroiditis	Most common cause of hypothyroidism in iodine-sufficient regions; an autoimmune disorder with antithyroid peroxidase (antimicrosomal) and antithyroglobulin antibodies. Associated with HLA-DR3, HLA-DR5, † risk of non-Hodgkin lymphoma (typically of B-cell origin). May be hyperthyroid early in course due to thyrotoxicosis during follicular rupture. Histology: Hürthle cells A, lymphoid aggregates with germinal centers. Findings: moderately enlarged, nontender thyroid.
Postpartum thyroiditis	Self-limited thyroiditis arising up to 1 year after delivery. Presents as transient hyperthyroidism, hypothyroidism, or hyperthyroidism followed by hypothyroidism. Majority of women are euthyroid following resolution. Thyroid usually painless and normal in size. Histology: lymphocytic infiltrate with occasional germinal center formation.
Congenital hypothyroidism (cretinism)	Severe fetal hypothyroidism due to antibody-mediated maternal hypothyroidism, thyroid dysgenesis (most common cause in US; eg, agenesis, ectopy, hypoplasia), iodine deficiency, dyshormonogenetic goiter (commonly due to mutations in thyroid peroxidase). Findings (6 P's): Pot-bellied, Pale, Puffy-faced child with Protruding umbilicus, Protuberant tongue and Poor brain development.
Subacute granulomatous thyroiditis (de Quervain)	Self-limited disease often following a flu-like illness (eg, viral infection). May be hyperthyroid early in course, followed by hypothyroidism (permanent in ~15% of cases). Histology: granulomatous inflammation. Findings: † ESR, jaw pain, very tender thyroid. (de Quervain is associated with pain.)
Riedel thyroiditis	Thyroid replaced by fibrous tissue and inflammatory infiltrate . Fibrosis may extend to local structures (eg, trachea, esophagus), mimicking anaplastic carcinoma. 1/3 of patients are hypothyroid. Considered a manifestation of IgG4-related systemic disease (eg, autoimmune pancreatitis, retroperitoneal fibrosis, noninfectious aortitis). Findings: fixed, hard (rock-like), painless goiter.
Other causes	Iodine deficiency (with goiter 🔳), goitrogens (eg, amiodarone, lithium), Wolff-Chaikoff effect (thyroid gland downregulation in response to † iodide).



FAS1_2019_08-Endocrine.indd 341 11/7/19 4:30 PM

Hyperthyroidism

Graves disease



Most common cause of hyperthyroidism. Thyroid-stimulating immunoglobulin (IgG, can cause transient neonatal hyperthyroidism; type II hypersensitivity) stimulates TSH receptors on thyroid (hyperthyroidism, diffuse goiter), dermal fibroblasts (pretibial myxedema), and orbital fibroblasts (Graves orbitopathy). Activation of T-cells \rightarrow lymphocytic infiltration of retroorbital space \rightarrow † cytokines (eg, TNF- α , IFN- γ) \rightarrow † fibroblast secretion of hydrophilic GAGs \rightarrow † osmotic muscle swelling, muscle inflammation, and adipocyte count \rightarrow exophthalmos \blacksquare . Often presents during stress (eg, pregnancy). Associated with HLA-DR3 and HLA-B8. Histology: tall, crowded follicular epithelial cells; scalloped colloid.

Toxic multinodular goiter

Focal patches of hyperfunctioning follicular cells distended with colloid working independently of TSH (due to TSH receptor mutations in 60% of cases). † release of T₃ and T₄. Hot nodules are rarely malignant.

Thyroid storm

Uncommon but serious complication that occurs when hyperthyroidism is incompletely treated/ untreated and then significantly worsens in the setting of acute stress such as infection, trauma, surgery. Presents with agitation, delirium, fever, diarrhea, coma, and tachyarrhythmia (cause of death). May see † LFTs. Treat with the 4 P's: β -blockers (eg, Propranolol), Propylthiouracil, corticosteroids (eg, Prednisolone), Potassium iodide (Lugol iodine). Iodide load $\rightarrow \downarrow T_4$ synthesis \rightarrow Wolff-Chaikoff effect.

Jod-Basedow phenomenon

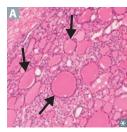
Iodine-induced hyperthyroidism. Occurs when a patient with iodine deficiency and partially autonomous thyroid tissue (eg, autonomous nodule) is made iodine replete. Can happen after iodine IV contrast or amiodarone use. Opposite to Wolff-Chaikoff effect.

Causes of goiter

Smooth/diffuse: Graves disease, Hashimoto thyroiditis, iodine deficiency, TSH-secreting pituitary adenoma.

Nodular: toxic multinodular goiter, thyroid adenoma, thyroid cancer, thyroid cyst.

Thyroid adenoma



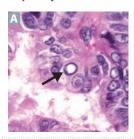
Benign solitary growth of the thyroid. Most are nonfunctional ("cold"), can rarely cause hyperthyroidism via autonomous thyroid hormone production ("hot" or "toxic"). Most common histology is follicular (arrows in A); absence of capsular or vascular invasion (unlike follicular carcinoma).

FAS1 2019 08-Endocrine.indd 342 11/7/19 4:30 PM

Thyroid cancer

Typically diagnosed with fine needle aspiration; treated with thyroidectomy. Complications of surgery include hypocalcemia (due to removal of parathyroid glands), transection of recurrent laryngeal nerve during ligation of inferior thyroid artery (leads to dysphagia and dysphonia [hoarseness]), and injury to the external branch of the superior laryngeal nerve during ligation of superior thyroid vascular pedicle (may lead to loss of tenor usually noticeable in professional voice users).

Papillary carcinoma

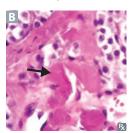


Most common, excellent prognosis. Empty-appearing nuclei with central clearing ("Orphan Annie" eyes) A, psamMoma bodies, nuclear grooves (Papi and Moma adopted Orphan Annie). † risk with RET/PTC rearrangements and BRAF mutations, childhood irradiation. Papillary carcinoma: most Prevalent, Palpable lymph nodes. Good prognosis.

Follicular carcinoma

Good prognosis. Invades thyroid capsule and vasculature (unlike follicular adenoma), uniform follicles; hematogenous spread is common. Associated with RAS mutation and PAX8-PPAR-γ translocations.

Medullary carcinoma

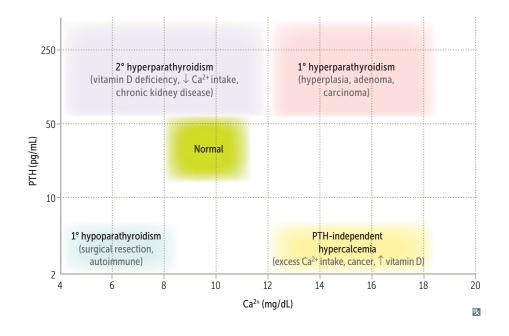


From parafollicular "C cells"; produces calcitonin, sheets of polygonal cells in an amyloid stroma **B** (stains with Congo red). Associated with MEN 2A and 2B (RET mutations).

Undifferentiated/ anaplastic carcinoma

Older patients; presents with rapidly enlarging neck mass → compressive symptoms (eg, dyspnea, dysphagia, hoarseness); very poor prognosis. Associated with TP53 mutation.

Diagnosing parathyroid disease



FAS1 2019 08-Endocrine.indd 343 11/7/19 4:30 PM

Hypoparathyroidism



Due to injury to parathyroid glands or their blood supply (usually during surgery), autoimmune destruction, or DiGeorge syndrome. Findings: tetany, hypocalcemia, hyperphosphatemia. Chvostek sign—tapping of facial nerve (tap the Cheek) → contraction of facial muscles. Trousseau sign—occlusion of brachial artery with BP cuff (cuff the Triceps) → carpal spasm.

Pseudohypoparathyroidism type 1A—autosomal dominant, maternally transmitted mutations (imprinted GNAS gene). GNAS1-inactivating mutation (coupled to PTH receptor) that encodes the G_s protein α subunit \rightarrow inactivation of adenylate cyclase when PTH binds to its receptor \rightarrow end-organ resistance (kidney and bone) to PTH.

Physical findings: Albright hereditary osteodystrophy (shortened 4th/5th digits A, short stature, round face, subcutaneous calcifications, developmental delay).

Labs: ↑ PTH, ↓ Ca²⁺, ↑ PO₄³⁻.

Pseudopseudohypoparathyroidism—autosomal dominant, paternally transmitted mutations (imprinted GNAS gene) but without end-organ resistance to PTH due to normal maternal allele maintaining renal responsiveness to PTH.

Physical findings: same as Albright hereditary osteodystrophy.

Labs: normal PTH, Ca²⁺, PO₄³⁻.

Lab values in hypocalcemia

DISORDER	Ca ²⁺	PO ₄ ³⁻	PTH
Vitamin D deficiency	ţ	1	†
Hypoparathyroidism	ţ	†	ţ
2° hyperparathyroidism (CKD)	ţ	1	†
Pseudohypoparathyroidism	ţ	†	†
Hyperphosphatemia	ţ	†	†

FAS1_2019_08-Endocrine.indd 344 11/7/19 4:30 PM

Hyperparathyroidism

Primary hyperparathyroidism



Usually due to parathyroid adenoma or hyperplasia. Hypercalcemia, hypercalciuria (renal stones), polyuria (thrones), hypophosphatemia, † PTH, † ALP, † urinary cAMP. Most often asymptomatic. May present with bone pain, weakness, constipation ("groans"), abdominal/flank pain (kidney stones, acute pancreatitis), neuropsychiatric disturbances ("psychiatric overtones").

Osteitis fibrosa cystica—cystic bone spaces filled with brown fibrous tissue A ("brown tumor" consisting of osteoclasts and deposited hemosiderin from hemorrhages; causes bone pain). Due to † PTH, classically associated with 1° (but also seen with 2°) hyperparathyroidism.

"Stones, thrones, bones, groans, and psychiatric overtones."

Secondary hyperparathyroidism 2° hyperplasia due to ↓ Ca²⁺ absorption and/or ↑ PO₄³⁻, most often in chronic kidney disease (causes hypovitaminosis D and hyperphosphatemia → ↓ Ca²⁺).

Hypocalcemia, hyperphosphatemia in chronic kidney disease (vs hypophosphatemia with most other causes), ↑ ALP, ↑ PTH.

Renal osteodystrophy—renal disease → 2° and 3° hyperparathyroidism → bone lesions.

Tertiary hyperparathyroidism Refractory (autonomous) hyperparathyroidism resulting from chronic kidney disease.

†† PTH, † Ca²⁺.

Familial hypocalciuric hypercalcemia

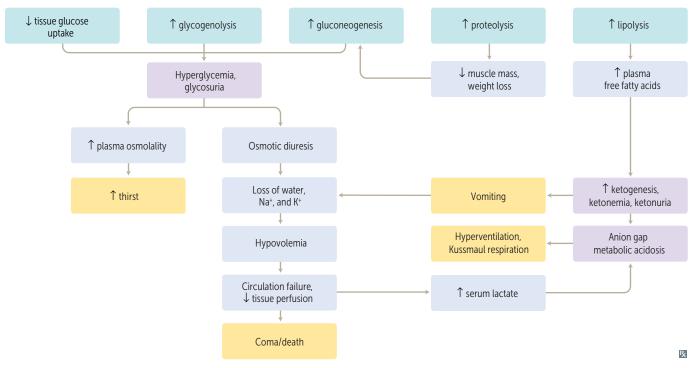
Defective G-coupled Ca^{2+} -sensing receptors in multiple tissues (eg, parathyroids, kidneys). Higher than normal Ca^{2+} levels required to suppress PTH. Excessive renal Ca^{2+} reabsorption \rightarrow mild hypercalcemia and hypocalciuria with normal to \uparrow PTH levels.

FAS1_2019_08-Endocrine.indd 345 11/7/19 4:30 PM

Diabetes mellitus

Plabetes Illellitus			
ACUTE MANIFESTATIONS	Polydipsia, polyuria, polyphagia, we (type 2).		77 07
	Rarely, can be caused by unopposed glucocorticoid therapy (steroid dial		epinephrine. Also seen in patients on
CHRONIC COMPLICATIONS	 Nonenzymatic glycation: Small vessel disease (diffuse thickening of basement membrane) → retinopathy (hemorrhage exudates, microaneurysms, vessel proliferation), glaucoma, nephropathy. Nodular glomerulosclerosis → progressive proteinuria (initially microalbuminuria; ACE inhibitors and ARBs are renoprotective) and arteriolosclerosis (causing hypertension) → chronic kidney disease. Large vessel atherosclerosis, CAD, peripheral vascular occlusive disease, gangrene → limb locerebrovascular disease. MI most common cause of death. Osmotic damage (sorbitol accumulation in organs with aldose reductase and ↓ or absent sorbitol dehydrogenase): Neuropathy (motor, sensory [glove and stocking distribution], and autonomic degeneration). Cataracts. 		
DIAGNOSIS	test HbA _{lc}	DIAGNOSTIC CUTOFF ≥ 6.5%	NOTES Reflects average blood glucose over prior 3 months
	Fasting plasma glucose	≥ 126 mg/dL	Fasting for > 8 hours
	2-hour oral glucose tolerance test	≥ 200 mg/dL	2 hours after consumption of 75 g of glucose in water

Insulin deficiency or severe insulin insensitivity



FAS1_2019_08-Endocrine.indd 346 11/7/19 4:30 PM

Type 1 vs type 2 diabetes mellitus

	Type 1	Type 2
1° DEFECT	Autoimmune T-cell–mediated destruction of β cells (eg, due to presence of glutamic acid decarboxylase antibodies)	† resistance to insulin, progressive pancreatic β-cell failure
INSULIN NECESSARY IN TREATMENT	Always	Sometimes
AGE (EXCEPTIONS COMMON)	< 30 yr	> 40 yr
ASSOCIATION WITH OBESITY	No	Yes
GENETIC PREDISPOSITION	Relatively weak (50% concordance in identical twins), polygenic	Relatively strong (90% concordance in identica twins), polygenic
ASSOCIATION WITH HLA SYSTEM	Yes, HLA-DR4 and -DR3 $(4 - 3 = \text{type } 1)$	No
GLUCOSE INTOLERANCE	Severe	Mild to moderate
INSULIN SENSITIVITY	High	Low
KETOACIDOSIS	Common	Rare
β-CELL NUMBERS IN THE ISLETS	↓	Variable (with amyloid deposits)
SERUM INSULIN LEVEL	↓	↑ initially, but ↓ in advanced disease
CLASSIC SYMPTOMS OF POLYURIA, POLYDIPSIA, POLYPHAGIA, WEIGHT LOSS	Common	Sometimes
HISTOLOGY Diabetic ketoacidosis	Islet leukocytic infiltrate Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑	
	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ tetogenesis from ↑ free fatty acids → ketone both DKA is Deadly: Delirium/psychosis, Kussmaul results of the complex of	ns). Stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). espirations (rapid, deep breathing), Abdominal
Diabetic ketoacidosis	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone border DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breadth	ns). The stress (eg, infection) → excess fat breakdown and sodies (β-hydroxybutyrate > acetoacetate). The stress (eg, infection) → excess fat breakdown and sodies (β-hydroxybutyrate > acetoacetate). The stress (eg, infection) → excess fat breakdown and sodies (β-hydroxybutyrate > acetoacetate).
Diabetic ketoacidosis SIGNS/SYMPTOMS	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ tetogenesis from ↑ free fatty acids → ketone both DKA is Deadly: Delirium/psychosis, Kussmaul results of the complex of	ns). If stress (eg, infection) → excess fat breakdown and rodies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K+ due to transcellular shift from
Diabetic ketoacidosis SIGNS/SYMPTOMS	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone b DKA is Deadly: Delirium/psychosis, Kussmaul r pain/nausea/vomiting, Dehydration. Fruity bree Hyperglycemia, ↑ H+, ↓ HCO ₃ - (↑ anion gap met leukocytosis. Normal/↑ serum K+, but depleted	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion.
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone book is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breathyperglycemia, ↑ H+, ↓ HCO ₃ - (↑ anion gap methology leukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+	ns). I stress (eg, infection) → excess fat breakdown and rodies (β-hydroxybutyrate > acetoacetate). espirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). abolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. cardiac arrhythmias, HF.
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS COMPLICATIONS	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone be DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breathyperglycemia, ↑ H+, ↓ HCO ₃ - (↑ anion gap metheukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+ Life-threatening mucormycosis, cerebral edema, IV fluids, IV insulin, K+ (to replete intracellular service) Insulin present, ketones absent. Profound hyperglycemia → excessive osmotic diagrams.	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. Readiac arrhythmias, HF. Retores) +/- glucose to prevent hypoglycemia.
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS COMPLICATIONS TREATMENT Hyperosmolar	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone be DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breed Hyperglycemia, ↑ H+, ↓ HCO3- (↑ anion gap methology leukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+ Life-threatening mucormycosis, cerebral edema, IV fluids, IV insulin, K+ (to replete intracellular service in the service of the profound hyperglycemia → excessive osmotic diuresis → HHS. Classically seen in elderly type 2 diabeta.	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. Reardiac arrhythmias, HF. Retores) +/- glucose to prevent hypoglycemia.
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS COMPLICATIONS TREATMENT Hyperosmolar	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone be DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breathyperglycemia, ↑ H+, ↓ HCO ₃ - (↑ anion gap metheukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+ Life-threatening mucormycosis, cerebral edema, IV fluids, IV insulin, K+ (to replete intracellular service) Insulin present, ketones absent. Profound hyperglycemia → excessive osmotic diagrams.	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. Reardiac arrhythmias, HF. Retores) +/- glucose to prevent hypoglycemia.
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS COMPLICATIONS TREATMENT Hyperosmolar hyperglycemic state	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone be DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breed Hyperglycemia, ↑ H+, ↓ HCO3- (↑ anion gap methology leukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+ Life-threatening mucormycosis, cerebral edema, IV fluids, IV insulin, K+ (to replete intracellular service in the service of the profound hyperglycemia → excessive osmotic diuresis → HHS. Classically seen in elderly type 2 diabeta.	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. Reardiac arrhythmias, HF. Retores) +/- glucose to prevent hypoglycemia. Retoresis → dehydration and ↑ serum osmolality etics with limited ability to drink. Rets, seizures. Real No. 1 acetose fat breakdown and acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown and acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose fat breakdown acetose f
Diabetic ketoacidosis SIGNS/SYMPTOMS LABS COMPLICATIONS TREATMENT Hyperosmolar hyperglycemic state SIGNS/SYMPTOMS	Insulin absent, ketones present (→ complication Insulin noncompliance or ↑ requirements from ↑ ketogenesis from ↑ free fatty acids → ketone be DKA is Deadly: Delirium/psychosis, Kussmaul repain/nausea/vomiting, Dehydration. Fruity breathyperglycemia, ↑ H+, ↓ HCO3- (↑ anion gap metheukocytosis. Normal/↑ serum K+, but depleted ↓ insulin and acidosis. Osmotic diuresis → ↑ K+ Life-threatening mucormycosis, cerebral edema, IV fluids, IV insulin, K+ (to replete intracellular service in the service of the HHS. Classically seen in elderly type 2 diabethyperglycemia, lethargy, focal neurologic deficientlyperglycemia (often >600 mg/dL), ↑ serum osm	ns). If stress (eg, infection) → excess fat breakdown and podies (β-hydroxybutyrate > acetoacetate). Respirations (rapid, deep breathing), Abdominal ath odor (due to exhaled acetone). Rabolic acidosis), ↑ urine and blood ketone levels, intracellular K⁺ due to transcellular shift from loss in urine → total body K⁺ depletion. Readiac arrhythmias, HF. Retores) +/- glucose to prevent hypoglycemia. Retoresis → dehydration and ↑ serum osmolality etics with limited ability to drink. Rets, seizures. Reading Stream of the serum osmolality etics with limited ability to drink.

FAS1_2019_08-Endocrine.indd 347 11/7/19 4:30 PM

Cushing syndrome

ETIOLOGY

† cortisol due to a variety of causes:

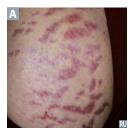
- Exogenous corticosteroids → ↓ ACTH → bilateral adrenal atrophy. Most common cause.
- Primary adrenal adenoma, hyperplasia, or carcinoma → ↓ ACTH → atrophy of uninvolved adrenal gland.
- ACTH-secreting pituitary adenoma (Cushing disease); paraneoplastic ACTH secretion (eg, small cell lung cancer, bronchial carcinoids) → bilateral adrenal hyperplasia. Cushing disease is responsible for the majority of endogenous cases of Cushing syndrome.

FINDINGS

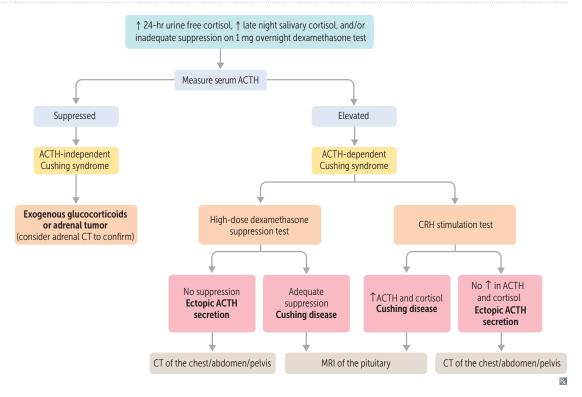
CUSHING Syndrome: † Cholesterol, † Urinary free cortisol, Skin changes (thinning, striae A), Hypertension, Immunosuppression, Neoplasm (a cause, not a finding), Growth retardation (in children), † Sugar (hyperglycemia, insulin resistance). Also, amenorrhea, moon facies B, buffalo hump, osteoporosis, † weight (truncal obesity), hirsutism.

DIAGNOSIS

Screening tests include: † free cortisol on 24-hr urinalysis, † late night salivary cortisol, and no suppression with overnight low-dose dexamethasone test.







Nelson syndrome

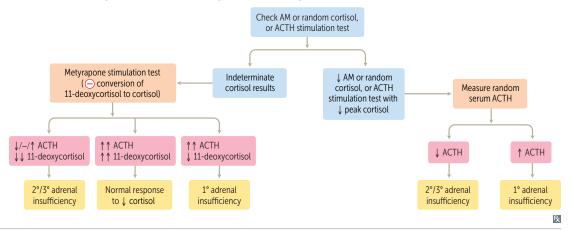
Enlargement of pre-existing ACTH–secreting pituitary adenoma after bilateral adrenalectomy for refractory Cushing disease → ↑ ACTH (hyperpigmentation), mass effect (headaches, bitemporal hemianopia).

Treatment: transsphenoidal resection, postoperative pituitary irradiation for residual tumor.

FAS1_2019_08-Endocrine.indd 348 11/7/19 4:30 PM

Adrenal insufficiency

Inability of adrenal glands to generate enough glucocorticoids +/- mineralocorticoids for the body's needs. Symptoms include weakness, fatigue, orthostatic hypotension, muscle aches, weight loss, GI disturbances, sugar and/or salt cravings. Treatment: glucocorticoid/mineralocorticoid replacement.



Primary adrenal insufficiency



- \downarrow gland function $\rightarrow \downarrow$ cortisol, \downarrow aldosterone
 - → hypotension (hyponatremic volume contraction), hyperkalemia, metabolic acidosis, skin/mucosal hyperpigmentation

 A († melanin synthesis due to † MSH, a byproduct of ACTH production from POMC).
 - Acute—sudden onset (eg, due to massive hemorrhage). May present with shock in acute adrenal crisis.
 - Chronic—Addison disease. Due to adrenal atrophy or destruction by disease (autoimmune destruction most common in the Western world; TB most common in the developing world).

Primary Pigments the skin/mucosa.

Associated with autoimmune polyglandular syndromes.

Waterhouse-Friderichsen syndrome—acute

1° adrenal insufficiency due to adrenal hemorrhage associated with septicemia (usually *Neisseria meningitidis*), DIC, endotoxic shock.

Secondary adrenal insufficiency

Seen with \$\frac{1}{2}\$ pituitary ACTH production. No skin/mucosal hyperpigmentation (ACTH is not elevated), no hyperkalemia (aldosterone synthesis preserved due to functioning adrenal gland, intact RAAS).

Secondary Spares the skin/mucosa.

Tertiary adrenal insufficiency

Seen in patients with chronic exogenous steroid use, precipitated by abrupt withdrawal. Aldosterone synthesis unaffected.

Tertiary from Treatment.

Hyperaldosteronism

Increased secretion of aldosterone from adrenal gland. Clinical features include hypertension, † or normal K⁺, metabolic alkalosis. 1° hyperaldosteronism does not directly cause edema due to aldosterone escape mechanism. However, certain 2° causes of hyperaldosteronism (eg, heart failure) impair the aldosterone escape mechanism, leading to worsening of edema.

Primary hyperaldosteronism

Seen with adrenal adenoma (Conn syndrome) or bilateral adrenal hyperplasia. † aldosterone, † renin. Leads to treatment-resistant hypertension.

Secondary hyperaldosteronism

Seen in patients with renovascular hypertension, juxtaglomerular cell tumors (renin-producing), and edema (eg, cirrhosis, heart failure, nephrotic syndrome).

FAS1_2019_08-Endocrine.indd 349 11/7/19 4:30 PM

350

SECTION III

ENDOCRINE ▶ ENDOCRINE—PATHOLOGY

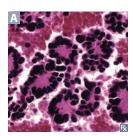
Neuroendocrine tumors

Heterogeneous group of neoplasms originating from neuroendocrine cells (which have traits similar to nerve cells and hormone-producing cells).

Most neoplasms occur in the GI system (eg, carcinoid, gastrinoma), pancreas (eg, insulinoma, glucagonoma), and lungs (eg, small cell carcinoma). Also in thyroid (eg, medullary carcinoma) and adrenals (eg, pheochromocytoma).

Neuroendocrine cells (eg, pancreatic β cells, enterochromaffin cells) share a common biologic function through amine precursor uptake decarboxylase (APUD) despite differences in embryologic origin, anatomic site, and secretory products (eg, chromogranin A, neuron-specific enolase [NSE], synaptophysin, serotonin, histamine, calcitonin). Treatment: surgical resection, somatostatin analogs.

Neuroblastoma



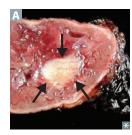
Most common tumor of the adrenal medulla in **children**, usually < 4 years old. Originates from Neural crest cells. Occurs anywhere along the sympathetic chain.

Most common presentation is abdominal distension and a firm, irregular mass that can cross the midline (vs Wilms tumor, which is smooth and unilateral). Less likely to develop hypertension than with pheochromocytoma (Neuroblastoma is Normotensive). Can also present with opsoclonus-myoclonus syndrome ("dancing eyes-dancing feet").

† HVA and VMA (catecholamine metabolites) in urine. Homer-Wright rosettes (neuroblasts surrounding a central lumen A) characteristic of neuroblastoma and medulloblastoma. Bombesin and NSE \oplus . Associated with amplification of N-myc oncogene.

Pheochromocytoma

ETIOLOGY



Most common tumor of the adrenal medulla in adults A. Derived from chromaffin cells (arise from neural crest).

May be associated with germline mutations (eg, NF-1, VHL, RET [MEN 2A, 2B]).

Rule of 10's:

10% malignant

10% bilateral

10% extra-adrenal (eg, bladder wall, organ of Zuckerkandl)

10% calcify

10% kids

SYMPTOMS

Most tumors secrete epinephrine, norepinephrine, and dopamine, which can cause episodic hypertension. May also secrete EPO → polycythemia.

Symptoms occur in "spells"—relapse and remit.

Episodic hyperadrenergic symptoms (5 P's):

Pressure († BP)

Pain (headache)

Perspiration

Palpitations (tachycardia)

Pallor

FINDINGS

† catecholamines and metanephrines (eg, homovanillic acid, vanillylmandelic acid) in urine and plasma.

Chromogranin, synaptophysin and NSE ⊕.

TREATMENT

Irreversible α -antagonists (eg, phenoxybenzamine) followed by β -blockers prior to tumor resection. α -blockade must be achieved before giving β -blockers to avoid a hypertensive crisis. A before B.

Phenoxybenzamine for pheochromocytoma.

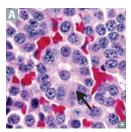
FAS1_2019_08-Endocrine.indd 350 11/7/19 4:30 PM

Multiple endocrine	All MEN syndromes have autosomal dominant	inheritance.
neoplasias	"All MEN are dominant" (or so they think).	
SUBTYPE	CHARACTERISTICS	COMMENTS
MEN 1	Pituitary tumors (prolactin or GH) Pancreatic endocrine tumors—Zollinger- Ellison syndrome, insulinomas, VIPomas, glucagonomas (rare) Parathyroid adenomas	Pituitary Pancreas
	Associated with mutation of MEN1 (menin, a tumor suppressor, chromosome 11), angiofibromas, collagenomas, meningiomas	
MEN 2A	Parathyroid hyperplasia Medullary thyroid carcinoma—neoplasm of parafollicular C cells; secretes calcitonin; prophylactic thyroidectomy required Pheochromocytoma (secretes catecholamines) Associated with mutation in RET (codes for receptor tyrosine kinase)	Thyroid (medullary carcinoma) Pheochromocytoma
MEN 2B	Medullary thyroid carcinoma Pheochromocytoma Mucosal neuromas A (oral/intestinal ganglioneuromatosis) Associated with marfanoid habitus; mutation in RET gene	Mucosal neuromas
		MEN 1 = 3 P's: Pituitary, Parathyroid, and Pancreas MEN 2A = 2 P's: Parathyroid and Pheochromocytoma MEN 2B = 1 P: Pheochromocytoma
Pancreatic islet cell tur		
Insulinoma	Tumor of pancreatic β cells \rightarrow overproduction of	insulin → hypoglycemia.

Insulinoma	Tumor of pancreatic β cells → overproduction of insulin → hypoglycemia. May see Whipple triad: low blood glucose, symptoms of hypoglycemia (eg, lethargy, syncope, diplopia), and resolution of symptoms after normalization of plasma glucose levels. Symptomatic patients have ↓ blood glucose and ↑ C-peptide levels (vs exogenous insulin use). ~ 10% of cases
	associated with MEN 1 syndrome. Treatment: surgical resection.
Glucagonoma	Tumor of pancreatic α cells → overproduction of glucagon. Presents with 6 D's: Dermatitis (necrolytic migratory erythema), Diabetes (hyperglycemia), DVT, Declining weight, Depression, Diarrhea. Treatment: octreotide, surgical resection.
Somatostatinoma	Tumor of pancreatic δ cells → overproduction of somatostatin → ↓ secretion of secretin, cholecystokinin, glucagon, insulin, gastrin, gastric inhibitory peptide (GIP). May present with diabetes/glucose intolerance, steatorrhea, gallstones, achlorhydria. Treatment: surgical resection; somatostatin analogs (eg, octreotide) for symptom control.

FAS1_2019_08-Endocrine.indd 351 11/7/19 4:30 PM

Carcinoid syndrome



Carcinoid tumors arise from neuroendocrine cells most commonly in the intestine or lung. Rare and does not occur if tumor is limited to the GI tract.

Prominent rosettes (arrow in \boxed{A}), chromogranin $A \oplus$ and synaptophysin \oplus).

Neuroendocrine cells secrete 5-HT → recurrent diarrhea, wheezing, right-sided valvular heart disease (eg, tricuspid regurgitation, pulmonic stenosis), niacin deficiency (pellagra). 5-HT undergoes hepatic first-pass metabolism and enzymatic breakdown by MAO in the lung.

Treatment: surgical resection, somatostatin analog (eg, octreotide, telotristat) for symptom control.

Rule of thirds:

- 1/3 metastasize
- 1/3 present with 2nd malignancy
- 1/3 are multiple

Zollinger-Ellison syndrome

Gastrin-secreting tumor (gastrinoma) of pancreas or duodenum. Acid hypersecretion causes recurrent ulcers in duodenum and jejunum. Presents with abdominal pain (peptic ulcer disease, distal ulcers), diarrhea (malabsorption). Positive secretin stimulation test: gastrin levels remain elevated after administration of secretin, which normally inhibits gastrin release. May be associated with MEN 1.

► ENDOCRINE—PHARMACOLOGY

Diabetes mellitus therapy

All patients with diabetes mellitus should receive education on diet, exercise, blood glucose monitoring, and complication management. Treatment differs based on the type of diabetes and glycemic control:

- Type 1 DM—insulin replacement
- Type 2 DM—oral agents (metformin is first line), non-insulin injectables, insulin replacement; weight loss particularly helpful in lowering blood glucose
- Gestational DM—insulin replacement if nutrition therapy and exercise alone fail Regular (short-acting) insulin is preferred for DKA (IV), hyperkalemia (+ glucose), stress hyperglycemia.

To Normalize Pancreatic Function (-gliTs, -gliNs, -gliPs, -gliFs).

MECHANISM DRUG CLASS **ADVERSE EFFECTS** Insulin preparations Rapid acting (1-hr Bind insulin receptor (tyrosine kinase activity) Hypoglycemia, lipodystrophy, hypersensitivity peak): Lispro, Aspart, Liver: † glucose storage as glycogen reactions (rare), weight gain Muscle: † glycogen, protein synthesis Glulisine (no LAG) Short acting (2-3 hr Fat: † TG storage Lispro, aspart, glulisine Plasma insulin level peak): regular Cell membrane: † K⁺ uptake Intermediate acting (4-10 hr peak): NPH Long acting (no real peak): detemir, glargine 10 12 18 Hours

FAS1_2019_08-Endocrine.indd 352 11/7/19 4:30 PM

Diabetes mellitus therapy (continued)

DRUG CLASS	MECHANISM	ADVERSE EFFECTS
Increase insulin sensitivit	у	
Biguanides Metformin	 Inhibit mGPD → inhibition of hepatic gluconeogenesis and the action of glucagon. † glycolysis, peripheral glucose uptake († insulin sensitivity). 	GI upset, lactic acidosis (use with caution in renal insufficiency), vitamin B_{12} deficiency. Weight loss (often desired).
Glitazones/ thiazolidinediones "-gliTs" Pioglitazone, rosiglitazone	Activate PPAR-γ (a nuclear receptor) → ↑ insulin sensitivity and levels of adiponectin → regulation of glucose metabolism and fatty acid storage.	Weight gain, edema, HF, ↑ risk of fractures. Delayed onset of action (several weeks). Rosiglitazone: ↑ risk of MI, cardiovascular death.
Increase insulin secretion	1	
Sulfonylureas (1st gen) Chlorpropamide, tolbutamide Sulfonylureas (2nd gen)	Close K ⁺ channels in pancreatic B cell	DisulFIRam-like reaction (FIRst-generation only). Rarely used. Hypoglycemia († risk in renal insufficiency),
Glipizide, glyburide Weglitinides "-gliNs" Nateglinide, repaglinide	membrane → cell depolarizes → insulin release via † Ca ²⁺ influx.	weight gain.
Increase glucose-induced	d insulin secretion	
GLP-1 analogs Exenatide, liraglutide	 ↓ glucagon release, ↓ gastric emptying, † glucose-dependent insulin release. 	Nausea, vomiting, pancreatitis. Weight loss (often desired). † satiety (often desired).
DPP-4 inhibitors "-gliPs" Linagliptin, saxagliptin, sitagliptin	Inhibit DPP-4 enzyme that deactivates GLP-1 → ↓ glucagon release, ↓ gastric emptying. ↑ glucose-dependent insulin release.	Respiratory and urinary infections, weight neutral. † satiety (often desired).
Decrease glucose absorp	otion	
co-transporter 2 (SGLT2) inhibitors "-gliFs" Canagliflozin, dapagliflozin, empagliflozin	Block reabsorption of glucose in proximal convoluted tubule.	Glucosuria (UTIs, vulvovaginal candidiasis), dehydration (orthostatic hypotension), hyperkalemia, weight loss. Use with caution in renal insufficiency (\$\dagger\$ efficacy with \$\dagger\$ GFR).
x-glucosidase inhibitors Acarbose, miglitol	Inhibit intestinal brush-border α-glucosidases → delayed carbohydrate hydrolysis and glucose absorption → ↓ postprandial hyperglycemia.	GI upset, bloating. Not recommended in renal insufficiency.
Others		
<mark>Amylin analogs</mark> Pr amlin tide	↓ glucagon release, ↓ gastric emptying.	Hypoglycemia, nausea. † satiety (often desired).

FAS1_2019_08-Endocrine.indd 353 11/7/19 4:30 PM

354 SECTION III ENDOCRINE ► ENDOCRINE—PHARMACOLOGY

Thionamides	Propylthiouracil, methimazole.
MECHANISM	Block thyroid peroxidase, inhibiting the oxidation of iodide as well as the organification and coupling of iodine → inhibition of thyroid hormone synthesis. PTU also blocks 5′-deiodinase → ↓ Peripheral conversion of T ₄ to T ₃ .
CLINICAL USE	Hyperthyroidism. PTU used in first trimester of pregnancy (due to methimazole teratogenicity); methimazole used in second and third trimesters of pregnancy (due to risk of PTU-induced hepatotoxicity). Not used to treat Graves ophthalmopathy (treated with corticosteroids).
ADVERSE EFFECTS	Skin rash, agranulocytosis (rare), aplastic anemia, hepatotoxicity. Methimazole is a possible teratogen (can cause aplasia cutis).
evothyroxine, liothyro	onine
MECHANISM	Hormone replacement for T ₄ (levothyroxine) or T ₃ (liothyronine).
CLINICAL USE	Hypothyroidism, myxedema. May be abused for weight loss. Distinguish exogenous hyperthyroidism from endogenous hyperthyroidism by using a combination of TSH receptor antibodies, radioactive iodine uptake, and/or measurement of thyroid blood flow on ultrasound.
ADVERSE EFFECTS	Tachycardia, heat intolerance, tremors, arrhythmias.
- Hypothalamic/pituitar	
-lypothalamic/pituitar	y drugs
-lypothalamic/pituitar y	y drugs CLINICAL USE ADH antagonists
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline	y drugs CLINICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin	CLINICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin GH	ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH Central DI, von Willebrand disease, sleep enuresis, hemophilia A
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin	y drugs CLINICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH Central DI, von Willebrand disease, sleep enuresis, hemophilia A GH deficiency, Turner syndrome
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin GH Oxytocin Somatostatin	CLINICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH Central DI, von Willebrand disease, sleep enuresis, hemophilia A GH deficiency, Turner syndrome Induction of labor (stimulates uterine contractions), control uterine hemorrhage
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin GH Oxytocin Somatostatin (octreotide)	CLINICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH Central DI, von Willebrand disease, sleep enuresis, hemophilia A GH deficiency, Turner syndrome Induction of labor (stimulates uterine contractions), control uterine hemorrhage
Hypothalamic/pituitary DRUG Conivaptan, tolvaptan Demeclocycline Desmopressin GH Oxytocin Somatostatin (octreotide) Fludrocortisone	CUNICAL USE ADH antagonists SIADH (block action of ADH at V ₂ -receptor) ADH antagonist, a tetracycline SIADH Central DI, von Willebrand disease, sleep enuresis, hemophilia A GH deficiency, Turner syndrome Induction of labor (stimulates uterine contractions), control uterine hemorrhage Acromegaly, carcinoid syndrome, gastrinoma, glucagonoma, esophageal varices

FAS1_2019_08-Endocrine.indd 354 11/7/19 4:30 PM

Cinacalcet

MECHANISM	Sensitizes Ca ²⁺ -sensing receptor (CaSR) in parathyroid gland to circulating Ca ²⁺ → ↓ PTH
CLINICAL USE	2° hyperparathyroidism in patients with CKD receiving hemodialysis, hypercalcemia in 1° hyperparathyroidism (if parathyroidectomy fails), or in parathyroid carcinoma.
ADVERSE EFFECTS	Hypocalcemia.
Carralaman	
Sevelamer	
Sevelamer MECHANISM	Nonabsorbable phosphate binder that prevents phosphate absorption from the GI tract.
	Nonabsorbable phosphate binder that prevents phosphate absorption from the GI tract. Hyperphosphatemia in CKD.

FAS1_2019_08-Endocrine.indd 355 11/7/19 4:30 PM

356

SECTION II ENDOCRINE ► ENDOCRINE—PHARMACOLOGY

► NOTES	

11/7/19 4:30 PM FAS1_2019_08-Endocrine.indd 356

HIGH-YIELD SYSTEMS

Gastrointestinal

"A good set of bowels is worth more to a man than any quantity of brains."

—Josh Billings

"Man should strive to have his intestines relaxed all the days of his life."

—Moses Maimonides

"All right, let's not panic. I'll make the money by selling one of my livers. I can get by with one."

-Homer Simpson

When studying the gastrointestinal system, be sure to understand the normal embryology, anatomy, and physiology and how it is affected in the various pathologic diseases. Study not only what a disease entails, but also its specific findings, so that you can differentiate between two similar diseases. For example, what specifically makes ulcerative colitis different than Crohn disease? Also, it is important to understand bile metabolism and which lab values increase or decrease depending on the disease process. Be comfortable with basic interpretation of abdominal x-rays, CT scans, and endoscopic images.

▶ Embryology	358
▶ Anatomy	360
▶ Physiology	371
▶ Pathology	376
▶ Pharmacology	398

FAS1_2019_09-Gastrointestinal.indd 357 11/7/19 4:42 PM

► GASTROINTESTINAL—EMBRYOLOGY

Normal gastrointestinal embryology

Foregut—esophagus to duodenum at level of pancreatic duct and common bile duct insertion (ampulla of Vater).

Midgut—lower duodenum to proximal 2/3 of transverse colon.

Hindgut—distal 1/3 of transverse colon to anal canal above pectinate line.

Midgut development:

- 6th week—physiologic herniation of midgut through umbilical ring
- 10th week—returns to abdominal cavity + rotates around superior mesenteric artery (SMA), total 270° counterclockwise

Ventral wall defects

Developmental defects due to failure of rostral fold closure (eg, sternal defects [ectopia cordis]), lateral fold closure (eg, omphalocele, gastroschisis), or caudal fold closure (eg, bladder exstrophy).

	Gastroschisis	Omphalocele
ETIOLOGY	Extrusion of abdominal contents through abdominal folds (typically right of umbilicus)	Failure of lateral walls to migrate at umbilical ring → persistent midline herniation of abdominal contents into umbilical cord
COVERAGE	Not covered by peritoneum or amnion A; "the guts come out of the gap (schism) in the letter G"	Surrounded by peritoneum () (light gray shiny sac); "abdominal contents are seal ed in the letter O "
ASSOCIATIONS	Not associated with chromosome abnormalities; favorable prognosis	Associated with congenital anomalies (eg, trisomies 13 and 18, Beckwith-Wiedemann syndrome) and other structural abnormalities (eg, cardiac, GU, neural tube)









Congenital umbilical hernia

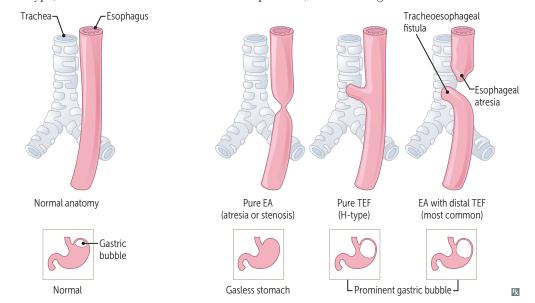
Failure of umbilical ring to close after physiologic herniation of the midgut. Small defects usually close spontaneously.

FAS1_2019_09-Gastrointestinal.indd 358 11/7/19 4:42 PM

Tracheoesophageal anomalies

Esophageal atresia (EA) with distal tracheoesophageal fistula (TEF) is the most common (85%) and often presents as polyhydramnios in utero (due to inability of fetus to swallow amniotic fluid). Neonates drool, choke, and vomit with first feeding. TEFs allow air to enter stomach (visible on CXR). Cyanosis is 2° to laryngospasm (to avoid reflux-related aspiration). Clinical test: failure to pass nasogastric tube into stomach.

In H-type, the fistula resembles the letter H. In pure EA, CXR shows gasless abdomen.



Intestinal atresia



Presents with bilious vomiting and abdominal distension within first 1–2 days of life.

Duodenal atresia—failure to recanalize. Abdominal x-ray A shows "double bubble" (dilated stomach, proximal duodenum). Associated with Down syndrome.

Jejunal and ileal atresia—disruption of mesenteric vessels (typically SMA) → ischemic necrosis of fetal intestine → segmental resorption: bowel becomes discontinuous. X-ray shows dilated loops of small bowel with air-fluid levels.

Hypertrophic pyloric stenosis



Most common cause of gastric outlet obstruction in infants (1:600). Palpable olive-shaped mass in epigastric region, visible peristaltic waves, and nonbilious projectile vomiting at $\sim 2-6$ weeks old. More common in firstborn males; associated with exposure to macrolides.

Results in hypokalemic hypochloremic metabolic alkalosis (2° to vomiting of gastric acid and subsequent volume contraction).

Ultrasound shows thickened and lengthened pylorus A.

Treatment: surgical incision of pyloric muscles (pyloromyotomy).

FAS1_2019_09-Gastrointestinal.indd 359 11/7/19 4:42 PM

Pancreas and spleen embryology



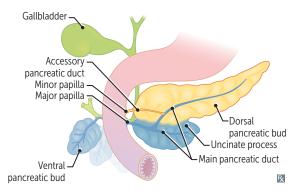
Pancreas—derived from foregut. Ventral pancreatic bud contributes to uncinate process and main pancreatic duct. The dorsal pancreatic bud alone becomes the body, tail, isthmus, and accessory pancreatic duct. Both the ventral and dorsal buds contribute to pancreatic head.

Annular pancreas—abnormal rotation of ventral pancreatic bud forms a ring of pancreatic tissue

→ encircles 2nd part of duodenum; may cause duodenal narrowing (arrows in A) and vomiting.

Pancreas divisum—ventral and dorsal parts fail to fuse at 8 weeks. Common anomaly; mostly asymptomatic, but may cause chronic abdominal pain and/or pancreatitis.

Spleen—arises in mesentery of stomach (hence is mesodermal) but has foregut supply (celiac trunk → splenic artery).



► GASTROINTESTINAL — ANATOMY

Retroperitoneal structures

Retroperitoneal structures A are posterior to (and outside of) the peritoneal cavity. Injuries to retroperitoneal structures can cause blood or gas accumulation in retroperitoneal space.

Duodenum/jejunum Ascending Colon Peritoneum Pancreas Liver IVC Aorta Kidney

SAD PUCKER:

Suprarenal (adrenal) glands [not shown]

Aorta and IVC

Duodenum (2nd through 4th parts)

Pancreas (except tail)

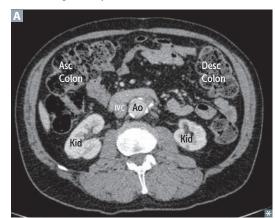
Ureters [not shown]

Colon (descending and ascending)

Kidneys

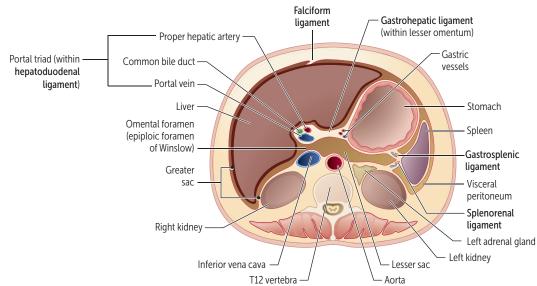
Esophagus (thoracic portion) [not shown]

Rectum (partially) [not shown]



FAS1_2019_09-Gastrointestinal.indd 360 11/7/19 4:42 PM

Important gastrointestinal ligaments



		T12 vertebra ─			
LIGAMENT	CONNECTS	STRUCTURES CONTAINED	NOTES		
Falciform ligament	Liver to anterior abdominal wall	Ligamentum teres hepatis (derivative of fetal umbilical vein), patent paraumbilical veins	Derivative of ventral mesentery		
Hepatoduodenal ligament	patoduodenal Liver to duodenum Portal triad: proper hepatic		igament artery, portal vein, common bile duct		Derivative of ventral mesentery Pringle maneuver—ligament is compressed manually or with a vascular clamp in omental foramen to control bleeding from hepatic inflow source Borders the omental foramen, which connects the greater and lesser sacs Part of lesser omentum
Gastrohepatic ligament	Liver to lesser curvature of stomach	Gastric vessels	Derivative of ventral mesentery Separates greater and lesser sacs on the right May be cut during surgery to access lesser sac Part of lesser omentum		
Gastrocolic ligament (not shown)	Greater curvature and transverse colon	Gastroepiploic arteries	Derivative of dorsal mesentery Part of greater omentum		
Gastrosplenic ligament	Greater curvature and spleen	Short gastrics, left gastroepiploic vessels	Derivative of dorsal mesentery Separates greater and lesser sacs on the left Part of greater omentum		
Splenorenal ligament	Spleen to left pararenal space	Splenic artery and vein, tail of pancreas	Derivative of dorsal mesentery		

FAS1_2019_09-Gastrointestinal.indd 361 11/7/19 4:42 PM

Digestive tract anatomy

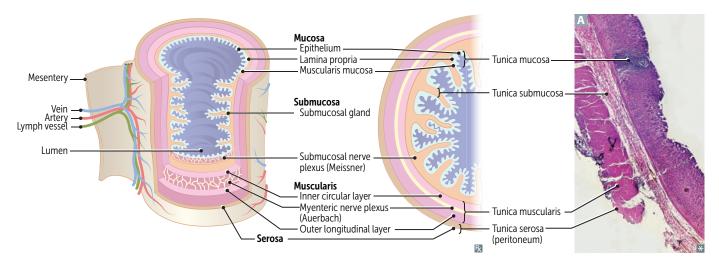
Layers of gut wall A (inside to outside—MSMS):

- Mucosa—epithelium, lamina propria, muscularis mucosa
- Submucosa—includes Submucosal nerve plexus (Meissner), Secretes fluid
- Muscularis externa—includes Myenteric nerve plexus (Auerbach), Motility
- Serosa (when intraperitoneal), adventitia (when retroperitoneal)

Ulcers can extend into submucosa, inner or outer muscular layer. Erosions are in mucosa only.

Frequency of basal electric rhythm (slow waves), which originate in the interstitial cells of Cajal:

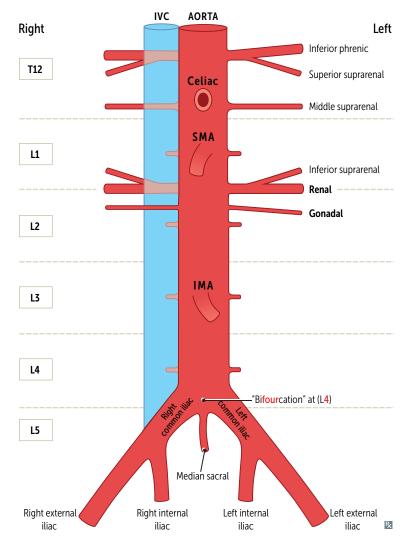
- Stomach—3 waves/min
- Duodenum—12 waves/min
- Ileum—8–9 waves/min



Digestive tract histo	ology
Esophagus	Nonkeratinized stratified squamous epithelium. Upper 1/3, striated muscle; middle and lower 2/3 smooth muscle, with some overlap at the transition.
Stomach	Gastric glands A.
Duodenum	Villi B and microvilli † absorptive surface. Brunner glands (HCO ₃ -secreting cells of submucosa) and crypts of Lieberkühn (contain stem cells that replace enterocytes/goblet cells and Paneth cells that secrete defensins, lysozyme, and TNF).
Jejunum	Villi, crypts of Lieberkühn, and plicae circulares (also present in distal duodenum) 🕻.
lleum	Peyer patches (arrow in D; lymphoid aggregates in lamina propria, submucosa), plicae circulares (proximal ileum), and crypts of Lieberkühn. Largest number of goblet cells in the small intestine.
Colon	Crypts of Lieberkühn with abundant goblet cells, but no villi 🗉.

FAS1_2019_09-Gastrointestinal.indd 362 11/7/19 4:42 PM

Abdominal aorta and branches



Arteries supplying GI structures are single and branch anteriorly.

Arteries supplying non-GI structures are paired and branch laterally and posteriorly.

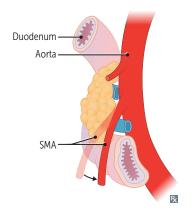
Two areas of the colon have dual blood supply from distal arterial branches ("watershed regions") → susceptible in colonic ischemia:

- Splenic flexure—SMA and IMA
- Rectosigmoid junction—the last sigmoid arterial branch from the IMA and superior rectal artery

Nutcracker syndrome—compression of left renal vein between superior mesenteric artery and aorta. Characterized by abdominal (flank) pain and gross hematuria (from rupture of thin-walled renal varicosities).

Superior mesenteric artery syndrome—

characterized by intermittent intestinal obstruction symptoms (primarily postprandial pain) when SMA and aorta compress transverse (third) portion of duodenum. Typically occurs in conditions associated with diminished mesenteric fat (eg, low body weight/malnutrition).



FAS1_2019_09-Gastrointestinal.indd 363 11/7/19 4:42 PM

Gastrointestinal blood supply and innervation

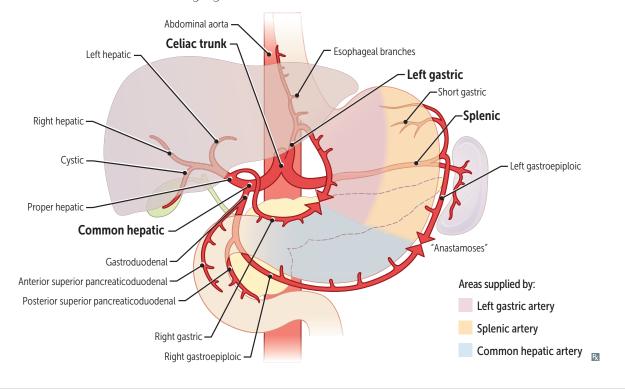
EMBRYONIC GUT REGION	ARTERY	PARASYMPATHETIC INNERVATION	VERTEBRAL LEVEL	STRUCTURES SUPPLIED
Foregut	Celiac	Vagus	T12/L1	Pharynx (vagus nerve only) and lower esophagus (celiac artery only) to proximal duodenum; liver, gallbladder, pancreas, spleen (mesoderm)
Midgut	SMA	Vagus	Ll	Distal duodenum to proximal 2/3 of transverse colon
Hindgut	IMA	Pelvic	L3	Distal 1/3 of transverse colon to upper portion of anal canal

Celiac trunk

Branches of celiac trunk: common hepatic, splenic, and left gastric. These constitute the main blood supply of the foregut.

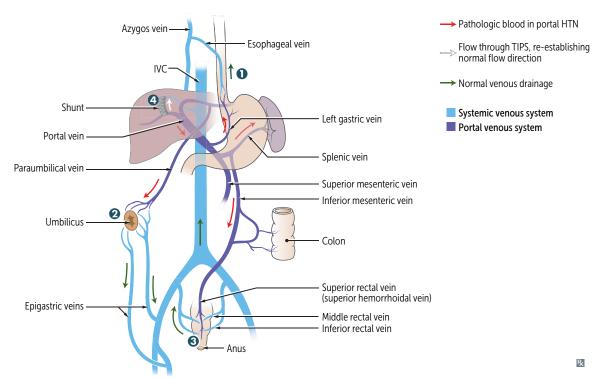
Strong anastomoses exist between:

- Left and right gastroepiploics
- Left and right gastrics



FAS1_2019_09-Gastrointestinal.indd 364 11/7/19 4:42 PM

Portosystemic anastomoses



SITE OF ANASTOMOSIS	CLINICAL SIGN	$PORTAL \leftrightarrow SYSTEMIC$
1 Esophagus	Esophageal varices	Left gastric ↔ esophageal (drains into azygos)
2 Umbilicus	Caput medusae	Paraumbilical ↔ small epigastric veins of the anterior abdominal wall.
3 Rectum	Anorectal varices	Superior rectal ↔ middle and inferior rectal

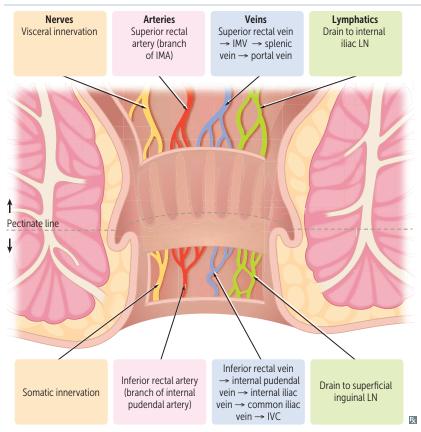
Varices of gut, butt, and caput (medusae) are commonly seen with portal hypertension.

Treatment with a transjugular intrahepatic portosystemic shunt (TIPS) between the portal vein and hepatic vein relieves portal hypertension by shunting blood to the systemic circulation, bypassing the liver. TIPS can precipitate hepatic encephalopathy due to ↓ clearance of ammonia from shunting.

FAS1_2019_09-Gastrointestinal.indd 365 11/7/19 4:42 PM

Pectinate line

Also called dentate line. Formed where endoderm (hindgut) meets ectoderm.



Above pectinate line: internal hemorrhoids, adenocarcinoma.

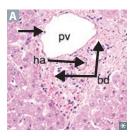
Internal hemorrhoids receive visceral innervation and are therefore **not painful**.

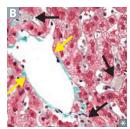
Below pectinate line: external hemorrhoids, anal fissures, squamous cell carcinoma. External hemorrhoids receive somatic innervation (inferior rectal branch of pudendal nerve) and are therefore painful if thrombosed.

Anal fissure—tear in anal mucosa below
Pectinate line. Pain while Pooping; blood
on toilet Paper. Located Posteriorly because
this area is Poorly Perfused. Innervated by
Pudendal nerve. Associated with low-fiber
diets and constipation.

FAS1_2019_09-Gastrointestinal.indd 366 11/7/19 4:42 PM

Liver tissue architecture





The functional unit of the liver is made up of hexagonally arranged lobules surrounding the central vein with portal triads on the edges (consisting of a portal vein, hepatic artery, bile ducts, as well as lymphatics) A.

Apical surface of hepatocytes faces bile canaliculi. Basolateral surface faces sinusoids. Kupffer cells (specialized macrophages) located in sinusoids (black arrows in **B**; yellow arrows show hepatic venule) clear bacteria and damaged or senescent RBCs.

Hepatic stellate (Ito) cells in space of Disse store vitamin A (when quiescent) and produce extracellular matrix (when activated). Responsible for hepatic fibrosis. Zone I—periportal zone:

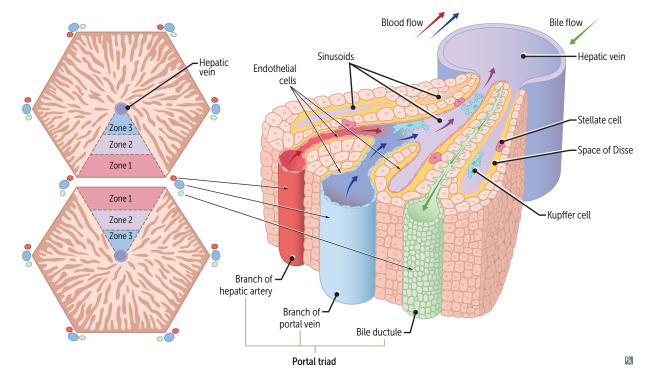
- Affected 1st by viral hepatitis
- Best oxygenated, most resistant to circulatory compromise
- Ingested toxins (eg, cocaine)

Zone II—intermediate zone:

Yellow fever

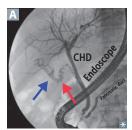
Zone III—pericentral vein (centrilobular) zone:

- Affected 1st by ischemia (least oxygenated)
- High concentration of cytochrome P-450
- Most sensitive to metabolic toxins (eg, ethanol, CCl₄, halothane, rifampin, acetaminophen)
- Site of alcoholic hepatitis



FAS1_2019_09-Gastrointestinal.indd 367 11/7/19 4:42 PM

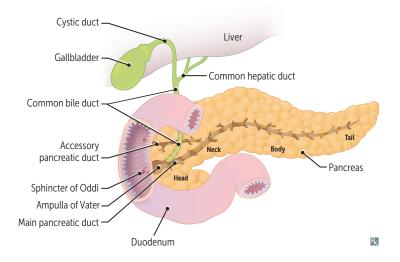
Biliary structures



Gallstones that reach the confluence of the common bile and pancreatic ducts at the ampulla of Vater can block both the common bile and pancreatic ducts (double duct sign), causing both cholangitis and pancreatitis, respectively.

Tumors that arise in head of pancreas (usually ductal adenocarcinoma) can cause obstruction of common bile duct → enlarged gallbladder with painless jaundice (Courvoisier sign).

Cholangiography shows filling defects in gallbladder (blue arrow) and cystic duct (red arrow) A.



Femoral region

ORGANIZATION

Lateral to medial: Nerve-Artery-Vein-Lymphatics.

You go from **lateral to medial** to find your **NAVeL**.

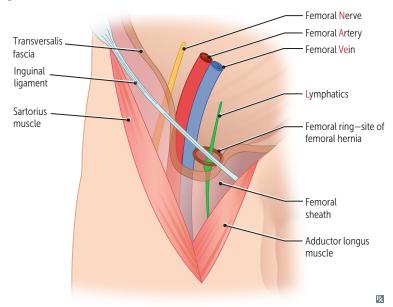
Femoral triangle

Contains femoral nerve, artery, vein.

Venous near the penis.

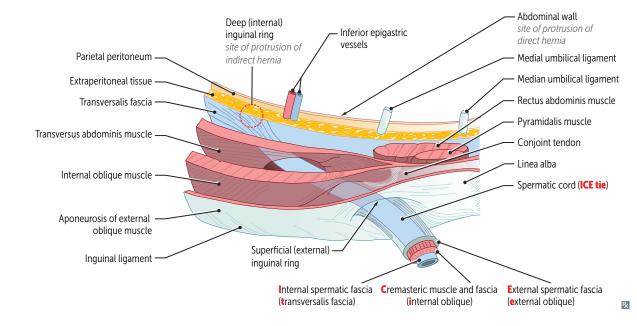
Femoral sheath

Fascial tube 3–4 cm below inguinal ligament. Contains femoral vein, artery, and canal (deep inguinal lymph nodes) but not femoral nerve.

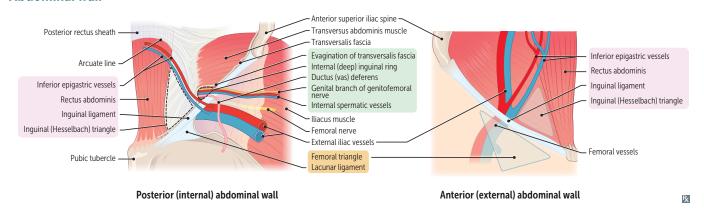


FAS1_2019_09-Gastrointestinal.indd 368 11/7/19 4:42 PM

Inguinal canal



Abdominal wall



FAS1_2019_09-Gastrointestinal.indd 369 11/7/19 4:42 PM

Hernias

Protrusion of peritoneum through an opening, usually at a site of weakness. Contents may be at risk for incarceration (not reducible back into abdomen/pelvis) and strangulation (ischemia and necrosis). Complicated hernias can present with tenderness, erythema, fever.

Diaphragmatic hernia



Abdominal structures enter the thorax A; may occur due to congenital defect of pleuroperitoneal membrane or from trauma. Commonly occurs on left side due to relative protection of right hemidiaphragm by liver. Most commonly a hiatal hernia, in which stomach herniates upward through the esophageal hiatus of the diaphragm.

Sliding hiatal hernia—gastroesophageal junction is displaced upward as gastric cardia slides into hiatus; "hourglass stomach." Most common type. Associated with GERD.

Paraesophageal hiatal hernia—

gastroesophageal junction is usually normal but gastric fundus protrudes into the thorax.

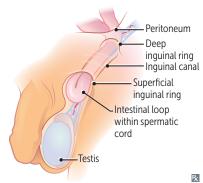


Indirect inguinal hernia



Goes through the internal (deep) inguinal ring, external (superficial) inguinal ring, and into the groin. Enters internal inguinal ring lateral to inferior epigastric vessels. Caused by failure of processus vaginalis to close (can form hydrocele). May be noticed in infants or discovered in adulthood. Much more common in males **B**.

Follows the pathway of testicular descent. Covered by all 3 layers of spermatic fascia.



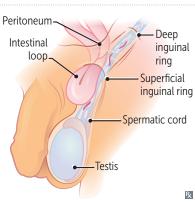
Direct inguinal hernia

Protrudes through inguinal (Hesselbach) triangle. Bulges directly through parietal peritoneum medial to the inferior epigastric vessels but lateral to the rectus abdominis. Goes through external (superficial) inguinal ring only. Covered by external spermatic fascia. Usually occurs in older men due to acquired weakness of transversalis fascia.

MDs don't LIe:

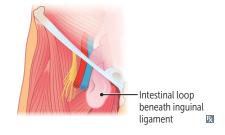
Medial to inferior epigastric vessels = Direct hernia.

Lateral to inferior epigastric vessels = Indirect hernia.



Femoral hernia

Protrudes below inguinal ligament through femoral canal below and lateral to pubic tubercle. More common in females, but overall inguinal hernias are the most common. More likely to present with incarceration or strangulation (vs inguinal hernia).



FAS1_2019_09-Gastrointestinal.indd 370 11/7/19 4:42 PM

► GASTROINTESTINAL—PHYSIOLOGY

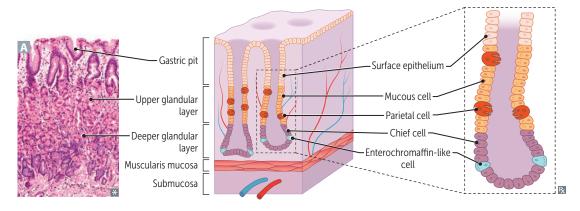
Gastrointestinal regulatory substances

REGULATORY SUBSTANCE	SOURCE	ACTION	REGULATION	NOTES	
Gastrin	G cells (antrum of stomach, duodenum)	↑ gastric H ⁺ secretion ↑ growth of gastric mucosa ↑ gastric motility	† by stomach distention/ alkalinization, amino acids, peptides, vagal stimulation via gastrin-releasing peptide (GRP) ↓ by pH < 1.5	† by chronic PPI use † in chronic atrophic gastritis (eg, <i>H pylori</i>) †† in Zollinger-Ellison syndrome (gastrinoma)	
Somatostatin	D cells (pancreatic islets, GI mucosa)	 ↓ gastric acid and pepsinogen secretion ↓ pancreatic and small intestine fluid secretion ↓ gallbladder contraction ↓ insulin and glucagon release 	↑ by acid ↓ by vagal stimulation	Inhibits secretion of various hormones (encourages somato-stasis) Octreotide is an analog used to treat acromegaly, carcinoid syndrome, and variceal bleeding	
Cholecystokinin	I cells (duodenum, jejunum)	 ↑ pancreatic secretion ↑ gallbladder contraction ↓ gastric emptying ↑ sphincter of Oddi relaxation 	the by fatty acids, amino acids	Acts on neural muscarinic pathways to cause pancreatic secretion	
Secretin	S cells (duodenum)	 ↑ pancreatic HCO₃⁻ secretion ↓ gastric acid secretion ↑ bile secretion 	the by acid, fatty acids in lumen of duodenum	† HCO ₃ ⁻ neutralizes gastric acid in duodenum, allowing pancreatic enzymes to function	
Glucose- dependent insulinotropic peptide	K cells (duodenum, jejunum)	Exocrine: ↓ gastric H ⁺ secretion Endocrine: ↑ insulin release	the by fatty acids, amino acids, oral glucose	Also called gastric inhibitory peptide (GIP) Oral glucose load † insulin compared to IV equivalent due to GIP secretion	
Motilin	Small intestine	Produces migrating motor complexes (MMCs)	† in fasting state	Motilin receptor agonists (eg, erythromycin) are used to stimulate intestinal peristalsis.	
Vasoactive intestinal polypeptide	Parasympathetic ganglia in sphincters, gallbladder, small intestine	 intestinal water and electrolyte secretion relaxation of intestinal smooth muscle and sphincters 	↑ by distention and vagal stimulation ↓ by adrenergic input	VIPoma—non-α, non-β islet cell pancreatic tumor that secretes VIP; associated with Watery Diarrhea, Hypokalemia, Achlorhydria (WDHA syndrome)	
Nitric oxide		† smooth muscle relaxation, including lower esophageal sphincter (LES)		Loss of NO secretion is implicated in † LES tone of achalasia	
Ghrelin	Stomach	† appetite ("ghrowlin' stomach")	↑ in fasting state ↓ by food	↑ in Prader-Willi syndrome ↓ after gastric bypass surgery	

FAS1_2019_09-Gastrointestinal.indd 371 11/7/19 4:42 PM

Gastrointestinal secretory products

PRODUCT	SOURCE	ACTION	REGULATION	NOTES
Intrinsic factor	Parietal cells (stomach A)	Vitamin B ₁₂ -binding protein (required for B ₁₂ uptake in terminal ileum)		Autoimmune destruction of parietal cells → chronic gastritis and pernicious anemia.
Gastric acid	Parietal cells (stomach)	↓ stomach pH	↑ by histamine, vagal stimulation (ACh), gastrin ↓ by somatostatin, GIP, prostaglandin, secretin	
Pepsin	Chief cells (stomach)	Protein digestion	† by vagal stimulation (ACh), local acid	Pepsinogen (inactive) is converted to pepsin (active) in the presence of H ⁺ .
Bicarbonate	Mucosal cells (stomach, duodenum, salivary glands, pancreas) and Brunner glands (duodenum)	Neutralizes acid	† by pancreatic and biliary secretion with secretin	Trapped in mucus that covers the gastric epithelium.



FAS1_2019_09-Gastrointestinal.indd 372 11/7/19 4:42 PM

Ŗ

Locations of gastrointestinal secretory cells Vagus nerve Fundus Cardia ACh Parietal cells HCl⊲ **Intrinsic**◀ ACh D cells Pyloric ACh sphincter Histamine Pepsinogen CCK Antrum I cells

Secretin

Duodenum

GIP

Gastrin † acid secretion primarily through its effects on enterochromaffin-like (ECL) cells (leading to histamine release) rather than through its direct effect on parietal cells.

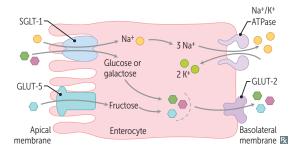
Mucous cells GRP

G cells

→ Gastrin (to circulation)

ENZYME	ROLE	NOTES
α -amylase	Starch digestion	Secreted in active form
Lipases	Fat digestion	
Proteases	Protein digestion	Includes trypsin, chymotrypsin, elastase, carboxypeptidases Secreted as proenzymes also called zymogen
Trypsinogen	Converted to active enzyme trypsin → activation of other proenzymes and cleaving of additional trypsinogen molecules into active trypsin (positive feedback loop)	Converted to trypsin by enterokinase/ enteropeptidase, a brush-border enzyme on duodenal and jejunal mucosa

Carbohydrate absorption



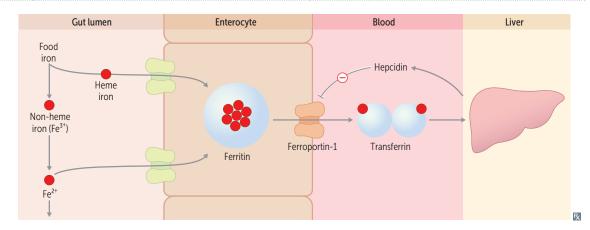
Only monosaccharides (glucose, galactose, fructose) are absorbed by enterocytes. Glucose and galactose are taken up by SGLT1 (Na⁺ dependent). Fructose is taken up via Facilitated diffusion by GLUT5. All are transported to blood by GLUT2.

D-xylose absorption test: simple sugar that requires intact mucosa for absorption, but does not require digestive enzymes. Helps distinguish GI mucosal damage from other causes of malabsorption.

FAS1_2019_09-Gastrointestinal.indd 373 11/7/19 4:42 PM

Vitamin and mineral absorption

Iron	Absorbed as Fe ²⁺ in duodenum	Iron Fist, Bro
Folate	Absorbed in small bowel	Clinically relevant in patients with small bowel
Vitamin B ₁₂	Absorbed in terminal ileum along with bile salts, requires intrinsic factor	disease or after resection (eg, vitamin B_{12} deficiency following terminal ileum resection)



Peyer patches



Unencapsulated lymphoid tissue A found in lamina propria and submucosa of ileum.
Contain specialized M cells that sample and present antigens to immune cells.

B cells stimulated in germinal centers of Peyer patches differentiate into IgA-secreting plasma cells, which ultimately reside in lamina propria. IgA receives protective secretory component and is then transported across the epithelium to the gut to deal with intraluminal antigen.

Think of **IgA**, the **I**ntra-**g**ut **A**ntibody

Bile

Composed of bile salts (bile acids conjugated to glycine or taurine, making them water soluble), phospholipids, cholesterol, bilirubin, water, and ions. Cholesterol 7α -hydroxylase catalyzes rate-limiting step of bile acid synthesis.

Functions:

- Digestion and absorption of lipids and fatsoluble vitamins
- Cholesterol excretion (body's l° means of eliminating cholesterol)
- Antimicrobial activity (via membrane disruption)

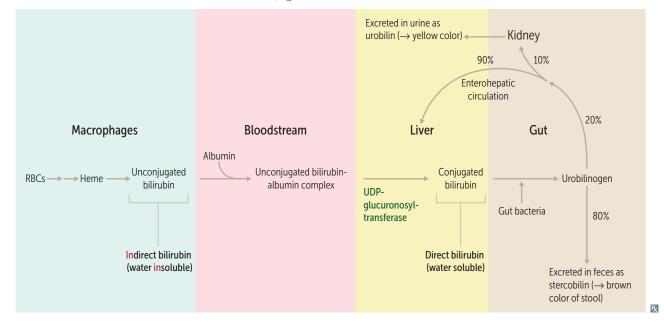
- ↓ absorption of enteric bile salts at distal ileum (as in short bowel syndrome, Crohn disease) prevents normal fat absorption
- Calcium, which normally binds oxalate, binds fat instead, so free oxalate is absorbed by gut
- → ↑ frequency of calcium oxalate kidney stones

FAS1_2019_09-Gastrointestinal.indd 374 11/7/19 4:42 PM

Bilirubin

Heme is metabolized by heme oxygenase to biliverdin, which is subsequently reduced to bilirubin. Unconjugated bilirubin is removed from blood by liver, conjugated with glucuronate, and excreted in bile.

Direct bilirubin: conjugated with glucuronic acid; water soluble (dissolves in water). Indirect bilirubin: unconjugated; water insoluble.



FAS1_2019_09-Gastrointestinal.indd 375 11/7/19 4:42 PM

► GASTROINTESTINAL—PATHOLOGY

Sialolithiasis



Stone(s) in salivary gland duct A. Can occur in 3 major salivary glands (parotid, submandibular, sublingual). Single stone more common in submandibular gland (Wharton duct).

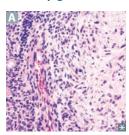
Presents as recurrent pre-/periprandial pain and swelling in affected gland.

Caused by dehydration or trauma.

Treat conservatively with NSAIDs, gland massage, warm compresses, sour candies (to promote salivary flow).

Sialadenitis—inflammation of salivary gland due to obstruction, infection, or immune-mediated mechanisms.

Salivary gland tumors



Most are benign and commonly affect parotid gland (80-85%). Nearly half of all submandibular gland neoplasms and most sublingual and minor salivary gland tumors are malignant. Typically present as painless mass/swelling. Facial paralysis or pain suggests malignant involvement.

- Pleomorphic adenoma (benign mixed tumor)—most common salivary gland tumor A.
 Composed of chondromyxoid stroma and epithelium and recurs if incompletely excised or ruptured intraoperatively. May undergo malignant transformation.
- Mucoepidermoid carcinoma—most common malignant tumor, has mucinous and squamous components.
- Warthin tumor (papillary cystadenoma lymphomatosum)—benign cystic tumor with germinal centers. Typically found in smokers. Bilateral in 10%; multifocal in 10%. "Warriors from Germany love smoking."

Achalasia



Failure of LES to relax due to degeneration of inhibitory neurons (containing NO and VIP) in the myenteric (Auerbach) plexus of the esophageal wall.

Manometry findings include uncoordinated or absent peristalsis with high LES resting pressure → progressive dysphagia to solids and liquids (vs obstruction—solids only). Barium swallow shows dilated esophagus with an area of distal stenosis ("bird's beak" A).

Associated with ↑ risk of esophageal cancer.

A-chalasia = absence of relaxation.

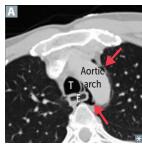
2° achalasia (pseudoachalasia) may arise from Chagas disease (*T cruzi* infection) or extraesophageal malignancies (mass effect or paraneoplastic).

Chagas disease can cause achalasia.

FAS1 2019 09-Gastrointestinal indd 376 11/7/19 4:42 PM

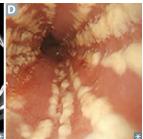
Esophageal pathologies

Diffuse esophageal spasm	Spontaneous, nonperistaltic (uncoordinated) contractions of the esophagus with normal LES pressure. Presents with dysphagia and angina-like chest pain. Barium swallow reveals "corkscrew" esophagus. Manometry is diagnostic. Treatment includes nitrates and CCBs.
Eosinophilic esophagitis	Infiltration of eosinophils in the esophagus often in atopic patients. Food allergens → dysphagia, food impaction. Esophageal rings and linear furrows often seen on endoscopy. Typically unresponsive to GERD therapy.
Esophageal perforation	Most commonly iatrogenic following esophageal instrumentation. Noniatrogenic causes include spontaneous rupture, foreign body ingestion, trauma, malignancy. May present with pneumomediastinum (arrows in A). Subcutaneous emphysema may be due to dissecting air (signs include crepitus in the neck region or chest wall). Boerhaave syndrome—transmural, usually distal esophageal rupture due to violent retching.
Esophageal strictures	Associated with caustic ingestion, acid reflux, and esophagitis.
Esophageal varices	Dilated submucosal veins (red arrows in B C) in lower 1/3 of esophagus 2° to portal hypertension. Common in cirrhotics, may be source of life-threatening hematemesis.
Esophagitis	Associated with reflux, infection in immunocompromised (<i>Candida</i> : white pseudomembrane D; HSV-1: punched-out ulcers; CMV: linear ulcers), caustic ingestion, or pill-induced esophagitis (eg, bisphosphonates, tetracycline, NSAIDs, iron, and potassium chloride).
Gastroesophageal reflux disease	Commonly presents as heartburn, regurgitation, dysphagia. May also present as chronic cough, hoarseness (laryngopharyngeal reflux). Associated with asthma. Transient decreases in LES tone.
Ma <mark>ll</mark> ory-Weiss syndrome	Partial thickness, longitudinal lacerations of gastroesophageal junction, confined to mucosa/ submucosa, due to severe vomiting. Often presents with hematemesis. Usually found in alcoholics and bulimics.
Plummer-Vinson syndrome	Triad of Dysphagia, Iron deficiency anemia, Esophageal webs. † risk of esophageal Squamous cell carcinoma ("Plumber DIES"). May be associated with glossitis.
Schatzki rings	Rings formed at gastroesophageal junction, typically due to chronic acid reflux. Can present with dysphagia.
Sclerodermal esophageal dysmotility	Esophageal smooth muscle atrophy → ↓ LES pressure and dysmotility → acid reflux and dysphagia → stricture, Barrett esophagus, and aspiration. Part of CREST syndrome.



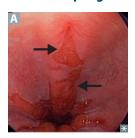




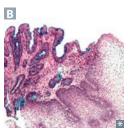


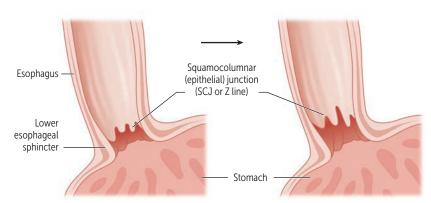
FAS1_2019_09-Gastrointestinal.indd 377 11/7/19 4:42 PM

Barrett esophagus



Specialized intestinal metaplasia A—replacement of nonkeratinized stratified squamous epithelium with intestinal epithelium (nonciliated columnar with goblet cells [stained blue in B]) in distal esophagus. Due to chronic gastroesophageal reflux disease (GERD). Associated with † risk of esophageal adenocarcinoma.





Esophageal cancer

Typically presents with progressive dysphagia (first solids, then liquids) and weight loss. Aggressive course due to lack of serosa in esophageal wall, allowing rapid extension. Poor prognosis due to advanced disease at presentation.

CANCER	PART OF ESOPHAGUS AFFECTED	RISK FACTORS	PREVALENCE
Squamous cell carcinoma	Upper 2/3	Alcohol, hot liquids, caustic strictures, smoking, achalasia	More common worldwide
Adenocarcinoma	Lower 1/3	Chronic GERD, Barrett esophagus, obesity, smoking, achalasia	More common in America

FAS1_2019_09-Gastrointestinal.indd 378 11/7/19 4:42 PM

Gastritis

Acute gastritis Erosions can be caused by: Especially common among alcoholics and NSAIDs—↓ PGE₂ → ↓ gastric mucosa patients taking daily NSAIDs (eg, patients with rheumatoid arthritis) protection Burns (Curling ulcer)—hypovolemia Burned by the Curling iron → mucosal ischemia Brain injury (Cushing ulcer)—† vagal Always Cushion the brain stimulation → ↑ ACh → ↑ H⁺ production Mucosal inflammation, often leading to atrophy **Chronic gastritis** (hypochlorhydria → hypergastrinemia) and intestinal metaplasia († risk of gastric cancers) H pylori Most common. † risk of peptic ulcer disease, Affects antrum first and spreads to body of MALT lymphoma stomach **Autoimmune** Autoantibodies to the H+/K+ ATPase on parietal Affects body/fundus of stomach cells and to intrinsic factor. † risk of pernicious anemia

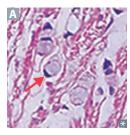
Ménétrier disease



Hyperplasia of gastric mucosa → hypertrophied rugae (look like brain gyri 🖪). Causes excess mucus production with resultant protein loss and parietal cell atrophy with ↓ acid production. Precancerous

Presents with Weight loss, Anorexia, Vomiting, Epigastric pain, Edema (due to protein loss) (WAVEE).

Gastric cancer



Most commonly gastric adenocarcinoma; lymphoma, GI stromal tumor, carcinoid (rare). Early aggressive local spread with node/liver metastases. Often presents late, with weight loss, abdominal pain, early satiety, and in some cases acanthosis nigricans or Leser-Trélat sign. Associated with blood type A.

- Intestinal—associated with H pylori, dietary nitrosamines (smoked foods), tobacco smoking, achlorhydria, chronic gastritis. Commonly on lesser curvature; looks like ulcer with raised margins.
- Diffuse—not associated with *H pylori*; most cases due to E-cadherin mutation; signet ring cells (mucin-filled cells with peripheral nuclei) A; stomach wall grossly thickened and leathery (linitis plastica).

Virchow node—involvement of left supraclavicular node by metastasis from stomach.

Krukenberg tumor—bilateral metastases to ovaries. Abundant mucin-secreting, signet ring cells.

Sister Mary Joseph nodule—subcutaneous periumbilical metastasis.

Blumer shelf—palpable mass on digital rectal exam suggesting metastasis to rectouterine pouch (pouch of Douglas).

FAS1_2019_09-Gastrointestinal.indd 379 11/7/19 4:42 PM

380

SECTION III

GASTROINTESTINAL ► GASTROINTESTINAL—PATHOLOGY

Peptic ulcer disease

	Gastric ulcer	Duodenal ulcer
PAIN	Can be Greater with meals—weight loss	Decreases with meals—weight gain
<i>H PYLORI</i> INFECTION	~ 70%	~ 90%
MECHANISM	↓ mucosal protection against gastric acid	↓ mucosal protection or ↑ gastric acid secretion
OTHER CAUSES	NSAIDs	Zollinger-Ellison syndrome
RISK OF CARCINOMA	†	Generally benign
OTHER	Biopsy margins to rule out malignancy	

Ulcer complications

Hemorrhage	Gastric, duodenal (posterior > anterior). Most common complication. Ruptured gastric ulcer on the lesser curvature of stomach → bleeding from left gastric artery. An ulcer on the posterior wall of duodenum → bleeding from gastroduodenal artery.
Obstruction	Pyloric channel, duodenal.
Perforation	Duodenal (anterior > posterior).



Anterior duodenal ulcers can perforate into the anterior abdominal cavity, potentially leading to pneumoperitoneum.

May see free air under diaphragm (pneumoperitoneum) A with referred pain to the shoulder via irritation of phrenic nerve.

FAS1_2019_09-Gastrointestinal.indd 380 11/7/19 4:42 PM

Malabsorption

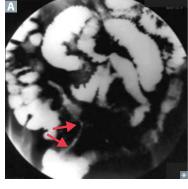
Can cause diarrhea, steatorrhea, weight loss, weakness, vitamin and mineral deficiencies. Screen for

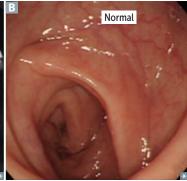
syndromes fecal fat (eg, Sudan stain). Celiac disease Gluten-sensitive enteropathy, celiac sprue. ↓ mucosal absorption primarily affects distal Autoimmune-mediated intolerance of duodenum and/or proximal jejunum. gliadin (gluten protein found in wheat) D-xylose test: passively absorbed in proximal → malabsorption and steatorrhea. Associated small intestine; blood and urine levels ↓ with with HLA-DQ2, HLA-DQ8, northern mucosa defects or bacterial overgrowth, European descent, dermatitis herpetiformis, normal in pancreatic insufficiency. ↓ bone density. Treatment: gluten-free diet. Findings: IgA anti-tissue transglutaminase (IgA tTG), anti-endomysial, anti-deamidated gliadin peptide antibodies; villous atrophy, crypt hyperplasia A, and intraepithelial lymphocytosis. Moderately † risk of malignancy (eg, T-cell lymphoma). Lactose intolerance Lactase deficiency. Normal-appearing villi, Lactose hydrogen breath test: ⊕ for lactose except when 2° to injury at tips of villi (eg, viral malabsorption if post-lactose breath hydrogen enteritis). Osmotic diarrhea with ↓ stool pH value rises > 20 ppm compared with baseline. (colonic bacteria ferment lactose). **Pancreatic** Due to chronic pancreatitis, cystic fibrosis, ↓ duodenal bicarbonate (and pH) and fecal insufficiency obstructing cancer. Causes malabsorption of elastase. fat and fat-soluble vitamins (A, D, E, K) as well as vitamin B_{12} . **Tropical sprue** Similar findings as celiac sprue (affects small ↓ mucosal absorption affecting duodenum and bowel), but responds to antibiotics. Cause is jejunum but can involve ileum with time. unknown, but seen in residents of or recent Associated with megaloblastic anemia due to visitors to tropics. folate deficiency and, later, B₁₂ deficiency. Infection with Tropheryma whipplei PAS the foamy Whipped cream in a CAN. Whipple disease (intracellular gram ⊕); PAS ⊕ foamy macrophages in intestinal lamina propria B, mesenteric nodes. Cardiac symptoms, Arthralgias, and Neurologic symptoms are common. Diarrhea/steatorrhea occur later in disease course. Most common in older men.

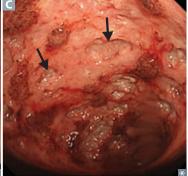
FAS1_2019_09-Gastrointestinal.indd 381 11/7/19 4:42 PM

Inflammatory bowel diseases

	Crohn disease	Ulcerative colitis	
LOCATION	Any portion of the GI tract, usually the terminal ileum and colon. Skip lesions, rectal sparing.	Colitis = colon inflammation. Continuous colonic lesions, always with rectal involvement.	
GROSS MORPHOLOGY	Transmural inflammation → fistulas. Cobblestone mucosa, creeping fat, bowel wall thickening ("string sign" on barium swallow x-ray A), linear ulcers, fissures.	Mucosal and submucosal inflammation only. Friable mucosa with superficial and/or deep ulcerations (compare normal with diseased Loss of haustra → "lead pipe" appearance on imaging.	
MICROSCOPIC MORPHOLOGY	Noncaseating granulomas and lymphoid aggregates. Th1 mediated.	Crypt abscesses and ulcers, bleeding, no granulomas. Th2 mediated.	
COMPLICATIONS	Malabsorption/malnutrition, colorectal cancer (†	risk with pancolitis).	
	Fistulas (eg, enterovesical fistulae, which can cause recurrent UTI and pneumaturia), phlegmon/abscess, strictures (causing obstruction), perianal disease.	Fulminant colitis, toxic megacolon, perforation.	
INTESTINAL MANIFESTATION	Diarrhea that may or may not be bloody.	Bloody diarrhea.	
EXTRAINTESTINAL MANIFESTATIONS	Rash (pyoderma gangrenosum, erythema nodosum), eye inflammation (episcleritis, uveitis), oral ulcerations (aphthous stomatitis), arthritis (peripheral, spondylitis).		
	Kidney stones (usually calcium oxalate), gallstones. May be ⊕ for anti-Saccharomyces cerevisiae antibodies (ASCA).	l° sclerosing cholangitis. Associated with p-ANCA.	
TREATMENT	Corticosteroids, azathioprine, antibiotics (eg, ciprofloxacin, metronidazole), biologics (eg, infliximab, adalimumab).	5-aminosalicylic preparations (eg, mesalamine), 6-mercaptopurine, infliximab, colectomy.	
	For Crohn, think of a fat granny and an old crone skipping down a cobblestone road away from the wreck (rectal sparing). Stones are more common in Crohns.	Ulcers Ulcers Large intestine Continuous, Colorectal carcinoma, Crypt abscesses Extends proximally Red diarrhea Sclerosing cholangitis	







FAS1_2019_09-Gastrointestinal.indd 382 11/7/19 4:42 PM

Irritable bowel syndrome

Recurrent abdominal pain associated with ≥ 2 of the following:

- Related to defecation
- Change in stool frequency
- Change in form (consistency) of stool

No structural abnormalities. Most common in middle-aged women. Chronic symptoms may be diarrhea-predominant, constipation-predominant, or mixed. Pathophysiology is multifaceted. First-line treatment is lifestyle modification and dietary changes.

Appendicitis



Acute inflammation of the appendix (yellow arrows in A), can be due to obstruction by fecalith (red arrow in A) (in adults) or lymphoid hyperplasia (in children).

Proximal obstruction of appendiceal lumen produces closed-loop obstruction → ↑ intraluminal pressure → stimulation of visceral afferent nerve fibers at T8-T10 → initial diffuse periumbilical pain → inflammation extends to serosa and irritates parietal peritoneum. Pain localized to RLQ/ McBurney point (1/3 the distance from right anterior superior iliac spine to umbilicus). Nausea, fever; may perforate → peritonitis; may elicit psoas, obturator, and Rovsing signs, guarding and rebound tenderness on exam.

Differential: diverticulitis (elderly), ectopic pregnancy (use hCG to rule out), pseudoappendicitis. Treatment: appendectomy.

Diverticula of the GI tract

Diverticula of the o	itiact	
Diverticulum	Blind pouch A protruding from the alimentary tract that communicates with the lumen of the gut. Most diverticula (esophagus, stomach, duodenum, colon) are acquired and are termed "false diverticula."	"True" diverticulum—all gut wall layers outpouch (eg, Meckel). "False" diverticulum or pseudodiverticulum—only mucosa and submucosa outpouch. Occur especially where vasa recta perforate muscularis externa.
Diverticulosis	Many false diverticula of the colon B , commonly sigmoid. Common (in ~ 50% of people > 60 years). Caused by † intraluminal pressure and focal weakness in colonic wall. Associated with obesity and diets low in fiber, high in total fat/red meat.	Often asymptomatic or associated with vague discomfort. Complications include diverticular bleeding (painless hematochezia), diverticulitis.
Diverticulitis	Inflammation of diverticula with wall thickening (red arrows in () classically causing LLQ pain, fever, leukocytosis. Treat with antibiotics.	Complications: abscess, fistula (colovesical fistula → pneumaturia), obstruction (inflammatory stenosis), perforation (white arrows in (→ peritonitis).
	A	<u> </u>



FAS1_2019_09-Gastrointestinal.indd 383 11/7/19 4:42 PM

Zenker diverticulum



Pharyngoesophageal **false** diverticulum A. Esophageal dysmotility causes herniation of mucosal tissue at Killian triangle between the thyropharyngeal and cricopharyngeal parts of the inferior pharyngeal constrictor. Presenting symptoms: dysphagia, obstruction, gurgling, aspiration, foul breath, neck mass. Most common in elderly males.

Elder MIKE has bad breath:

Elderly

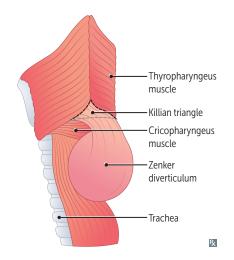
Males

Inferior pharyngeal constrictor

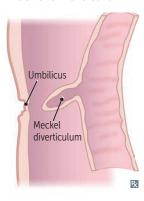
Killian triangle

Esophageal dysmotility

Halitosis



Meckel diverticulum



True diverticulum. Persistence of the vitelline (omphalomesenteric) duct. May contain ectopic acid–secreting gastric mucosa and/or pancreatic tissue. Most common congenital anomaly of GI tract. Can cause hematochezia/melena (less common), RLQ pain, intussusception, volvulus, or obstruction near terminal ileum.

Contrast with omphalomesenteric cyst = cystic dilation of vitelline duct.

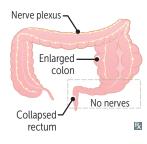
Diagnosis: ^{99m}Tc-pertechnetate scan (aka Meckel scan) for uptake by heterotopic gastric mucosa.

The rule of 2's:

- 2 times as likely in males.
- 2 inches long.
- 2 feet from the ileocecal valve.
- 2% of population.

Commonly presents in first 2 years of life. May have 2 types of epithelia (gastric/pancreatic).

Hirschsprung disease



Congenital megacolon characterized by lack of ganglion cells/enteric nervous plexuses (Auerbach and Meissner plexuses) in distal segment of colon. Due to failure of neural crest cell migration. Associated with loss of function mutations in *RET*.

Presents with bilious emesis, abdominal distention, and failure to pass meconium within 48 hours → chronic constipation.

Normal portion of the colon proximal to the aganglionic segment is dilated, resulting in a "transition zone."

Risk † with Down syndrome.

Explosive expulsion of feces (squirt sign)

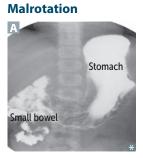
→ empty rectum on digital exam.

Diagnosed by absence of ganglionic cells on rectal suction biopsy.

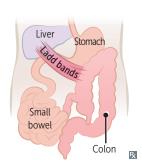
Treatment: resection.

RET mutation in the **REcT**um.

FAS1_2019_09-Gastrointestinal.indd 384 11/7/19 4:42 PM



Anomaly of midgut rotation during fetal development → improper positioning of bowel (small bowel clumped on the right side) A, formation of fibrous bands (Ladd bands). Can lead to volvulus, duodenal obstruction.



Intussusception



Telescoping A of proximal bowel segment into a distal segment, commonly at the ileocecal junction. Most commonly idiopathic, but may be due to lead point.

Compromised blood supply → intermittent, severe, abdominal pain often with "currant jelly" dark red stools.

Majority of cases in infants, unusual in adults. Most common pathologic lead point:

- Children—Meckel diverticulum
- Adults—intraluminal mass/tumor

On physical exam, patient may draw their legs to chest to ease pain, sausage shaped mass on palpation.

Imaging—Ultrasound/CT may show "target sign." B

May be associated with IgA vasculitis (HSP), recent viral infection (eg, adenovirus; Peyer patch hypertrophy creates lead point).

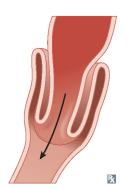
FAS1_2019_09-Gastrointestinal.indd 385 11/7/19 4:42 PM

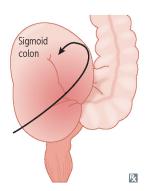
Volvulus



Twisting of portion of bowel around its mesentery; can lead to obstruction and infarction. Can occur throughout the GI tract.

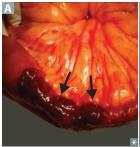
- Midgut volvulus more common in infants and children (minors)
- Sigmoid volvulus (coffee bean sign on x-ray
 A) more common in seniors (elderly)





Other intestinal disorders

Acute mesenteric ischemia	Critical blockage of intestinal blood flow (often embolic occlusion of SMA) → small bowel necrosis A → abdominal pain out of proportion to physical findings. May see red "currant jelly" stools.
Adhesion	Fibrous band of scar tissue; commonly forms after surgery. Most common cause of small bowel obstruction, demonstrated by multiple dilated small bowel loops on x-ray (arrows in B).
Angiodysplasia	Tortuous dilation of vessels → hematochezia. Most often found in the right-sided colon. More common in older patients. Confirmed by angiography. Associated with end-stage renal disease, von Willebrand disease, aortic stenosis.
Chronic mesenteric ischemia	"Intestinal angina": atherosclerosis of celiac artery, SMA, or IMA → intestinal hypoperfusion → postprandial epigastric pain → food aversion and weight loss.
Colonic ischemia	Reduction in intestinal blood flow causes ischemia. Crampy abdominal pain followed by hematochezia. Commonly occurs at watershed areas (splenic flexure, rectosigmoid junction). Typically affects elderly. Thumbprint sign on imaging due to mucosal edema/hemorrhage.
lleus	Intestinal hypomotility without obstruction → constipation and ↓ flatus; distended/tympanic abdomen with ↓ bowel sounds. Associated with abdominal surgeries, opiates, hypokalemia, sepsis. Treatment: bowel rest, electrolyte correction, cholinergic drugs (stimulate intestinal motility).
Meconium ileus	Meconium plug obstructs intestine, prevents stool passage at birth. Associated with cystic fibrosis.
Necrotizing enterocolitis	Seen in premature, formula-fed infants with immature immune system. Necrosis of intestinal mucosa (most commonly terminal ileum and proximal colon) with possible perforation, which can lead to pneumatosis intestinalis (arrows in D), pneumoperitoneum, portal venous gas.



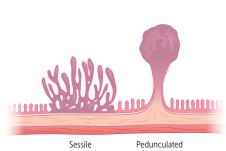


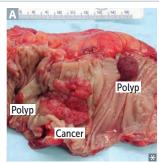


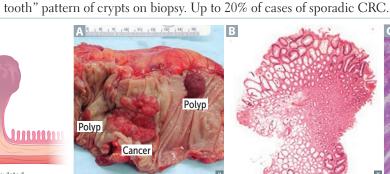


FAS1_2019_09-Gastrointestinal.indd 386 11/7/19 4:42 PM

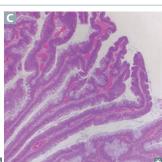
Colonic polyps	Growths of tissue within the colon A. Grossly characterized as flat, sessile, or pedunculated on the basis of protrusion into colonic lumen. Generally classified by histologic type.
HISTOLOGIC TYPE	CHARACTERISTICS
Generally non-neoplast	ic
Hamartomatous polyps	Solitary lesions do not have significant risk of transformation. Growths of normal colonic tissue with distorted architecture. Associated with Peutz-Jeghers syndrome and juvenile polyposis.
Hyperplastic polyps	Most common; generally smaller and predominantly located in rectosigmoid region. Occasionally evolves into serrated polyps and more advanced lesions.
Inflammatory pseudopolyps	Due to mucosal erosion in inflammatory bowel disease.
Mucosal polyps	Small, usually < 5 mm. Look similar to normal mucosa. Clinically insignificant.
Submucosal polyps	May include lipomas, leiomyomas, fibromas, and other lesions.
Malignant potential	
Adenomatous polyps	Neoplastic, via chromosomal instability pathway with mutations in <i>APC</i> and <i>KRAS</i> . Tubular bistology has less malignant potential than villous ("villous histology is villainous"); tubulovillous has intermediate malignant potential. Usually asymptomatic; may present with occult bleeding.
Serrated polyps	Neoplastic. Characterized by CpG island methylator phenotype (CIMP; cytosine base followed by guanine, linked by a phosphodiester bond). Defect may silence MMR gene (DNA mismatch







repair) expression. Mutations lead to microsatellite instability and mutations in BRAF. "Saw-



Polyposis syndromes

Familial adenomatous polyposis	Autosomal dominant mutation of <i>APC</i> tumor suppressor gene on chromosome 5q22. 2-hit hypothesis. Thousands of polyps arise starting after puberty; pancolonic; always involves rectum. Prophylactic colectomy or else 100% progress to CRC.
Gardner syndrome	FAP + osseous and soft tissue tumors (eg, osteomas of skull or mandible), congenital hypertrophy of retinal pigment epithelium, impacted/supernumerary teeth.
Turcot syndrome	FAP or Lynch syndrome + malignant CNS tumor (eg, medulloblastoma, glioma). Tur cot = Tur ban.
Peutz-Jeghers syndrome	Autosomal dominant syndrome featuring numerous hamartomas throughout GI tract, along with hyperpigmented macules on mouth, lips, hands, genitalia. Associated with † risk of breast and GI cancers (eg, colorectal, stomach, small bowel, pancreatic).
Juvenile polyposis syndrome	Autosomal dominant syndrome in children (typically < 5 years old) featuring numerous hamartomatous polyps in the colon, stomach, small bowel. Associated with † risk of CRC.

FAS1_2019_09-Gastrointestinal.indd 387 11/7/19 4:42 PM **SECTION III**

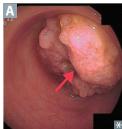
GASTROINTESTINAL → GASTROINTESTINAL—PATHOLOGY

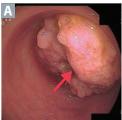
Lynch syndrome

Previously called hereditary nonpolyposis colorectal cancer (HNPCC). Autosomal dominant mutation of mismatch repair genes (eg, MLH1, MSH2) with subsequent microsatellite instability. ~ 80% progress to CRC. Proximal colon is always involved. Associated with endometrial, ovarian, and skin cancers.

Colorectal cancer

DIAGNOSIS







Iron deficiency anemia in males (especially > 50 years old) and postmenopausal females raises suspicion.

Screening:

- Low risk: screen at age 50 with colonoscopy (polyp seen in A); alternatives include flexible sigmoidoscopy, fecal occult blood testing (FOBT), fecal immunochemical testing (FIT), FIT-fecal DNA, CT colonography
- Patients with a first-degree relative who has colon cancer: screen at age 40 with colonoscopy, or 10 years prior to the relative's presentation
- Patients with IBD: distinct screening protocol

"Apple core" lesion seen on barium enema x-ray B.

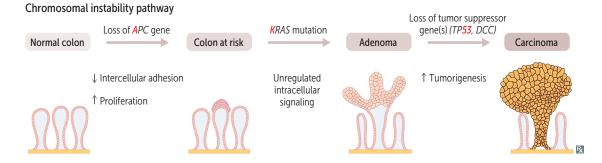
CEA tumor marker: good for monitoring recurrence, should not be used for screening.

EPIDEMIOLOGY Most patients are > 50 years old. $\sim 25\%$ have a family history.	
PRESENTATION	Rectosigmoid > ascending > descending.
	Right side (cecal, ascending) associated with occult bleeding; left side (rectosigmoid) associated
	with hematochezia and obstruction (narrower lumen).
	Ascending—exophytic mass, iron deficiency anemia, weight loss.
	Descending—infiltrating mass, partial obstruction, colicky pain, hematochezia.
	Can present with S bovis (gallolyticus) bacteremia/endocarditis or as an episode of diverticulitis.
RISK FACTORS	Adenomatous and serrated polyps, familial cancer syndromes, IBD, tobacco use, diet of processed meat with low fiber.

FAS1_2019_09-Gastrointestinal.indd 388 11/7/19 4:42 PM Molecular pathogenesis of colorectal cancer Chromosomal instability pathway: mutations in APC cause FAP and most sporadic cases of CRC via adenoma-carcinoma sequence; (firing order of events is "AK-53").

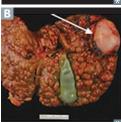
Microsatellite instability pathway: mutations or methylation of mismatch repair genes (eg, MLH1) cause Lynch syndrome and some sporadic CRC (via serrated polyp pathway).

Overexpression of COX-2 has been linked to colorectal cancer, NSAIDs may be chemopreventive.



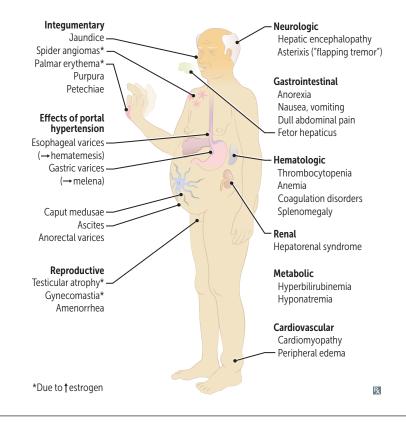
Cirrhosis and portal hypertension





Cirrhosis—diffuse bridging fibrosis (via stellate cells) and regenerative nodules (red arrows in A; white arrows show splenomegaly) disrupt normal architecture of liver; † risk for hepatocellular carcinoma (white arrow in B). Etiologies include alcohol, nonalcoholic steatohepatitis, chronic viral hepatitis, autoimmune hepatitis, biliary disease, genetic/metabolic disorders.

Portal hypertension—† pressure in portal venous system. Etiologies include cirrhosis (most common cause in Western countries), vascular obstruction (eg, portal vein thrombosis, Budd-Chiari syndrome), schistosomiasis.



FAS1 2019 09-Gastrointestinal.indd 389 11/7/19 4:42 PM

Spontaneous bacterial peritonitis

Also called 1° bacterial peritonitis. Common and potentially fatal bacterial infection in patients with cirrhosis and ascites. Often asymptomatic, but can cause fevers, chills, abdominal pain, ileus, or worsening encephalopathy. Commonly caused by gram \ominus organisms (eg, E coli, Klebsiella) or less commonly gram \oplus Streptococcus.

Diagnosis: paracentesis with ascitic fluid absolute neutrophil count (ANC) > 250 cells/mm³. Empiric first-line treatment is 3rd generation cephalosporin (eg, cefotaxime).

_		4	and the second second
Seriim	markers	of liver	pathology
JCIGIII	III al IXCI 3		putilology

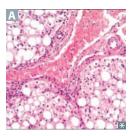
ENZYMES RELEASED IN LIVER DAMAGE			
Aspartate aminotransferase and alanine aminotransferase	† in most liver disease: ALT > AST † in alcoholic liver disease: AST > ALT (AST usually will not exceed 500 U/L in alcoholic hepatitis) AST > ALT in nonalcoholic liver disease suggests progression to advanced fibrosis or cirrhosis ††† aminotransferases (>1000 U/L): differential includes drug-induced liver injury (eg, acetaminophen toxicity), ischemic hepatitis, acute viral hepatitis, autoimmune hepatitis		
Alkaline phosphatase	† in cholestasis (eg, biliary obstruction), infiltrativ	ve disorders, bone disease	
γ-glutamyl transpeptidase FUNCTIONAL LIVER MARKERS	† in various liver and biliary diseases (just as ALP can), but not in bone disease; associated with alcohol use		
Bilirubin	† in various liver diseases (eg, biliary obstruction, alcoholic or viral hepatitis, cirrhosis), hemolysis		
Albumin	↓ in advanced liver disease (marker of liver's biosynthetic function)		
Prothrombin time	† in advanced liver disease (‡ production of clotting factors, thereby measuring the liver's biosynthetic function)		
Platelets	↓ in advanced liver disease (↓ thrombopoietin, liver sequestration) and portal hypertension (splenomegaly/splenic sequestration)		
Reye syndrome	Rare, often fatal childhood hepatic encephalopathy. Associated with viral infection (especially VZV and influenza) that has been treated with aspirin. Aspirin metabolites ↓ β-oxidation by reversible inhibition of mitochondrial enzymes. Findings: mitochondrial abnormalities, fatty liver (microvesicular fatty changes), hypoglycemia, vomiting, hepatomegaly, coma.	Avoid aspirin in children, except in those with Kawasaki disease. Salicylates aren't a ray (Reye) of sunSHINE for kids: Steatosis of liver/hepatocytes Hypoglycemia/Hepatomegaly Infection (VZV, influenza) Not awake (coma) Encephalopathy	

FAS1_2019_09-Gastrointestinal.indd 390 11/7/19 4:42 PM

Alcoholic liver disease

Macrovesicular fatty change A that may be **Hepatic steatosis** reversible with alcohol cessation. Requires sustained, long-term consumption. Make a to**AST** with alcohol: **Alcoholic hepatitis** Swollen and necrotic hepatocytes with **AST** > ALT (ratio usually > 2:1). neutrophilic infiltration. Mallory bodies B (intracytoplasmic eosinophilic inclusions of damaged keratin filaments). **Alcoholic cirrhosis** Final and usually irreversible form. Sclerosis around central vein (arrows in C) may be seen in early disease. Regenerative nodules surrounded by fibrous bands in response to chronic liver injury → portal hypertension and end-stage liver disease.

Nonalcoholic fatty liver disease



Metabolic syndrome (insulin resistance); obesity → fatty infiltration of hepatocytes A → cellular "ballooning" and eventual necrosis. May cause cirrhosis and HCC. Independent of alcohol use. ALT > AST (Lipids)

Hepatic encephalopathy

Cirrhosis → portosystemic shunts → ↓ NH₃ metabolism → neuropsychiatric dysfunction. Reversible neuropsychiatric dysfunction ranging from disorientation/asterixis (mild) to difficult arousal or coma (severe).

Triggers:

- † NH₃ production and absorption (due to GI bleed, constipation, infection).
- ↓ NH₂ removal (due to renal failure, diuretics, bypassed hepatic blood flow post-TIPS).

Treatment: lactulose († NH₄+ generation) and rifaximin (↓ NH₃-producing gut bacteria).

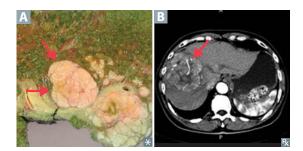
FAS1_2019_09-Gastrointestinal.indd 391 11/7/19 4:42 PM

Hepatocellular carcinoma/hepatoma

Most common 1° malignant tumor of liver in adults A. Associated with HBV (+/– cirrhosis) and all other causes of cirrhosis (including HCV, alcoholic and nonalcoholic fatty liver disease, autoimmune disease, hemochromatosis, Wilson disease, α₁-antitrypsin deficiency) and specific carcinogens (eg, aflatoxin from Aspergillus). May lead to Budd-Chiari syndrome. Findings: jaundice, tender hepatomegaly, ascites, polycythemia, anorexia. Spreads

hematogenously.

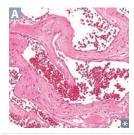
Diagnosis: † α-fetoprotein; ultrasound or contrast CT/MRI **B**, biopsy.



Other liver tumors

Angiosarcoma

Cavernous hemangioma



Malignant tumor of endothelial origin; associated with exposure to arsenic, vinyl chloride.

Most common benign liver tumor (venous malformation) A; typically occurs at age 30–50 years. Biopsy contraindicated because of risk of hemorrhage.

Hepatic adenoma

Rare, benign liver tumor, often related to oral contraceptive or anabolic steroid use; may regress spontaneously or rupture (abdominal pain and shock).

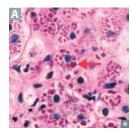
Metastases

GI malignancies, breast and lung cancer. Most common overall; metastases are rarely solitary.

Budd-Chiari syndrome

Thrombosis or compression of hepatic veins with centrilobular congestion and necrosis → congestive liver disease (hepatomegaly, ascites, varices, abdominal pain, liver failure). Absence of JVD. Associated with hypercoagulable states, polycythemia vera, postpartum state, HCC. May cause nutmeg liver (mottled appearance).

α_1 -antitrypsin deficiency

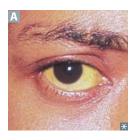


Misfolded gene product protein aggregates in hepatocellular ER → cirrhosis with PAS ⊕ globules A in liver. Codominant trait. Often presents in young patients with liver damage and dyspnea without a history of smoking.

In lungs, $\downarrow \alpha_1$ -antitrypsin \rightarrow uninhibited elastase in alveoli $\rightarrow \downarrow$ elastic tissue \rightarrow panacinar emphysema.

FAS1_2019_09-Gastrointestinal.indd 392 11/7/19 4:42 PM

Jaundice



Abnormal yellowing of the skin and/or sclera A due to bilirubin deposition. Hyperbilirubinemia 2° to ↑ production or ↓ clearance (impaired hepatic uptake, conjugation, excretion).

HOT Liver—common causes of † bilirubin

level:

Hemolysis

Obstruction

Tumor

Liver disease

Conjugated (direct) hyperbilirubinemia

Biliary tract obstruction: gallstones, cholangiocarcinoma, pancreatic or liver cancer, liver fluke. Biliary tract disease:

- 1° sclerosing cholangitis
- 1° biliary cholangitis

Excretion defect: Dubin-Johnson syndrome, Rotor syndrome.

Unconjugated (indirect) hyperbilirubinemia

Hemolytic, physiologic (newborns), Crigler-Najjar, Gilbert syndrome.

Mixed (direct and indirect) hyperbilirubinemia

Hepatitis, cirrhosis.

Physiologic neonatal jaundice

At birth, immature UDP-glucuronosyltransferase → unconjugated hyperbilirubinemia → jaundice/ kernicterus (deposition of unconjugated, lipid-soluble bilirubin in the brain, particularly basal ganglia).

Occurs after first 24 hours of life and usually resolves without treatment in 1–2 weeks. Treatment: phototherapy (non-UV) isomerizes unconjugated bilirubin to water-soluble form.

Biliary atresia

Most common reason for pediatric liver transplantation.

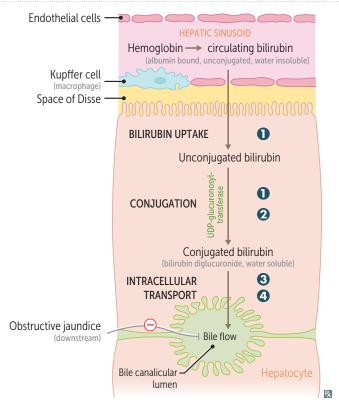
Fibro-obliterative destruction of extrahepatic bile ducts → cholestasis.

Often presents as a newborn with persistent jaundice after 2 weeks of life, darkening urine, acholic stools, hepatomegaly.

Labs: † direct bilirubin and GGT.

FAS1_2019_09-Gastrointestinal.indd 393 11/7/19 4:42 PM

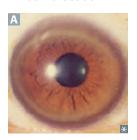
Hereditary hyperbilirubinemias	All autosomal recessive.
1 Gilbert syndrome	Mildly \(\psi\) UDP-glucuronosyltransferase conjugation and impaired bilirubin uptake. Asymptomatic or mild jaundice usually with stress, illness, or fasting. \(\dagger\) unconjugated bilirubin without overt hemolysis. Relatively common, benign condition.
2 Crigler-Najjar syndrome, type I	Absent UDP-glucuronosyltransferase. Presents early in life, but some patients may not have neurologic signs until later in life. Findings: jaundice, kernicterus (bilirubin deposition in brain), † unconjugated bilirubin. Treatment: plasmapheresis and phototherapy (does not conjugate UCB; but does † polarity and † water solubility to allow excretion). Liver transplant is curative. Type II is less severe and responds to phenobarbital, which † liver enzyme synthesis.
3 Dubin-Johnson syndrome	Conjugated hyperbilirubinemia due to defective liver excretion. Grossly black (D ark) liver due to impaired excretion of epinephrine metabolites. Benign.
Rotor syndrome	Similar to Dubin-Johnson syndrome, but milder in presentation without black (Regular) liver. Due to impaired hepatic uptake and excretion.



FAS1_2019_09-Gastrointestinal.indd 394 11/7/19 4:42 PM

SECTION III

Wilson disease

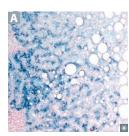


Also called hepatolenticular degeneration. Autosomal recessive mutations in hepatocyte copper-transporting ATPase (ATP7B gene; chromosome 13) → ↓ copper incorporation into apoceruloplasmin and excretion into bile → ↓ serum ceruloplasmin. Copper accumulates, especially in liver, brain, cornea, kidneys; † urine copper.

Presents before age 40 with liver disease (eg, hepatitis, acute liver failure, cirrhosis), neurologic disease (eg, dysarthria, dystonia, tremor, parkinsonism), psychiatric disease, Kayser-Fleischer rings (deposits in Descemet membrane of cornea) A, hemolytic anemia, renal disease (eg, Fanconi

Treatment: chelation with penicillamine or trientine, oral zinc. Liver transplant in acute liver failure related to Wilson disease.

Hemochromatosis



Autosomal recessive. On HFE gene, located on chromosome 6; associated with HLA-A3. Leads to abnormal iron sensing and ↑ intestinal absorption (↑ ferritin, ↑ iron, ↓ TIBC → ↑ transferrin saturation). Iron overload can also be 2° to chronic transfusion therapy (eg, β-thalassemia major). Iron accumulates, especially in liver, pancreas, skin, heart, pituitary, joints. Hemosiderin (iron) can be identified on liver MRI or biopsy with Prussian blue stain A.

Presents after age 40 when total body iron > 20 g; iron loss through menstruation slows progression in women. Classic triad of cirrhosis, diabetes mellitus, skin pigmentation ("bronze diabetes"). Also causes restrictive cardiomyopathy (classic) or dilated cardiomyopathy (reversible), hypogonadism, arthropathy (calcium pyrophosphate deposition; especially metacarpophalangeal joints). HCC is common cause of death.

Treatment: repeated phlebotomy, iron (Fe) chelation with deferasirox, deferoxamine, deferiprone.

Biliary tract disease

May present with pruritus, jaundice, dark urine, light-colored stool, hepatosplenomegaly. Typically with cholestatic pattern of LETs († conjugated bilirubin † cholesterol † ALP † CCT)

	PATHOLOGY	EPIDEMIOLOGY	ADDITIONAL FEATURES
Primary sclerosing cholangitis	Unknown cause of concentric "onion skin" bile duct fibrosis → alternating strictures and dilation with "beading" of intra- and extrahepatic bile ducts on ERCP, magnetic resonance cholangiopancreatography (MRCP).	Classically in middle-aged men with ulcerative colitis.	Associated with ulcerative colitis. p-ANCA ⊕. ↑ IgM. Can lead to 2° biliary cholangitis. ↑ risk of cholangiocarcinoma and gallbladder cancer.
Primary biliary cholangitis	Autoimmune reaction → lymphocytic infiltrate +/- granulomas → destruction of lobular bile ducts.	Classically in middle-aged women.	Anti-mitochondrial antibody ⊕, † IgM. Associated with other autoimmune conditions (eg, Hashimoto thyroiditis, rheumatoid arthritis, celiac disease). Treatment: ursodiol.
Secondary biliary cirrhosis	Extrahepatic biliary obstruction → ↑ pressure in intrahepatic ducts → injury/ fibrosis and bile stasis.	Patients with known obstructive lesions (gallstones, biliary strictures, pancreatic carcinoma).	May be complicated by ascending cholangitis.

FAS1 2019 09-Gastrointestinal.indd 395 11/7/19 4:42 PM

Cholelithiasis and related pathologies



↑ cholesterol and/or bilirubin, ↓ bile salts, and gallbladder stasis all cause stones.

2 types of stones:

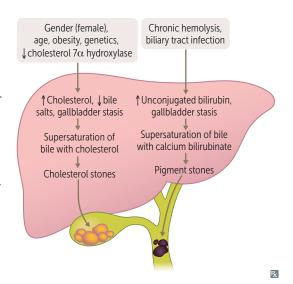
- Cholesterol stones (radiolucent with 10–20% opaque due to calcifications)—80% of stones. Associated with obesity, Crohn disease, advanced age, estrogen therapy, multiparity, rapid weight loss, Native American origin.
- Pigment stones A (black = radiopaque, Ca²+ bilirubinate, hemolysis; brown = radiolucent, infection). Associated with Crohn disease, chronic hemolysis, alcoholic cirrhosis, advanced age, biliary infections, total parenteral nutrition (TPN).

Risk factors (4 F's):

- 1. Female
- 2. **F**at
- 3. Fertile (multiparity)
- 4. Forty

Most common complication is cholecystitis; can also cause acute pancreatitis, ascending cholangitis.

Diagnose with ultrasound. Treat with elective cholecystectomy if symptomatic.



RELATED PATHOLOGIES

CHARACTERISTICS

Biliary colic

Associated with nausea/vomiting and dull RUQ pain. Neurohormonal activation (eg, by CCK after a fatty meal) triggers contraction of gallbladder, forcing stone into cystic duct. Labs are normal, ultrasound shows cholelithiasis.

Choledocholithiasis

Presence of gallstone(s) in common bile duct, often leading to elevated ALP, GGT, direct bilirubin, and/or AST/ALT.

Cholecystitis



Acute or chronic inflammation of gallbladder.

Calculous cholecystitis—most common type; due to gallstone impaction in the cystic duct resulting in inflammation and gallbladder wall thickening (arrows in B); can produce 2° infection.

Acalculous cholecystitis—due to gallbladder stasis, hypoperfusion, or infection (CMV); seen in critically ill patients.

Murphy sign: inspiratory arrest on RUQ palpation due to pain. Pain may radiate to right shoulder (due to irritation of phrenic nerve). † ALP if bile duct becomes involved (eg, ascending cholangitis).

Diagnose with ultrasound or cholescintigraphy (HIDA scan). Failure to visualize gallbladder on HIDA scan suggests obstruction.

Gallstone ileus—fistula between gallbladder and GI tract → stone enters GI lumen → obstructs at ileocecal valve (narrowest point); can see air in biliary tree (pneumobilia). Rigler triad: radiographic findings of pneumobilia, small bowel obstruction, gallstone (usually in iliac fossa).

FAS1 2019 09-Gastrointestinal.indd 396 11/7/19 4:42 PM

SECTION III

Cholelithiasis and related pathologies (continued)

Porcelain gallbladder



Calcified gallbladder due to chronic cholecystitis; usually found incidentally on imaging C. Treatment: prophylactic cholecystectomy generally recommended due to † risk of gallbladder cancer (mostly adenocarcinoma).

Ascending cholangitis

Infection of biliary tree usually due to obstruction that leads to stasis/bacterial overgrowth. Charcot triad of cholangitis includes jaundice, fever, RUQ pain. Reynolds pentad is Charcot triad plus altered mental status and shock (hypotension).

Acute pancreatitis

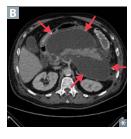


Autodigestion of pancreas by pancreatic enzymes (A shows pancreas [yellow arrows] surrounded by edema [red arrows]).

Causes: Idiopathic, Gallstones, Ethanol, Trauma, Steroids, Mumps, Autoimmune disease, Scorpion sting, Hypercalcemia/Hypertriglyceridemia (> 1000 mg/dL), ERCP, Drugs (eg, sulfa drugs, NRTIs, protease inhibitors). I GET SMASHED.

Diagnosis by 2 of 3 criteria: acute epigastric pain often radiating to the back, † serum amylase or lipase (more specific) to 3× upper limit of normal, or characteristic imaging findings.

Complications: pseudocyst B (lined by granulation tissue, not epithelium), abscess, necrosis, hemorrhage, infection, organ failure (ALI/ARDS, shock, renal failure), hypocalcemia (precipitation of Ca²⁺ soaps).



Chronic pancreatitis



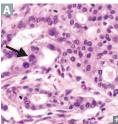
Chronic inflammation, atrophy, calcification of the pancreas A. Major causes include alcohol abuse and genetic predisposition (ie, cystic fibrosis); can be idiopathic. Complications include pancreatic insufficiency and pseudocysts.

Pancreatic insufficiency (typically when <10% pancreatic function) may manifest with steatorrhea, fat-soluble vitamin deficiency, diabetes mellitus.

Amylase and lipase may or may not be elevated (almost always elevated in acute pancreatitis).

FAS1 2019 09-Gastrointestinal.indd 397 11/7/19 4:42 PM

Pancreatic adenocarcinoma





Very aggressive tumor arising from pancreatic ducts (disorganized glandular structure with cellular infiltration A); often metastatic at presentation, with average survival ~ 1 year after diagnosis. Tumors more common in pancreatic head B (lead to obstructive jaundice). Associated with CA 19-9 tumor marker (also CEA, less specific).

Risk factors:

- Tobacco use
- Chronic pancreatitis (especially > 20 years)
- Diabetes
- Age > 50 years
- Jewish and African-American males

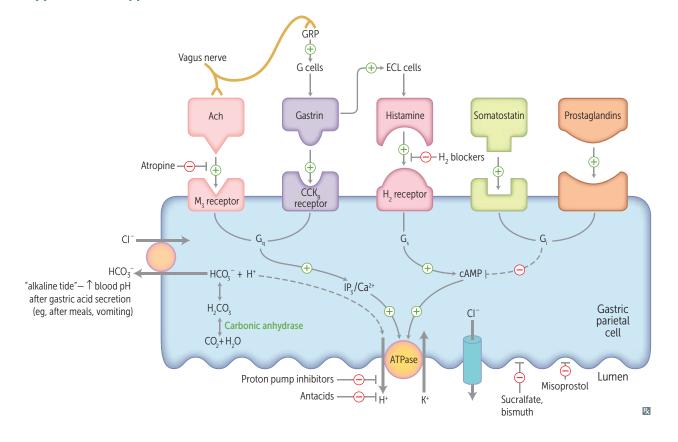
Often presents with:

- Abdominal pain radiating to back
- Weight loss (due to malabsorption and anorexia)
- Migratory thrombophlebitis—redness and tenderness on palpation of extremities (Trousseau syndrome)
- Obstructive jaundice with palpable, nontender gallbladder (Courvoisier sign)

Treatment: Whipple procedure (pancreaticoduodenectomy), chemotherapy, radiation therapy.

► GASTROINTESTINAL—PHARMACOLOGY

Acid suppression therapy



FAS1_2019_09-Gastrointestinal.indd 398 11/7/19 4:42 PM

Histamine-2 blockers	Cimetidine, ranitidine, famotidine, nizatidine.	Take H ₂ blockers before you dine. Think "table for 2" to remember H ₂ .	
MECHANISM	Reversible block of histamine H₂-receptors → ↓ H	H ⁺ secretion by parietal cells.	
CLINICAL USE	Peptic ulcer, gastritis, mild esophageal reflux.		
ADVERSE EFFECTS	Cimetidine is a potent inhibitor of cytochrome P-450 (multiple drug interactions); it also has antiandrogenic effects (prolactin release, gynecomastia, impotence, ↓ libido in males); can cross blood-brain barrier (confusion, dizziness, headaches) and placenta. Both cimetidine and ranitidine ↓ renal excretion of creatinine. Other H ₂ blockers are relatively free of these effects.		
Proton pump inhibitors	Omeprazole, lansoprazole, esomeprazole, pantop	razole, dexlansoprazole.	
MECHANISM	Irreversibly inhibit H+/K+ ATPase in stomach pari	etal cells.	
CLINICAL USE	Peptic ulcer, gastritis, esophageal reflux, Zollinge <i>H pylori</i> , stress ulcer prophylaxis.	r-Ellison syndrome, component of therapy for	
ADVERSE EFFECTS	↑ risk of <i>C difficile</i> infection, pneumonia, acute in ↓ serum Mg ²⁺ and ↓ Ca ²⁺ absorption (potentially		
Antacids	Can affect absorption, bioavailability, or urinary excretion of other drugs by altering gastric and urinary pH or by delaying gastric emptying. All can cause hypokalemia. Overuse can also cause the following problems:		
Aluminum hydroxide	Constipation, Hypophosphatemia, Osteodystrophy, Proximal muscle weakness, Seizures	Aluminimum amount of feces CHOPS	
Calcium carbonate	Hypercalcemia (milk-alkali syndrome), rebound acid †	Can chelate and ↓ effectiveness of other drugs (eg, tetracycline)	
Magnesium hydroxide	Diarrhea, hyporeflexia, hypotension, cardiac arrest	$Mg^{2+} = Must go 2$ the bathroom	
Bismuth, sucralfate			
MECHANISM	Bind to ulcer base, providing physical protection gradient in the mucous layer. Sucralfate require blockers.	- /	
CLINICAL USE	† ulcer healing, travelers' diarrhea (bismuth). Bismuth also used in quadruple therapy for <i>H pylori</i> gastritis.		
Misoprostol			
MECHANISM	PGE_1 analog. \uparrow production and secretion of gastri	ic mucous barrier, ↓ acid production.	
CLINICAL USE	Prevention of NSAID-induced peptic ulcers (NSAIDs block PGE_1 production). Also used off-label for induction of labor (ripens cervix).		
ADVERSE EFFECTS	Diarrhea. Contraindicated in women of childbearing potential (abortifacient).		

11/7/19 4:42 PM FAS1_2019_09-Gastrointestinal.indd 399

Octreotide	
MECHANISM	Long-acting somatostatin analog; inhibits secretion of various splanchnic vasodilatory hormones.
CLINICAL USE	Acute variceal bleeds, acromegaly, VIPoma, carcinoid tumors.
ADVERSE EFFECTS	Nausea, cramps, steatorrhea. † risk of cholelithiasis due to CCK inhibition.
Sulfasalazine	
MECHANISM	A combination of sulfapyridine (antibacterial) and 5-aminosalicylic acid (anti-inflammatory). Activated by colonic bacteria.
CLINICAL USE	Ulcerative colitis, Crohn disease (colitis component).
ADVERSE EFFECTS	Malaise, nausea, sulfonamide toxicity, reversible oligospermia.
Loperamide	
MECHANISM	Agonist at μ -opioid receptors; slows gut motility. Poor CNS penetration (low addictive potential).
CLINICAL USE	Diarrhea.
ADVERSE EFFECTS	Constipation, nausea.
Ondansetron	
MECHANISM	5-HT₃ antagonist; ↓ vagal stimulation. Powerful central-acting antiemetic.
CLINICAL USE	Control vomiting postoperatively and in patients undergoing cancer chemotherapy.
ADVERSE EFFECTS	Headache, constipation, QT interval prolongation, serotonin syndrome.
Metoclopramide	
MECHANISM	D ₂ receptor antagonist. † resting tone, contractility, LES tone, motility, promotes gastric emptying. Does not influence colon transport time.
CLINICAL USE	Diabetic and postoperative gastroparesis, antiemetic, persistent GERD.
ADVERSE EFFECTS	\uparrow parkinsonian effects, tardive dyskinesia. Restlessness, drowsiness, fatigue, depression, diarrhea. Drug interaction with digoxin and diabetic agents. Contraindicated in patients with small bowel obstruction, Parkinson disease (due to D_2 -receptor blockade), \downarrow seizure threshold.
Orlistat	
MECHANISM	Inhibits gastric and pancreatic lipase $\rightarrow \downarrow$ breakdown and absorption of dietary fats. Taken with fat-containing meals.
CLINICAL USE	Weight loss.
ADVERSE EFFECTS	Abdominal pain, flatulence, bowel urgency/frequent bowel movements, steatorrhea; ↓ absorption of fat-soluble vitamins.

11/7/19 4:42 PM FAS1_2019_09-Gastrointestinal.indd 400

	EXAMPLES	MECHANISM	ADVERSE EFFECTS
Bulk-forming laxatives	Psyllium, methylcellulose	Soluble fibers draw water into gut lumen, forming a viscous liquid that promotes peristalsis	Bloating
Osmotic laxatives	Magnesium hydroxide, magnesium citrate, polyethylene glycol, lactulose	Provides osmotic load to draw water into GI lumen Lactulose also treats hepatic encephalopathy: gut flora degrade lactulose into metabolites (lactic acid, acetic acid) that promote nitrogen excretion as NH ₄ ⁺	Diarrhea, dehydration; may be abused by bulimics
Stimulants	Senna	Enteric nerve stimulation → colonic contraction	Diarrhea, melanosis coli
Emollients	Docusate	Promotes incorporation of water and fat into stool	Diarrhea
Aprepitant			
MECHANISM	Substance P antagonist. Blocks NK ₁ (neurokinin-l) receptors in brain.		
CLINICAL USE	Antiemetic for chemotherapy-induced nausea and vomiting.		

FAS1_2019_09-Gastrointestinal.indd 401 11/7/19 4:42 PM

402 SECTION

SECTION III GASTROINTESTINAL

▶ NOTES	

FAS1_2019_09-Gastrointestinal.indd 402 11/7/19 4:42 PM

HIGH-YIELD SYSTEMS

Hematology and Oncology

"You're always somebody's type! (blood type, that is)"

-BloodLink

"All the soarings of my mind begin in my blood."

-Rainer Maria Rilke

"The best blood will at some time get into a fool or a mosquito."

-Austin O'Malley

When studying hematology, pay close attention to the many cross connections to immunology. Make sure you master the different types of anemias. Be comfortable interpreting blood smears. When reviewing oncologic drugs, focus on mechanisms and adverse effects rather than details of clinical uses, which may be lower yield.

Please note that solid tumors are covered in their respective organ system chapters.

▶ Embryology	404
▶ Anatomy	406
▶ Physiology	410
▶ Pathology	414
▶ Pharmacology	435

FAS1_2019_10-HemaOncol.indd 403 11/7/19 5:04 PM

► HEMATOLOGY AND ONCOLOGY—EMBRYOLOGY

Fetal erythropoiesis

Fetal erythropoiesis occurs in:

- Yolk sac (3–8 weeks)
- Liver (6 weeks-birth)
- **S**pleen (10–28 weeks)
- Bone marrow (18 weeks to adult)

Hemoglobin development

Embryonic globins: ζ and ϵ .

Fetal hemoglobin (HbF) = $\alpha_2 \gamma_2$.

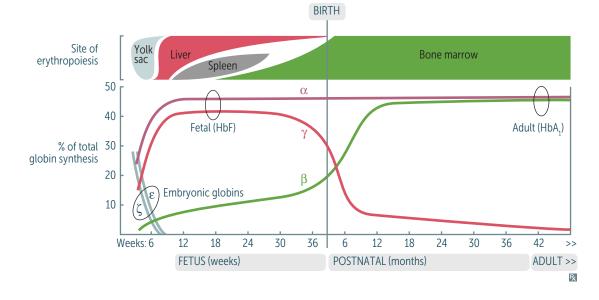
Adult hemoglobin $(HbA_1) = \alpha_2 \beta_2$.

HbF has higher affinity for O_2 due to less avid binding of 2,3-BPG, allowing HbF to extract O_2 from maternal hemoglobin (HbA₁ and HbA₂) across the placenta. HbA₂ ($\alpha_2\delta_2$) is a form of adult hemoglobin present in small amounts.

Young Liver Synthesizes Blood.

From fetal to adult hemoglobin:

Alpha Always; Gamma Goes, Becomes Beta.



FAS1_2019_10-HemaOncol.indd 404 11/7/19 5:04 PM

Blood groups

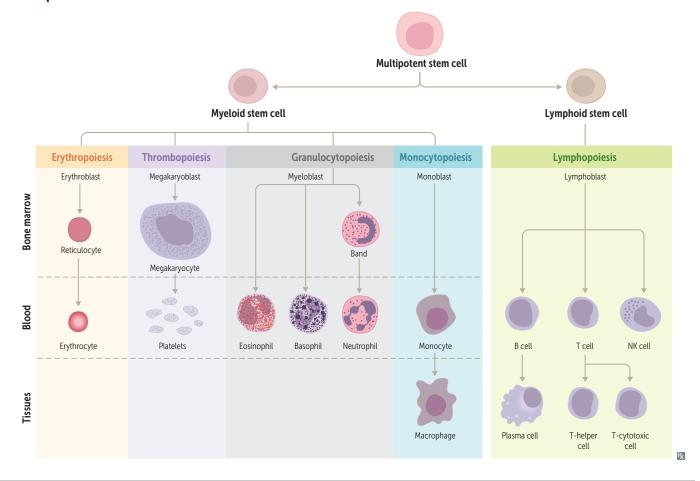
	ABO classification			Rh classification		
	A	В	АВ	0	Rh ⊕	Rh⊝
RBC type	A	B	AB	0		
Group antigens on RBC surface	A	В	A & B	None	Rh (D)	None
Antibodies in plasma	Anti-B	Anti-A	None	Anti-A Anti-B	None	Anti-D IgG
Clinical relevance	Receive B or AB → hemolytic reaction	Receive A or AB → hemolytic reaction	Universal recipient of RBCs; universal donor of plasma	Receive any non-O → hemolytic reaction Universal donor of RBCs; universal recipient of plasma	Can receive either Rh⊕ or Rh⊖ blood	Treat mother with anti-D IgG during and after each pregnancy to prevent anti-D IgG formation

Hemolytic disease of the newborn	Also known as erythroblastosis fetalis.			
	Rh hemolytic disease of the newborn	ABO hemolytic disease of the newborn		
INTERACTION	$Rh \ominus$ mother; $Rh \oplus$ fetus.	Type O mother; type A or B fetus.		
MECHANISM	First pregnancy: mother exposed to fetal blood (often during delivery) → formation of maternal anti-D IgG. Subsequent pregnancies: anti-D IgG crosses the placenta → attacks fetal RBCs → hemolysis in the fetus.	Pre-existing maternal anti-A and/or anti-B IgG antibodies cross placenta → hemolysis in the fetus.		
PRESENTATION	Hydrops fetalis, jaundice shortly after birth, kernicterus.	Mild jaundice in the neonate within 24 hours of birth. Unlike Rh HDN, can occur in firstborn babies and is usually less severe.		
TREATMENT/PREVENTION	Prevent by administration of anti-D IgG to Rh ☐ pregnant women during third trimester and early postpartum period (if fetus Rh ⊕). Prevents maternal anti-D IgG production.	Treatment: phototherapy or exchange transfusion.		

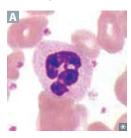
FAS1_2019_10-HemaOncol.indd 405 11/7/19 5:04 PM

► HEMATOLOGY AND ONCOLOGY—ANATOMY

Hematopoiesis



Neutrophils



Acute inflammatory response cells. Numbers † in bacterial infections. Phagocytic.

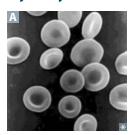
Multilobed nucleus A. Specific granules contain leukocyte alkaline phosphatase (LAP), collagenase, lysozyme, and lactoferrin. Azurophilic granules (lysosomes) contain proteinases, acid phosphatase, myeloperoxidase, and β-glucuronidase.

Hypersegmented neutrophils (nucleus has 6+ lobes) are seen in vitamin B₁₂/ folate deficiency. A left shift with † band cells (immature neutrophils) reflects states of † myeloid proliferation (eg, bacterial infections, CML). Important neutrophil chemotactic agents: C5a, IL-8, LTB₄, kallikrein, platelet-activating factor.

FAS1_2019_10-HemaOncol.indd 406 11/7/19 5:04 PM

► HEMATOLOGY AND ONCOLOGY—ANATOMY

Erythrocytes



Carry O, to tissues and CO, to lungs. Anucleate and lack organelles; biconcave A, with large surface area-to-volume ratio for rapid gas exchange. Life span of 120 days. Source of energy is glucose (90% used in glycolysis, 10% used in HMP shunt). Membranes contain Cl⁻/HCO₂ antiporter, which allow RBCs to export HCO₂ and transport CO₂ from the periphery to the lungs for elimination.

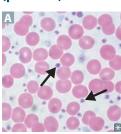
Eryth = red; cyte = cell.

Erythrocytosis = polycythemia = \uparrow Hct. Anisocytosis = varying sizes. Poikilocytosis = varying shapes.

Reticulocyte = immature RBC; reflects erythroid proliferation.

Bluish color (polychromasia) on Wright-Giemsa stain of reticulocytes represents residual ribosomal RNA.

Thrombocytes (platelets)



Involved in 1° hemostasis. Small cytoplasmic fragments A derived from megakaryocytes. Life span of 8–10 days. When activated by endothelial injury, aggregate with other platelets and interact with fibrinogen to form platelet plug. Contain dense granules (Ca²⁺, ADP, Serotonin, Histamine; CASH) and α granules (vWF, fibrinogen, fibronectin, platelet factor 4). Approximately 1/3 of platelet pool is stored in the spleen.

Thrombocytopenia or ↓ platelet function results in petechiae.

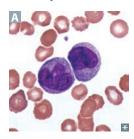
vWF receptor: GpIb.

Fibrinogen receptor: GpIIb/IIIa.

Thrombopoietin stimulates megakaryocyte proliferation.

Alfa granules contain vWF, fibrinogen, fibronectin, platelet factor four.

Monocytes

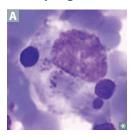


Found in blood, differentiate into macrophages

Large, kidney-shaped nucleus A. Extensive "frosted glass" cytoplasm.

Mono = one (nucleus); cyte = cell.

Macrophages

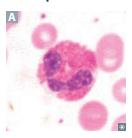


Phagocytose bacteria, cellular debris, and senescent RBCs. Long life in tissues. Differentiate from circulating blood monocytes **A**. Activated by γ -interferon. Can function as antigen-presenting cell via MHC II. Important cellular component of granulomas (eg, TB, sarcoidosis).

Macro = large; phage = eater.Macrophage naming varies by specific tissue type (eg, Kupffer cells in liver, histiocytes in connective tissue, Langerhans cells in skin, osteoclasts in bone, microglial cells in brain). Lipid A from bacterial LPS binds CD14 on macrophages to initiate septic shock.

FAS1 2019 10-HemaOncol.indd 407 11/7/19 5:04 PM

Eosinophils



Defend against helminthic infections (major basic protein). Bilobate nucleus. Packed with large eosinophilic granules of uniform size A. Highly phagocytic for antigenantibody complexes.

Produce histaminase, major basic protein (MBP, a helminthotoxin), eosinophil peroxidase, eosinophil cationic protein, and eosinophilderived neurotoxin.

Eosin = pink dye; philic = loving. Causes of eosinophilia = PACCMAN:

Parasites

Asthma

Eosinophilic granulomatosis with polyangiitis (Churg-Strauss syndrome)

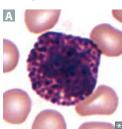
Chronic adrenal insufficiency

Myeloproliferative disorders

Allergic processes

Neoplasia (eg, Hodgkin lymphoma)

Basophils

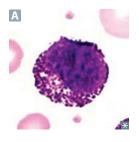


Mediate allergic reaction. Densely basophilic granules A contain heparin (anticoagulant) and histamine (vasodilator). Leukotrienes synthesized and released on demand.

Basophilic—stains readily with basic stains.

Basophilia is uncommon, but can be a sign of myeloproliferative disorders, particularly CML.

Mast cells



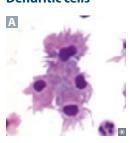
Mediate local tissue allergic reactions. Contain basophilic granules ⚠. Originate from same precursor as basophils but are not the same cell type. Can bind the Fc portion of IgE to membrane. Activated by tissue trauma, C3a and C5a, surface IgE cross-linking by antigen (IgE receptor aggregation) → degranulation → release of histamine, heparin, tryptase, and eosinophil chemotactic factors.

Involved in type I hypersensitivity reactions.

Cromolyn sodium prevents mast cell
degranulation (used for asthma prophylaxis).

Vancomycin, opioids, and radiocontrast dye can
elicit IgE-independent mast cell degranulation.

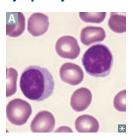
Dendritic cells



Highly phagocytic antigen-presenting cells (APCs) A. Function as link between innate and adaptive immune systems. Express MHC class II and Fc receptors on surface.

FAS1_2019_10-HemaOncol.indd 408 11/7/19 5:04 PM

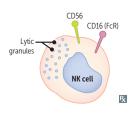
Lymphocytes



Refer to B cells, T cells, and NK cells. B cells and T cells mediate adaptive immunity. NK cells are part of the innate immune response. Round, densely staining nucleus with small amount of pale cytoplasm A.

► HEMATOLOGY AND ONCOLOGY—ANATOMY

Natural killer cells



Important in innate immunity, especially against intracellular pathogens. Larger than B and T cells, with distinctive cytoplasmic lytic granules (containing perforin and granzymes) that, when released, act on target cells to induce apoptosis. Distinguish between healthy and infected cells by identifying cell surface proteins (induced by stress, malignant transformation, or microbial infections).

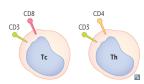
B cells



Mediate humoral immune response. Originate from stem cells in bone marrow and matures in marrow. Migrate to peripheral lymphoid tissue (follicles of lymph nodes, white pulp of spleen, unencapsulated lymphoid tissue). When antigen is encountered, B cells differentiate into plasma cells (which produce antibodies) and memory cells. Can function as an APC.

 $\mathbf{B} = \mathbf{B}$ one marrow.

T cells



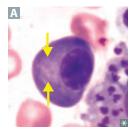
Mediate cellular immune response. Originate from stem cells in the bone marrow, but mature in the thymus. Differentiate into cytotoxic T cells (express CD8, recognize MHC I), helper T cells (express CD4, recognize MHC II), and regulatory T cells. CD28 (costimulatory signal) necessary for T-cell activation. Most circulating lymphocytes are T cells (80%).

T = Thymus.

CD4+ helper T cells are the primary target of HIV.

Rule of 8: MHC II \times CD4 = 8; MHC I \times CD8 = 8.

Plasma cells



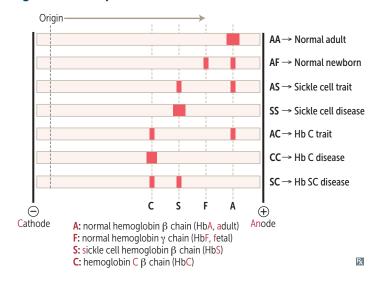
Produce large amounts of antibody specific to a particular antigen. "Clock-face" chromatin distribution and eccentric nucleus, abundant RER, and well-developed Golgi apparatus (arrows in A). Found in bone marrow and normally do not circulate in peripheral blood.

Multiple myeloma is a plasma cell dyscrasia.

FAS1_2019_10-HemaOncol.indd 409 11/7/19 5:04 PM

► HEMATOLOGY AND ONCOLOGY—PHYSIOLOGY

Hemoglobin electrophoresis



On a gel, hemoglobin migrates from the negatively charged cathode to the positively charged anode. HbA migrates the farthest, followed by HbF, HbS, and HbC. This is because the missense mutations in HbS and HbC replace glutamic acid ⊖ with valine (neutral) and lysine ⊕, respectively, making HbC and HbS more positively charged than HbA.

A Fat Santa Claus can't (cathode → anode) go far.

FAS1_2019_10-HemaOncol.indd 410 11/7/19 5:04 PM

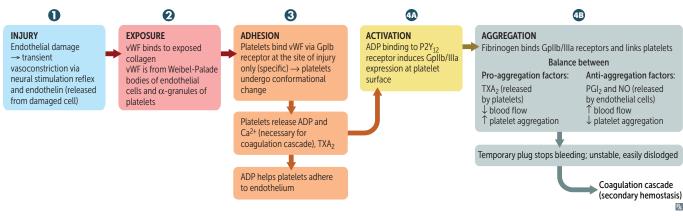
Platelet plug formation (primary hemostasis)

Deficiency: Bernard-

Soulier syndrome -

Subendothelial

collagen



Formation of insoluble fibrin mesh. **Thrombogenesis** Aspirin irreversibly inhibits cyclooxygenase, thereby inhibiting TXA, synthesis. Clopidogrel, prasugrel, and ticlopidine inhibit ADP-induced expression of GpIIb/IIIa by irreversibly blocking $P2Y_{12}$ receptor. Abciximab, eptifibatide, and tirofiban inhibit GpIIb/IIIa directly. Ristocetin activates vWF to bind GpIb. Failure of aggregation with ristocetin assay occurs in Clopidogrel, prasugrel, Platelet von Willebrand disease and Bernard-Soulier ticlopidine syndrome. vWF Inside vWF carries/protects factor VIII; volksWagen Aspirin platelets Fibrinogen Factories make gr8 cars. Fibrinogen Arachidonic ADP (P2Y₁₂) receptor acid 4A Deficiency: Glanzmann thrombasthenia \ominus

Thrombin-

complex

thrombomodulin

Abciximab,

eptifibatide,

tirofiban

Deficiency: von

Willebrand

disease

Gpllb/Illa

insertion

vWI

3

0

2

Activated Protein C protein C

Vascular endothelial cells

Inside

cells

endothelial

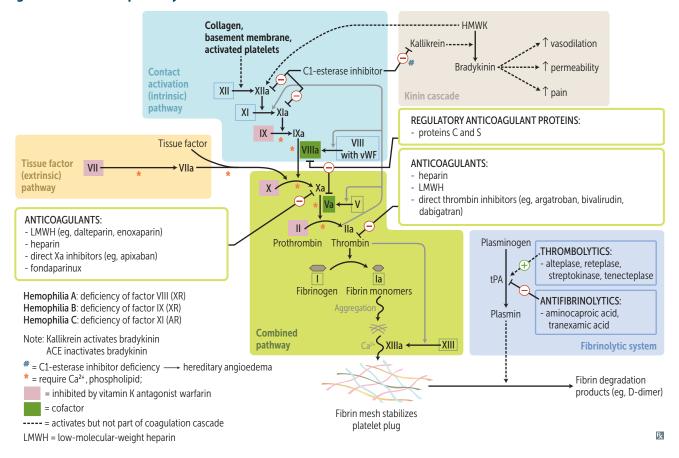
(vWF + factor VIII)

Thromboplastin

LtPA, PGI₂

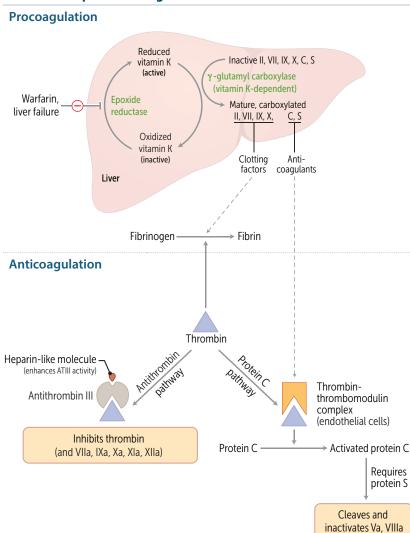
FAS1_2019_10-HemaOncol.indd 411 11/7/19 5:04 PM

Coagulation and kinin pathways



FAS1_2019_10-HemaOncol.indd 412 11/7/19 5:04 PM

Vitamin K-dependent coagulation



Vitamin K deficiency: ↓ synthesis of factors II, VII, IX, X, protein C, protein S.

Warfarin inhibits vitamin K epoxide reductase. Vitamin K administration can potentially reverse inhibitory effect of warfarin on clotting factor synthesis (delayed). FFP or PCC administration reverses action of warfarin immediately and can be given with vitamin K in cases of severe bleeding.

Neonates lack enteric bacteria, which produce vitamin K. Early administration of vitamin K overcomes neonatal deficiency/coagulopathy. Factor VII (seven)—shortest half-life. Factor II (two)—longest (tallest) half-life.

Antithrombin inhibits thrombin (factor IIa) and factors VIIa, IXa, Xa, XIa, XIIa.

Heparin enhances the activity of antithrombin. Principal targets of antithrombin: thrombin and factor Xa.

Factor V Leiden mutation produces a factor V resistant to inhibition by activated protein C. tPA is used clinically as a thrombolytic.

FAS1_2019_10-HemaOncol.indd 413 11/7/19 5:04 PM

Ŗ

► HEMATOLOGY AND ONCOLOGY—PATHOLOGY

ТҮРЕ	EXAMPLE	ASSOCIATED PATHOLOGY	NOTES
Acanthocytes ("spur cells")		Liver disease, abetalipoproteinemia	Projections of varying size at irregular intervals.
Echinocytes ("burr cells")	R	Liver disease, ESRD, pyruvate kinase deficiency	Smaller and more uniform projections than acanthocytes
Dacrocytes ("teardrop cells")		Bone marrow infiltration (eg, myelofibrosis)	RBC "sheds a tear " because it's mechanically squeezed out of its home in the bone marrow
Schistocytes (eg, "helmet" cells)		MAHAs (eg, DIC, TTP/HUS, HELLP syndrome), mechanical hemolysis (eg, heart valve prosthesis)	Fragmented RBCs
Degmacytes ("bite cells")		G6PD deficiency	Due to removal of Heinz bodies by splenic macrophages
Elliptocytes		Hereditary elliptocytosis	Caused by mutation in genes encoding RBC membrane proteins (eg, spectrin)

11/7/19 5:04 PM FAS1_2019_10-HemaOncol.indd 414

RBC morphology (continued)

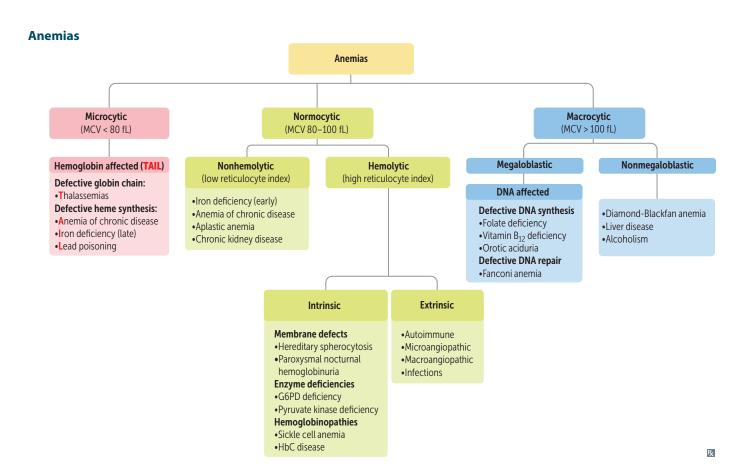
TYPE	EXAMPLE	ASSOCIATED PATHOLOGY	NOTES
Spherocytes		Hereditary spherocytosis, autoimmune hemolytic anemia	Small, spherical cells without central pallor
Macro-ovalocytes		Megaloblastic anemia (also hypersegmented PMNs)	
Target cells	R	HbC disease, Asplenia, Liver disease, Thalassemia	"HALT," said the hunter to his target
Sickle cells	*	Sickle cell anemia	Sickling occurs with low O ₂ conditions (eg, high altitude, acidosis)

11/7/19 5:04 PM FAS1_2019_10-HemaOncol.indd 415

RBC inclusions

EXAMPLE	ASSOCIATED PATHOLOGY	NOTES
*	Sideroblastic anemias (eg, lead poisoning, myelodysplastic syndromes, alcoholism)	Perinuclear mitochondria with excess iron (forming ring in ringed sideroblasts) Require Prussian blue stain to be visualized
	Functional hyposplenia (eg, sickle cell disease), asplenia	Basophilic nuclear remnants (do not contain iron) Usually removed by splenic macrophages
*	Sideroblastic anemias, thalassemias	Basophilic ribosomal precipitates (do not contain iron)
*	Sideroblastic anemia	Basophilic granules (contain iron)
	G6PD deficiency	Denatured and precipitated hemoglobin (contain iron) Phagocytic removal of Heinz bodies → bite cells Requires supravital stain (eg,
	EXAMPLE	Sideroblastic anemias (eg, lead poisoning, myelodysplastic syndromes, alcoholism) Functional hyposplenia (eg, sickle cell disease), asplenia Sideroblastic anemias, thalassemias Sideroblastic anemia

FAS1_2019_10-HemaOncol.indd 416 11/7/19 5:05 PM



Reticulocyte index

Also called corrected reticulocyte count. Used to correct falsely elevated reticulocyte count in anemia. Measures appropriate bone marrow response to anemic conditions (effective erythropoiesis). High reticulocyte index (RI) indicates compensatory RBC production; low RI indicates inadequate response to correct anemia. Calculated as:

> RI = reticulocyte % × actual Hct/normal Hct [normal Hct $\approx 45\%$]

FAS1_2019_10-HemaOncol.indd 417 11/7/19 5:05 PM

Microcytic,

hypochromic anemias

MCV < 80 fL

Iron deficiency

↓ iron due to chronic bleeding (eg, GI loss, menorrhagia), malnutrition, absorption disorders, GI surgery (eg, gastrectomy), or ↑ demand (eg, pregnancy) → ↓ final step in heme synthesis.

Labs: ↓ iron, ↑ TIBC, ↓ ferritin, ↑ free erythrocyte protoporphyrin, ↑ RDW, ↓ RI. Microcytosis and

hypochromasia († central pallor) A.

Symptoms: fatigue, conjunctival pallor **B**, pica (persistent craving and compulsive eating of nonfood substances), spoon nails (koilonychia).

May manifest as glossitis, cheilosis, Plummer-Vinson syndrome (triad of iron deficiency anemia, esophageal webs, and dysphagia).

α-thalassemia

 α -globin gene deletions on chromosome $16 \rightarrow 4$ α -globin synthesis. *cis* deletion (deletions occur on same chromosome) prevalent in Asian populations; *trans* deletion (deletions occur on separate chromosomes) prevalent in African populations. Normal is $\alpha\alpha/\alpha\alpha$.

NUMBER OF α-GLOBIN GENES DELETED	DISEASE	CLINICAL OUTCOME
1 (α α/α –)	α-thalassemia minima	No anemia (silent carrier)
2 (α -/ α -; trans) or (α α /; cis)	α-thalassemia minor	Mild microcytic, hypochromic anemia; <i>cis</i> deletion may worsen outcome for the carrier's offspring
3 (/- α)	Hemoglobin H disease (HbH); excess β-globin forms $β_4$	Moderate to severe microcytic hypochromic anemia
4 (/)	Hemoglobin Barts disease; no α-globin, excess γ-globin forms γ ₄	Hydrops fetalis; incompatible with life

B-thalassemia

Point mutations in splice sites and promoter sequences on chromosome 11 \rightarrow \$\dagger\$ \beta\$-globin synthesis. Prevalent in Mediterranean populations.

β-thalassemia minor (heterozygote): **β** chain is underproduced. Usually asymptomatic. Diagnosis confirmed by † HbA, (> 3.5%) on electrophoresis.

HbS/ β -thalassemia heterozygote: mild to moderate sickle cell disease depending on amount of β -globin production.

FAS1_2019_10-HemaOncol.indd 418 11/7/19 5:05 PM

Microcytic, hypochromic anemias (continued)

Lead poisoning

Lead inhibits ferrochelatase and ALA dehydratase → ↓ heme synthesis and ↑ RBC protoporphyrin. Also inhibits rRNA degradation → RBCs retain aggregates of rRNA (basophilic stippling).

Symptoms of **LEAD** poisoning:

- Lead Lines on gingivae (Burton lines) and on metaphyses of long bones **D** on x-ray.
- Encephalopathy and Erythrocyte basophilic stippling.
- Abdominal colic and sideroblastic Anemia.
- Drops—wrist and foot drop. Dimercaprol and EDTA are 1st line of treatment.

Succimer used for chelation for kids (It "sucks" to be a kid who eats lead).

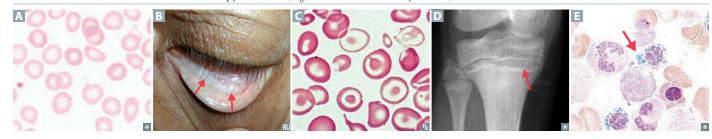
Exposure risk † in old houses with chipped paint.

Sideroblastic anemia

Causes: genetic (eg, X-linked defect in ALA synthase gene), acquired (myelodysplastic syndromes), and reversible (alcohol is most common; also lead poisoning, vitamin B₆ deficiency, copper deficiency, drugs [eg, isoniazid, linezolid]).

Lab findings: † iron, normal/‡ TIBC, † ferritin. Ringed sideroblasts (with iron-laden, Prussian blue–stained mitochondria) seen in bone marrow **E**. Peripheral blood smear: basophilic stippling of RBCs. Some acquired variants may be normocytic or macrocytic.

Treatment: pyridoxine (B₆, cofactor for ALA synthase).



Interpretation of iron studies

	Iron deficiency	Chronic disease	Hemochromatosis	Pregnancy/ OCP use
Serum iron	†	ţ	†	_
Transferrin or TIBC	1	↓a	Ţ	†
Ferritin	Į.	†	†	_
% transferrin saturation (serum iron/TIBC)	††	—/↓	††	ţ

 $\uparrow \downarrow = 1^{\circ}$ disturbance.

Transferrin—transports iron in blood.

TIBC—indirectly measures transferrin.

Ferritin—1° iron storage protein of body.

^aEvolutionary reasoning—pathogens use circulating iron to thrive. The body has adapted a system in which iron is stored within the cells of the body and prevents pathogens from acquiring circulating iron.

FAS1_2019_10-HemaOncol.indd 419 11/7/19 5:05 PM

420 SECTION III HEMATOLOGY AND ONCOLOGY • HEMATOLOGY AND ONCOLOGY—PATHOLOGY

Macrocytic anemias	MCV > 100 fL.	
	DESCRIPTION	FINDINGS
Megaloblastic anemia A	Impaired DNA synthesis → maturation of nucleus of precursor cells in bone marrow delayed relative to maturation of cytoplasm. Causes: vitamin B ₁₂ deficiency, folate deficiency, medications (eg, hydroxyurea, phenytoin, methotrexate, sulfa drugs).	RBC macrocytosis, hypersegmented neutrophils (arrow in A), glossitis.
Folate deficiency	Causes: malnutrition (eg, alcoholics), malabsorption, drugs (eg, methotrexate, trimethoprim, phenytoin), † requirement (eg, hemolytic anemia, pregnancy).	† homocysteine, normal methylmalonic acid. No neurologic symptoms (vs B ₁₂ deficiency).
Vitamin B ₁₂ (cobalamin) deficiency	Causes: pernicious anemia, malabsorption (eg, Crohn disease), pancreatic insufficiency, gastrectomy, insufficient intake (eg, veganism), Diphyllobothrium latum (fish tapeworm).	↑ homocysteine, ↑ methylmalonic acid. Neurologic symptoms: reversible dementia, subacute combined degeneration (due to involvement of B₁₂ in fatty acid pathways and myelin synthesis): spinocerebellar tract, lateral corticospinal tract, dorsal column dysfunction. Folate supplementation in vitamin B₁₂ deficiency can correct the anemia, but worsens neurologic symptoms. Historically diagnosed with the Schilling test, a test that determines if the cause is dietary insufficiency vs malabsorption. Anemia 2° to insufficient intake may take several years to develop due to liver's ability to store B₁₂ (as opposed to folate deficiency).
Orotic aciduria	Inability to convert orotic acid to UMP (de novo pyrimidine synthesis pathway) because of defect in UMP synthase. Autosomal recessive. Presents in children as failure to thrive, developmental delay, and megaloblastic anemia refractory to folate and B₁₂. No hyperammonemia (vs ornithine transcarbamylase deficiency—↑ orotic acid with hyperammonemia).	Orotic acid in urine. Treatment: uridine monophosphate or uridine triacetate to bypass mutated enzyme.
Nonmegaloblastic anemia	Macrocytic anemia in which DNA synthesis is normal. Causes: alcoholism, liver disease.	RBC macrocytosis without hypersegmented neutrophils.
Diamond-Blackfan anemia	A congenital form of pure red cell aplasia. Rapid-onset anemia within 1st year of life due to intrinsic defect in erythroid progenitor cells.	↑ % HbF (but ↓ total Hb). Short stature, craniofacial abnormalities, and upper extremity malformations (triphalangeal thumbs) in up to 50% of cases.

11/7/19 5:05 PM FAS1_2019_10-HemaOncol.indd 420

HEMATOLOGY AND ONCOLOGY ► HEMATOLOGY AND ONCOLOGY—PATHOLOGY SECTION III

Normocytic, normochromic anemias	Normocytic, normochromic anemias are classified as nonhemolytic or hemolytic. The hemolytic anemias are further classified according to the cause of the hemolysis (intrinsic vs extrinsic to the RBC) and by the location of the hemolysis (intravascular vs extravascular). Hemolysis can lead to increases in LDH, reticulocytes, unconjugated bilirubin, pigmented gallstones, and urobilinogen in urine.
Intravascular hemolysis	Findings: ↓ haptoglobin, ↑ schistocytes on blood smear. Characteristic hemoglobinuria, hemosiderinuria, and urobilinogen in urine. Notable causes are mechanical hemolysis (eg, prosthetic valve), paroxysmal nocturnal hemoglobinuria, microangiopathic hemolytic anemias.
Extravascular hemolysis	Mechanism: macrophages in spleen clear RBCs. Findings: spherocytes in peripheral smear (most commonly due to hereditary spherocytosis and autoimmune hemolytic anemia), no hemoglobinuria/hemosiderinuria. Can present with urobilinogen in urine.

	DESCRIPTION	FINDINGS	
Anemia of chronic disease	Inflammation (eg, ↑ IL-6) → ↑ hepcidin (released by liver, binds ferroportin on intestinal mucosal cells and macrophages, thus inhibiting iron transport) → ↓ release of iron from macrophages and ↓ iron absorption from gut. Associated with conditions such as chronic infections, neoplastic disorders, chronic kidney disease, and autoimmune diseases (eg, SLE, rheumatoid arthritis).	↓ iron, ↓ TIBC, ↑ ferritin. Normocytic, but can become microcytic. Treatment: address underlying cause of inflammation, judicious use of blood transfusion, consider erythropoiesisstimulating agents such as EPO (eg, in chronic kidney disease).	
Aplastic anemia	Caused by failure or destruction of hematopoietic stem cells due to: Radiation and drugs (eg, benzene, chloramphenicol, alkylating agents, antimetabolites) Viral agents (eg, EBV, HIV, hepatitis viruses) Fanconi anemia (autosomal recessive DNA repair defect → bone marrow failure); normocytosis or macrocytosis on CBC Idiopathic (immune mediated, 1° stem cell defect); may follow acute hepatitis		

11/7/19 5:05 PM FAS1_2019_10-HemaOncol.indd 421

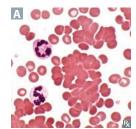
Intrinsic hemolytic anemias

	DESCRIPTION	FINDINGS
Hereditary spherocytosis	Primarily autosomal dominant. Due to defect in proteins interacting with RBC membrane skeleton and plasma membrane (eg, ankyrin, band 3, protein 4.2, spectrin). Small, round RBCs with less surface area and no central pallor (↑ MCHC) → premature removal by spleen (extravascular hemolysis).	Splenomegaly, aplastic crisis (parvovirus B19 infection). Labs: ↓ mean fluorescence of RBCs in eosin 5-maleimide (EMA) binding test, ↑ fragility in osmotic fragility test. Normal to ↓ MCV with abundance of RBCs. Treatment: splenectomy.
G6PD deficiency	X-linked recessive. G6PD defect → ↓ NADPH → ↓ reduced glutathione → ↑ RBC susceptibility to oxidative stress (eg, sulfa drugs, antimalarials, fava beans) → hemolysis. Causes extravascular and intravascular hemolysis.	Back pain, hemoglobinuria a few days after oxidant stress. Labs: blood smear shows RBCs with Heinz bodies and bite cells. "Stress makes me eat bites of fava beans with Heinz ketchup."
Pyruvate kinase deficiency	Autosomal recessive. Pyruvate kinase defect → ↓ ATP → rigid RBCs → extravascular hemolysis. Increases levels of 2,3-BPG → ↓ hemoglobin affinity for O ₂ .	Hemolytic anemia in a newborn.
Paroxysmal nocturnal hemoglobinuria	Hematopoietic stem cell mutation → ↑ complement-mediated intravascular hemolysis, especially at night. Acquired PIGA mutation → impaired GPI anchor synthesis for decay-accelerating factor (DAF/CD55) and membrane inhibitor of reactive lysis (MIRL/ CD59), which protect RBC membrane from complement.	Triad: Coombs ⊜ hemolytic anemia, pancytopenia, venous thrombosis (eg, Budd-Chiari syndrome). Pink/red urine in morning. Associated with aplastic anemia, acute leukemias. Labs: CD55/59 ⊖ RBCs on flow cytometry. Treatment: eculizumab (targets terminal complement protein C5).
Sickle cell anemia	Point mutation in β-globin gene → single amino acid substitution (glutamic acid → valine). Mutant HbA is termed HbS. Causes extravascular and intravascular hemolysis. Pathogenesis: low O₂, high altitude, or acidosis precipitates sickling (deoxygenated HbS polymerizes) → anemia, vaso-occlusive disease. Newborns are initially asymptomatic because of ↑ HbF and ↓ HbS. Heterozygotes (sickle cell trait) have resistance to malaria. 8% of African Americans carry an HbS allele. Sickle cells are crescent-shaped RBCs A. "Crew cut" on skull x-ray due to marrow expansion from ↑ erythropoiesis (also seen in thalassemias).	 Complications in sickle cell disease: Aplastic crisis (transient arrest of erythropoiesis due to parvovirus B19). Autosplenectomy (Howell-Jolly bodies) → ↑ risk of infection by encapsulated organisms (eg, <i>S pneumoniae</i>). Splenic infarct/sequestration crisis. Salmonella osteomyelitis. Painful vaso-occlusive crises: dactylitis (painful swelling of hands/feet), priapism, acute chest syndrome (respiratory distress, new pulmonary infiltrates on CXR, common cause of death), avascular necrosis, stroke. Sickling in renal medulla (‡ Po₂) → renal papillary necrosis → hematuria. Hb electrophoresis: ‡‡ HbA, ↑ HbF, ↑↑ HbS. Treatment: hydroxyurea († HbF), hydration.
HbC disease	Glutamic acid–to-ly Cine (lysine) mutation in β-globin. Causes extravascular hemolysis.	Patients with HbSC (1 of each mutant gene) have milder disease than HbSS patients. Blood smear in homozygotes: hemoglobin Crystals inside RBCs, target cells.

FAS1_2019_10-HemaOncol.indd 422 11/7/19 5:05 PM

Extrinsic hemolytic anemias

Autoimmune hemolytic anemia



DESCRIPTION

A normocytic anemia that is usually idiopathic and Coombs ⊕. Two types:

- Warm AIHA-chronic anemia in which IgG causes RBC agglutination. Seen in SLE and CLL and with certain drugs (eg, α-methyldopa). "Warm weather is Good."
- Cold AIHA–acute anemia in which IgM

 + complement causes RBC agglutination
 upon exposure to cold → painful, blue
 fingers and toes. Seen in CLL, Mycoplasma pneumoniae infections, infectious
 Mononucleosis.

FINDINGS

Spherocytes and agglutinated RBCs A on peripheral blood smear.

Warm AIHA treatment: steroids, rituximab, splenectomy (if refractory).

Cold AIHA treatment: cold avoidance, rituximab.

Direct Coombs test—anti-Ig antibody (Coombs reagent) added to patient's RBCs. RBCs agglutinate if RBCs are coated with Ig.

For comparison, Indirect Coombs test—normal RBCs added to patient's serum. If serum has anti-RBC surface Ig, RBCs agglutinate when Coombs reagent added.

	Patient component	Reagent(s)	⊕ Result (agglutination)	Result(no agglutination)
DIRECT COOMDS		~\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	A CHANGE	r
	RBCs +/- anti-RBC Ab	Anti-human globulin (Coombs reagent)	Result Anti-RBC Ab present	Result Anti-RBC Ab absent
Indirect Coombs	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Donor blood	THE THE PERSON OF THE PERSON O	4
	Patient serum +/- anti-donor RBC Ab	Anti-human globulin (Coombs reagent)	Result Anti-donor RBC Ab present	Result Anti-donor RBC Ab absent

Microangiopathic hemolytic anemia

RBCs are damaged when passing through obstructed or narrowed vessels. Causes intravascular hemolysis.

Seen in DIC, TTP/HUS, SLE, HELLP syndrome, hypertensive emergency.

Schistocytes (eg, "helmet cells") are seen on peripheral blood smear due to mechanical destruction (*schisto* = to split) of RBCs.

Macroangiopathic hemolytic anemia

Prosthetic heart valves and aortic stenosis may also cause hemolytic anemia 2° to mechanical destruction of RBCs.

Schistocytes on peripheral blood smear.

Hemolytic anemia due to infection

† destruction of RBCs (eg, malaria, *Babesia*).

FAS1_2019_10-HemaOncol.indd 423 11/7/19 5:05 PM

474

SECTION III

HEMATOLOGY AND ONCOLOGY ► HEMATOLOGY AND ONCOLOGY—PATHOLOGY

Leukopenias

=		
CELL TYPE	CELL COUNT	CAUSES
Neutropenia	Absolute neutrophil count < 1500 cells/mm ³ Severe infections typical when < 500 cells/mm ³	Sepsis/postinfection, drugs (including chemotherapy), aplastic anemia, SLE, radiation
Lymphopenia	Absolute lymphocyte count < 1500 cells/mm³ (< 3000 cells/mm³ in children)	HIV, DiGeorge syndrome, SCID, SLE, corticosteroids ^a , radiation, sepsis, postoperative
Eosinopenia	Absolute eosinophil count < 30 cells/mm³	Cushing syndrome, corticosteroids ^a

^aCorticosteroids cause neutrophilia, despite causing eosinopenia and lymphopenia. Corticosteroids ↓ activation of neutrophil adhesion molecules, impairing migration out of the vasculature to sites of inflammation. In contrast, corticosteroids sequester eosinophils in lymph nodes and cause apoptosis of lymphocytes.

Neutrophil left shift

† neutrophil precursors, such as band cells and metamyelocytes, in peripheral blood. Usually seen with neutrophilia in the acute response to infection or inflammation. Called leukoerythroblastic reaction when left shift is seen with immature RBCs. Occurs with severe anemia (physiologic response) or marrow response (eg, fibrosis, tumor taking up space in marrow).

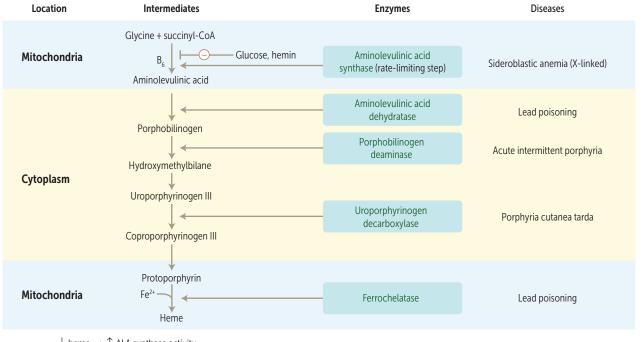
A left shift is a shift to a more immature cell in the maturation process.

FAS1_2019_10-HemaOncol.indd 424 11/7/19 5:05 PM

Heme synthesis, porphyrias, and lead poisoning

The porphyrias are hereditary or acquired conditions of defective heme synthesis that lead to the accumulation of heme precursors. Lead inhibits specific enzymes needed in heme synthesis, leading to a similar condition.

CONDITION	AFFECTED ENZYME	ACCUMULATED SUBSTRATE	PRESENTING SYMPTOMS
Lead poisoning A	Ferrochelatase and ALA dehydratase	Protoporphyrin, ALA (blood)	Microcytic anemia (basophilic stippling in peripheral smear A, ringed sideroblasts in bone marrow), GI and kidney disease. Children—exposure to lead paint → mental deterioration. Adults—environmental exposure (eg, batteries, ammunition) → headache, memory loss, demyelination (peripheral neuropathy).
Acute intermittent porphyria	Porphobilinogen deaminase, previously called uroporphyrinogen I synthase (autosomal dominant mutation)	Porphobilinogen, ALA	Symptoms (5 P's): Painful abdomen Port wine–colored Pee Polyneuropathy Psychological disturbances Precipitated by drugs (eg, cytochrome P-450 inducers), alcohol, starvation Treatment: hemin and glucose.
Porphyria cutanea tarda B	Uroporphyrinogen decarboxylase	Uroporphyrin (teacolored urine)	Blistering cutaneous photosensitivity and hyperpigmentation B . Most common porphyria. Exacerbated with alcohol consumption. Causes: familial, hepatitis C. Treatment: phlebotomy, sun avoidance, antimalarials (eg, hydroxychloroquine).



 \downarrow heme \rightarrow \uparrow ALA synthase activity

 \uparrow heme $\rightarrow \downarrow$ ALA synthase activity

Ŗ

FAS1_2019_10-HemaOncol.indd 425 11/7/19 5:05 PM

Iron poisoning

	Acute	Chronic	
FINDINGS	High mortality rate associated with accidental ingestion by children (adult iron tablets may look like candy).	Seen in patients with 1° (hereditary) or 2° (eg, chronic blood transfusions for thalassemia or sickle cell disease) hemochromatosis.	
MECHANISM	Cell death due to formation of free radicals and peroxidation of membrane lipids.		
SYMPTOMS/SIGNS	Abdominal pain, vomiting, GI bleeding. Radiopaque pill seen on x-ray. May progress to anion gap metabolic acidosis and multiorgan failure. Leads to scarring with GI obstruction.	Arthropathy, cirrhosis, cardiomyopathy, diabetes mellitus and skin pigmentation ("bronze diabetes"), hypogonadism.	
TREATMENT	Chelation (eg, deferoxamine, deferasirox), gastric lavage.	Phlebotomy (patients without anemia) or chelation.	

Coagulation disorders

PT—tests function of common and extrinsic pathway (factors I, II, V, VII, and X). Defect → ↑ PT (Play Tennis outside [extrinsic pathway]).

INR (international normalized ratio) = patient PT/control PT. 1 = normal, > 1 = prolonged. Most common test used to follow patients on warfarin, which prolongs INR.

PTT—tests function of common and intrinsic pathway (all factors except VII and XIII). Defect
→ ↑ PTT (Play Table Tennis inside).

Coagulation disorders can be due to clotting factor deficiencies or acquired factor inhibitors. Diagnosed with a mixing study, in which normal plasma is added to patient's plasma. Clotting factor deficiencies should correct (the PT or PTT returns to within the appropriate normal range), whereas factor inhibitors will not correct.

DISORDER	PT	PTT	MECHANISM AND COMMENTS
Hemophilia A, B, or C	_	1	 Intrinsic pathway coagulation defect († PTT). A: deficiency of factor VIII; X-linked recessive. B: deficiency of factor IX; X-linked recessive. C: deficiency of factor XI; autosomal recessive. Hemorrhage in hemophilia—hemarthroses (bleeding into joints, eg, knee A), easy bruising, bleeding after trauma or surgery (eg, dental procedures). Treatment: desmopressin + factor VIII concentrate (A); factor IX concentrate (B); factor XI concentrate (C).
Vitamin K deficiency	†	†	General coagulation defect. Bleeding time normal. ↓ activity of factors II, VII, IX, X, protein C, protein S.

FAS1_2019_10-HemaOncol.indd 426 11/7/19 5:05 PM

► HEMATOLOGY AND ONCOLOGY—PATHOLOGY **HEMATOLOGY AND ONCOLOGY**

Platelet disorders

All platelet disorders have † bleeding time (BT), mucous membrane bleeding, and microhemorrhages (eg, petechiae, epistaxis). Platelet count (PC) is usually low, but may be normal in qualitative disorders.

DISORDER	PC	ВТ	NOTES
Bernard-Soulier syndrome	_/↓	†	Defect in adhesion. ↓ GpIb → ↓ platelet-to-vWF adhesion. Labs: abnormal ristocetin test, large platelets.
Glanzmann thrombasthenia	_	†	Defect in aggregation. \downarrow GpIIb/IIIa (\downarrow integrin $\alpha_{IIb}\beta_3$) $\rightarrow \downarrow$ platelet-to-platelet aggregation and defective platelet plug formation. Labs: blood smear shows no platelet clumping.
Immune thrombocytopenia	1	1	Destruction of platelets in spleen. Anti-GpIIb/IIIa antibodies → splenic macrophages phagocytose platelets. May be idiopathic or 2° to autoimmune disorders (eg, SLE), viral illness (eg, HIV, HCV), malignancy (eg, CLL), or drug reactions. Labs: ↑ megakaryocytes on bone marrow biopsy, ↓ platelet count. Treatment: steroids, IVIG, rituximab, TPO receptor agonists (eg, eltrombopag, romiplostim), or splenectomy for refractory ITP.

Thrombotic

Disorders overlap significantly in symptomatology.

	Thrombotic thrombocytopenic purpura	Typically children DAMTS13 (a Commonly caused by Shiga-like toxin from degradation of EHEC (serotype O157:H7) infection WF multimers		
EPIDEMIOLOGY	Typically females			
PATHOPHYSIOLOGY	Inhibition or deficiency of ADAMTS13 (a vWF metalloprotease) → ↓ degradation of vWF multimers → ↑ large vWF multimers → ↑ platelet adhesion and aggregation (microthrombi formation)			
PRESENTATION	Triad of thrombocytopenia (\$\dagger\$ platelets), microangiopathic hemolytic anemia (\$\dagger\$ Hb, schistocytes, \$\dagger\$ LDH), acute kidney injury (\$\dagger\$ Cr)			
DIFFERENTIATING SYMPTOMS	Triad + fever + neurologic symptoms	Triad + bloody diarrhea		
LABS	Normal PT and PTT helps distinguish TTP and HUS (coagulation pathway is not activate DIC (coagulation pathway is activated)			
TREATMENT	Plasmapheresis, steroids, rituximab	Supportive care		

FAS1_2019_10-HemaOncol.indd 427 11/7/19 5:05 PM 428 SECTION III

HEMATOLOGY AND ONCOLOGY ► HEMATOLOGY AND ONCOLOGY—PATHOLOGY

Mixed platelet and coagulation disorders

DISORDER	PC	ВТ	PT	PTT	NOTES
von Willebrand disease	-	†	_	—/ †	Intrinsic pathway coagulation defect: ↓ vWF → ↑ PTT (vWF carries/protects factor VIII). Defect in platelet plug formation: ↓ vWF → defect in platelet-to-vWF adhesion. Autosomal dominant. Mild but most common inherited bleeding disorder. No platelet aggregation with ristocetin cofactor assay. Treatment: desmopressin, which releases vWF stored in endothelium.
Disseminated intravascular coagulation	†	1	1	t	Widespread clotting factor activation → deficiency in clotting factors → bleeding state. Causes: Snake bites, Sepsis (gram ⊖), Trauma, Obstetric complications, acute Pancreatitis, Malignancy, Nephrotic syndrome, Transfusion (SSTOP Making New Thrombi). Labs: schistocytes, ↑ fibrin degradation products (D-dimers), ↓ fibrinogen, ↓ factors V and VIII.

Hereditary thrombosis syndromes leading to hypercoagulability

DISEASE	DESCRIPTION
Antithrombin deficiency	 Autosomal dominant inherited deficiency of antithrombin: has no direct effect on the PT, PTT, or thrombin time but diminishes the increase in PTT following heparin administration. Can also be acquired: renal failure/nephrotic syndrome → antithrombin loss in urine → ↓ inhibition of factors IIa and Xa.
Factor V Leiden	Autosomal dominant, most common cause of inherited hypercoagulability in Caucasians. Production of mutant factor V (guanine → adenine DNA point mutation → Arg506Gln mutation near the cleavage site) that is resistant to degradation by activated protein C. Complications include DVT, cerebral vein thrombosis, recurrent pregnancy loss.
Protein C or S deficiency	↓ ability to inactivate factors Va and VIIIa. ↑ risk of thrombotic skin necrosis with hemorrhage after administration of warfarin. If this occurs, think protein C deficiency. Together, protein C Cancels, and protein S Stops, coagulation.
Prothrombin gene mutation	Mutation in 3' untranslated region → ↑ production of prothrombin → ↑ plasma levels and venous clots.

FAS1_2019_10-HemaOncol.indd 428 11/7/19 5:05 PM

► HEMATOLOGY AND ONCOLOGY—PATHOLOGY **HEMATOLOGY AND ONCOLOGY**

Blood transfusion therapy

COMPONENT	DOSAGE EFFECT	CLINICAL USE	
Packed RBCs	† Hb and O ₂ carrying capacity	Acute blood loss, severe anemia Stop significant bleeding (thrombocytopenia, qualitative platelet defects) Cirrhosis, immediate anticoagulation reversal	
Platelets	† platelet count († ~ 5000/mm³/unit)		
Fresh frozen plasma/prothrombin complex concentrate	† coagulation factor levels; FFP contains all coagulation factors and plasma proteins; PCC generally contains factors II, VII, IX, and X, as well as protein C and S		
Cryoprecipitate	Contains fibrinogen, factor VIII, factor XIII, vWF, and fibronectin	Coagulation factor deficiencies involving fibrinogen and factor VIII	

Blood transfusion risks include infection transmission (low), transfusion reactions, iron overload (may lead to 2° hemochromatosis), hypocalcemia (citrate is a Ca²⁺ chelator), and hyperkalemia (RBCs may lyse in old blood units).

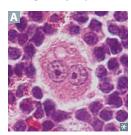
Leukemia vs lymphoma

Leukemia	Lymphoid or myeloid neoplasm with widespread involvement of bone marrow. Tumor cells are usually found in peripheral blood.
Lymphoma	Discrete tumor mass arising from lymph nodes. Presentations often blur definitions.

Hodgkin vs non-Hodgkin lymphoma

Hodgkin	Non-Hodgkin
Both may present with constitutional ("B") signs/loss.	symptoms: low-grade fever, night sweats, weight
Localized, single group of nodes with contiguous spread (stage is strongest predictor of prognosis). Better prognosis.	Multiple lymph nodes involved; extranodal involvement common; noncontiguous spread. Worse prognosis.
Characterized by Reed-Sternberg cells.	Majority involve B cells; a few are of T-cell lineage.
Bimodal distribution: young adulthood and > 55 years; more common in men except for nodular sclerosing type.	Can occur in children and adults.
Associated with EBV.	May be associated with autoimmune diseases and viral infections (eg, HIV, EBV, HTLV).

Hodgkin lymphoma



Contains Reed-Sternberg cells: distinctive tumor giant cells; binucleate or bilobed with the 2 halves as mirror images ("owl eyes" A). RS cells are CD15+ and CD30+ B-cell origin. 2 owl eyes \times 15 = 30.

9
NOTES
Most common
Best prognosis
Eosinophilia, seen in immunocompromised patients
Seen in immunocompromised patients

FAS1_2019_10-HemaOncol.indd 429 11/7/19 5:05 PM

Non-Hodgkin lymphoma

TYPE	OCCURS IN	GENETICS	COMMENTS
Neoplasms of mature B c	ells		
Burkitt lymphoma	Adolescents or young adults	t(8;14)—translocation of c-myc (8) and heavy-chain Ig (14)	"Starry sky" appearance, sheets of lymphocytes with interspersed "tingible body" macrophages (arrows in A). Associated with EBV. Jaw lesion B in endemic form in Africa; pelvis or abdomen in sporadic form.
Diffuse large B-cell lymphoma	Usually older adults, but 20% in children	Mutations in BCL-2, BCL-6	Most common type of non-Hodgkin lymphoma in adults.
Follicular lymphoma	Adults	t(14;18)—translocation of heavy-chain Ig (14) and <i>BCL</i> -2 (18)	Indolent course with painless "waxing and waning" lymphadenopathy. Bcl-2 normally inhibits apoptosis.
Mantle cell lymphoma	Adult males >> adult females	t(11;14)—translocation of cyclin D1 (11) and heavy-chain Ig (14), CD5+	Very aggressive, patients typically present with late-stage disease.
Marginal zone lymphoma	Adults	t(11;18)	Associated with chronic inflammation (eg, Sjögren syndrome, chronic gastritis [MALT lymphoma]).
Primary central nervous system lymphoma	Adults	EBV related; associated with HIV/ AIDS	Considered an AIDS-defining illness. Variable presentation: confusion, memory loss, seizures. CNS mass (often single, ring-enhancing lesion on MRI) in immunocompromised patients C, needs to be distinguished from toxoplasmosis via CSF analysis or other lab tests.
Neoplasms of mature T c	ells		
Adult T-cell lymphoma	Adults	Caused by HTLV (associated with IV drug abuse)	Adults present with cutaneous lesions; common in Japan (T-cell in Tokyo), West Africa, and the Caribbean. Lytic bone lesions, hypercalcemia.
Mycosis fungoides/ Sézary syndrome	Adults		Mycosis fungoides: skin patches and plaques (cutaneous T-cell lymphoma), characterized by atypical CD4+ cells with "cerebriform" nuclei and intraepidermal neoplastic cell aggregates (Pautrier microabscess). May progress to Sézary syndrome (T-cell leukemia).
	A R	B	D N N N N N N N N N N N N N N N N N N N

FAS1_2019_10-HemaOncol.indd 430 11/7/19 5:05 PM

HEMATOLOGY AND ONCOLOGY ► HEMATOLOGY AND ONCOLOGY—PATHOLOGY

Plasma cell dyscrasias

M spike → $\overline{\text{Albumin}}$ α_1 α_2 β

Characterized by monoclonal immunoglobulin (Ig) overproduction due to plasma cell disorder. Labs: serum protein electrophoresis (SPEP) or free light chain (FLC) assay for initial tests (M spike on SPEP represents overproduction of a monoclonal Ig fragment). For urinalysis, use 24-hr urine protein electrophoresis (UPEP) to detect light chain, as routine urine dipstick detects only albumin.

Confirm with bone marrow biopsy.

Multiple myeloma

Overproduction of IgG (55% of cases) > IgA.

Clinical features: CRAB

- HyperCalcemia
- Renal involvement
- Anemia
- Bone lytic lesions ("punched out" on X-ray A) → Back pain.

Peripheral blood smear shows Rouleaux formation B (RBCs stacked like poker chips).

Urinalysis shows Ig light chains (Bence Jones proteinuria) with Θ urine dipstick.

Bone marrow analysis shows > 10% monoclonal plasma cells with clock-face chromatin [and intracytoplasmic inclusions containing IgG.

Complications: † infection risk, 1° amyloidosis (AL).

Waldenstrom macroglobulinemia

Overproduction of IgM (macroglobulinemia because IgM is the largest Ig).

Clinical features:

- Peripheral neuropathy
- No CRAB findings
- Hyperviscosity syndrome:
 - Headache
 - Blurry vision
 - Raynaud phenomenon
 - Retinal hemorrhages

Bone marrow analysis shows >10% small lymphocytes with IgM-containing vacuoles (lymphoplasmacytic lymphoma).

Complication: thrombosis.

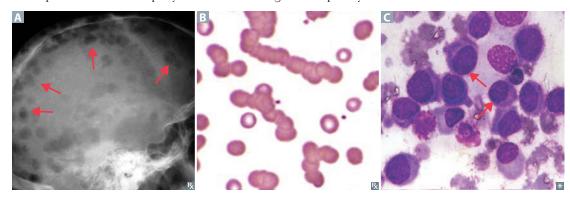
Monoclonal gammopathy of undetermined significance

Overproduction of any Ig type.

Usually asymptomatic. No CRAB findings.

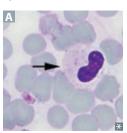
Bone marrow analysis shows < 10% monoclonal plasma cells.

Complication: 1-2% risk per year of transitioning to multiple myeloma.



FAS1 2019 10-HemaOncol.indd 431 11/7/19 5:05 PM

Myelodysplastic **syndromes**



Stem cell disorders involving ineffective hematopoiesis → defects in cell maturation of nonlymphoid lineages. Caused by de novo mutations or environmental exposure (eg, radiation, benzene, chemotherapy). Risk of transformation to AML.

Pseudo-Pelger-Huet anomaly—neutrophils with bilobed ("duet") nuclei A. Typically seen after chemotherapy.

Leukemias

Unregulated growth and differentiation of WBCs in bone marrow → marrow failure → anemia (\dagger RBCs), infections (\dagger mature WBCs), and hemorrhage (\dagger platelets). Usually presents with † circulating WBCs (malignant leukocytes in blood); rare cases present with normal/4 WBCs. Leukemic cell infiltration of liver, spleen, lymph nodes, and skin (leukemia cutis) possible.

TYPE

NOTES

Lymphoid neoplasms

Acute lymphoblastic leukemia/lymphoma

Most frequently occurs in children; less common in adults (worse prognosis). T-cell ALL can present as mediastinal mass (presenting as SVC-like syndrome). Associated with Down syndrome. Peripheral blood and bone marrow have 111 lymphoblasts A.

TdT+ (marker of pre-T and pre-B cells), CD10+ (marker of pre-B cells).

Most responsive to therapy. May spread to CNS and testes. $t(12;21) \rightarrow better prognosis.$

Chronic lymphocytic leukemia/small lymphocytic

Age > 60 years. Most common adult leukemia. CD20+, CD23+, CD5+ B-cell neoplasm. Often asymptomatic, progresses slowly; smudge cells B in peripheral blood smear; autoimmune hemolytic anemia. CLL = Crushed Little Lymphocytes (smudge cells).

Richter transformation—CLL/SLL transformation into an aggressive lymphoma, most commonly diffuse large B-cell lymphoma (DLBCL).

Hairy cell leukemia

lymphoma

Adult males. Mature B-cell tumor. Cells have filamentous, hair-like projections (fuzzy appearing on LM C). Peripheral lymphadenopathy is uncommon.

Causes marrow fibrosis → dry tap on aspiration. Patients usually present with massive splenomegaly and pancytopenia.

Stains TRAP (tartrate-resistant acid phosphatase) \oplus (trapped in a hairy situation). TRAP stain largely replaced with flow cytometry. Associated with BRAF mutations. Treatment: cladribine, pentostatin.

Myeloid neoplasms

Acute myelogenous leukemia

Median onset 65 years. Auer rods □; myeloperoxidase ⊕ cytoplasmic inclusions seen mostly in APL (formerly M3 AML); ††† circulating myeloblasts on peripheral smear.

Risk factors: prior exposure to alkylating chemotherapy, radiation, myeloproliferative disorders, Down syndrome. APL: t(15;17), responds to all-trans retinoic acid (vitamin A) and arsenic, which induce differentiation of promyelocytes; DIC is a common presentation.

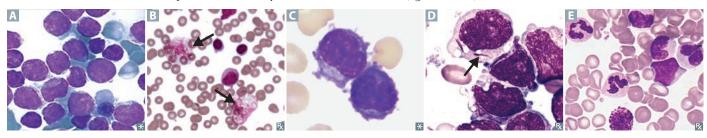
FAS1 2019 10-HemaOncol.indd 432 11/7/19 5:05 PM

Leukemias (continued)

Chronic myelogenous leukemia

Peak incidence: 45—85 years; median age: 64 years. Defined by the Philadelphia chromosome (t[9;22], BCR-ABL) and myeloid stem cell proliferation. Presents with dysregulated production of mature and maturing granulocytes (eg, neutrophils, metamyelocytes, myelocytes, basophils E) and splenomegaly. May accelerate and transform to AML or ALL ("blast crisis").

Very low leukocyte alkaline phosphatase (LAP) as a result of low activity in malignant neutrophils, vs benign neutrophilia (leukemoid reaction) in which LAP is † due to † leukocyte count with neutrophilia in response to stressors (eg, infections, medications, severe hemorrhage). Responds to ber-abl tyrosine kinase inhibitors (eg, imatinib).



Chronic myeloproliferative disorders

Malignant hematopoietic neoplasms with varying impacts on WBCs and myeloid cell lines.

Polycythemia vera

Primary polycythemia. Disorder of † RBCs, usually due to acquired *JAK2* mutation. May present as intense itching after shower (aquagenic pruritus). Rare but classic symptom is erythromelalgia (severe, burning pain and red-blue coloration) due to episodic blood clots in vessels of the extremities A.

↓ EPO (vs 2° polycythemia, which presents with endogenous or artificially † EPO). Treatment: phlebotomy, hydroxyurea, ruxolitinib (JAK1/2 inhibitor).

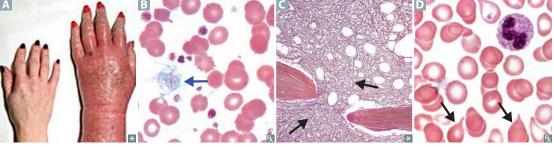
Essential thrombocythemia

Characterized by massive proliferation of megakaryocytes and platelets. Symptoms include bleeding and thrombosis. Blood smear shows markedly increased number of platelets, which may be large or otherwise abnormally formed **B**. Erythromelalgia may occur.

Myelofibrosis

Obliteration of bone marrow with fibrosis \(\bigcirc\) due to \(\bigcirc\) fibroblast activity. Associated with massive splenomegaly and "teardrop" RBCs \(\bigcirc\). "Bone marrow cries because it's fibrosed and is a dry tap."

	1 0 .	1			/ I
	RBCs	WBCs	PLATELETS	PHILADELPHIA CHROMOSOME	JAK2 MUTATIONS
Polycythemia vera	†	1	†	\ominus	\oplus
Essential thrombocythemia	-	_	†	Θ	⊕ (30–50%)
Myelofibrosis	1	Variable	Variable	\ominus	⊕ (30–50%)
CML	Ţ	†	†	\oplus	\ominus



FAS1_2019_10-HemaOncol.indd 433 11/7/19 5:05 PM

Polycythemia

	PLASMA VOLUME	RBC MASS	O ₂ SATURATION	EPO LEVELS	ASSOCIATIONS
Relative	4	_	_	_	Dehydration, burns.
Appropriate absolute	-	1	1	†	Lung disease, congenital heart disease, high altitude.
Inappropriate absolute	-	†	-	†	Exogenous EPO: athlete abuse ("blood doping"). Inappropriate EPO secretion: malignancy (eg, renal cell carcinoma, hepatocellular carcinoma).
Polycythemia vera	1	††	_	ţ	EPO ↓ in PCV due to negative feedback suppressing renal EPO production.

HEMATOLOGY AND ONCOLOGY

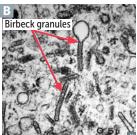
Chromosomal translocations

TRANSLOCATION	ASSOCIATED DISORDER	NOTES
t(8;14)	Burkitt (Burk-8) lymphoma (c-myc activation)	The Ig heavy chain genes on chromosome 14
t(11;14)	Mantle cell lymphoma (cyclin Dl activation)	are constitutively expressed. When other
t(11;18)	Marginal zone lymphoma	genes (eg, <i>c-myc</i> and <i>BCL-2</i>) are translocated next to this heavy chain gene region, they are
t(14;18)	Follicular lymphoma (BCL-2 activation)	overexpressed.
t(15;17)	APL (M3 type of AML; responds to all-trans retinoic acid)	
t(9;22) (Philadelphia chromosome)	CML (BCR-ABL hybrid), ALL (less common, poor prognostic factor); Philadelphia CreaML cheese	

Langerhans cell histiocytosis

Collective group of proliferative disorders of Langerhans cells. Presents in a child as lytic bone lesions and skin rash or as recurrent otitis media with a mass involving the mastoid bone. Cells are functionally immature and do not effectively stimulate primary T cells via antigen presentation. Cells express S-100 (mesodermal origin) and CDla. Birbeck granules ("tennis rackets" or rod shaped on EM) are characteristic .

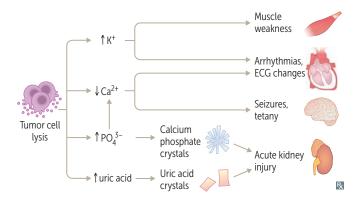




FAS1_2019_10-HemaOncol.indd 434 11/7/19 5:05 PM

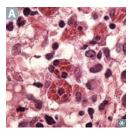
[↑] = 1° disturbance

Tumor lysis syndrome



Oncologic emergency triggered by massive tumor cell lysis, most often in lymphomas/ leukemias. Release of K⁺ → hyperkalemia, release of PO₄ ³⁻ → hyperphosphatemia, hypocalcemia due to Ca²⁺ sequestration by PO₄ ³⁻. ↑ nucleic acid breakdown → hyperuricemia → acute kidney injury. Prevention and treatment include aggressive hydration, allopurinol, rasburicase.

Hemophagocytic lymphohistiocytosis



Systemic overactivation of macrophages and cytotoxic T cells → fever, pancytopenia, hepatosplenomegaly, ↑↑↑ serum ferritin levels. Can be inherited or 2° to strong immunologic activation (eg, after EBV infection, malignancy). Bone marrow biopsy shows macrophages phagocytosing marrow elements A.

► HEMATOLOGY AND ONCOLOGY—PHARMACOLOGY

Direct thrombin inhibitors	Bivalirudin, Argatroban, Dabigatran (only oral agent in class). Directly inhibits activity of free and clot-associated thrombin.	
MECHANISM		
CLINICAL USE	Venous thromboembolism, atrial fibrillation. Can be used in HIT, when heparin is BAD for the patient. Does not require lab monitoring.	
ADVERSE EFFECTS	Bleeding; can reverse dabigatran with idarucizumab. Consider PCC and/or antifibrinolytics (eg, tranexamic acid) if no reversal agent available.	

FAS1_2019_10-HemaOncol.indd 435 11/7/19 5:05 PM

Heparin

Heparin				
MECHANISM	Activates antithrombin, which ↓ action of IIa (thro	ombin) and factor Xa. Short half-life.		
CLINICAL USE	Immediate anticoagulation for pulmonary embolism (PE), acute coronary syndrome, MI, deep venous thrombosis (DVT). Used during pregnancy (does not cross placenta). Follow PTT.			
ADVERSE EFFECTS	Bleeding, thrombocytopenia (HIT), osteoporosis, drug-drug interactions. For rapid reversal (antidote), use protamine sulfate (positively charged molecule that binds negatively charged heparin).			
NOTES	Fondaparinux acts only on factor Xa. Have bette unfractionated heparin; can be administered sul	Low-molecular-weight heparins (eg, enoxaparin, dalteparin)—act predominantly on factor Xa. Fondaparinux acts only on factor Xa. Have better bioavailability and 2–4× longer half life than unfractionated heparin; can be administered subcutaneously and without laboratory monitoring. LMWHs undergo renal clearance (vs hepatic clearance of unfractionated heparin) and are contraindicated in renal insufficiency. Not easily reversible		
	Heparin-induced thrombocytopenia (HIT) type 2 —development of IgG antibodies against heparin-bound platelet factor 4 (PF4). Antibody-heparin-PF4 complex activates platelets → thrombosis and thrombocytopenia. Highest risk with unfractionated heparin. HIT type 1 characterized by nonimmunologic milder drop in platelet count, usually asymptomatic.			
Varfarin				
MECHANISM	Inhibits epoxide reductase, which interferes with γ-carboxylation of vitamin K-dependent clotting factors II, VII, IX, X, and proteins C, S. Metabolism affected by polymorphisms in the gene for vitamin K epoxide reductase complex (VKORCI). In laboratory assay, has effect on EXtrinsic pathway and ↑ PT. Long half-life.	The EX-PresidenT went to war(farin).		
CLINICAL USE	Chronic anticoagulation (eg, venous thromboembolism prophylaxis, and prevention of stroke in atrial fibrillation). Not used in pregnant women (because warfarin, unlike heparin, crosses placenta). Follow PT/INR.			
ADVERSE EFFECTS A	Bleeding, teratogenic, skin/tissue necrosis A, drug-drug interactions. Initial risk of hypercoagulation: protein C has a shorter half-life than factors II and X. Existing protein C depletes before existing factors II and X deplete, and before warfarin can reduce factors II and X production → hypercoagulation. Skin/tissue necrosis within first few days of large doses believed to be due to small vessel microthrombosis.	For reversal of warfarin, give vitamin K. For rapid reversal, give fresh frozen plasma (FFP) or PCC. Heparin "bridging": heparin frequently used when starting warfarin. Heparin's activation of antithrombin enables anticoagulation during initial, transient hypercoagulable state caused by warfarin. Initial heparin therapy reduces risk of recurrent venous thromboembolism and skin/tissue necrosis.		

FAS1_2019_10-HemaOncol.indd 436 11/7/19 5:05 PM

Metabolized by cytochrome P-450.

Heparin vs warfarin

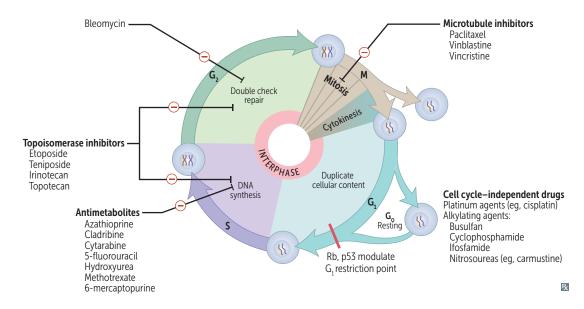
	Heparin	Warfarin	
ROUTE OF ADMINISTRATION	Parenteral (IV, SC)	Oral	
SITE OF ACTION	Blood	Liver	
ONSET OF ACTION	Rapid (seconds)	Slow, limited by half-lives of normal clotting factors	
MECHANISM OF ACTION	Activates antithrombin, which ↓ the action of IIa (thrombin) and factor Xa	Impairs synthesis of vitamin K-dependent clotting factors II, VII, IX, and X, and anticlotting proteins C and S	
DURATION OF ACTION	Hours	Days	
AGENTS FOR REVERSAL	Protamine sulfate	Vitamin K, FFP, PCC	
MONITORING	PTT (intrinsic pathway)	PT/INR (extrinsic pathway)	
CROSSES PLACENTA	No	Yes (teratogenic)	
Direct factor Xa inhibitors	Api Xa ban, rivaro Xa ban.		
MECHANISM	Bind to and directly inhibit factor Xa.		
CLINICAL USE	Treatment and prophylaxis for DVT and PE; stro Oral agents do not usually require coagulation r	oke prophylaxis in patients with atrial fibrillation. nonitoring.	
ADVERSE EFFECTS	Bleeding. Reverse with andeXanet alfa.		
Thrombolytics	Alteplase (tPA), reteplase (rPA), streptokinase, ter	necteplase (TNK-tPA).	
MECHANISM	Directly or indirectly aid conversion of plasminogen to plasmin, which cleaves thrombin and fibrin clots. † PT, † PTT, no change in platelet count.		
CLINICAL USE	Early MI, early ischemic stroke, direct thrombol	ysis of severe PE.	
ADVERSE EFFECTS	Bleeding. Contraindicated in patients with active recent surgery, known bleeding diatheses, or see antifibrinolytics (eg, aminocaproic acid, tranex corrections (eg, cryoprecipitate, FFP, PCC).	evere hypertension. Nonspecific reversal with	
ADP receptor inhibitors	Clopidogrel, prasugrel, ticagrelor (reversible), tic	lopidine.	
MECHANISM	Irreversibly block ADP (P2Y ₁₂) receptor, which prevents subsequent platelet aggregation. Prevent expression of glycoproteins IIb/IIIa on platelet surface.		
CLINICAL USE	Acute coronary syndrome; coronary stenting. ↓ incidence or recurrence of thrombotic stroke.		
ADVERSE EFFECTS	Neutropenia (ticlopidine). TTP may be seen.		

FAS1_2019_10-HemaOncol.indd 437 11/7/19 5:05 PM

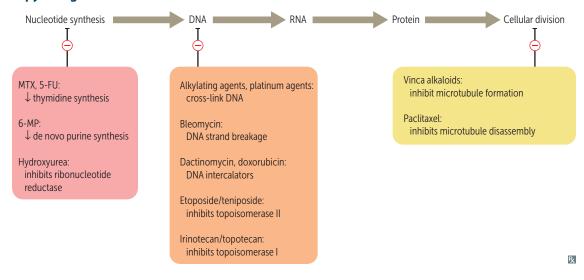
Glycoprotein IIb/IIIa

inhibitors	Abciximab, eptifibatide, tirofiban.
MECHANISM	Bind to the glycoprotein receptor IIb/IIIa (fibrinogen receptor) on activated platelets, preventing aggregation. Abciximab is made from monoclonal antibody Fab fragments.
CLINICAL USE	Unstable angina, percutaneous coronary intervention.
ADVERSE EFFECTS	Bleeding, thrombocytopenia.

Cancer therapy—cell cycle



Cancer therapy—targets



FAS1_2019_10-HemaOncol.indd 438 11/7/19 5:05 PM

Antitumor antibiotics

DRUG	MECHANISM	CLINICAL USE	ADVERSE EFFECTS
Bleomycin	Induces free radical formation → breaks in DNA strands.	Testicular cancer, Hodgkin lymphoma.	Pulmonary fibrosis, skin hyperpigmentation. Minimal myelosuppression.
Dactinomycin (actinomycin D)	Intercalates into DNA, preventing RNA synthesis.	Wilms tumor, Ewing sarcoma, rhabdomyosarcoma. Used for childhood tumors.	Myelosuppression.
Anthracyclines (eg, doxorubicin, daunorubicin)	Generate free radicals. Intercalate in DNA → breaks in DNA → ↓ replication. Interferes with topoisomerase II enzyme.	Solid tumors, leukemias, lymphomas.	Cardiotoxicity (dilated cardiomyopathy), myelosuppression, alopecia. Dexrazoxane (iron chelating agent) used to prevent cardiotoxicity.

FAS1_2019_10-HemaOncol.indd 439 11/7/19 5:05 PM

Antimetabolites

DRUG	MECHANISM ^a	CLINICAL USE	ADVERSE EFFECTS
Azathioprine, 6-mercaptopurine	Purine (thiol) analogs → ↓ de novo purine synthesis. Activated by HGPRT. Azathioprine is metabolized into 6-MP.	Preventing organ rejection, rheumatoid arthritis, IBD, SLE; used to wean patients off steroids in chronic disease and to treat steroid-refractory chronic disease.	Myelosuppression; GI, liver toxicity. Azathioprine and 6-MP are metabolized by xanthine oxidase; thus both have † risk of toxicity with allopurinol or febuxostat.
Cladribine	Purine analog → multiple mechanisms (eg, inhibition of DNA polymerase, DNA strand breaks).	Hairy cell leukemia.	Myelosuppression, nephrotoxicity, and neurotoxicity.
Cytarabine (arabinofuranosyl cytidine)	Pyrimidine analog → DNA chain termination. At higher concentrations, inhibits DNA polymerase.	Leukemias (AML), lymphomas.	Myelosuppression with megaloblastic anemia. CYTarabine causes panCYTopenia.
5-fluorouracil	Pyrimidine analog bioactivated to 5-FdUMP, which covalently complexes with thymidylate synthase and folic acid. Capecitabine is a prodrug. This complex inhibits thymidylate synthase → ↓ dTMP → ↓ DNA synthesis.	Colon cancer, pancreatic cancer, actinic keratosis, basal cell carcinoma (topical). Effects enhanced with the addition of leucovorin.	Myelosuppression, palmar- plantar erythrodysesthesia (hand-foot syndrome).
Methotrexate	Folic acid analog that competitively inhibits dihydrofolate reductase → ↓ dTMP → ↓ DNA synthesis.	Cancers: leukemias (ALL), lymphomas, choriocarcinoma, sarcomas. Non-neoplastic: ectopic pregnancy, medical abortion (with misoprostol), rheumatoid arthritis, psoriasis, IBD, vasculitis.	Myelosuppression, which is reversible with leucovorin (folinic acid) "rescue." Hepatotoxicity. Mucositis (eg, mouth ulcers). Pulmonary fibrosis. Folate deficiency, which may be teratogenic (neural tube defects) without supplementation. Nephrotoxicity.

^aAll are S-phase specific except cladribine, which is cell cycle nonspecific.

FAS1_2019_10-HemaOncol.indd 440 11/7/19 5:05 PM

Alkylating agents

DRUG	MECHANISM	CLINICAL USE	ADVERSE EFFECTS
Busulfan	Cross-links DNA.	Used to ablate patient's bone marrow before bone marrow transplantation.	Severe myelosuppression (in almost all cases), pulmonary fibrosis, hyperpigmentation.
Cyclophosphamide, ifosfamide	Cross-link DNA at guanine. Require bioactivation by liver. A nitrogen mustard.	Solid tumors, leukemia, lymphomas, rheumatic disease (eg, SLE, granulomatosis with polyangiitis).	Myelosuppression; SIADH; Fanconi syndrome (ifosfamide); hemorrhagic cystitis and bladder cancer, prevented with mesna (sulfhydryl group of mesna binds toxic metabolites) and adequate hydration.
Nitrosoureas (eg, carmustine, lomustine)	Require bioactivation. Cross blood-brain barrier → CNS. Cross-link DNA.	Brain tumors (including glioblastoma multiforme).	CNS toxicity (convulsions, dizziness, ataxia).
Procarbazine	Cell cycle phase–nonspecific alkylating agent, mechanism unknown. Also a weak MAO inhibitor.	Hodgkin lymphoma, brain tumors.	Bone marrow suppression, pulmonary toxicity, leukemia, disulfiram-like reaction, tyramine-induced hypertensive crisis with consumption of tyramine-rich foods (eg, aged cheese, wine, fava beans).

Microtubule inhibitors

DRUG	MECHANISM	CLINICAL USE	ADVERSE EFFECTS
Paclitaxel, other taxanes	Hyperstabilize polymerized microtubules in M phase so that mitotic spindle cannot break down (anaphase cannot occur).	Ovarian and breast carcinomas.	Myelosuppression, neuropathy, hypersensitivity. Taxes stabilize society.
Vincristine, vinblastine	Vinca alkaloids that bind β-tubulin and inhibit its polymerization into microtubules → prevent mitotic spindle formation (M-phase arrest).	Solid tumors, leukemias, Hodgkin and non-Hodgkin lymphomas.	Vincristine: neurotoxicity (areflexia, peripheral neuritis), constipation (including paralytic ileus). Crisps the nerves. Vinblastine: bone marrow suppression. Blasts the bone marrow.

FAS1_2019_10-HemaOncol.indd 441 11/7/19 5:05 PM

ADVERSE EFFECTS

Cisplatin, carboplatin, oxaliplatin

Cisplatin, carbopla	atin, oxaliplatin
MECHANISM	Cross-link DNA.
CLINICAL USE	Testicular, bladder, ovary, GI, and lung carcinomas.
ADVERSE EFFECTS	Nephrotoxicity (including Fanconi syndrome), peripheral neuropathy, ototoxicity. Prevent nephrotoxicity with amifostine (free radical scavenger) and chloride (saline) diuresis.
Etoposide, tenipos	side
MECHANISM	Inhibit topoisomerase II \rightarrow † DNA degradation (cell cycle arrest in G_2 and S phases).
CLINICAL USE	Solid tumors (particularly testicular and small cell lung cancer), leukemias, lymphomas.
ADVERSE EFFECTS	Myelosuppression, alopecia.
lrinotecan, topote	can
MECHANISM	Inhibit topoisomerase I and prevent DNA unwinding and replication.
CLINICAL USE	Colon cancer (irinotecan); ovarian and small cell lung cancers (topotecan).
ADVERSE EFFECTS	Severe myelosuppression, diarrhea.
Hydroxyurea	
MECHANISM	Inhibits ribonucleotide reductase → ↓ DNA Synthesis (S-phase specific).
CLINICAL USE	Myeloproliferative disorders (eg, CML, polycythemia vera), sickle cell disease († HbF).
ADVERSE EFFECTS	Severe myelosuppression, megaloblastic anemia.
Bevacizumab	
MECHANISM	Monoclonal antibody against VEGF. Inhibits angiogenesis (BeVacizumab inhibits Blood Vessel formation).
CLINICAL USE	Solid tumors (eg, colorectal cancer, renal cell carcinoma), wet age-related macular degeneration.
ADVERSE EFFECTS	Hemorrhage, blood clots, and impaired wound healing.
Erlotinib	
MECHANISM	EGFR tyrosine kinase inhibitor.
CLINICAL USE	Non-small cell lung cancer.
ADVERSE EFFECTS	Rash, diarrhea.
Cetuximab, panitu	umumab
MECHANISM	Monoclonal antibodies against EGFR.
CLINICAL USE	Stage IV colorectal cancer (wild-type KRAS), head and neck cancer.

FAS1_2019_10-HemaOncol.indd 442 11/7/19 5:05 PM

Rash, elevated LFTs, diarrhea.

ADVERSE EFFECTS

MECHANISM	Tyrosine kinase inhibitors of bcr-abl (encoded by Philadelphia chromosome fusion gene in CI and c-kit (common in GI stromal tumors).		
CLINICAL USE	CML, GI stromal tumors (GISTs).		
ADVERSE EFFECTS	Fluid retention.		
Rituximab			
MECHANISM	Monoclonal antibody against CD20, which is found on most B-cell neoplasms.		
CLINICAL USE	Non-Hodgkin lymphoma, CLL, ITP, rheumatoid arthritis, TTP, AIHA.		
ADVERSE EFFECTS	† risk of progressive multifocal leukoencephalopathy.		
Bortezomib, carfilz	omib		
MECHANISM	Proteasome inhibitors, induce arrest at G2-M phase and apoptosis.		
CLINICAL USE	Multiple myeloma, mantle cell lymphoma.		
ADVERSE EFFECTS	Peripheral neuropathy, herpes zoster reactivation.		
Tamoxifen, raloxife	ne		
MECHANISM	Selective estrogen receptor modulators (SERMs)—receptor antagonists in breast and agonists i bone. Block the binding of estrogen to ER \oplus cells.		
CLINICAL USE	Breast cancer treatment (tamoxifen only) and prevention. Raloxifene also useful to prevent osteoporosis.		
ADVERSE EFFECTS	Tamoxifen—partial agonist in endometrium, which † the risk of endometrial cancer. Raloxifene—no † in endometrial carcinoma (so you can relax!), because it is an estrogen receptor antagonist in endometrial tissue.		
	Both † risk of thromboembolic events (eg, DVT, PE) and "hot flashes."		
Trastuzumab			
MECHANISM	Monoclonal antibody against HER-2 (<i>c-erbB2</i>), a tyrosine kinase receptor. Helps kill cancer cell that overexpress HER-2 through inhibition of HER-2 initiated cellular signaling and antibody dependent cytotoxicity.		

FAS1_2019_10-HemaOncol.indd 443 11/7/19 5:05 PM

Dilated cardiomyopathy. "Heartceptin" damages the heart.

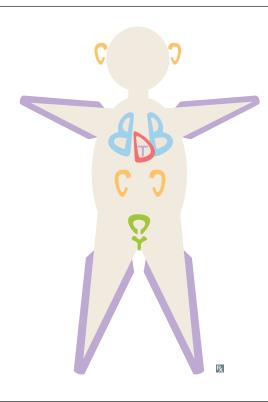
Dabrafenib, vemurafenib

MECHANISM	Small molecule inhibitors of <i>BRAF</i> oncogene ⊕ melanoma. VEmuRAF-enib is for V 600 E-mu tated <i>BRAF</i> inhibition. Often co-administered with MEK inhibitors (eg, trametinib).
CLINICAL USE	Metastatic melanoma.

Rasburicase

MECHANISM	Recombinant uricase that catalyzes metabolism of uric acid to allantoin.
CLINICAL USE	Prevention and treatment of tumor lysis syndrome.

Key chemotoxicities



Cisplatin/Carboplatin → ototoxicity

Vincristine → peripheral neuropathy
Bleomycin, Busulfan → pulmonary fibrosis
Doxorubicin → cardiotoxicity
Trastuzumab → cardiotoxicity
Cisplatin/Carboplatin → nephrotoxicity

CYclophosphamide → hemorrhagic cystitis

Nonspecific common toxicities of nearly all cytotoxic chemotherapies include myelosuppression (neutropenia, anemia, thrombocytopenia), GI toxicity (nausea, vomiting, mucositis), alopecia.

FAS1_2019_10-HemaOncol.indd 444 11/7/19 5:05 PM

HIGH-YIELD SYSTEMS

Musculoskeletal, Skin, and Connective Tissue

"Rigid, the skeleton of habit alone upholds the human frame."

-Virginia Woolf

"Beauty may be skin deep, but ugly goes clear to the bone."

—Redd Foxx

"The function of muscle is to pull and not to push, except in the case of the genitals and the tongue."

—Leonardo da Vinci

"To thrive in life you need three bones. A wishbone. A backbone. And a funny bone."

-Reba McEntire

This chapter provides information you will need to understand certain anatomical dysfunctions, rheumatic diseases, and dermatologic conditions. Be able to interpret 3D anatomy in the context of radiologic imaging. For the rheumatic diseases, create instructional cases or personas that include the most likely presentation and symptoms: risk factors, gender, important markers (eg, autoantibodies), and other epidemiologic factors. Doing so will allow you to answer the higher order questions that are likely to be asked on the exam.

Anatomy and Physiology	446
▶ Pathology	459
▶ Dermatology	473
▶ Pharmacology	485

FAS1_2019_11-Musculo.indd 445 11/7/19 5:23 PM

▶ MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE—ANATOMY AND PHYSIOLOGY

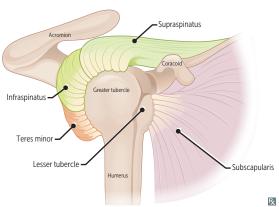
Rotator cuff muscles



Shoulder muscles that form the rotator cuff:

- Supraspinatus (suprascapular nerve)—
 abducts arm initially (before the action
 of the deltoid); most common rotator
 cuff injury (trauma or degeneration and
 impingement → tendinopathy or tear [arrow
 in A]), assessed by "empty/full can" test
- Infraspinatus (suprascapular nerve) externally rotates arm; pitching injury
- teres minor (axillary nerve)—adducts and externally rotates arm
- Subscapularis (upper and lower subscapular nerves)—internally rotates and adducts arm Innervated primarily by C5-C6.

SItS (small t is for teres minor).



Arm abduction

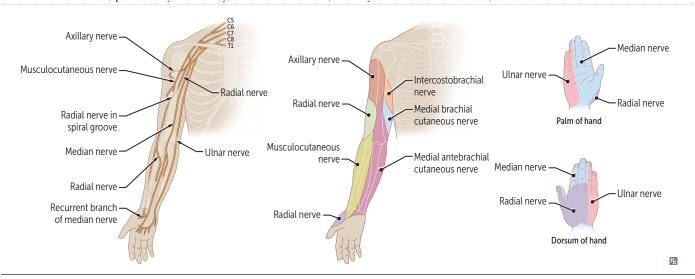
DEGREE	MUSCLE	NERVE
0°-15°	Supraspinatus	Suprascapular
15°-100°	Deltoid	Axillary
> 90°	Trapezius	Accessory
> 100°	Serratus Anterior	Long Thoracic (SALT)

FAS1_2019_11-Musculo.indd 446 11/7/19 5:23 PM

Upper extremity nerves

NERVE	CAUSES OF INJURY	PRESENTATION
Axillary (C5-C6)	Fractured surgical neck of humerus Anterior dislocation of humerus	Flattened deltoid Loss of arm abduction at shoulder (> 15°) Loss of sensation over deltoid and lateral arm
Musculocutaneous (C5-C7)	Upper trunk compression	↓ biceps (C5-6) reflex Weakness of forearm flexion and supination Loss of sensation over lateral forearm
Radial (C5-T1)	Compression of axilla, eg, due to crutches or sleeping with arm over chair ("Saturday night palsy") Midshaft fracture of humerus Repetitive pronation/supination of forearm, eg, due to screwdriver use ("finger drop")	Wrist drop: loss of elbow, wrist, and finger extension ↓ grip strength (wrist extension necessary for maximal action of flexors) Loss of sensation over posterior arm/forearm and dorsal hand
Median (C5-T1)	Supracondylar fracture of humerus → proximal lesion of the nerve Carpal tunnel syndrome and wrist laceration → distal lesion of the nerve	"Ape hand" and "Pope's blessing" Loss of wrist flexion, flexion of lateral fingers, thumb opposition, lumbricals of index and middle fingers Loss of sensation over thenar eminence and dorsal and palmar aspects of lateral 3½ fingers with proximal lesion
Ulnar (C8-T1)	Fracture of medial epicondyle of humerus "funny bone" (proximal lesion) Fractured hook of hamate (distal lesion) from fall on outstretched hand	"Ulnar claw" on digit extension Radial deviation of wrist upon flexion (proximal lesion) Loss of wrist flexion, flexion of medial fingers, abduction and adduction of fingers (interossei), actions of medial 2 lumbrical muscles Loss of sensation over medial 11/2 fingers including hypothenar eminence
Recurrent branch of median nerve (C5-T1)	Superficial laceration of palm	"Ape hand" Loss of thenar muscle group: opposition, abduction, and flexion of thumb No loss of sensation

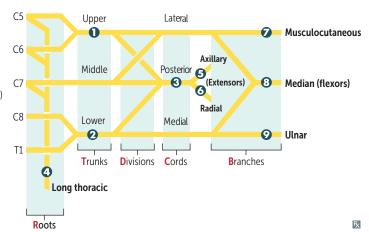
Humerus fractures, proximally to distally, follow the ARM (Axillary → Radial → Median)



FAS1_2019_11-Musculo.indd 447 11/7/19 5:23 PM

Brachial plexus lesions

- Erb palsy ("waiter's tip")
- Klumpke palsy (claw hand)
- 3 Wrist drop
- Winged scapula
- **6** Deltoid paralysis
- "Saturday night palsy" (wrist drop)
- Difficulty flexing elbow, variable sensory loss
- ② Decreased thumb function, "Pope's blessing"
- ② Intrinsic muscles of hand, claw hand



Randy Travis Drinks Cold Beer

CONDITION	INJURY	CAUSES	MUSCLE DEFICIT	FUNCTIONAL DEFICIT	PRESENTATION
Erb palsy ("waiter's tip")	Traction or tear of upper trunk: traction on neck during delivery Adults—trauma	traction on neck	Deltoid, supraspinatus	Abduction (arm hangs by side)	
		Infraspinatus	Lateral rotation (arm medially rotated)		
			Biceps brachii Herb gets DIBs on tips	Flexion, supination (arm extended and pronated)	The state of the s
Klumpke palsy	Traction or tear of lower trunk: C8-T1 roots	Infants—upward force on arm during delivery Adults—trauma (eg, grabbing a tree branch to break a fall)	Intrinsic hand muscles: lumbricals, interossei, thenar, hypothenar	Total claw hand: lumbricals normally flex MCP joints and extend DIP and PIP joints	299
Thoracic outlet syndrome	Compression of lower trunk and subclavian vessels, most commonly within the scalene triangle	Cervical rib (arrows in A, Pancoast tumor	Same as Klumpke palsy	Atrophy of intrinsic hand muscles; ischemia, pain, and edema due to vascular compression	C5 C6 C7 II
Winged scapula	Lesion of long thoracic nerve, roots C5-C7 ("wings of heaven")	Axillary node dissection after mastectomy, stab wounds	Serratus anterior	Inability to anchor scapula to thoracic cage → cannot abduct arm above horizontal position B	B

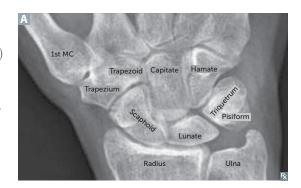
FAS1_2019_11-Musculo.indd 448 11/7/19 5:23 PM

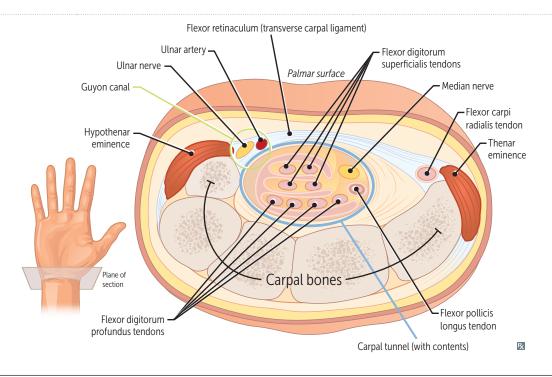
Wrist region



Scaphoid, Lunate, Triquetrum, Pisiform, Hamate, Capitate, Trapezoid, Trapezium A. (So Long To Pinky, Here Comes The Thumb) Scaphoid (palpable in anatomic snuff box B) is the most commonly fractured carpal bone, typically due to a fall on an outstretched hand. Complications of proximal scaphoid fractures include avascular necrosis and nonunion due to retrograde blood supply from a branch of the radial artery. Fracture not always seen on initial x-ray.

Dislocation of lunate may cause acute carpal tunnel syndrome.

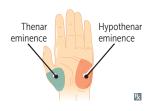




FAS1_2019_11-Musculo.indd 449 11/7/19 5:23 PM

MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE ► ANATOMY AND PHYSIOLOGY

Hand muscles



Thenar (median)—Opponens pollicis, Abductor pollicis brevis, Flexor pollicis brevis, superficial head (deep head by ulnar nerve).

Hypothenar (ulnar)—Opponens digiti minimi, Abductor digiti minimi, Flexor digiti minimi brevis.

Dorsal interossei (ulnar)—abduct the fingers. Palmar interossei (ulnar)—adduct the fingers. Lumbricals (lst/2nd, median; 3rd/4th, ulnar)—flex at the MCP joint, extend PIP and DIP joints.

Both groups perform the same functions: Oppose, Abduct, and Flex (OAF).

DAB = Dorsals ABduct. PAD = Palmars ADduct.

FAS1_2019_11-Musculo.indd 450 11/7/19 5:23 PM

Distortions of the hand At rest, a balance exists between the extrinsic flexors and extensors of the hand, as well as the intrinsic muscles of the hand-particularly the lumbrical muscles (flexion of MCP, extension of DIP and PIP joints).

> "Clawing"—seen best with distal lesions of median or ulnar nerves. Remaining extrinsic flexors of the digits exaggerate the loss of the lumbricals → fingers extend at MCP, flex at DIP and PIP

Deficits less pronounced in **proximal** lesions; deficits present during voluntary flexion of the digits.

SIGN	"Ulnar claw"	"Pope's blessing"	"Median claw"	"OK gesture"
PRESENTATION				
CONTEXT	Extending fingers/at rest	Making a fist	Extending fingers/at rest	Making a fist
LOCATION OF LESION	Distal ulnar nerve	Proximal median nerve	Distal median nerve	Proximal ulnar nerve

Note: Atrophy of the thenar eminence (unopposable thumb → "ape hand") can be seen in median nerve lesions, while atrophy of the hypothenar eminence can be seen in ulnar nerve lesions.

Actions of hip muscles

ACTION	MUSCLES	
Abductors	Gluteus medius, gluteus minimus	
Adductors	Adductor magnus, adductor longus, adductor brevis	
Extensors	Gluteus maximus, semitendinosus, semimembranosus	
Flexors	Iliopsoas, rectus femoris, tensor fascia lata, pectineus, sartorius	
Internal rotation	Gluteus medius, gluteus minimus, tensor fascia latae	
External rotation	Iliopsoas, gluteus maximus, piriformis, obturator	

FAS1_2019_11-Musculo.indd 451 11/7/19 5:23 PM

Lower extremity nerves

NERVE	INNERVATION	CAUSE OF INJURY	PRESENTATION/COMMENTS
Iliohypogastric (T12-L1)	Sensory—suprapubic region Motor—transversus abdominis and internal oblique	Abdominal surgery	Burning or tingling pain in surgical incision site radiating to inguinal and suprapubic region
Genitofemoral nerve (L1-L2)	Sensory—scrotum/labia majora, medial thigh Motor—cremaster	Laparoscopic surgery	↓ upper medial thigh and anterior thigh sensation beneath the inguinal ligament (lateral part of the femoral triangle); absent cremasteric reflex
Lateral femoral cutaneous (L2-L3)	Sensory—anterior and lateral thigh	Tight clothing, obesity, pregnancy, pelvic procedures	thigh sensation (anterior and lateral)
Obturator (L2-L4)	Sensory—medial thigh Motor—obturator externus, adductor longus, adductor brevis, gracilis, pectineus, adductor magnus	Pelvic surgery	thigh sensation (medial) and adduction
Femoral (L2-L4)	Sensory—anterior thigh, medial leg Motor—quadriceps, iliacus, pectineus, sartorius	Pelvic fracture	↓ leg extension (↓ patellar reflex)
Sciatic (L4-S3)	Motor—semitendinosus, semimembranosus, biceps femoris, adductor magnus	Herniated disc, posterior hip dislocation	Splits into common peroneal and tibial nerves

11/7/19 5:23 PM FAS1_2019_11-Musculo.indd 452

Lower extremity nerves (continued)

NERVE	INNERVATION	CAUSE OF INJURY	PRESENTATION/COMMENTS
Common (fibular) peroneal (L4-S2)	Superficial peroneal nerve: Sensory—dorsum of foot (except webspace between hallux and 2nd digit) Motor—peroneus longus and brevis Deep peroneal nerve: Sensory—webspace between hallux and 2nd digit Motor—tibialis anterior	Trauma or compression of lateral aspect of leg, fibular neck fracture	PED = Peroneal Everts and Dorsiflexes; if injured, foot dropPED Loss of sensation on dorsum of foot Foot drop—inverted and plantarflexed at rest, loss of eversion and dorsiflexion; "steppage gait"
Tibial (L4-S3)	Sensory—sole of foot Motor—biceps femoris (long head), triceps surae, plantaris, popliteus, flexor muscles of foot	Knee trauma, Baker cyst (proximal lesion); tarsal tunnel syndrome (distal lesion)	TIP = Tibial Inverts and Plantarflexes; if injured, can't stand on TIPtoes Inability to curl toes and loss of sensation on sole; in proximal lesions, foot everted at rest with loss of inversion and plantar flexion
Superior gluteal (L4-S1) Trendelenburg sign	Motor—gluteus medius, gluteus minimus, tensor fascia latae	Iatrogenic injury during intramuscular injection to superomedial gluteal region (prevent by choosing superolateral quadrant, preferably anterolateral region)	Trendelenburg sign/gait— pelvis tilts because weight- bearing leg cannot maintain alignment of pelvis through hip abduction Lesion is contralateral to the side of the hip that drops, ipsilateral to extremity on which the patient stands
Inferior gluteal (L5-S2)	Motor—gluteus maximus	Posterior hip dislocation	Difficulty climbing stairs, rising from seated position; loss of hip extension
Pudendal (S2-S4)	Sensory—perineum Motor—external urethral and anal sphincters	Stretch injury during childbirth, prolonged cycling, horseback riding	sensation in perineum and genital area; can cause fecal and/or urinary incontinence Can be blocked with local anesthetic during childbirth using ischial spine as a landmark for injection

FAS1_2019_11-Musculo.indd 453 11/7/19 5:23 PM

-Medial

condyle

PCL -MCL

-Medial

Tibia

meniscus

Knee exam Lateral femoral condyle to anterior tibia: ACL. Femur Medial femoral condyle to posterior tibia: PCL. LAMP. Lateralcondyle ACL-LCL-Lateral meniscus Fibula TEST PROCEDURE Bending knee at 90° angle, † anterior gliding of tibia (relative to femur) due to ACL injury Anterior drawer sign

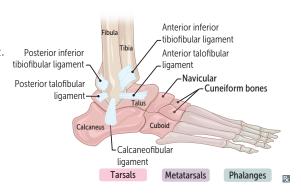
	tibia (relative to femur) due to ACL injury Lachman test also tests ACL, but is more sensitive († anterior gliding of tibia [relative to femur] with knee bent at 30° angle)	ACL tear
Posterior drawer sign	Bending knee at 90° angle, † posterior gliding of tibia due to PCL injury	PCL tear
Abnormal passive abduction	Knee either extended or at ~ 30° angle, lateral (valgus) force → medial space widening of tibia → MCL injury	Abduction (valgus) force MCL tear
Abnormal passive adduction	Knee either extended or at ~ 30° angle, medial (varus) force → lateral space widening of tibia → LCL injury	Adduction (varus) force
McMurray test	During flexion and extension of knee with rotation of tibia/foot (LIME): ■ Pain, "popping" on internal rotation and varus force → Lateral meniscal tear (Internal rotation stresses lateral meniscus)	Internal rotation and varus force Lateral meniscal tear
	 Pain, "popping" on external rotation and valgus force → Medial meniscal tear (External rotation stresses medial meniscus) 	External rotation and valgus force Medial meniscal tear

FAS1_2019_11-Musculo.indd 454 11/7/19 5:23 PM

Ankle sprains

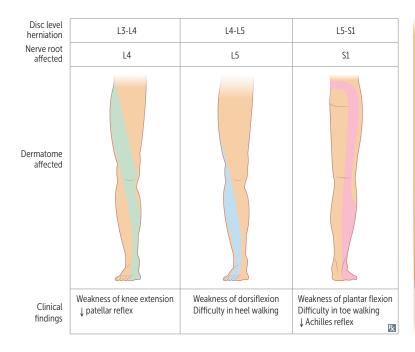
Anterior TaloFibular ligament—most common ankle sprain overall, classified as a low ankle sprain. Due to overinversion/supination of foot. Anterior inferior tibiofibular ligament—most common high ankle sprain.

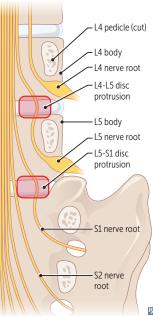
Always Tears First.



Signs of lumbosacral radiculopathy

Paresthesia and weakness related to specific lumbosacral spinal nerves. Intervertebral disc (nucleus pulposus) herniates posterolaterally through annulus fibrosus (outer ring) into central canal due to thin posterior longitudinal ligament and thicker anterior longitudinal ligament along midline of vertebral bodies. Nerve affected is usually below the level of herniation.





Neurovascular pairing

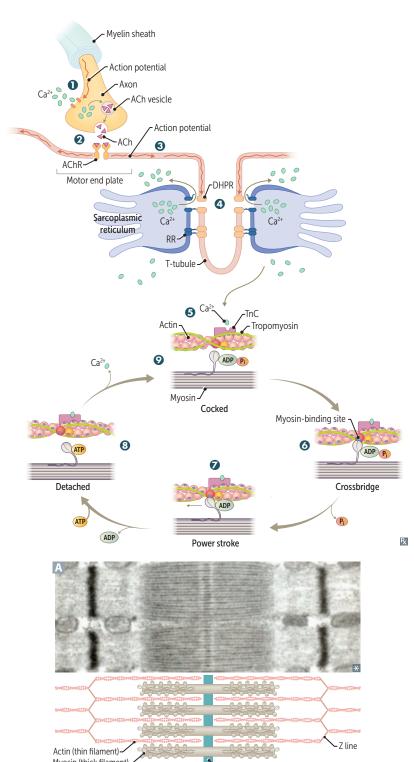
Nerves and arteries are frequently named together by the bones/regions with which they are associated. The following are exceptions to this naming convention.

LOCATION	NERVE	ARTERY Lateral thoracic	
Axilla/lateral thorax	Long thoracic		
Surgical neck of humerus	Axillary	Posterior circumflex	
Midshaft of humerus	Radial	Deep brachial	
Distal humerus/cubital fossa	Median	Brachial	
Popliteal fossa	Tibial	Popliteal	
Posterior to medial malleolus	Tibial	Posterior tibial	

FAS1_2019_11-Musculo.indd 455

Motoneuron action potential to muscle contraction

T-tubules are extensions of plasma membrane in contact with the sarcoplasmic reticulum, allowing for coordinated contraction of striated muscles.



H band A band

Sarcomere (Z line to Z line)

- Action potential opens presynaptic voltagegated Ca²⁺ channels, inducing acetylcholine (ACh) release.
- 2 Postsynaptic ACh binding leads to muscle cell depolarization at the motor end plate.
- 3 Depolarization travels over the entire muscle cell and deep into the muscle via the T-tubules.
- Membrane depolarization induces conformational changes in the voltagesensitive dihydropyridine receptor (DHPR) and its mechanically coupled ryanodine receptor (RR) → Ca²⁺ release from the sarcoplasmic reticulum into the cytoplasm.
- **5** Tropomyosin is blocking myosin-binding sites on the actin filament. Released Ca²⁺ binds to troponin C (TnC), shifting tropomyosin to expose the myosin-binding sites.
- **6** The myosin head binds strongly to actin, forming a crossbridge. P_i is then released, initiating the power stroke.
- During the power stroke, force is produced as myosin pulls on the thin filament A. Muscle shortening occurs, with shortening of H and I bands and between Z lines (HIZ shrinkage). The A band remains the same length (A band is Always the same length). ADP is released at the end of the power stroke.
- **3** Binding of new ATP molecule causes detachment of myosin head from actin filament. Ca²⁺ is resequestered.
- ATP hydrolysis into ADP and P₁ results in myosin head returning to high-energy position (cocked). The myosin head can bind to a new site on actin to form a crossbridge if Ca²+ remains available.

FAS1_2019_11-Musculo.indd 456 11/7/19 5:23 PM

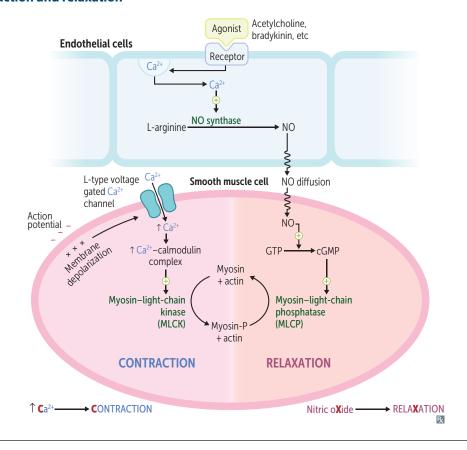
Ŗ

I band

Types of muscle fibers

	Type I	Type II
CONTRACTION VELOCITY	Slow	Fast
FIBER COLOR	Red	White
PREDOMINANT METABOLISM	Oxidative phosphorylation → sustained contraction	Anaerobic glycolysis
MITOCHONDRIA, MYOGLOBIN	†	↓
TYPE OF TRAINING	Endurance training	Weight/resistance training, sprinting
NOTES	Think "1 slow red ox"	

Vascular smooth muscle contraction and relaxation

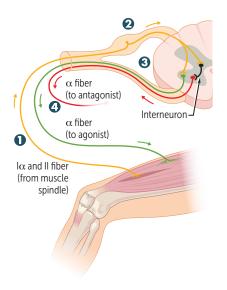


FAS1_2019_11-Musculo.indd 457 11/7/19 5:23 PM

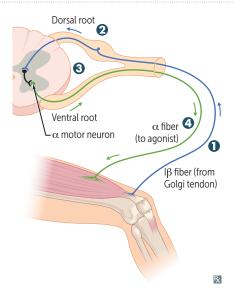
ossification

Muscle	proprioce	ptors S	pecialized	sensory	receptor	s that rela	y information	about muscle d	ynamics.
--------	-----------	---------	------------	---------	----------	-------------	---------------	----------------	----------

	Muscle spindle	Golgi tendon organ
PATHWAY	 ↑ length and speed of stretch → ② via dorsal root ganglion (DRG) → ③ activation of inhibitory interneuron and α motor neuron → ④ simultaneous inhibition of antagonist muscle (prevents overstretching) and activation of agonist muscle (contraction). 	↑ tension → ② via DRG → ③ activation of inhibitory interneuron → ④ inhibition of agonist muscle (reduced tension within muscle and tendon)
LOCATION	Body of muscle/type Ia and II sensory axons	Tendons/type Ib sensory axons
ACTIVATION BY	↑ muscle stretch	† muscle force



remodeled to lamellar bone.



Bone formation	
Endochondral ossification	Bones of axial skeleton, appendicular skeleton, and base of skull. Cartilaginous model of bone is first made by chondrocytes. Osteoclasts and osteoblasts later replace with woven bone and then remodel to lamellar bone. In adults, woven bone occurs after fractures and in Paget disease. Defective in achondroplasia.
Membranous	Bones of calvarium, facial bones, and clavicle. Woven bone formed directly without cartilage. Later

FAS1_2019_11-Musculo.indd 458 11/7/19 5:23 PM

SECTION III

Cell biology of bone

Builds bone by secreting collagen and catalyzing mineralization in alkaline environment via AL Differentiates from mesenchymal stem cells in periosteum. Osteoblastic activity measured by bone ALP, osteocalcin, propeptides of type I procollagen.
Dissolves ("crushes") bone by secreting H ⁺ and collagenases. Differentiates from a fusion of monocyte/macrophage lineage precursors. RANK receptors on osteoclasts are stimulated by RANKL (RANK ligand, expressed on osteoblasts). OPG (osteoprotegerin, a RANKL decoy receptor) binds RANKL to prevent RANK-RANKL interaction → ↓ osteoclast activity.
At low, intermittent levels, exerts anabolic effects (building bone) on osteoblasts and osteoclasts (indirect). Chronically † PTH levels (1° hyperparathyroidism) cause catabolic effects (osteitis fibrosa cystica).
Inhibits apoptosis in bone-forming osteoblasts and induces apoptosis in bone-resorbing osteoclasts. Causes closure of epiphyseal plate during puberty. Estrogen deficiency (surgical or postmenopausal) → ↑ cycles of remodeling and bone resorption → ↑ risk of osteoporosis.

► MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE—PATHOLOGY

Overuse injuries of the elbow

Medial epicondylitis (golfer's elbow)	Repetitive flexion (forehand shots) or idiopathic → pain near medial epicondyle.
Lateral epicondylitis (tennis elbow)	Repetitive extension (backhand shots) or idiopathic → pain near lateral epicondyle.

Wrist and hand injuries

Metacarpal neck fracture



Also called boxer's fracture. Common fracture caused by direct blow with a closed fist (eg, from punching a wall). Most commonly seen in 4th and 5th metacarpals A.

Carpal tunnel syndrome



Entrapment of median nerve in carpal tunnel (between transverse carpal ligament and carpal bones) → nerve compression → paresthesia, pain, and numbness in distribution of median nerve. Thenar eminence atrophies B but sensation spared, because palmar cutaneous branch enters hand external to carpal tunnel.

Suggested by ⊕ Tinel sign (percussion of wrist causes tingling) and Phalen maneuver (90° flexion of wrist causes tingling). Associated with pregnancy (due to edema), rheumatoid arthritis, hypothyroidism, diabetes, acromegaly, dialysis-related amyloidosis; may be associated with repetitive use.

Guyon canal syndrome

Compression of ulnar nerve at wrist. Classically seen in cyclists due to pressure from handlebars.

FAS1_2019_11-Musculo.indd 459 11/7/19 5:23 PM

Clavicle fractures

Common in children and as birth trauma. Usually caused by a fall on outstretched hand or by direct trauma to shoulder. Weakest point at the junction of middle and lateral thirds; fractures at the middle third segment are most common. Presents as shoulder drop, shortened clavicle (lateral fragment is depressed due to arm weight and medially rotated by arm adductors [eg, pectoralis major]).

Common hip and knee conditions

"Unhappy triad"

Common injury in contact sports due to lateral force applied to a planted foot. Consists of damage to the ACL A, MCL, and medial meniscus (attached to MCL). However, lateral meniscus involvement is more common than medial meniscus involvement in conjunction with ACL and MCL injury. Presents with acute pain and signs of joint instability.



Prepatellar bursitis

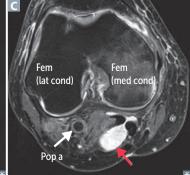
Inflammation of the prepatellar bursa in front of the kneecap (red arrow in **B**). Can be caused by repeated trauma or pressure from excessive kneeling (also called "housemaid's knee").

Baker cyst

Popliteal fluid collection (red arrow in c) in gastrocnemius-semimembranosus bursa commonly communicating with synovial space and related to chronic joint disease (eg, osteoarthritis, rheumatoid arthritis).







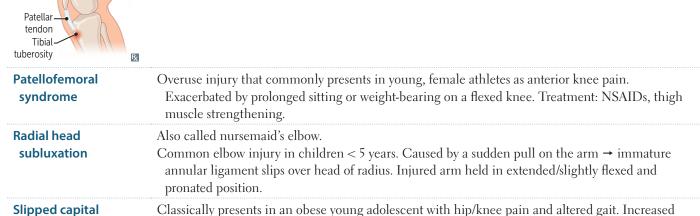
FAS1_2019_11-Musculo.indd 460 11/7/19 5:23 PM

Common musculoskeletal conditions

De Quervain tenosynovitis	Noninflammatory thickening of abductor pollicis longus and extensor pollicis brevis tendons → pain or tenderness at radial styloid. ⊕ Finkelstein test (pain at radial styloid with active or passive stretch of thumb tendons). ↑ risk in new mothers, golfers, racquet sport players, "thumb" texters.
Ganglion cyst	Fluid-filled swelling overlying joint or tendon sheath, most commonly at dorsal side of wrist. Arises from herniation of dense connective tissue.
Iliotibial band syndrome	Overuse injury of lateral knee that occurs primarily in runners. Pain develops 2° to friction of iliotibial band against lateral femoral epicondyle.
Limb compartment syndrome	† pressure within fascial compartment of a limb → venous outflow obstruction and arteriolar collapse → anoxia and necrosis. Causes include significant long bone fractures, reperfusion injury, animal venoms. Presents with severe pain and tense, swollen compartments with passive stretch of muscles in the affected compartment. Motor deficits are late sign of irreversible muscle and nerve damage.
Medial tibial stress syndrome	Also called shin splints. Common cause of shin pain and diffuse tenderness in runners and military recruits. Caused by bone resorption that outpaces bone formation in tibial cortex.
Plantar fasciitis	Inflammation of plantar aponeurosis characterized by heel pain (worse with first steps in the morning or after period of inactivity) and tenderness.

Childhood musculoskeletal conditions

Developmental dysplasia of the hip	Abnormal acetabulum development in newborns. Major risk factor includes breech presentation. Results in hip instability/dislocation. Commonly tested with Ortolani and Barlow maneuvers (manipulation of newborn hip reveals a "clunk"). Confirmed via ultrasound (x-ray not used until
	~4–6 months because cartilage is not ossified).
Legg-Calvé-Perthes disease	Idiopathic avascular necrosis of femoral head. Commonly presents between 5–7 years with insidious onset of hip pain that may cause child to limp. More common in males (4:1 ratio). Initial x-ray often normal.
Osgood-Schlatter disease	Also called traction apophysitis. Overuse injury caused by repetitive strain and chronic avulsion of the secondary ossification center of proximal tibial tubercle. Occurs in adolescents after growth spurt. Common in running and jumping athletes. Presents with progressive anterior knee pain.



pronated position.

Classically presents in an obese young adolescent with hip/knee pain and altered gait. Increased axial force on femoral head → epiphysis displaces relative to femoral neck (like a scoop of ice cream slipping off a cone). Diagnosed via x-ray.

FAS1_2019_11-Musculo.indd 461 11/7/19 5:23 PM

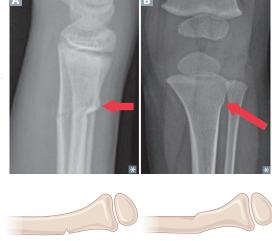
Common pediatric fractures

Greenstick fracture

Incomplete fracture extending partway through width of bone A following bending stress; bone fails on tension side; compression side intact (compare to torus fracture). Bone is bent like a green twig.

Torus (buckle) fracture

Axial force applied to immature bone → cortex buckles on compression (concave) side and fractures B. Tension (convex) side remains solid (intact).





Norma

Complete fracture

Greenstick fracture

Torus fracture

Achondroplasia

Failure of longitudinal bone growth (endochondral ossification) → short limbs. Membranous ossification is not affected → large head relative to limbs. Constitutive activation of fibroblast growth factor receptor (FGFR3) actually inhibits chondrocyte proliferation. > 85% of mutations occur sporadically; autosomal dominant with full penetrance (homozygosity is lethal). Associated with † paternal age. Most common cause of short-limbed dwarfism.

Osteoporosis



Trabecular (spongy) and cortical bone lose mass Can lead to vertebral compression despite normal bone mineralization and lab values (serum Ca²⁺ and PO₄³⁻).

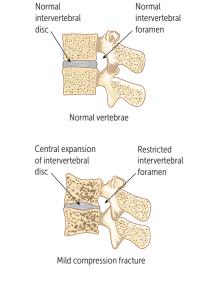
Most commonly due to † bone resorption related to ↓ estrogen levels and old age. Can be 2° to drugs (eg, steroids, alcohol, anticonvulsants, anticoagulants, thyroid replacement therapy) or other conditions (eg, hyperparathyroidism, hyperthyroidism, multiple myeloma, malabsorption syndromes, anorexia).

Diagnosed by bone mineral density measurement by DEXA (dual-energy X-ray absorptiometry) at the lumbar spine, total hip, and femoral neck, with a T-score of ≤ -2.5 or by a fragility fracture (eg, fall from standing height, minimal trauma) at hip or vertebra. One time screening recommended in women \geq 65 years old.

Prophylaxis: regular weight-bearing exercise and adequate Ca²⁺ and vitamin D intake throughout adulthood.

Treatment: bisphosphonates, teriparatide, SERMs, rarely calcitonin; denosumab (monoclonal antibody against RANKL).

fractures A — acute back pain, loss of height, kyphosis. Also can present with fractures of femoral neck, distal radius (Colles fracture).



FAS1 2019 11-Musculo.indd 462 11/7/19 5:23 PM

Osteopetrosis



Failure of normal bone resorption due to defective osteoclasts → thickened, dense bones that are prone to fracture. Mutations (eg, carbonic anhydrase II) impair ability of osteoclast to generate acidic environment necessary for bone resorption. Overgrowth of cortical bone fills marrow space → pancytopenia, extramedullary hematopoiesis. Can result in cranial nerve impingement and palsies due to narrowed foramina.

X-rays show diffuse symmetric sclerosis (bone-in-bone, "stone bone" A). Bone marrow transplant is potentially curative as osteoclasts are derived from monocytes.

Osteomalacia/rickets

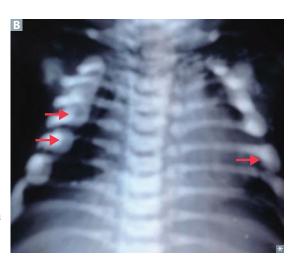


Defective mineralization of osteoid (osteomalacia) or cartilaginous growth plates (rickets, only in children). Most commonly due to vitamin D deficiency.

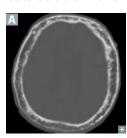
X-rays show osteopenia and "Looser zones" (pseudofractures) in osteomalacia, epiphyseal widening and metaphyseal cupping/fraying in rickets. Children with rickets have pathologic bow legs (genu varum A), bead-like costochondral junctions (rachitic rosary B), craniotabes (soft skull).

↓ vitamin D → ↓ serum Ca²⁺ → ↑ PTH secretion
 → ↓ serum PO₄³⁻.

Hyperactivity of osteoblasts → ↑ ALP.



Osteitis deformans



Also called Paget disease of bone. Common, localized disorder of bone remodeling caused by † osteoclastic activity followed by † osteoblastic activity that forms poor-quality bone. Serum Ca²⁺, phosphorus, and PTH levels are normal. † ALP. Mosaic pattern of woven and lamellar bone (osteocytes within lacunae in chaotic juxtapositions); long bone chalk-stick fractures. † blood flow from † arteriovenous shunts may cause high-output heart failure. † risk of osteosarcoma.

Hat size can be increased due to skull thickening A; hearing loss is common due to auditory foramen narrowing.

Stages of Paget disease:

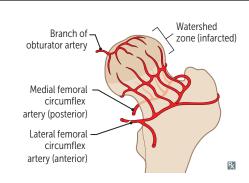
- Lytic—osteoclasts
- Mixed—osteoclasts + osteoblasts
- Sclerotic—osteoblasts
- Quiescent—minimal osteoclast/osteoblast activity

Treatment: bisphosphonates.

Avascular necrosis of bone



Infarction of bone and marrow, usually very painful. Most common site is femoral head (watershed zone) A (due to insufficiency of medial circumflex femoral artery). Causes include Corticosteroids, Alcoholism, Sickle cell disease, Trauma, SLE, "the Bends" (caisson/decompression disease), LEgg-Calvé-Perthes disease (idiopathic), Gaucher disease, Slipped capital femoral epiphysis—CASTS Bend LEGS.



FAS1_2019_11-Musculo.indd 463

Lab values in bone disorders

DISORDER	SERUM Ca ²⁺	PO ₄ 3-	ALP	PTH	COMMENTS
Osteoporosis	_	_	_	_	↓ bone mass
Osteopetrosis	_/↓	_	_	_	Dense, brittle bones. Ca²+ ↓ in severe, malignant disease
Paget disease of bone	_	_	†	_	Abnormal "mosaic" bone architecture
Osteitis fibrosa cystica Primary hyperparathyroidism	t	ţ	1	†	"Brown tumors" due to fibrous replacement of bone, subperiosteal thinning Idiopathic or parathyroid hyperplasia, adenoma, carcinoma
Secondary hyperparathyroidism	1	†	†	†	Often as compensation for CKD (\$\dagger\$ PO ₄ 3- excretion and production of activated vitamin D)
Osteomalacia/rickets	Ţ	†	†	†	Soft bones; vitamin D deficiency also causes 2° hyperparathyroidism
Hypervitaminosis D	†	1	_	1	Caused by oversupplementation or granulomatous disease (eg, sarcoidosis)

 $↑ ↓ = 1^{\circ}$ change.

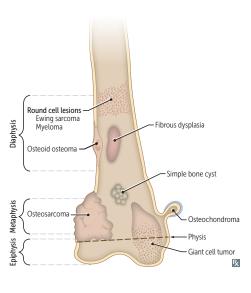
Primary bone tumors Metastatic disease is more common than 1° bone tumors. Benign bone tumors that start with O are more common in boys.

TUMOR TYPE	EPIDEMIOLOGY	LOCATION	CHARACTERISTICS
Benign tumors			
Osteochondroma	Most common benign bone tumor Males < 25 years old	Metaphysis of long bones	Lateral bony projection of growth plate (continuous with marrow space) covered by cartilaginous cap A Rarely transforms to chondrosarcoma
Osteoma	Middle age	Surface of facial bones	Associated with Gardner syndrome
Osteoid osteoma	Adults < 25 years old Males > females	Cortex of long bones	Presents as bone pain (worse at night) that is relieved by NSAIDs Bony mass (< 2 cm) with radiolucent osteoid core
Osteoblastoma	Males > females	Vertebrae	Similar histology to osteoid osteoma Larger size (> 2 cm), pain unresponsive to NSAIDs
Chondroma		Medulla of small bones of hand and feet	Benign tumor of cartilage
Giant cell tumor	20–40 years old	Epiphysis of long bones (often in knee region)	Locally aggressive benign tumor Neoplastic mononuclear cells that express RANKL and reactive multinucleated giant (osteoclast-like) cells. "Osteoclastoma" "Soap bubble" appearance on x-ray

FAS1_2019_11-Musculo.indd 464 11/7/19 5:23 PM

Primary bone tumors (continued)

Osteosarcoma (osteogenic sarcoma) Osteogenic sarcoma) Osteogenic sarcoma Osteogeni	TUMOR TYPE	EPIDEMIOLOGY	LOCATION	CHARACTERISTICS
bone cancers. Peak incidence of 1° tumor in males < 20 years. Less common in elderly; usually 2° to predisposing factors, such as Paget disease of bone, bone infarcts, radiation, familial retinoblastoma, Li-Fraumeni syndrome. Chondrosarcoma Most common in Caucasians. Generally boys < 15 years old. Most common in Caucasians. Generally boys < 15 years old. Most common in Caucasians. Generally boys < 15 years old. (often in knee region). (rmalignant osteoblasts). Presents as painful enlarging mass or pathologic fractures. Codman triangle □ (from elevation of periosteum) or sumburst pattern on x-ray □ (think of an osteocod (bone fish) swimming in the sun). Aggressive. 1° usually responsive to treatment (surgery, chemotherapy), poor prognosis for 2°. Tumor of malignant chondrocytes. Tumor of malignant chondrocytes. Anaplastic small blue cells of neuroectodermal origin (resemble lymphocytes) □. Differentiate from conditions with similar morphology (eg. lymphoma, chronic osteomyelitis) by testing for t(11;22) (fusion protein EWS-FLII). "Onion skin" periosteal reaction in bone. Aggressive with early metastases, but responsive to chemotherapy. 11 + 22 = 33 (Patrick Ewing's jersey	Malignant tumors			
Fewing sarcoma Most common in Caucasians. Generally boys < 15 years old. Diaphysis of long bones (especially femur), pelvic flat bones. Differentiate from conditions with similar morphology (eg, lymphoma, chronic osteomyelitis) by testing for t(11;22) (fusion protein EWS-FLII). "Onion skin" periosteal reaction in bone. Aggressive with early metastases, but responsive to chemotherapy. 11 + 22 = 33 (Patrick Ewing's jersey		bone cancers. Peak incidence of 1° tumor in males < 20 years. Less common in elderly; usually 2° to predisposing factors, such as Paget disease of bone, bone infarcts, radiation, familial retinoblastoma,	1	(malignant osteoblasts). Presents as painful enlarging mass or pathologic fractures. Codman triangle □ (from elevation of periosteum) or sunburst pattern on x-ray □ (think of an osteocod (bone fish) swimming in the sun). Aggressive. 1° usually responsive to treatment (surgery, chemotherapy),
Caucasians. Generally boys < 15 years old. Caucasians. (especially femur), pelvic flat bones. old. Differentiate from conditions with similar morphology (eg, lymphoma, chronic osteomyelitis) by testing for t(11;22) (fusion protein EWS-FLI1). "Onion skin" periosteal reaction in bone. Aggressive with early metastases, but responsive to chemotherapy. 11 + 22 = 33 (Patrick Ewing's jersey	Chondrosarcoma		1 1	Tumor of malignant chondrocytes.
	Ewing sarcoma	Caucasians. Generally boys < 15 years	(especially femur), pelvic	neuroectodermal origin (resemble lymphocytes) F . Differentiate from conditions with similar morphology (eg, lymphoma, chronic osteomyelitis) by testing for t(11;22) (fusion protein EWS-FLII). "Onion skin" periosteal reaction in bone. Aggressive with early metastases, but responsive to chemotherapy. 11 + 22 = 33 (Patrick Ewing's jersey



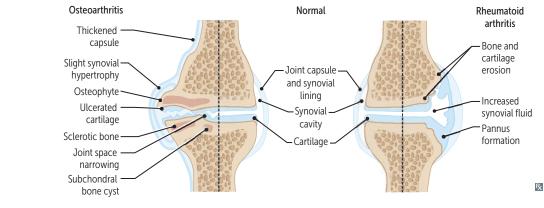


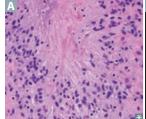
FAS1_2019_11-Musculo.indd 465 11/7/19 5:23 PM

Osteoarthritis vs rheumatoid arthritis

	Osteoarthritis	Rheumatoid arthritis
PATHOGENESIS	Mechanical—wear and tear destroys articular cartilage (degenerative joint disorder) → inflammation with inadequate repair. Chondrocytes mediate degradation and inadequate repair.	Autoimmune—inflammation A induces formation of pannus (proliferative granulation tissue), which erodes articular cartilage and bone.
PREDISPOSING FACTORS	Age, female, obesity, joint trauma.	Female, HLA-DR4 (4-walled "rheum"), smoking. ⊕ rheumatoid factor (IgM antibody that targets IgG Fc region; in 80%), anti-cyclic citrullinated peptide antibody (more specific).
PRESENTATION	Pain in weight-bearing joints after use (eg, at the end of the day), improving with rest. Asymmetric joint involvement. Knee cartilage loss begins medially ("bowlegged"). No systemic symptoms.	Pain, swelling, and morning stiffness lasting > 1 hour, improving with use. Symmetric joint involvement. Systemic symptoms (fever, fatigue, weight loss). Extraarticular manifestations common.*
JOINT FINDINGS	Osteophytes (bone spurs), joint space narrowing, subchondral sclerosis and cysts. Synovial fluid noninflammatory (WBC < 2000/mm³). Development of Heberden nodes B (at DIP) and Bouchard nodes C (at PIP), and 1st CMC; not MCP.	Erosions, juxta-articular osteopenia, soft tissue swelling, subchondral cysts, joint space narrowing. Deformities: cervical subluxation, ulnar finger deviation, swan neck D, boutonniere E. Involves MCP, PIP, wrist; not DIP or 1st CMC.
TREATMENT	Activity modification, acetaminophen, NSAIDs, intra-articular glucocorticoids.	NSAIDs, glucocorticoids, disease-modifying agents (eg, methotrexate, sulfasalazine), biologic agents (eg, TNF-α inhibitors).

^{*}Extraarticular manifestations include rheumatoid nodules (fibrinoid necrosis with palisading histiocytes) in subcutaneous tissue and lung (+ pneumoconiosis → Caplan syndrome), interstitial lung disease, pleuritis, pericarditis, anemia of chronic disease, neutropenia + splenomegaly (Felty syndrome), AA amyloidosis, Sjögren syndrome, scleritis, carpal tunnel syndrome.













FAS1_2019_11-Musculo.indd 466 11/7/19 5:23 PM

Gout

FINDINGS

Acute inflammatory monoarthritis caused by precipitation of monosodium urate crystals in joints A. Risk factors: male sex, hypertension, obesity, diabetes, dyslipidemia, alcohol use. Strongest risk factor is hyperuricemia, which can be caused by:

- Underexcretion of uric acid (90% of patients)—largely idiopathic, potentiated by renal failure; can be exacerbated by certain medications (eg, thiazide diuretics).
- Overproduction of uric acid (10% of patients)—Lesch-Nyhan syndrome, PRPP excess, † cell turnover (eg, tumor lysis syndrome), von Gierke disease.

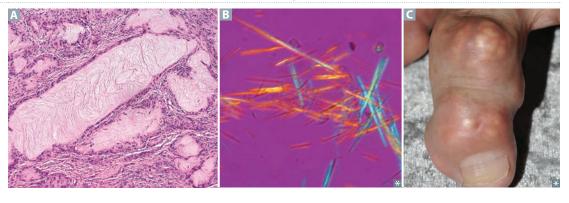
Crystals are needle shaped and ⊖ birefringent under polarized light (yellow under parallel light, blue under perpendicular light B). Serum uric acid levels may be normal during an acute attack.

SYMPTOMS

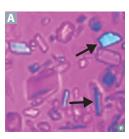
Asymmetric joint distribution. Joint is swollen, red, and painful. Classic manifestation is painful MTP joint of big toe (podagra). Tophus formation **()** (often on external ear, olecranon bursa, or Achilles tendon). Acute attack tends to occur after a large meal with foods rich in purines (eg, red meat, seafood), trauma, surgery, dehydration, diuresis, or alcohol consumption (alcohol metabolites compete for same excretion sites in kidney as uric acid → ↓ uric acid secretion and subsequent buildup in blood).

TREATMENT

Acute: NSAIDs (eg, indomethacin), glucocorticoids, colchicine. Chronic (preventive): xanthine oxidase inhibitors (eg, allopurinol, febuxostat).



Calcium pyrophosphate deposition disease



Previously called pseudogout. Deposition of calcium pyrophosphate crystals within the joint space. Occurs in patients > 50 years old; both sexes affected equally. Usually idiopathic, sometimes associated with hemochromatosis, hyperparathyroidism, joint trauma.

Pain and swelling with acute inflammation (pseudogout) and/or chronic degeneration (pseudo-osteoarthritis). Most commonly affected joint is the knee.

Chondrocalcinosis (cartilage calcification) on x-ray.

Crystals are rhomboid and weakly ⊕ birefringent under polarized light (blue when parallel to light) A.

Acute treatment: NSAIDs, colchicine, glucocorticoids.

Prophylaxis: colchicine.

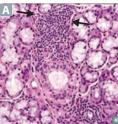
The blue P's—blue (when Parallel), Positive birefringence, calcium Pyrophosphate,
Pseudogout

FAS1_2019_11-Musculo.indd 467 11/7/19 5:23 PM

Systemic juvenile idiopathic arthritis

Systemic arthritis seen in < 16 year olds. Usually presents with daily spiking fevers, salmonpink macular rash, arthritis (commonly 2+ joints). Associated with anterior uveitis. Frequently presents with leukocytosis, thrombocytosis, anemia, † ESR, † CRP. Treatment: NSAIDs, steroids, methotrexate, TNF inhibitors.

Sjögren syndrome





Autoimmune disorder characterized by destruction of exocrine glands (especially lacrimal and salivary) by lymphocytic infiltrates A. Predominantly affects women 40-60 years old.

Findings:

- Inflammatory joint pain
- Keratoconjunctivitis sicca (↓ tear production and subsequent corneal damage)
- Xerostomia (↓ saliva production) → mucosal atrophy, fissuring of the tongue B
- Presence of antinuclear antibodies, rheumatoid factor (can be positive in the absence of rheumatoid arthritis), antiribonucleoprotein antibodies: SS-A (anti-Ro) and/or SS-B (anti-La)
- Bilateral parotid enlargement

Anti-SSA and anti-SSB may also be seen in SLE.

A common 1° disorder or a 2° syndrome associated with other autoimmune disorders (eg, rheumatoid arthritis, SLE, systemic sclerosis).

Complications: dental caries; mucosa-associated lymphoid tissue (MALT) lymphoma (may present as parotid enlargement).

Focal lymphocytic sialadenitis on labial salivary gland biopsy can confirm diagnosis.

Septic arthritis



S aureus, Streptococcus, and Neisseria gonorrhoeae are common causes. Affected joint is swollen A, red, and painful. Synovial fluid purulent (WBC > 50,000/mm³).

Gonococcal arthritis—STI that presents as either purulent arthritis (eg, knee) or triad of polyarthralgia, tenosynovitis (eg, hand), dermatitis (eg, pustules).

FAS1 2019 11-Musculo.indd 468 11/7/19 5:23 PM

Seronegative spondyloarthritis	Arthritis without rheumatoid factor (no anti-IgG antibody). Strong association with HLA-B27 (MHC class I serotype). Subtypes (PAIR) share variable occurrence of inflammatory back pain (associated with morning stiffness, improves with exercise), peripheral arthritis, enthesitis (inflamed insertion sites of tendons, eg, Achilles), dactylitis ("sausage fingers"), uveitis.		
Psoriatic arthritis	Associated with skin psoriasis and nail lesions. Asymmetric and patchy involvement A. Dactylitis and "pencil-in-cup" deformity of DIP on x-ray B.	Seen in fewer than ½ of patients with psoriasis.	
Ankylosing spondylitis	Symmetric involvement of spine and sacroiliac joints → ankylosis (joint fusion), uveitis, aortic regurgitation.	Bamboo spine (vertebral fusion) . Costovertebral and costosternal ankylosis may cause restrictive lung disease. Monitor degree of reduced chest wall expansion to assess disease severity. More common in males.	
Inflammatory bowel disease	Crohn disease and ulcerative colitis are often associated with spondyloarthritis.		
Reactive arthritis	Formerly called Reiter syndrome. Classic triad:	"Can't see, can't pee, can't bend my knee." Shigella, Yersinia, Chlamydia, Campylobacter, Salmonella (ShY ChiCS).	
	A	C	



FAS1_2019_11-Musculo.indd 469 11/7/19 5:23 PM

Systemic lupus erythematosus

Systemic, remitting, and relapsing autoimmune disease. Organ damage primarily due to a type III hypersensitivity reaction and, to a lesser degree, a type II hypersensitivity reaction. Associated with deficiency of early complement proteins (eg, Clq, C4, C2) → ↓ clearance of immune complexes. Classic presentation: rash, joint pain, and fever in a female of reproductive age (especially of African-American or Hispanic descent).



Libman-Sacks Endocarditis—nonbacterial, verrucous thrombi usually on mitral or aortic valve and can be present on either surface of the valve (but usually on undersurface). LSE in SLE.

Lupus nephritis (glomerular deposition of DNA-anti-DNA immune complexes) can be nephritic or nephrotic (causing hematuria or proteinuria). Most common and severe type is diffuse proliferative.

Common causes of death in SLE: Renal disease (most common), Infections, Cardiovascular disease (accelerated CAD).

In an anti-SSA ⊕ pregnant woman, † risk of newborn developing neonatal lupus → congenital heart block, periorbital/diffuse rash, transaminitis, and cytopenias at birth.

RASH OR PAIN:

Rash (malar A or discoid B)

Arthritis (nonerosive)

Serositis (eg, pleuritis, pericarditis)

Hematologic disorders (eg, cytopenias)

Oral/nasopharyngeal ulcers (usually painless)

Renal disease

Photosensitivity

Antinuclear antibodies

Immunologic disorder (anti-dsDNA, anti-Sm, antiphospholipid)

Neurologic disorders (eg, seizures, psychosis)

Lupus patients die with Redness In their Cheeks.



Features of SLE, systemic sclerosis, and/or polymyositis. Associated with anti-U1 RNP antibodies (speckled ANA).

Antiphospholipid syndrome

1° or 2° autoimmune disorder (most commonly in SLE).

Diagnosed based on clinical criteria including history of thrombosis (arterial or venous) or spontaneous abortion along with laboratory findings of lupus anticoagulant, anticardiolipin, anti- β_2 glycoprotein I antibodies.

Treatment: systemic anticoagulation.

Anticardiolipin antibodies can cause false-positive VDRL/RPR.

Lupus anticoagulant can cause prolonged PTT that is not corrected by the addition of normal platelet-free plasma.

Polymyalgia rheumatica

SYMPTOMS	Pain and stiffness in proximal muscles (eg, shoulders, hips), often with fever, malaise, weight loss. Does not cause muscular weakness. More common in women > 50 years old; associated with giant cell (temporal) arteritis.
FINDINGS	† ESR, † CRP, normal CK.
TREATMENT	Rapid response to low-dose corticosteroids.

FAS1_2019_11-Musculo.indd 470 11/7/19 5:23 PM

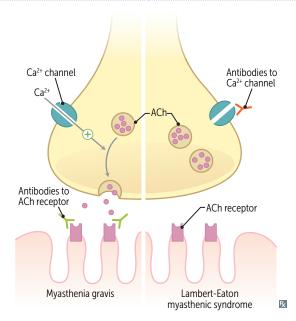
Fibromyalgia Most common in women 20-50 years old. Chronic, widespread musculoskeletal pain associated with "tender points," stiffness, paresthesias, poor sleep, fatigue, cognitive disturbance ("fibro fog"). Treatment: regular exercise, antidepressants (TCAs, SNRIs), neuropathic pain agents (eg, gabapentin). Polymyositis/ Nonspecific: ⊕ ANA, ↑ CK. Specific: ⊕ anti-Jo-l (histidyl-tRNA synthetase), ⊕ anti-SRP (signal dermatomyositis recognition particle), \oplus anti-Mi-2 (helicase). **Polymyositis** Progressive symmetric proximal muscle weakness, characterized by endomysial inflammation with CD8+ T cells. Most often involves shoulders. **Dermatomyositis** Clinically similar to polymyositis, but also involves Gottron papules A, photodistributed facial erythema (eg, heliotrope [violaceous] edema of the eyelids **B**), "shawl and face" rash **C**, darkening and thickening of fingertips and sides resulting in irregular, "dirty"-appearing marks. † risk of occult malignancy. Perimysial inflammation and atrophy with CD4+ T cells.



FAS1_2019_11-Musculo.indd 471 11/7/19 5:23 PM

Neuromuscular junction diseases

	Myasthenia gravis	Lambert-Eaton myasthenic syndrome
FREQUENCY	Most common NMJ disorder	Uncommon
PATHOPHYSIOLOGY	Autoantibodies to postsynaptic ACh receptor	Autoantibodies to presynaptic Ca²+ channel → ↓ ACh release
CLINICAL	Fatigable muscle weakness—ptosis; diplopia; proximal weakness; respiratory muscle involvement → dyspnea; bulbar muscle involvement → dysphagia, difficulty chewing	Proximal muscle weakness, autonomic symptoms (dry mouth, constipation, impotence)
	Spared reflexes	Hyporeflexia
	Worsens with muscle use	Improves with muscle use
ASSOCIATED WITH	Thymoma, thymic hyperplasia	Small cell lung cancer
ACHE INHIBITOR ADMINISTRATION	Reverses symptoms (pyridostigmine for treatment)	Minimal effect



Raynaud phenomenon



↓ blood flow to skin due to arteriolar (small vessel) vasospasm in response to cold or stress: color change from white (ischemia) to blue (hypoxia) to red (reperfusion). Most often in the fingers ⚠ and toes. Called Raynaud disease when 1° (idiopathic), Raynaud syndrome when 2° to a disease process such as mixed connective tissue disease, SLE, or CREST syndrome (limited form of systemic sclerosis). Digital ulceration (critical ischemia) seen in 2° Raynaud syndrome. Treat with calcium²+ channel blockers.

FAS1_2019_11-Musculo.indd 472 11/7/19 5:23 PM

Scleroderma

Systemic sclerosis. Triad of autoimmunity, noninflammatory vasculopathy, and collagen deposition with fibrosis. Commonly sclerosis of skin, manifesting as puffy, taut skin A without wrinkles, fingertip pitting B. Can involve other systems, eg, renal (scleroderma renal crisis; treat with ACE inhibitors), pulmonary (interstitial fibrosis, pulmonary HTN), GI (esophageal dysmotility and reflux), cardiovascular. 75% female. 2 major types:

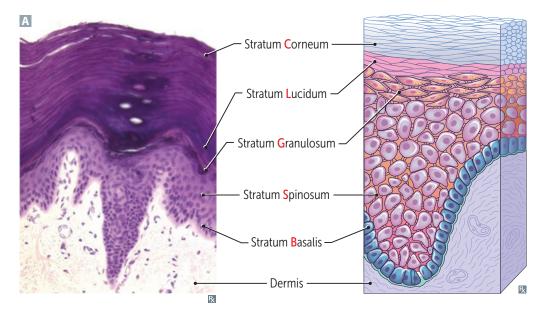
- **Diffuse scleroderma**—widespread skin involvement, rapid progression, early visceral involvement. Associated with anti-Scl-70 antibody (anti-DNA topoisomerase-I antibody) and anti-RNA polymerase III.
- Limited scleroderma—limited skin involvement confined to fingers and face. Also with CREST syndrome: Calcinosis cutis , anti-Centromere antibody, Raynaud phenomenon, Esophageal dysmotility, Sclerodactyly, and Telangiectasia. More benign clinical course.



► MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE—DERMATOLOGY

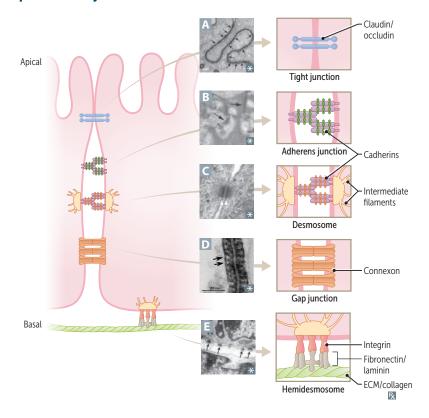
Skin layers

Skin has 3 layers: epidermis, dermis, subcutaneous fat (hypodermis, subcutis). Epidermal layers: Come, Let's Get Sun Burned.



FAS1_2019_11-Musculo.indd 473 11/7/19 5:24 PM

Epithelial cell junctions



Tight junctions (zonula occludens) A—prevents paracellular movement of solutes; composed of claudins and occludins.

Adherens junction (belt desmosome, zonula adherens) B—forms "belt" connecting actin cytoskeletons of adjacent cells with CADherins (Ca²⁺-dependent adhesion proteins). Loss of E-cadherin promotes metastasis.

Desmosome (spot desmosome, macula adherens)

C—structural support via intermediate filament interactions. Autoantibodies to desmoglein 1 and/or 3 → pemphigus vulgaris.

Gap junction —channel proteins called connexons permit electrical and chemical communication between cells.

Hemidesmosome E—connects keratin in basal cells to underlying basement membrane.
Autoantibodies → bullous pemphigoid.
(Hemidesmosomes are down "bullow.")

Integrins—membrane proteins that maintain integrity of basolateral membrane by binding to collagen, laminin, and fibronectin in basement membrane.

FAS1_2019_11-Musculo.indd 474 11/7/19 5:24 PM

Dermatologic macroscopic terms

CHARACTERISTICS	EXAMPLES
Flat lesion with well-circumscribed change in skin color < 1 cm	Freckle (ephelide), labial macule A
Macule > 1 cm	Large birthmark (congenital nevus)
Elevated solid skin lesion < 1 cm	Mole (nevus) 🕻, acne
Papule > 1 cm	Psoriasis D
Small fluid-containing blister < 1 cm	Chickenpox (varicella), shingles (zoster) E
Large fluid-containing blister > 1 cm	Bullous pemphigoid F
Vesicle containing pus	Pustular psoriasis 🜀
Transient smooth papule or plaque	Hives (urticaria) H
Flaking off of stratum corneum	Eczema, psoriasis, SCC 👖
Dry exudate	Impetigo J
	Flat lesion with well-circumscribed change in skin color < 1 cm Macule > 1 cm Elevated solid skin lesion < 1 cm Papule > 1 cm Small fluid-containing blister < 1 cm Large fluid-containing blister > 1 cm Vesicle containing pus Transient smooth papule or plaque Flaking off of stratum corneum



Dermatologic microscopic terms

LESION	CHARACTERISTICS	EXAMPLES
Hyperkeratosis	† thickness of stratum corneum	Psoriasis, calluses
Parakeratosis	Retention of nuclei in stratum corneum	Psoriasis, actinic keratosis
Hypergranulosis	† thickness of stratum granulosum	Lichen planus
Spongiosis	Epidermal accumulation of edematous fluid in intercellular spaces	Eczematous dermatitis
Acantholysis	Separation of epidermal cells	Pemphigus vulgaris
Acanthosis	Epidermal hyperplasia († spinosum)	Acanthosis nigricans, psoriasis

FAS1_2019_11-Musculo.indd 475 11/7/19 5:24 PM

Pigmented skin disorders

Albinism	Normal melanocyte number with ↓ melanin production ⚠ due to ↓ tyrosinase activity or defective tyrosine transport. ↑ risk of skin cancer.
Melasma (chloasma)	Acquired hyperpigmentation associated with pregnancy ("mask of pregnancy" () or OCP use. More common in women with darker complexions.
Vitiligo	Irregular patches of complete depigmentation C . Caused by destruction of melanocytes (believed to be autoimmune). Associated with other autoimmune disorders.



Seborrheic dermatitis



Erythematous, well-demarcated plaques A with greasy yellow scales in areas rich in sebaceous glands, such as scalp, face, and periocular region. Common in both infants (cradle cap) and adults, associated with Parkinson disease. Sebaceous glands are not inflamed, but play a role in disease development. Possibly associated with *Malassezia* spp. Treatment: topical antifungals and corticosteroids.

FAS1_2019_11-Musculo.indd 476 11/7/19 5:24 PM

Verrucae

Urticaria

Common skin disorders Multifactorial etiology—↑ sebum/androgen production, abnormal keratinocyte desquamation, Acne Cutibacterium acnes colonization of the pilosebaceous unit (comedones), and inflammation (papules/pustules A, nodules, cysts). Treatment: retinoids, benzoyl peroxide, and antibiotics. **Atopic dermatitis** Type I hypersensitivity reaction. Pruritic eruption, commonly on skin flexures. Associated with other atopic diseases (asthma, allergic rhinitis, food allergies); † serum IgE. Mutations in filaggrin gene (eczema) predispose (via skin barrier dysfunction). Often appears on face in infancy B and then in antecubital fossa C in children and adults. Allergic contact Type IV hypersensitivity reaction secondary to contact allergen (eg, nickel D, poison ivy, neomycin E). dermatitis Melanocytic nevus Common mole. Benign, but melanoma can arise in congenital or atypical moles. Intradermal nevi are papular **F**. Junctional nevi are flat macules **G**. **Pseudofolliculitis** Foreign body inflammatory facial skin disorder characterized by firm, hyperpigmented papules and barbae pustules that are painful and pruritic. Located on cheeks, jawline, and neck. Commonly occurs as a result of shaving ("razor bumps"), primarily affects African-American males. **Psoriasis** Papules and plaques with silvery scaling H, especially on knees and elbows. Acanthosis with parakeratotic scaling (nuclei still in stratum corneum), Munro microabscesses. † stratum spinosum, ↓ stratum granulosum. Auspitz sign (II)—pinpoint bleeding spots from exposure of dermal papillae when scales are scraped off. Associated with nail pitting and psoriatic arthritis. Inflammatory facial skin disorder characterized by erythematous papules and pustules \mathbf{J} , but no Rosacea comedones. May be associated with facial flushing in response to external stimuli (eg, alcohol, heat). Phymatous rosacea can cause rhinophyma (bulbous deformation of nose). Seborrheic keratosis Flat, greasy, pigmented squamous epithelial proliferation of immature keratinocytes with keratin-

filled cysts (horn cysts) K. Looks "stuck on." Lesions occur on head, trunk, and extremities. Common benign neoplasm of older persons. Leser-Trélat sign —rapid onset of multiple

Warts; caused by low-risk HPV strains. Soft, tan-colored, cauliflower-like papules M. Epidermal hyperplasia, hyperkeratosis, koilocytosis. Condyloma acuminatum on anus or genitals N. Hives. Pruritic wheals that form after mast cell degranulation Q. Characterized by superficial

seborrheic keratoses, indicates possible malignancy (eg, GI adenocarcinoma).



FAS1_2019_11-Musculo.indd 477 11/7/19 5:24 PM

Vascular tumors of skin

Angiosarcoma	Rare blood vessel malignancy typically occurring in the head, neck, and breast areas. Usually in elderly, on sun-exposed areas. Associated with radiation therapy and chronic postmastectomy lymphedema. Hepatic angiosarcoma associated with vinyl chloride and arsenic exposures. Very aggressive and difficult to resect due to delay in diagnosis.
Bacillary angiomatosis	Benign capillary skin papules A found in AIDS patients. Caused by <i>Bartonella</i> infections. Frequently mistaken for Kaposi sarcoma, but has neutrophilic infiltrate.
Cherry hemangioma	Benign capillary hemangioma B commonly appearing in middle-aged adults. Does not regress. Frequency † with age.
Glomus tumor	Benign, painful, red-blue tumor, commonly under fingernails . Arises from modified smooth muscle cells of the thermoregulatory glomus body.
Kaposi sarcoma	Endothelial malignancy most commonly affecting the skin, mouth, GI tract, respiratory tract. Classically seen in older Eastern European males, patients with AIDS, and organ transplant patients. Associated with HHV-8 and HIV. Rarely mistaken for bacillary angiomatosis, but has lymphocytic infiltrate.
Pyogenic granuloma	Polypoid lobulated capillary hemangioma D that can ulcerate and bleed. Associated with trauma and pregnancy.
Strawberry hemangioma	Benign capillary hemangioma of infancy E . Appears in first few weeks of life (1/200 births); grows rapidly and regresses spontaneously by 5–8 years old.











FAS1_2019_11-Musculo.indd 478 11/7/19 5:24 PM

Skin infections			
Bacterial infections			
Impetigo	Very superficial skin infection. Usually from <i>S aureus</i> or <i>S pyogenes</i> . Highly contagious. Honeycolored crusting A. Bullous impetigo B has bullae and is usually caused by <i>S aureus</i> .		
Erysipelas	Infection involving upper dermis and superficial lymphatics, usually from <i>S pyogenes</i> . Presents wi well-defined, raised demarcation between infected and normal skin C .		
Cellulitis	Acute, painful, spreading infection of deeper dermis and subcutaneous tissues. Usually from <i>S pyogenes</i> or <i>S aureus</i> . Often starts with a break in skin from trauma or another infection D .		
Abscess	Collection of pus from a walled-off infection within deeper layers of skin E . Offending organism is almost always <i>S aureus</i> .		
Necrotizing fasciitis	Deeper tissue injury, usually from anaerobic bacteria or <i>S pyogenes</i> . Pain may be out of proportion to exam findings. Results in crepitus from methane and CO₂ production. "Flesh-eating bacteria." Causes bullae and skin necrosis → violaceous color of bullae, surrounding skin . Surgical emergency.		
Staphylococcal scalded skin syndrome	Exotoxin destroys keratinocyte attachments in stratum granulosum only (vs toxic epidermal necrolysis, which destroys epidermal-dermal junction). Characterized by fever and generalized erythematous rash with sloughing of the upper layers of the epidermis c that heals completely. ① Nikolsky sign (separation of epidermis upon manual stroking of skin). Commonly seen in newborns and children/adults with renal insufficiency.		
Viral infections			
Herpes	Herpes virus infections (HSV1 and HSV2) of skin can occur anywhere from mucosal surfaces to normal skin. These include herpes labialis, herpes genitalis, herpetic whitlow \mathbf{H} (finger).		
Molluscum contagiosum	Umbilicated papules caused by a poxvirus. While frequently seen in children, it may be sexually transmitted in adults.		
Varicella zoster virus	Causes varicella (chickenpox) and zoster (shingles). Varicella presents with multiple crops of lesions in various stages from vesicles to crusts. Zoster is a reactivation of the virus in dermatomal distribution (unless it is disseminated).		
Hairy leukoplakia	Irregular, white, painless plaques on lateral tongue that cannot be scraped off . EBV mediated. Occurs in HIV-positive patients, organ transplant recipients. Contrast with thrush (scrapable) and leukoplakia (precancerous).		
A	B C D D E		



11/7/19 5:24 PM FAS1_2019_11-Musculo.indd 479

Autoimmune blistering skin disorders

	Pemphigus vulgaris	Bullous pemphigoid	
PATHOPHYSIOLOGY	Potentially fatal. Most commonly seen in older adults. Type II hypersensitivity reaction. IgG antibodies against desmoglein-1 and/or desmoglein-3 (component of desmosomes, which connect keratinocytes in the stratum spinosum).	Less severe than pemphigus vulgaris. Most commonly seen in older adults. Type II hypersensitivity reaction. IgG antibodies against hemidesmosomes (epidermal basement membrane; antibodies are "bullow" the epidermis). Tense blisters containing eosinophils; oral mucosa spared. Nikolsky sign .	
GROSS MORPHOLOGY	Flaccid intraepidermal bullae A caused by acantholysis (separation of keratinocytes, "row of tombstones" on H&E stain); oral mucosa is involved. Nikolsky sign ⊕.		
IMMUNOFLUORESCENCE	Reticular pattern around epidermal cells B.	Linear pattern at epidermal-dermal junction D	
	A B	D RU	

FAS1_2019_11-Musculo.indd 480 11/7/19 5:24 PM

Other blistering skin disorders

Dermatitis herpetiformis	Pruritic papules, vesicles, and bullae (often found on elbows, knees, buttocks) A. Deposits of IgA at tips of dermal papillae. Associated with celiac disease. Treatment: dapsone, gluten-free diet.
Erythema multiforme	Associated with infections (eg, <i>Mycoplasma pneumoniae</i> , HSV), drugs (eg, sulfa drugs, β-lactams, phenytoin). Presents with multiple types of lesions—macules, papules, vesicles, target lesions (look like targets with multiple rings and dusky center showing epithelial disruption) B .
Stevens-Johnson syndrome	Characterized by fever, bullae formation and necrosis, sloughing of skin at dermal-epidermal junction (⊕ Nikolsky), high mortality rate. Typically mucous membranes are involved ☑ ☑. Targetoid skin lesions may appear, as seen in erythema multiforme. Usually associated with adverse drug reaction. Toxic epidermal necrolysis (TEN) ☑ ☑ is more severe form of SJS involving > 30% body surface area. 10–30% involvement denotes SJS-TEN.



FAS1_2019_11-Musculo.indd 481 11/7/19 5:24 PM

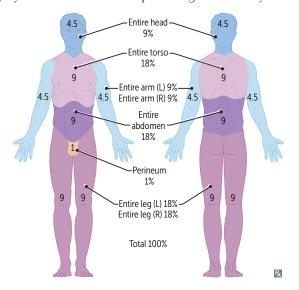
Miscellaneous skin disorders

Miscellarieous skiil uisc			
Acanthosis nigricans	Epidermal hyperplasia causing symmetric, hyperpigmented thickening of skin, especially in axilla or on neck A B. Associated with insulin resistance (eg, diabetes, obesity, Cushing syndrome, PCOS), visceral malignancy (eg, gastric adenocarcinoma).		
Actinic keratosis	Premalignant lesions caused by sun exposure. Small, rough, erythematous or brownish papules or plaques 🗖 D. Risk of squamous cell carcinoma is proportional to degree of epithelial dysplasia.		
Erythema nodosum	Painful, raised inflammatory lesions of subcutaneous fat (panniculitis), usually on anterior shins. Often idiopathic, but can be associated with sarcoidosis, coccidioidomycosis, histoplasmosis, TB, streptococcal infections E , leprosy F , inflammatory bowel disease.		
Lichen Planus	Pruritic, Purple, Polygonal Planar Papules and Plaques are the 6 P's of lichen Planus G H. Mucosal involvement manifests as Wickham striae (reticular white lines) and hypergranulosis. Sawtooth infiltrate of lymphocytes at dermal-epidermal junction. Associated with hepatitis C.		
Pityriasis rosea	"Herald patch" followed days later by other scaly erythematous plaques, often in a "Christmas tree" distribution on trunk . Multiple pink plaques with collarette scale. Self-resolving in 6–8 weeks.		
Sunburn	Acute cutaneous inflammatory reaction due to excessive UV irradiation. Causes DNA mutations, inducing apoptosis of keratinocytes. UVB is dominant in sunBurn, UVA in tAnning and photoAging. Exposure to UVA and UVB † risk of skin cancer.		
A RI			

FAS1_2019_11-Musculo.indd 482 11/7/19 5:24 PM

Rule of 9's

The extent of a burn injury can be estimated as a percentage of the body surface area.



Burn classification

DEPTH	INVOLVEMENT	APPEARANCE	SENSATION
Superficial burn	Epidermis only	Similar to sunburn; localized, painful, dry, blanching redness with no blisters	Painful
Superficial partial- thickness	All of epidermis and some dermis	Blisters, blanches with pressure, swollen, warm	Painful to temperature and air
Deep partial- thickness burn	All of epidermis and some dermis	Blisters (easily unroofed), does not blanch with pressure	Painless; perception of pressure only
Full-thickness burn	All of skin (epidermis and dermis)	White, waxy, dry, inelastic, leathery, does not blanch with pressure	Painless; perception of deep pressure only
Deeper injury burn	All of skin and at least partial involvement of muscle and/or fascia	White, dry, inelastic, does not blanch with pressure	Painless; some perception of deep pressure

FAS1_2019_11-Musculo.indd 483 11/7/19 5:24 PM

Skin cancer

Basal cell carcinoma more common above upper lip Squamous cell carcinoma more common below lower lip Sun exposure strongly predisposes to skin cancer.



Basal cell carcinoma

Most common skin cancer. Found in sun-exposed areas of body (eg, face). Locally invasive, but rarely metastasizes. Waxy, pink, pearly nodules, commonly with telangiectasias, rolled borders A, central crusting or ulceration. BCCs also appear as nonhealing ulcers with infiltrating growth B or as a scaling plaque (superficial BCC) . Basal cell tumors have "palisading" (aligned) nuclei D.

Keratoacanthoma

Seen in middle-aged and elderly individuals. Rapidly growing, resembles squamous cell carcinoma. Presents as dome-shaped nodule with keratin-filled center. Grows rapidly (4-6 weeks) and may spontaneously regress **E**.

Melanoma

Common tumor with significant risk of metastasis. S-100 tumor marker. Associated with dysplastic nevi; fair-skinned persons are at † risk. Depth of tumor (Breslow thickness) correlates with risk of metastasis. Look for the ABCDEs: Asymmetry, Border irregularity, Color variation, Diameter > 6 mm, and Evolution over time. At least 4 different types of melanoma, including superficial spreading F, nodular G, lentigo maligna H, and acral lentiginous (highest prevalence in African-Americans and Asians) I. Often driven by activating mutation in BRAF kinase. Primary treatment is excision with appropriately wide margins. Metastatic or unresectable melanoma in patients with BRAF V600E mutation may benefit from vemurafenib, a BRAF kinase inhibitor.

Squamous cell carcinoma

Second most common skin cancer. Associated with immunosuppression, chronic nonhealing wounds, and occasionally arsenic exposure. Commonly appears on face , lower lip , ears, hands. Locally invasive, may spread to lymph nodes, and will rarely metastasize. Ulcerative red lesions. Histopathology: keratin "pearls" .

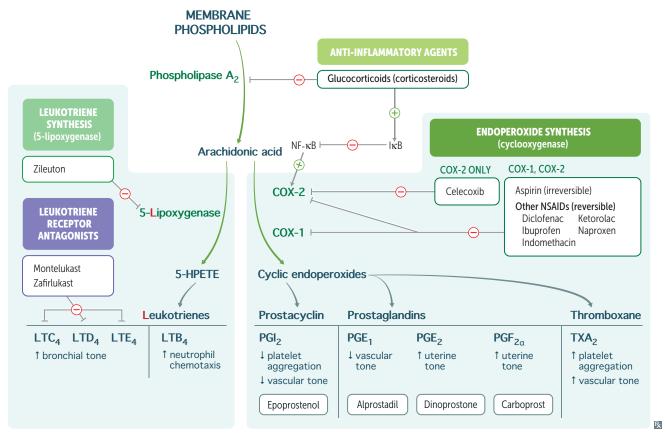
Actinic keratosis, a scaly plaque, is a precursor to squamous cell carcinoma.



FAS1_2019_11-Musculo.indd 484 11/7/19 5:24 PM

► MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE—PHARMACOLOGY

Arachidonic acid pathways



LTB₄ is a **neutrophil** chemotactic agent. **PGI**₂ inhibits platelet aggregation and promotes vasodilation.

Neutrophils arrive "B4" others. Platelet-Gathering Inhibitor.

Acetaminophen

MECHANISM	Reversibly inhibits cyclooxygenase, mostly in CNS. Inactivated peripherally.
CLINICAL USE	Antipyretic, analgesic, but not anti-inflammatory. Used instead of aspirin to avoid Reye syndrome in children with viral infection.
ADVERSE EFFECTS	Overdose produces hepatic necrosis; acetaminophen metabolite (NAPQI) depletes glutathione and forms toxic tissue byproducts in liver. N-acetylcysteine is antidote—regenerates glutathione.

FAS1_2019_11-Musculo.indd 485 11/7/19 5:24 PM

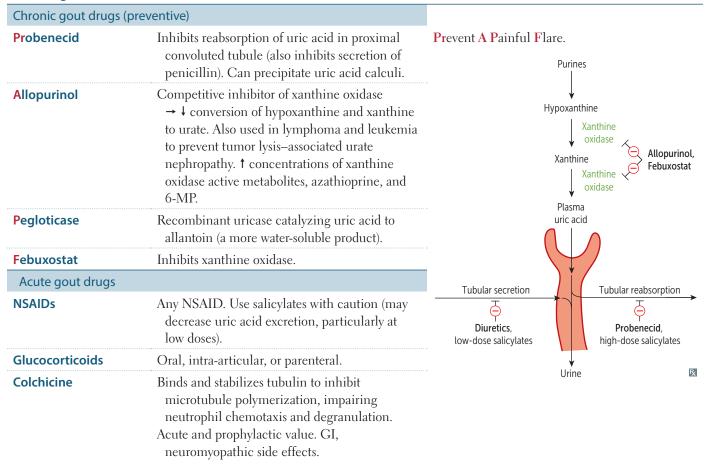
Aspirin		
MECHANISM	NSAID that irreversibly inhibits cyclooxygenase (both COX-1 and COX-2) by covalent acetylation → ↓ synthesis of TXA₂ and prostaglandins. ↑ bleeding time. No effect on PT, PTT. Effect lasts until new platelets are produced.	
CLINICAL USE	Low dose (< 300 mg/day): ↓ platelet aggregation. Intermediate dose (300–2400 mg/day): antipyretic and analgesic. High dose (2400–4000 mg/day): anti-inflammatory.	
ADVERSE EFFECTS	Gastric ulceration, tinnitus (CN VIII), allergic reactions (especially in patients with asthma or nasal polyps). Chronic use can lead to acute kidney injury, interstitial nephritis, GI bleeding. R of Reye syndrome in children treated with aspirin for viral infection. Toxic doses cause respirat alkalosis early, but transitions to mixed metabolic acidosis-respiratory alkalosis. Treatment of overdose: NaHCO ₃ .	
Celecoxib		
MECHANISM	Reversibly and selectively inhibits the cyclooxygenase (COX) isoform 2 (" Selecoxib "), which is found in inflammatory cells and vascular endothelium and mediates inflammation and pain; spares COX-1, which helps maintain gastric mucosa. Thus, does not have the corrosive effects of other NSAIDs on the GI lining. Spares platelet function as TXA ₂ production is dependent on COX-1.	
CLINICAL USE	Rheumatoid arthritis, osteoarthritis.	
ADVERSE EFFECTS	† risk of thrombosis, sulfa allergy.	
Nonsteroidal anti-inflammatory drugs	Ibuprofen, naproxen, indomethacin, ketorolac, diclofenac, meloxicam, piroxicam.	
MECHANISM	Reversibly inhibit cyclooxygenase (both COX-1 and COX-2). Block prostaglandin synthesis.	
CLINICAL USE	Antipyretic, analgesic, anti-inflammatory. Indomethacin is used to close a PDA.	
ADVERSE EFFECTS	Interstitial nephritis, gastric ulcer (prostaglandins protect gastric mucosa), renal ischemia (prostaglandins vasodilate afferent arteriole), aplastic anemia.	
Leflunomide		
MECHANISM	Reversibly inhibits dihydroorotate dehydrogenase, preventing pyrimidine synthesis. Suppresses T-cell proliferation.	
CLINICAL USE	Rheumatoid arthritis, psoriatic arthritis.	
ADVERSE EFFECTS	Diarrhea, hypertension, hepatotoxicity, teratogenicity.	
Bisphosphonates	Alendronate, ibandronate, risedronate, zoledronate.	
MECHANISM	Pyrophosphate analogs; bind hydroxyapatite in bone, inhibiting osteoclast activity.	
CLINICAL USE	Osteoporosis, hypercalcemia, Paget disease of bone, metastatic bone disease, osteogenesis imperfecta.	
ADVERSE EFFECTS	Esophagitis (if taken orally, patients are advised to take with water and remain upright for 30 minutes), osteonecrosis of jaw, atypical femoral stress fractures.	

FAS1_2019_11-Musculo.indd 486 11/7/19 5:24 PM

Teriparatide

MECHANISM	Recombinant PTH analog. † osteoblastic activity when administered in pulsatile fashion.
CLINICAL USE	Osteoporosis. Causes † bone growth compared to antiresorptive therapies (eg, bisphosphonates).
ADVERSE EFFECTS	† risk of osteosarcoma (avoid use in patients with Paget disease of the bone or unexplained elevation of alkaline phosphatase). Avoid in patients who have had prior cancers or radiation therapy. Transient hypercalcemia.

Gout drugs



TNF-α inhibitors

DRUG	MECHANISM	CLINICAL USE	ADVERSE EFFECTS
Etanercept	Fusion protein (decoy receptor for TNF-α + IgG ₁ Fc), produced by recombinant DNA. Etanercept intercepts TNF.	Rheumatoid arthritis, psoriasis, ankylosing spondylitis	Predisposition to infection, including reactivation of latent TB, since TNF is important in granuloma
Infliximab, adalimumab, certolizumab, golimumab	Anti-TNF-α monoclonal antibody.	Inflammatory bowel disease, rheumatoid arthritis, ankylosing spondylitis, psoriasis	formation and stabilization. Can also lead to drug-induced lupus.

FAS1_2019_11-Musculo.indd 487 11/7/19 5:24 PM

488 SECTION I

SECTION II MUSCULOSKELETAL, SKIN, AND CONNECTIVE TISSUE → PHARMACOLOGY

► NOTES	

FAS1_2019_11-Musculo.indd 488 11/7/19 5:24 PM

HIGH-YIELD SYSTEMS

Neurology and Special Senses

"We are all now connected by the Internet, like neurons in a giant brain."

—Stephen Hawking

"Anything's possible if you've got enough nerve."

—J.K. Rowling, Harry Potter and the Order of the Phoenix

"I like nonsense; it wakes up the brain cells."

-Dr. Seuss

"I believe in an open mind, but not so open that your brains fall out."

—Arthur Hays Sulzberger

"The chief function of the body is to carry the brain around."

—Thomas Edison

"Exactly how [the brain] operates remains one of the biggest unsolved mysteries, and it seems the more we probe its secrets, the more surprises we find."

—Neil deGrasse Tyson

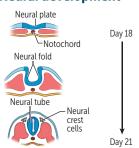
Understand the difference between upper motor neuron (UMN) and lower motor neuron (LMN) findings and the underlying anatomy. Know the major motor, sensory, cerebellar and visual pathways and their respective locations in the CNS. Connect key neurological associations with certain pathologies (eg, cerebellar lesions, stroke manifestations, Brown-Séquard syndrome). Recognize common findings on MRI/CT (eg, ischemic and hemorrhagic stroke) and on neuropathology (eg, neurofibrillary tangles and Lewy bodies). High-yield medications include those used to treat epilepsy, Parkinson disease, migraine, and pain (eg, opioids).

▶ Embryology	490
Anatomy and Physiology	493
▶ Pathology	511
▶Otology	533
▶ Ophthalmology	534
Pharmacology	544

FAS1_2019_12-Neurol.indd 489 11/8/19 7:39 AM

► NEUROLOGY—EMBRYOLOGY

Neural development



Notochord induces overlying ectoderm to differentiate into neuroectoderm and form neural plate. Neural plate gives rise to neural tube and neural crest cells.

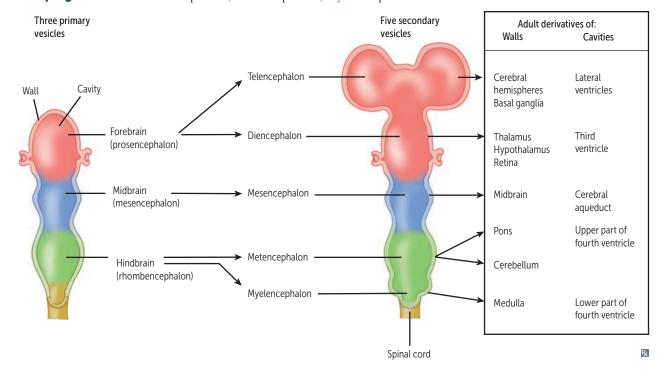
Notochord becomes nucleus pulposus of intervertebral disc in adults.

Alar plate (dorsal): sensory; regulated by TGF-β (including bone morphogenetic protein [*BMP*]) Basal plate (ventral): motor; regulated by sonic hedgehog gene (*SHH*)

Same orientation as spinal cord

Regional specification of developing brain

Telencephalon is the 1st part. Diencephalon is the 2nd part. The rest are arranged alphabetically: mesencephalon, metencephalon, myelencephalon.



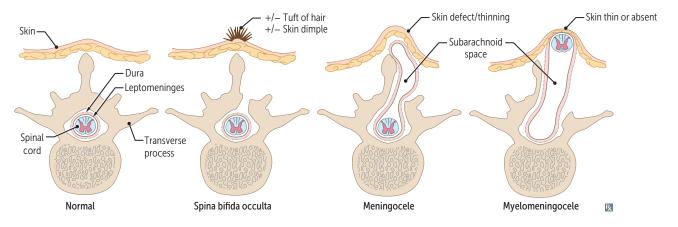
Central and peripheral nervous systems origins

Neuroepithelia in neural tube—CNS neurons, ependymal cells (inner lining of ventricles, make CSF), oligodendrocytes, astrocytes.

Neural crest—PNS neurons, Schwann cells, glia, melanocytes, adrenal medulla. Mesoderm—Microglia (like Macrophages).

FAS1_2019_12-Neurol.indd 490 11/8/19 7:39 AM

Neural tube defects	Neuropores fail to fuse (4th week) → persistent connection between amniotic cavity and spinal canal. Associated with maternal diabetes and folate deficiency. ↑ α-fetoprotein (AFP) in amniotic fluid and maternal serum (except spina bifida occulta = normal AFP). ↑ acetylcholinesterase (AChE) in amniotic fluid is a helpful confirmatory test.				
Spina bifida occulta	Failure of caudal neuropore to close, but no herniation. Usually seen at lower vertebral levels. Dura is intact. Associated with tuft of hair or skin dimple at level of bony defect.				
Meningocele	Meninges (but no neural tissue) herniate through bony defect.				
Myelomeningocele	Meninges and neural tissue (eg, cauda equina) herniate through bony defect.				
Myeloschisis	Also called rachischisis. Exposed, unfused neural tissue without skin/meningeal covering.				
Anencephaly	Failure of rostral neuropore to close → no forebrain, open calvarium. Clinical findings: polyhydramnios (no swallowing center in brain).				



Holoprosencephaly



Failure of the embryonic forebrain (prosencephalon) to separate into 2 cerebral hemispheres; usually occurs during weeks 5–6. May be related to mutations in sonic hedgehog signaling pathway. Associated with other midline defects including cleft lip/palate (moderate form) and cyclopia (severe form). † risk for pituitary dysfunction (eg, diabetes insipidus). Can be seen with Patau syndrome (trisomy 13).

MRI reveals monoventricle **A** and fusion of basal ganglia (star in **A**).

Lissencephaly

Failure of neuronal migration resulting in a "smooth brain" that lacks sulci and gyri. May be associated with microcephaly, ventriculomegaly.

FAS1_2019_12-Neurol.indd 491 11/8/19 7:39 AM

Posterior fossa malformations

Chiari I malformation

Ectopia of cerebellar **tonsils** inferior to foramen magnum (1 structure) A. Congenital, usually asymptomatic in childhood, manifests in adulthood with headaches and cerebellar symptoms. Associated with spinal cavitations (eg, syringomyelia).

Chiari II malformation

Herniation of cerebellar **vermis** and **tonsils** (2 structures) through foramen magnum with aqueductal stenosis → noncommunicating hydrocephalus. Usually associated with lumbosacral myelomeningocele (may present as paralysis/sensory loss at and below the level of the lesion). More severe than Chiari I, usually presents early in life.

Dandy-Walker malformation

Agenesis of cerebellar vermis → cystic enlargement of 4th ventricle (arrow in **B**) that fills the enlarged posterior fossa. Associated with noncommunicating hydrocephalus, spina bifida.

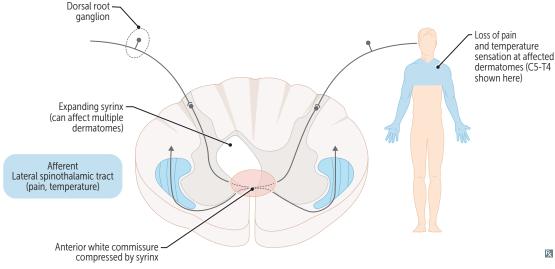


Syringomyelia



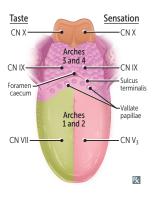
Cystic cavity (syrinx) within central canal of spinal cord (yellow arrows in A). Fibers crossing in anterior white commissure (spinothalamic tract) are typically damaged first. Results in a "capelike," bilateral, symmetrical loss of pain and temperature sensation in upper extremities (fine touch sensation is preserved).

Associated with Chiari I malformation (red arrow in A shows low-lying cerebellar tonsils), scoliosis and other congenital malformations; acquired causes include trauma and tumors. Most common location cervical > thoracic >> lumbar. Syrinx = tube, as in "syringe."



FAS1_2019_12-Neurol.indd 492 11/8/19 7:39 AM

Tongue development



1st and 2nd pharyngeal arches form anterior 2/3 (thus sensation via CN V₃, taste via CN VII).
3rd and 4th pharyngeal arches form posterior 1/3(thus sensation and taste mainly via CN IX, extreme posterior via CN X).

Motor innervation is via CN XII to hyoglossus (retracts and depresses tongue), **geni**oglossus (**protrudes** tongue), and **styl**oglossus (draws sides of tongue upward to create a trough for swallowing).

Motor innervation is via CN X to palatoglossus (elevates posterior tongue during swallowing).

Taste—CN VII, IX, X (solitary nucleus). Pain—CN V₃, IX, X.

Motor—CN X, XII.

The Genie comes out of the lamp in style.

► NEUROLOGY—ANATOMY AND PHYSIOLOGY

Neurons

Signal-transmitting cells of the nervous system. Permanent cells—do not divide in adulthood. Signal-relaying cells with dendrites (receive input), cell bodies, and axons (send output). Cell bodies and dendrites can be seen on Nissl staining (stains RER). RER is not present in the axon. Neuron markers: neurofilament protein, synaptophysin.

Astrocytes



Most common glial cell type in CNS. Physical support, repair, extracellular K⁺ buffer, removal of excess neurotransmitter, component of blood-brain barrier, glycogen fuel reserve buffer. Reactive gliosis in response to neural injury.

Derived from neuroectoderm. Astrocyte marker: GFAP.

Microglia



Phagocytic scavenger cells of CNS (mesodermal, mononuclear origin). Activation in response to tissue damage → release of inflammatory mediators (eg, nitric oxide, glutamate). Not readily discernible by Nissl stain.

HIV-infected microglia fuse to form multinucleated giant cells in CNS seen in HIV-associated dementia.

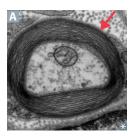
Ependymal cells

Ciliated simple columnar glial cells line the ventricles and central canal of spinal cord. Apical surfaces are covered in cilia (which circulate CSF) and microvilli (which help with CSF absorption). Specialized ependymal cells (choroid plexus) produce CSF.

FAS1_2019_12-Neurol.indd 493

NEUROLOGY AND SPECIAL SENSES ▶ NEUROLOGY — ANATOMY AND PHYSIOLOGY

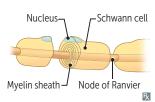
Myelin



† conduction velocity of signals transmitted down axons → saltatory conduction of action potential at the nodes of Ranvier, where there are high concentrations of Na⁺ channels. In CNS (including CN II), myelin is synthesized by oligodendrocytes; in PNS (including CN III-XII), myelin is synthesized by Schwann cells. Wraps and insulates axons (arrow in A): † space constant and † conduction velocity.

COPS: CNS = Oligodendrocytes, PNS = Schwann cells.

Schwann cells

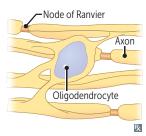


Promote axonal regeneration. Derived from neural crest.

Each "Schwone" cell myelinates only 1 PNS axon.

Injured in Guillain-Barré syndrome.

Oligodendrocytes



Myelinate axons of neurons in CNS. Each oligodendrocyte can myelinate many axons (~ 30). Predominant type of glial cell in white matter.

Derived from neuroectoderm.

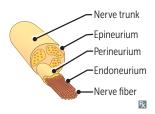
"Fried egg" appearance histologically.
Injured in multiple sclerosis, progressive multifocal leukoencephalopathy (PML), leukodystrophies.

Sensory receptors

RECEPTOR TYPE	SENSORY NEURON FIBER TYPE	LOCATION	SENSES		
Free nerve endings	Aδ—fast, myelinated fibers C—slow, unmyelinated A Delta plane is fast, but a taxC is slow	All skin, epidermis, some viscera	Pain, temperature		
Meissner corpuscles	Large, myelinated fibers; adapt quickly	Glabrous (hairless) skin	Dynamic, fine/light touch, position sense, low-frequency vibration		
Pacinian corpuscles	Large, myelinated fibers; adapt quickly	Deep skin layers, ligaments, joints	High-frequency vibration, pressure		
Merkel discs	Large, myelinated fibers; adapt slowly	Finger tips, superficial skin	Pressure, deep static touch (eg, shapes, edges), position sense		
Ruffini corpuscles	Dendritic endings with capsule; adapt slowly	Finger tips, joints	Pressure, slippage of objects along surface of skin, joint angle change		

FAS1_2019_12-Neurol.indd 494 11/8/19 7:39 AM

Peripheral nerve

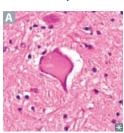


Endoneurium—thin, supportive connective tissue that ensheathes and supports individual myelinated nerve fibers.

Perineurium (blood-nerve Permeability barrier)—surrounds a fascicle of nerve fibers. Epineurium—dense connective tissue that surrounds entire nerve (fascicles and blood vessels).

Endo = inner Peri = around Epi = outer

Chromatolysis

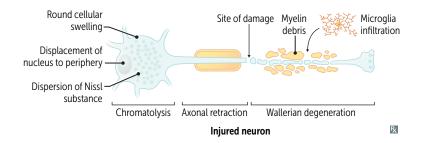


Reaction of neuronal cell body to axonal injury. Changes reflect † protein synthesis in effort to repair the damaged axon. Characterized by:

- Round cellular swelling A
- Displacement of the nucleus to the periphery
- Dispersion of Nissl substance throughout cytoplasm

Wallerian degeneration—disintegration of the axon and myelin sheath distal to site of axonal injury with macrophages removing debris.

Proximal to the injury, the axon retracts, and the cell body sprouts new protrusions that grow toward other neurons for potential reinnervation. Serves as a preparation for axonal regeneration and functional recovery.

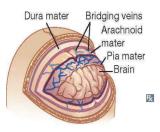


Neurotransmitter changes with disease

	LOCATION OF SYNTHESIS	ANXIETY	DEPRESSION	SCHIZOPHRENIA	ALZHEIMER DISEASE	HUNTINGTON DISEASE	PARKINSON DISEASE
Acetylcholine	Basal nucleus of Meynert				†	ţ	†
Dopamine	Ventral tegmentum, SNc		†	†		†	†
GABA	Nucleus accumbens	†				↓	
Norepinephrine	Locus ceruleus (pons)	†	†				
Serotonin	Raphe nuclei (medulla, pons)	1	1				1

FAS1_2019_12-Neurol.indd 495 11/8/19 7:39 AM

Meninges



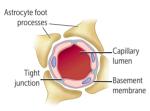
Three membranes that surround and protect the brain and spinal cord:

- Dura mater—thick outer layer closest to skull. Derived from mesoderm.
- Arachnoid mater—middle layer, contains web-like connections. Derived from neural crest.
- Pia mater—thin, fibrous inner layer that firmly adheres to brain and spinal cord.
 Derived from neural crest.

CSF flows in the subarachnoid space, located between arachnoid and pia mater.

Epidural space—potential space between the dura mater and skull/vertebral column containing fat and blood vessels. Site of blood collection associated with middle meningeal artery injury.

Blood-brain barrier



Prevents circulating blood substances (eg, bacteria, drugs) from reaching the CSF/CNS. Formed by 3 structures:

- Tight junctions between nonfenestrated capillary endothelial cells
- Basement membrane
- Astrocyte foot processes

Glucose and amino acids cross slowly by carrier-mediated transport mechanisms.

Nonpolar/lipid-soluble substances cross rapidly via diffusion.

Circumventricular organs with fenestrated capillaries and no blood-brain barrier allow molecules in blood to affect brain function (eg, area postrema—vomiting after chemotherapy; OVLT [organum vasculosum lamina terminalis]—osmoreceptors) or neurosecretory products to enter circulation (eg, neurohypophysis—ADH release). Infarction and/or neoplasm destroys endothelial cell tight junctions → vasogenic edema.

Hyperosmolar agents (eg, mannitol) can disrupt the BBB $\rightarrow \uparrow$ permeability of medications.

Vomiting center

Coordinated by nucleus tractus solitarius (NTS) in the medulla, which receives information from the chemoreceptor trigger zone (CTZ, located within area postrema in 4th ventricle), GI tract (via vagus nerve), vestibular system, and CNS.

CTZ and adjacent vomiting center nuclei receive input from 5 major receptors: muscarinic (M₁), dopamine (D₂), histamine (H₁), serotonin (5-HT₂), and neurokinin (NK-1) receptors.

- 5-HT₃, D₂, and NK-1 antagonists used to treat chemotherapy-induced vomiting.
- H₁ and M₂ antagonists treat motion sickness; H₂ antagonists treat hyperemesis gravidarum.

Sleep physiology	Sleep cycle is regulated by the circadian rhythm, which is driven by suprachiasmatic nucleus (SC of the hypothalamus. Circadian rhythm controls nocturnal release of ACTH, prolactin, melator norepinephrine: SCN → norepinephrine release → pineal gland → ↑ melatonin. SCN is regular by environment (eg, light). Two stages: rapid-eye movement (REM) and non-REM. Alcohol, benzodiazepines, and barbiturates are associated with ↓ REM sleep and N3 sleep; norepinephrine also ↓ REM sleep. Benzodiazepines are useful for night terrors and sleepwalking by ↓ N3 and REM sleep.			
SLEEP STAGE (% OF TOTAL SLEEP TIME IN YOUNG ADULTS)	DESCRIPTION	EEG WAVEFORM AND NOTES		
Awake (eyes open)	Alert, active mental concentration.	Beta (highest frequency, lowest amplitude)		
Awake (eyes closed)		A lpha		
Non-REM sleep				
Stage N1 (5%)	Light sleep.	T heta		
Stage N <mark>2</mark> (45%)	Deeper sleep; when bruxism ("twoth" [tooth] grinding) occurs.	Sleep spindles and K complexes		
Stage N3 (25%)	Deepest non-REM sleep (slow-wave sleep); sleepwalking, night terrors, and bedwetting occur (wee and flee in N3).	Delta (lowest frequency, highest amplitude)		
REM sleep (25%)	Loss of motor tone, † brain O ₂ use, variable pulse/BP, † ACh. REM is when dreaming, nightmares, and penile/clitoral tumescence occur; may serve memory processing function. Extraocular movements due to activity of PPRF (paramedian pontine reticular formation/conjugate gaze center). Occurs every 90 minutes, and duration † through the night.	Beta Changes in elderly: ↓ REM sleep time, ↓ N3. Changes in depression: ↑ REM sleep time, ↓ REM latency, ↓ N3, repeated nighttime awakenings, early morning awakening (terminal insomnia). Changes in narcolepsy: ↓ REM latency. At night, BATS Drink Blood		

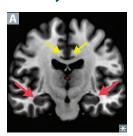
11/8/19 7:39 AM FAS1_2019_12-Neurol.indd 497

Hypothalamus	Maintains homeostasis by regulating Thirst and water balance, controlling Adenohypophysis (anterior pituitary) and Neurohypophysis (posterior pituitary) release of hormones produced in the hypothalamus, and regulating Hunger, Autonomic nervous system, Temperature, and Sexua urges (TAN HATS). Inputs (areas not protected by blood-brain barrier): OVLT (senses change in osmolarity), area postrema (found in dorsal medulla, responds to emetics).		
Lateral nucleus	Hunger. Destruction → anorexia, failure to thrive (infants). Stimulated by ghrelin, inhibited by leptin.	Lateral injury makes you Lean.	
Ventromedial nucleus	Satiety. Destruction (eg, craniopharyngioma) → hyperphagia. Stimulated by leptin.	VentroMedial injury makes you Very Massive.	
Anterior nucleus	Cooling, parasympathetic.	A/C = Anterior Cooling.	
Posterior nucleus	Heating, sympathetic.	Heating controlled by Posterior nucleus ("Hot Pot").	
Suprachiasmatic nucleus	Circadian rhythm.	SCN is a Sun-Censing Nucleus.	
Supraoptic and paraventricular nuclei	Synthesize ADH and oxytocin.	SAD POX: Supraoptic = ADH, Paraventricular = OXytocin ADH and oxytocin are carried by neurophysins down axons to posterior pituitary, where these hormones are stored and released.	
Preoptic nucleus	Thermoregulation, sexual behavior. Releases GnRH.	Failure of GnRH-producing neurons to migrate from olfactory pit → Kallmann syndrome.	

NUCLEI	INPUT	SENSES	DESTINATION	MNEMONIC
Ventral Postero- Lateral nucleus	Spinothalamic and dorsal columns/medial lemniscus	Vibration, Pain, Pressure, Proprioception, Light touch, temperature	l° somatosensory cortex	
Ventral postero- Medial nucleus	Trigeminal and gustatory pathway	Face sensation, taste	l° somatosensory cortex	Makeup goes on the face
Lateral geniculate nucleus	CN II, optic chiasm, optic tract	Vision	l° visual cortex (calcarine sulcus)	Lateral = Light
Medial geniculate nucleus	Superior olive and inferior colliculus of tectum	Hearing	Auditory cortex of temporal lobe	Medial = Music
Ventral lateral nucleus	Cerebellum, basal ganglia	Motor	Motor cortex	

11/8/19 7:39 AM FAS1_2019_12-Neurol.indd 498

Limbic system



Collection of neural structures involved in emotion, long-term memory, olfaction, behavior modulation, ANS function.

Consists of hippocampus (red arrows in A), amygdalae, mammillary bodies, anterior thalamic nuclei, cingulate gyrus (yellow arrows in A), entorhinal cortex. Responsible for Feeding, Fleeing, Fighting, Feeling, and Sex.

The famous 5 F's.

Dopaminergic pathways	Commonly altered by drugs (eg, antipsychotics) an	nd movement disorders (eg, Parkinson disease).
PATHWAY	SYMPTOMS OF ALTERED ACTIVITY	NOTES
Mesocortical	↓ activity → "negative" symptoms (eg, anergia, apathy, lack of spontaneity)	Antipsychotic drugs have limited effect
Mesolimbic	↑ activity → "positive" symptoms (eg, delusions, hallucinations)	1° therapeutic target of antipsychotic drugs → ↓ positive symptoms (eg, in schizophrenia)
Nigrostriatal	 ↓ activity → extrapyramidal symptoms (eg, dystonia, akathisia, parkinsonism, tardive dyskinesia) 	Major dopaminergic pathway in brain Significantly affected by movement disorders and antipsychotic drugs
Tuberoinfundibular	↓ activity → ↑ prolactin → ↓ libido, sexual dysfunction, galactorrhea, gynecomastia (in men)	

Cerebellum



Modulates movement; aids in coordination and balance A.

Input:

- Contralateral cortex via middle cerebellar peduncle
- Ipsilateral proprioceptive information via inferior cerebellar peduncle from spinal cord

Output:

- Deep nuclei (lateral → medial)—Dentate,
 Emboliform, Globose, Fastigial

Lateral lesions—affect voluntary movement of extremities (**lateral** structures); when injured, propensity to fall toward injured (ipsilateral) side.

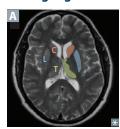
Medial lesions (eg, vermis, fastigial nuclei, flocculonodular lobe)—truncal ataxia (widebased cerebellar gait), nystagmus, head tilting. Generally result in bilateral motor deficits affecting axial and proximal limb musculature (medial structures).

Don't Eat Greasy Foods

FAS1_2019_12-Neurol.indd 499 11/8/19 7:39 AM

NEUROLOGY AND SPECIAL SENSES ► NEUROLOGY—ANATOMY AND PHYSIOLOGY

Basal ganglia



Important in voluntary movements and adjusting posture A. Receives cortical input, provides negative feedback to cortex to modulate movement.

D₁ Receptor = D1Rect pathway. Indirect (D₂) = Inhibitory.

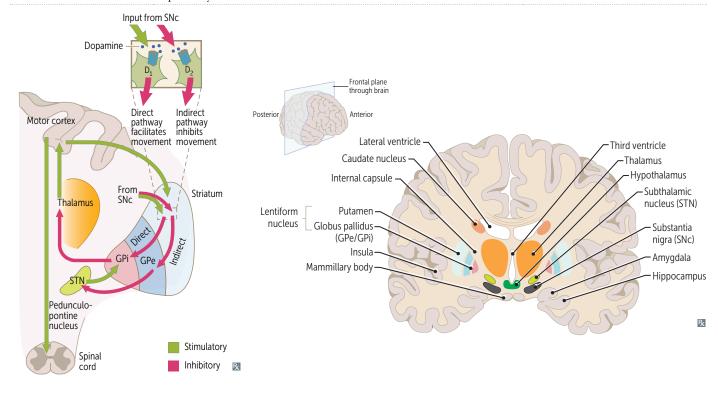
Striatum = putamen (motor) + Caudate (cognitive).

Lentiform = putamen + globus pallidus.

Direct (excitatory) pathway—SNc input to the striatum via the nigrostriatal dopaminergic pathway releases GABA, which inhibits GABA release from the GPi, disinhibiting the Thalamus via the GPi († motion).

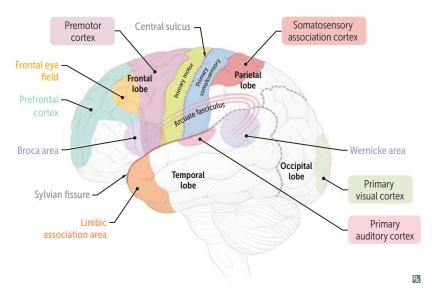
Indirect (inhibitory) pathway—SNc input to the striatum via the nigrostriatal dopaminergic pathway releases GABA that disinhibits STN via GPe inhibition, and STN stimulates GPi to inhibit the thalamus (‡ motion).

Dopamine binds to D_1 , stimulating the excitatory pathway, and to D_2 , inhibiting the inhibitory pathway $\rightarrow \uparrow$ motion.



FAS1_2019_12-Neurol.indd 500 11/8/19 7:39 AM

Cerebral cortex regions



Cerebral perfusion

Relies on tight autoregulation. Primarily driven by Pco₂ (Po₂ also modulates perfusion in severe hypoxia).

Also relies on a pressure gradient between mean arterial pressure (MAP) and intracranial pressure (ICP). ↓ blood pressure or † ICP → ↓ cerebral perfusion pressure (CPP).

Therapeutic hyperventilation → ↓ Pco,

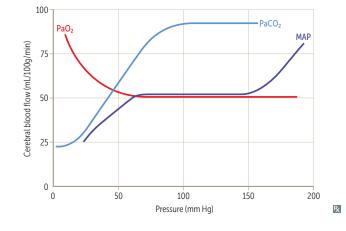
- → vasoconstriction → ↓ cerebral blood flow
- → ↓ ICP. May be used to treat acute cerebral edema (eg, 2° to stroke) unresponsive to other interventions.

CPP = MAP – ICP. If CPP = 0, there is no cerebral perfusion \rightarrow brain death.

Hypoxemia increases CPP only if Po₂

< 50 mm Hg.

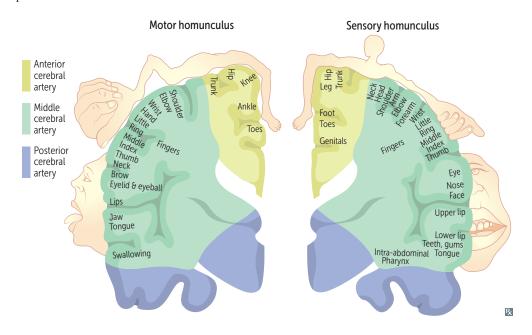
CPP is directly proportional to Pco₂ until Pco₂ > 90 mm Hg.



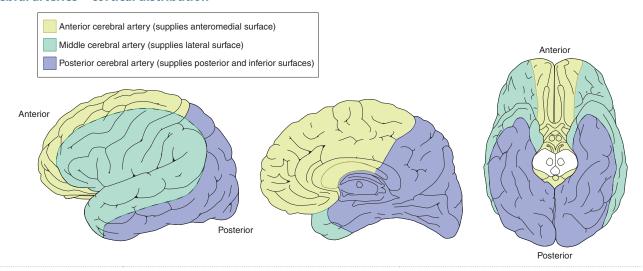
FAS1_2019_12-Neurol.indd 501 11/8/19 7:39 AM

Homunculus

Topographic representation of motor and sensory areas in the cerebral cortex. Distorted appearance is due to certain body regions being more richly innervated and thus having † cortical representation.



Cerebral arteries—cortical distribution



Watershed zones



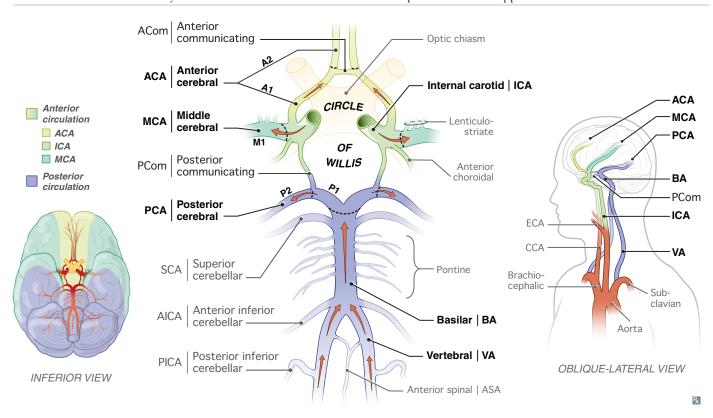
Cortical border zones occur between anterior and middle cerebral arteries and posterior and middle cerebral arteries (blue areas in A). Internal border zones occur between the superficial and deep vascular territories of the middle cerebral artery (red areas in A).

Infarct due to severe hypoperfusion → proximal upper and lower extremity weakness ("manin-the-barrel syndrome"), higher order visual dysfunction (if posterior cerebral/middle cerebral cortical border zone stroke).

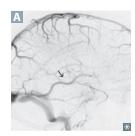
FAS1_2019_12-Neurol.indd 502 11/8/19 7:39 AM

Circle of Willis

System of anastomoses between anterior and posterior blood supplies to brain.

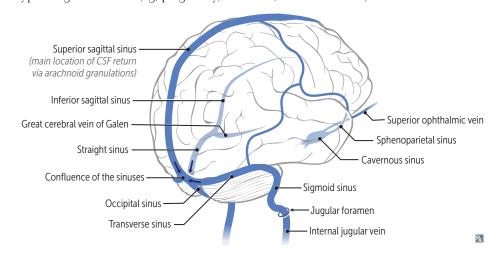


Dural venous sinuses



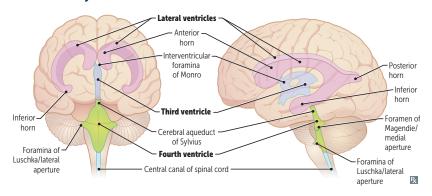
Large venous channels A that run through the periosteal and meningeal layers of the dura mater. Drain blood from cerebral veins (arrow) and receive CSF from arachnoid granulations. Empty into internal jugular vein.

Venous sinus thrombosis—presents with signs/symptoms of † ICP (eg, headache, seizures, papilledema, focal neurologic deficits). May lead to venous hemorrhage. Associated with hypercoagulable states (eg, pregnancy, OCP use, factor V Leiden).



FAS1_2019_12-Neurol.indd 503 11/8/19 7:39 AM

Ventricular system



Lateral ventricles → 3rd ventricle via right and left interventricular foramina of Monro.

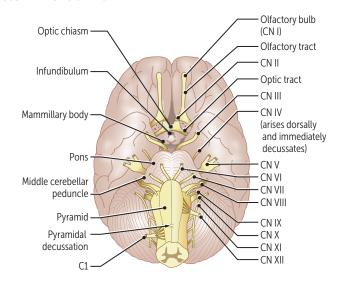
3rd ventricle → 4th ventricle via cerebral aqueduct of Sylvius.

4th ventricle → subarachnoid space via:

- Foramina of Luschka = Lateral.
- Foramen of Magendie = Medial.

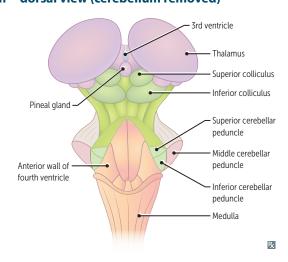
CSF made by choroid plexuses located in the lateral and fourth ventricles. Travels to subarachnoid space via foramina of Luschka and Magendie, is reabsorbed by arachnoid granulations, and then drains into dural venous sinuses.

Brain stem—ventral view



- 4 CN are above pons (I, II, III, IV).
- 4 CN exit the pons (V, VI, VII, VIII).
- 4 CN are in medulla (IX, X, XI, XII).
- 4 CN nuclei are medial (III, IV, VI, XII). "Factors of 12, except 1 and 2."

Brain stem—dorsal view (cerebellum removed)



Pineal gland—melatonin secretion, circadian rhythms.

Superior colliculi—direct eye movements to stimuli (noise/movements) or objects of interest.

Inferior colliculi—auditory.

Your eyes are **above** your ears, and the superior colliculus (visual) is **above** the inferior colliculus (auditory).

FAS1_2019_12-Neurol.indd 504 11/8/19 7:39 AM

Cranial nerve nuclei

Located in tegmentum portion of brain stem (between dorsal and ventral portions):

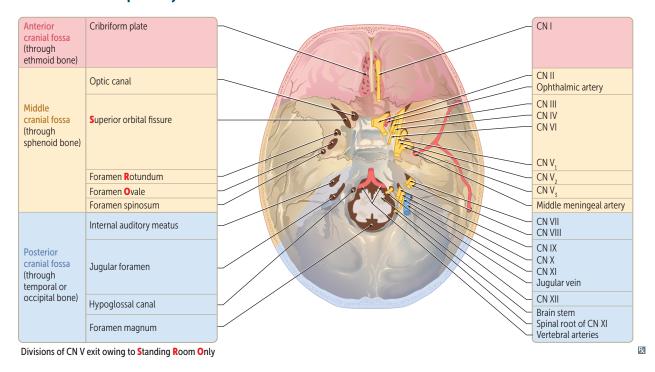
- Midbrain—nuclei of CN III, IV
- Pons—nuclei of CN V, VI, VII, VIII
- Medulla—nuclei of CN IX, X, XII
- Spinal cord—nucleus of CN XI

Lateral nuclei = sensory (aLar plate).

-Sulcus limitans-

Medial nuclei = Motor (basal plate).

Cranial nerve and vessel pathways



FAS1_2019_12-Neurol.indd 505 11/8/19 7:39 AM

Cranial nerves

NERVE	CN	FUNCTION	TYPE	MNEMONIC
Olfactory	I	Smell (only CN without thalamic relay to cortex)	Sensory	Some
Optic	II	Sight	Sensory	S ay
Oculomotor	III	Eye movement (SR, IR, MR, IO), pupillary constriction (sphincter pupillae: Edinger-Westphal nucleus, muscarinic receptors), accommodation, eyelid opening (levator palpebrae)	Motor	M arry
Trochlear	IV	Eye movement (SO)	Motor	Money
Trigeminal	V	Mastication, facial sensation (ophthalmic, maxillary, mandibular divisions), somatosensation from anterior 2/3 of tongue, dampening of loud noises (tensor tympani)	Both	But
Abducens	VI	Eye movement (LR)	Motor	My
Facial	VII	Facial movement, taste from anterior 2/3 of tongue (chorda tympani), lacrimation, salivation (submandibular and sublingual glands are innervated by CN seven), eye closing (orbicularis oculi), auditory volume modulation (stapedius)	Both	B rother
Vestibulocochlear	VIII	Hearing, balance	Sensory	Says
Glossopharyngeal	IX	Taste and sensation from posterior 1/3 of tongue, swallowing, salivation (parotid gland), monitoring carotid body and sinus chemo- and baroreceptors, and elevation of pharynx/larynx (stylopharyngeus)	Both	Big
Vagus	X	Taste from supraglottic region, swallowing, soft palate elevation, midline uvula, talking, cough reflex, parasympathetics to thoracoabdominal viscera, monitoring aortic arch chemo- and baroreceptors	Both	Brains
Accessory	XI	Head turning, shoulder shrugging (SCM, trapezius)	Motor	Matter
Hypoglossal	XII	Tongue movement	Motor	Most

Vagal nuclei

NUCLEUS	FUNCTION	CRANIAL NERVES
Nucleus tractus Solitarius	Visceral Sensory information (eg, taste, baroreceptors, gut distention)	VII, IX, X
Nucleus a <mark>M</mark> biguus	M otor innervation of pharynx, larynx, upper esophagus (eg, swallowing, palate elevation)	IX, X, XI (cranial portion)
Dorsal motor nucleus	Sends autonomic (parasympathetic) fibers to heart, lungs, upper GI	X

FAS1_2019_12-Neurol.indd 506 11/8/19 7:39 AM

Cranial nerve reflexes

REFLEX	AFFERENT	EFFERENT
Corneal	V_1 ophthalmic (nasociliary branch)	Bilateral VII (temporal branch—orbicularis oculi)
Lacrimation	$V_{_{1}}$ (loss of reflex does not preclude emotional tears)	VII
Jaw jerk	V_3 (sensory—muscle spindle from masseter)	V ₃ (motor—masseter)
Pupillary	II	III
Gag	IX	X
Cough	X	X
Mastication muscles	3 muscles close jaw: Masseter, teMporalis, Medial pterygoid. 1 opens: Lateral pterygoid.	M's Munch. Lateral Lowers (when speaking of pterygoids

muscles close jaw: Masseter, teMporalis, Medial pterygoid. 1 opens: Lateral pterygoid. All are innervated by trigeminal nerve (V₃).

Lateral Lowers (when speaking of pterygoids with respect to jaw motion).

"It takes more muscle to keep your mouth shut."

Spinal nerves

There are 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 1 coccygeal. Nerves C1–C7 exit above the corresponding vertebrae (eg, C3 exits above the 3rd cervical vertebra). C8 spinal nerve exits below C7 and above T1. All other nerves exit below (eg, L2 exits below the 2nd lumbar vertebra).

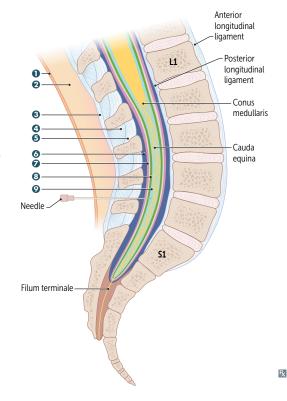
Spinal cord—lower extent

In adults, spinal cord ends at lower border of L1–L2 vertebrae. Subarachnoid Space (which contains the CSF) extends to lower border of S2 vertebra. Lumbar puncture is usually performed between L3–L4 or L4–L5 (level of cauda equina).

Goal of lumbar puncture is to obtain sample of CSF without damaging spinal cord. To keep the cord alive, keep the spinal needle between L3 and L5.

Needle passes through:

- n skin
- 2 fascia and fat
- 3 supraspinous ligament
- 4 interspinous ligament
- 6 ligamentum flavum
- epidural space (epidural anesthesia needle stops here)
- dura mater
- arachnoid mater
- subarachnoid space (CSF collection occurs here)

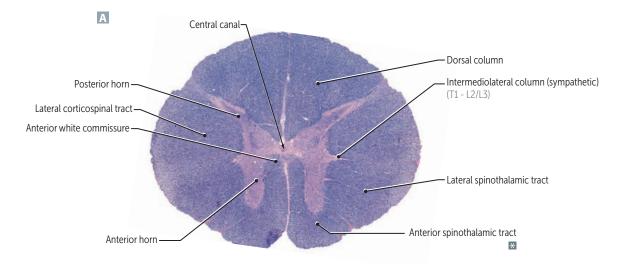


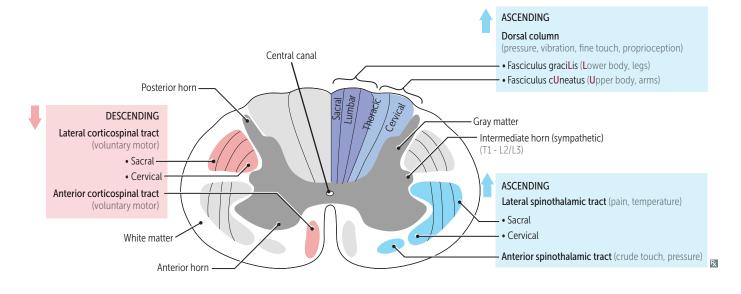
FAS1_2019_12-Neurol.indd 507 11/8/19 7:39 AM

Spinal cord and associated tracts

Legs (Lumbosacral) are Lateral in Lateral corticospinal, spinothalamic tracts. Thoracic spinal cord section in A.

Dorsal columns are organized as you are, with hands at sides. "Arms outside, legs inside."





FAS1_2019_12-Neurol.indd 508 11/8/19 7:39 AM

Spinal tract anatomy Ascending tracts synapse and then cross. **and functions**

TRACT	FUNCTION	1ST-ORDER NEURON	SYNAPSE 1	2ND-ORDER NEURON	SYNAPSE 2 + PROJECTIONS
Ascending tracts					
Dorsal column	Pressure, vibration, fine touch, proprioception	Sensory nerve ending → bypasses pseudounipolar cell body in dorsal root ganglion → enters spinal cord → ascends ipsilaterally in dorsal columns	Nucleus gracilis, nucleus cuneatus (ipsilateral medulla)	Decussates in medulla → ascends contralaterally as the medial lemniscus	VPL (thalamus)
Spinothalamic tract	Lateral: pain, temperature Anterior: crude touch, pressure	Sensory nerve ending (Aδ and C fibers) → bypasses pseudounipolar cell body in dorsal root ganglion → enters spinal cord	Ipsilateral gray matter (spinal cord)	Decussates in spinal cord as the anterior white commissure → ascends contralaterally	→ sensory cortex
Descending tract					
Lateral corticospinal tract	Voluntary movement of contralateral limbs	UMN: cell body in 1° motor cortex → descends ipsilaterally (through posterior limb of internal capsule and cerebral peduncle), most fibers decussate at caudal medulla (pyramidal decussation) → descends contralaterally	Cell body of anterior horn (spinal cord)	LMN: leaves spinal cord	NMJ → muscle fibers

FAS1_2019_12-Neurol.indd 509 11/8/19 7:39 AM

Clinical reflexes

C5, 6 C6, 7, 8 L2, 3, 4 S1, 2 Reflexes count up in order (main nerve root in **bold**):

Achilles reflex = S1, S2 ("buckle my shoe")
Patellar reflex = L2-L4 ("kick the door")
Biceps and brachioradialis reflexes = C5, C6

("pick up sticks") **Triceps reflex** = C6, **C7**, C8 ("lay them

straight")

Additional reflexes:

Cremasteric reflex = L1, L2 ("testicles move") **Anal wink reflex** = S3, S4 ("winks galore")

Primitive reflexes	CNS reflexes that are present in a healthy infant, but are absent in a neurologically intact adult. Normally disappear within 1st year of life. These primitive reflexes are inhibited by a mature/ developing frontal lobe. They may reemerge in adults following frontal lobe lesions → loss of inhibition of these reflexes.
Moro reflex	"Hang on for life" reflex—abduct/extend arms when startled, and then draw together
Rooting reflex	Movement of head toward one side if cheek or mouth is stroked (nipple seeking)
Sucking reflex	Sucking response when roof of mouth is touched
Palmar reflex	Curling of fingers if palm is stroked
Plantar reflex	Dorsiflexion of large toe and fanning of other toes with plantar stimulation Babinski sign—presence of this reflex in an adult, which may signify a UMN lesion
Galant reflex	Stroking along one side of the spine while newborn is in ventral suspension (face down) causes lateral flexion of lower body toward stimulated side

Landmark dermatomes

DERMATOME	CHARACTERISTICS		
C2	Posterior half of skull	VI	
C3	High turtleneck shirt Diaphragm and gallbladder pain referred to the right shoulder via phrenic nerve C3, 4, 5 keeps the diaphragm alive	10 C2 C2 C3 C4 C4 C5 C5 C5 C5 C5 C5 C5 C5 C5 C5 C5 C5 C5	a acide acid
C4	Low-collar shirt	75 16 17	C6 C8 T10 T11
C6	Includes thumbs Thumbs up sign on left hand looks like a 6	78 79 710 711 112 112	10 11 12 12 12 13 14 15 15 15 15 15 15 15 15 15 15 15 15 15
T4	At the <mark>nipple</mark> T 4 at the teat <mark>pore</mark>	12 12 CG	σ ₍₃) (3) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4
T7	At the xiphoid process 7 letters in xiphoid	L4	11-12-
T10	At the umbilicus (belly but <mark>ten</mark>) Point of referred pain in early appendicitis	15)	S1 S2
Ll	At the <mark>I</mark> nguinal <mark>L</mark> igament		L4
L4	Includes the kneecaps Down on ALL 4 's	LS	14
S2, S3, S4	Sensation of penile and anal zones S2, 3, 4 keep the penis off the floor		

FAS1_2019_12-Neurol.indd 510 11/8/19 7:39 AM

Common brain lesions	CONCEOUENCE	EVALUDIES (CONTRETE)
AREA OF LESION Frontal lobe	CONSEQUENCE Disinhibition and deficits in concentration,	EXAMPLES/COMMENTS
Fioritariose	orientation, judgment; may have reemergence of primitive reflexes	
Frontal eye fields	Destructive lesions (eg, MCA stroke): eyes look toward brain lesion (ie, away from side of hemiplegia)	
Paramedian pontine reticular formation	Eyes look away from brain lesion (ie, toward side of hemiplegia)	
Medial longitudinal fasciculus	Internuclear ophthalmoplegia (impaired adduction of ipsilateral eye; nystagmus of contralateral eye with abduction)	Multiple sclerosis
Dominant parietal cortex	Agraphia, acalculia, finger agnosia, left-right disorientation	Gerstmann syndrome
Nondominant parietal cortex	Agnosia of the contralateral side of the world	Hemispatial neglect syndrome
Hippocampus (bilateral)	Anterograde amnesia—inability to make new memories	
Basal ganglia	May result in tremor at rest, chorea, athetosis	Parkinson disease, Huntington disease, Wilson disease
Subthalamic nucleus	Contralateral hemiballismus	
Mammillary bodies (bilateral)	Wernicke-Korsakoff syndrome—Confusion, Ataxia, Nystagmus, Ophthalmoplegia, memory loss (anterograde and retrograde amnesia), confabulation, personality changes	Wernicke problems come in a CAN O' beer and other conditions associated with thiamine deficiency
Amygdala (bilateral)	Klüver-Bucy syndrome—disinhibited behavior (eg, hyperphagia, hypersexuality, hyperorality)	HSV-1 encephalitis
Dorsal midbrain	Parinaud syndrome—vertical gaze palsy, pupillary light-near dissociation, lid retraction, convergence-retraction nystagmus	Stroke, hydrocephalus, pinealoma
Reticular activating system (midbrain)	Reduced levels of arousal and wakefulness	Coma
Cerebellar hemisphere	Intention tremor, limb ataxia, loss of balance; damage to cerebellum → ipsilateral deficits; fall toward side of lesion	Cerebellar hemispheres are laterally located—affect lateral limbs
Cerebellar vermis	Truncal ataxia (wide-based, "drunken sailor" gait), nystagmus	Vermis is central ly located—affects central body Degeneration associated with chronic alcohol use
Red nucleus (midbrain)	Decorticate (flexor) posturing—lesion above red nucleus, presents with flexion of upper extremities and extension of lower extremities Decerebrate (extensor) posturing—lesion at or below red nucleus, presents with extension of upper and lower extremities	Worse prognosis with decerebrate posturing In decorticate posturing, your hands are near the cor (heart)

FAS1_2019_12-Neurol.indd 511 11/8/19 7:39 AM

Ischemic brain disease/stroke

Irreversible neuronal injury begins after 5 minutes of hypoxia. Most vulnerable: hippocampus, neocortex, cerebellum (Purkinje cells), watershed areas ("vulnerable hippos need pure water"). Stroke imaging: noncontrast CT to exclude hemorrhage (before tPA can be given). CT detects ischemic changes in 6–24 hr. Diffusion-weighted MRI can detect ischemia within 3–30 min.

TIME SINCE ISCHEMIC EVENT	12-24 HOURS	24-72 HOURS	3-5 DAYS	1–2 WEEKS	> 2 WEEKS
Histologic features	Eosinophilic cytoplasm + pyknotic nuclei (red neurons)	Necrosis + neutrophils	Macrophages (microglia)	Reactive gliosis (astrocytes) + vascular proliferation	Glial scar

Ischemic stroke

Acute blockage of vessels → disruption of blood flow and subsequent ischemia → infarction → liquefactive necrosis.



- Thrombotic—due to a clot forming directly at site of infarction (commonly the MCA A), usually over a ruptured atherosclerotic plaque.
- Embolic—embolus from another part of the body obstructs vessel. Can affect multiple vascular territories. Examples: atrial fibrillation, carotid artery stenosis, DVT with patent foramen ovale, infective endocarditis.
- Hypoxic—due to hypoperfusion or hypoxemia. Common during cardiovascular surgeries, tends to affect watershed areas.

Treatment: tPA (if within 3–4.5 hr of onset and no hemorrhage/risk of hemorrhage) and/or thrombectomy (if large artery occlusion). Reduce risk with medical therapy (eg, aspirin, clopidogrel); optimum control of blood pressure, blood sugars, lipids; smoking cessation; and treat conditions that † risk (eg, atrial fibrillation, carotid artery stenosis).

Transient ischemic attack

Brief, reversible episode of focal neurologic dysfunction without acute infarction (⊝ MRI), with the majority resolving in < 15 minutes; ischemia (eg, embolus, small vessel stenosis).

Neonatal intraventricular hemorrhage



Bleeding into ventricles (arrow in coronal transcranial ultrasound A shows blood in right intraventricular space, extending into periventricular white matter). Increased risk in premature and low-birth-weight infants. Originates in germinal matrix, a highly vascularized layer within the subventricular zone. Due to reduced glial fiber support and impaired autoregulation of BP in premature infants. Can present with altered level of consciousness, bulging fontanelle, hypotension, seizures, coma.

FAS1_2019_12-Neurol.indd 512 11/8/19 7:39 AM

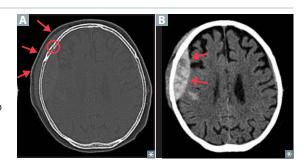
Intracranial hemorrhage

Epidural hematoma

Rupture of middle meningeal artery (branch of maxillary artery), often 2° to skull fracture (circle in A) involving the pterion (thinnest area of the lateral skull). Might present with transient loss of consciousness → recovery ("lucid interval") → rapid deterioration due to hematoma expansion.

Scalp hematoma (arrows in A) and rapid intracranial expansion (arrows in B) under systemic arterial pressure → transtentorial herniation, CN III palsy.

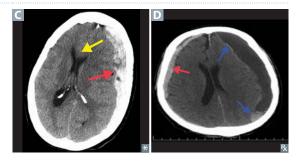
CT shows biconvex (lentiform), hyperdense blood collection **B** not crossing suture lines.



Subdural hematoma

Rupture of bridging veins. Can be acute (traumatic, high-energy impact → hyperdense on CT) or chronic (associated with mild trauma, cerebral atrophy, elderly, alcoholism → hypodense on CT). Also seen in shaken babies. Predisposing factors: brain atrophy,

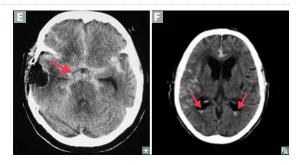
Crescent-shaped hemorrhage (red arrows in C and **D**) that **crosses suture lines**. Can cause midline shift (yellow arrow in **C**), findings of "acute on chronic" hemorrhage (blue arrows



Subarachnoid hemorrhage

Bleeding **E F** due to trauma, or rupture of an aneurysm (such as a saccular aneurysm E) or arteriovenous malformation. Rapid time course. Patients complain of "worst headache of my life." Bloody or yellow (xanthochromic) lumbar puncture.

Vasospasm can occur due to blood breakdown or rebleed 3-10 days after hemorrhage → ischemic infarct; nimodipine used to prevent/reduce vasospasm. † risk of developing communicating and/or obstructive hydrocephalus.



Intraparenchymal hemorrhage

Most commonly caused by systemic hypertension. Also seen with amyloid angiopathy (recurrent lobar hemorrhagic stroke in elderly), vasculitis, neoplasm. May be 2° to reperfusion injury in ischemic stroke. Hypertensive hemorrhages (Charcot-Bouchard microaneurysm) most often occur in putamen of basal ganglia (lenticulostriate vessels (G), followed by thalamus, pons, and cerebellum H.



FAS1 2019 12-Neurol.indd 513 11/8/19 7:39 AM

Effects of strokes

ARTERY	AREA OF LESION	SYMPTOMS	NOTES
Anterior circula	ation		
Middle cerebral artery	Motor and sensory cortices A—upper limb and face. Temporal lobe (Wernicke area); frontal lobe (Broca area).	Contralateral paralysis and sensory loss—face and upper limb. Aphasia if in dominant (usually left) hemisphere. Hemineglect if lesion affects nondominant (usually right) hemisphere.	Wernicke aphasia is associated with right superior quadrant visual field defect due to temporal lobe involvement.
Anterior cerebral artery	Motor and sensory cortices—lower limb.	Contralateral paralysis and sensory loss—lower limb, urinary incontinence.	
Lenticulo- striate artery	Striatum, internal capsule.	Contralateral paralysis. Absence of cortical signs (eg, neglect, aphasia, visual field loss).	Pure motor stroke. Common location of lacunar infarcts B , due to hyaline arteriosclerosis (lipohyalinosis) 2° to unmanaged hypertension.
Posterior circul	ation		
Anterior spinal artery	Corticospinal tract. Medial lemniscus. Caudal medulla—hypoglossal nerve.	Contralateral paralysis—upper and lower limbs. ↓ contralateral proprioception. Ipsilateral hypoglossal dysfunction (tongue deviates ipsilaterally).	Medial medullary syndrome—caused by infarct of paramedian branches of ASA and/or vertebral arteries.
Posterior inferior cerebellar artery	Lateral medulla: Nucleus ambiguus (CN IX, X, XI) Vestibular nuclei Lateral spinothalamic tract, spinal trigeminal nucleus Sympathetic fibers Inferior cerebellar peduncle	Dysphagia, hoarseness, ↓ gag reflex, hiccups. Vomiting, vertigo, nystagmus ↓ pain and temperature sensation from contralateral body, ipsilateral face. Ipsilateral Horner syndrome. Ipsilateral ataxia, dysmetria.	syndrome. Nucleus ambiguus effects are specific to PICA lesions C. "Don't pick a (PICA) horse (hoarseness) that can't eat (dysphagia)." Also supplies inferior cerebellar peduncle (part of cerebellum).
Anterior inferior cerebellar artery	Lateral pons: Facial nucleus Vestibular nuclei Spinothalamic tract, spinal trigeminal nucleus Sympathetic fibers Middle and inferior cerebellar peduncles Labyrinthine artery	Paralysis of face (LMN lesion vs UMN lesion in cortical stroke), ↓ lacrimation, ↓ salivation, ↓ taste from anterior 2/3 of tongue. Vomiting, vertigo, nystagmus ↓ pain and temperature sensation from contralateral body, ipsilateral face. Ipsilateral Horner syndrome. Ipsilateral ataxia, dysmetria. Ipsilateral sensorineural deafness, vertigo.	Lateral pontine syndrome. Facial nucleus effects are specific to AICA lesions. "Facial droop means AICA's pooped." Also supplies middle and inferior cerebellar peduncles (part of cerebellum).

FAS1_2019_12-Neurol.indd 514 11/8/19 7:39 AM

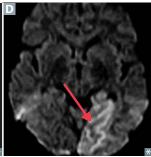
Effects of strokes (continued)

ARTERY	AREA OF LESION	SYMPTOMS	NOTES
Basilar artery	Pons, medulla, lower midbrain.	If RAS spared, consciousness is preserved.	Locked-in syndrome (locked in the basement).
	Corticospinal and corticobulbar tracts.	Quadriplegia; loss of voluntary facial, mouth, and tongue movements.	
	Ocular cranial nerve nuclei, paramedian pontine reticular formation.	Loss of horizontal, but not vertical, eye movements.	
Posterior cerebral artery	Occipital lobe D.	Contralateral hemianopia with macular sparing; alexia without agraphia (dominant hemisphere).	









Central poststroke pain syndrome

Neuropathic pain due to thalamic lesions. Initial paresthesias followed in weeks to months by allodynia (ordinarily painless stimuli cause pain) and dysesthesia (altered sensation) on the contralateral side. Occurs in 10% of stroke patients.

Diffuse axonal injury



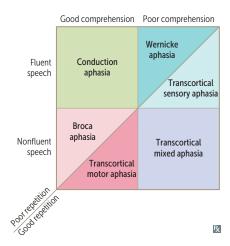
Caused by traumatic shearing forces during rapid acceleration and/or deceleration of the brain (eg, motor vehicle accident). Usually results in devastating neurologic injury, often causing coma or persistent vegetative state. MRI A shows multiple lesions (punctate hemorrhages) involving the white matter tracts.

FAS1_2019_12-Neurol.indd 515 11/8/19 7:39 AM

Aphasia

Aphasia—higher-order language deficit (inability to understand/produce/use language appropriately); caused by pathology in dominant cerebral hemisphere (usually left).

Dysarthria—motor inability to produce speech (movement deficit).



TYPE	COMMENTS	
Broca (expressive)	Broca area in inferior frontal gyrus of frontal lobe. Patient appears frustrated, insight intact. Broca = Broken Boca (boca = mouth in Spanish).	
Wernicke (receptive)	Wernicke area in superior temporal gyrus of temporal lobe. Patients do not have insight. Wernicke is a Word salad and makes no sense.	
Conduction	Can be caused by damage to arCuate fasciculus.	
Global	Broca and Wernicke areas affected.	
Transcortical motor	Affects frontal lobe around Broca area, but Broca area is spared.	
Transcortical sensory	Affects temporal lobe around Wernicke area, but Wernicke area is spared.	
Transcortical mixed	Broca and Wernicke areas and arcuate fasciculus remain intact; surrounding watershed areas affected.	

Aneurysms

Abnormal dilation of an artery due to weakening of vessel wall.

Saccular aneurysm



Also called berry aneurysm A. Occurs at bifurcations in the circle of Willis. Most common site is junction of ACom and ACA. Associated with ADPKD, Ehlers-Danlos syndrome. Other risk factors: advanced age, hypertension, smoking, race († risk in African-Americans).

Usually clinically silent until rupture (most common complication) → subarachnoid hemorrhage ("worst headache of my life" or "thunderclap headache") → focal neurologic deficits. Can also cause symptoms via direct compression of surrounding structures by growing aneurysm.

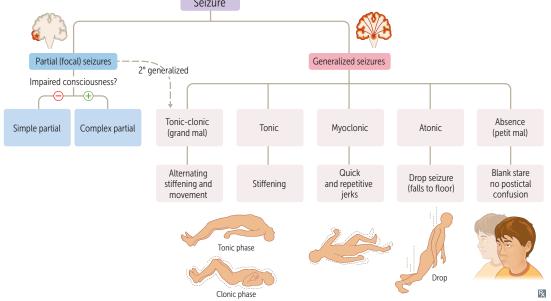
- ACom—compression → bitemporal hemianopia (compression of optic chiasm); visual acuity deficits; rupture → ischemia in ACA distribution → contralateral lower extremity hemiparesis, sensory deficits.
- MCA—rupture → ischemia in MCA distribution → contralateral upper extremity and lower facial hemiparesis, sensory deficits.
- PCom—compression → ipsilateral CN III palsy → mydriasis ("blown pupil"); may also see ptosis, "down and out" eye.

Charcot-Bouchard microaneurysm

Common, associated with chronic hypertension; affects small vessels (eg, lenticulostriate arteries in basal ganglia, thalamus) and can cause hemorrhagic intraparenchymal strokes. Not visible on angiography.

FAS1_2019_12-Neurol.indd 516 11/8/19 7:39 AM

Seizures	Characterized by synchronized, high-frequency r	neuronal firing. Variety of forms.	
Partial (focal) seizures	Affect single area of the brain. Most commonly originate in medial temporal lobe. Types: Simple partial (consciousness intact)— motor, sensory, autonomic, psychic Complex partial (impaired consciousness, automatisms)	Epilepsy—disorder of recurrent, unprovoked seizures (febrile seizures are not epilepsy). Status epilepticus—continuous (≥ 5 min) or recurring seizures that may result in brain injury. Causes of seizures by age:	
Generalized seizures	Diffuse. Types: Absence (petit mal)—3 Hz spike-and-wave discharges, no postictal confusion, blank stare Myoclonic—quick, repetitive jerks Tonic-clonic (grand mal)—alternating stiffening and movement, postictal confusion, urinary incontinence, tongue biting Tonic—stiffening Atonic—"drop" seizures (falls to floor); commonly mistaken for fainting	 Children—genetic, infection (febrile), trauma, congenital, metabolic Adults—tumor, trauma, stroke, infection Elderly—stroke, tumor, trauma, metabolic infection 	
	Seizure		
		ASAD.	



Fever vs heat stroke

	Fever	Heat stroke
PATHOPHYSIOLOGY	Cytokine activation during inflammation (eg, infection)	Inability of body to dissipate heat (eg, exertion)
TEMPERATURE	Usually < 40 °C	Usually > 40 °C
COMPLICATIONS	Febrile seizure (benign, usually self-limiting)	CNS dysfunction (eg, confusion), end-organ damage, acute respiratory distress syndrome, rhabdomyolysis
MANAGEMENT	Acetaminophen or ibuprofen for comfort (does not prevent future febrile seizures), antibiotic therapy if indicated	Rapid external cooling, rehydration and electrolyte correction

FAS1_2019_12-Neurol.indd 517 11/8/19 7:39 AM

Headaches

Pain due to irritation of structures such as the dura, cranial nerves, or extracranial structures. More common in females, except cluster headaches.

CLASSIFICATION	LOCALIZATION	DURATION	DESCRIPTION	TREATMENT
Clustera	Unilateral	15 min–3 hr; repetitive	Excruciating periorbital pain ("suicide headache") with lacrimation and rhinorrhea. May present with Horner syndrome. More common in males.	Acute: sumatriptan, 100% O ₂ . Prophylaxis: verapamil.
Migraine	Unilateral	4–72 hr	Pulsating pain with nausea, photophobia, or phonophobia. May have "aura." Due to irritation of CN V, meninges, or blood vessels (release of vasoactive neuropeptides [eg, substance P, calcitonin gene-related peptide]).	Acute: NSAIDs, triptans, dihydroergotamine. Prophylaxis: lifestyle changes (eg, sleep, exercise, diet), β-blockers, amitriptyline, topiramate, valproate, botulinum toxin, anti-CGRP monoclonal antibodies. POUND-Pulsatile, One-day duration, Unilateral, Nausea, Disabling.
Tension	Bilateral	> 30 min (typically 4–6 hr); constant	Steady, "band-like" pain. No photophobia or phonophobia. No aura.	Acute: analgesics, NSAIDs, acetaminophen. Prophylaxis: TCAs (eg, amitriptyline), behavioral therapy.

Other causes of headache include subarachnoid hemorrhage ("worst headache of my life"), meningitis, hydrocephalus, neoplasia, giant cell (temporal) arteritis.

^aCompare with **trigeminal neuralgia**, which produces repetitive, unilateral, shooting/shock-like pain in the distribution of CN V. Triggered by chewing, talking, touching certain parts of the face. Lasts (typically) for seconds to minutes, but episodes often increase in intensity and frequency over time. First-line therapy: carbamazepine.

FAS1_2019_12-Neurol.indd 518 11/8/19 7:39 AM

Movement disorders

DISORDER	PRESENTATION	CHARACTERISTIC LESION	NOTES
Akathisia	Restlessness and intense urge to move.		Can be seen with neuroleptic use or as a side effect of Parkinson treatment.
Asterixis	Extension of wrists causes "flapping" motion.		Associated with hepatic encephalopathy, Wilson disease, and other metabolic derangements.
Athetosis	Slow, snake-like, writhing movements; especially seen in the fingers.	Basal ganglia.	Seen in Huntington disease.
Chorea	Sudden, jerky, purposeless movements.	Basal ganglia.	Chorea = dancing. Seen in Huntington disease and in acute rheumatic fever (Sydenham chorea).
Dystonia	Sustained, involuntary muscle contractions.		Writer's cramp, blepharospasm, torticollis. Treatment: botulinum toxin injection.
Essential tremor	High-frequency tremor with sustained posture (eg, outstretched arms), worsened with movement or when anxious.		Often familial. Patients often self-medicate with alcohol, which ↓ tremor amplitude. Treatment: nonselective β-blockers (eg, propranolol), primidone.
Intention tremor	Slow, zigzag motion when pointing/extending toward a target.	Cerebellar dysfunction.	
Resting tremor	Uncontrolled movement of distal appendages (most noticeable in hands); tremor alleviated by intentional movement.	Substantia nigra (Park inson disease).	Occurs at rest; "pill-rolling tremor" of Parkinson disease. When you park your car, it is at rest.
Hemiballismus	Sudden, wild flailing of one side of the body.	Contralateral subthalamic nucleus (eg, lacunar stroke).	Pronounce "Half-of-body ballistic."
Myoclonus	Sudden, brief, uncontrolled muscle contraction.		Jerks; hiccups; common in metabolic abnormalities such as renal and liver failure.
Restless legs syndrome	Worse at rest/nighttime. Relieved by movement.		Associated with iron deficiency, CKD. Treatment: dopamine agonists (pramipexole, ropinirole).

FAS1_2019_12-Neurol.indd 519 11/8/19 7:39 AM

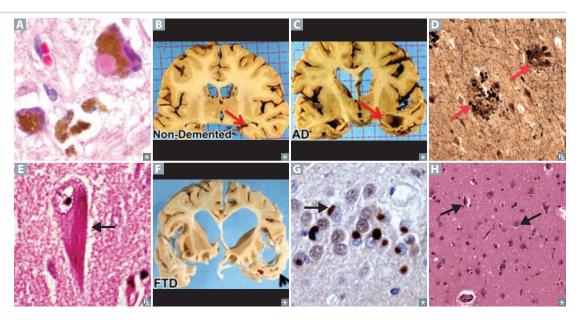
520 SECTION III NEUROLOGY AND SPECIAL SENSES ➤ NEUROLOGY—PATHOLOGY

Neurodegenerative disorders	↓ in cognitive ability, memory, or function with intact consciousness. Must rule out depression as cause of dementia (called pseudodementia). Other reversible causes of dementia: hypothyroidism, vitamin B ₁₂ deficiency, neurosyphilis, normal pressure hydrocephalus.		
DISEASE	DESCRIPTION	HISTOLOGIC/GROSS FINDINGS	
Parkinson disease	Parkinson TRAPSS your body: Tremor (pill-rolling tremor at rest) Rigidity (cogwheel) Akinesia (or bradykinesia) Postural instability Shuffling gait Small handwriting (micrographia) MPTP, a contaminant in illegal drugs, is metabolized to MPP+, which is toxic to substantia nigra.	Loss of dopaminergic neurons (ie, depigmentation) of substantia nigra pars compacta. Lewy bodies: composed of α-synuclein (intracellular eosinophilic inclusions A).	
Huntington disease	Autosomal dominant trinucleotide (CAG) _n repeat expansion in the hunt ingtin (HTT) gene on chromosome 4 (4 letters). Symptoms manifest between ages 20 and 50: chorea, athetosis, aggression, depression, dementia (sometimes initially mistaken for substance abuse). Anticipation results from expansion of CAG repeats. Caudate loses ACh and GABA.	Atrophy of caudate and putamen with ex vacuo ventriculomegaly. ↑ dopamine, ↓ GABA, ↓ ACh in brain. Neuronal death via NMDA-R binding and glutamate excitotoxicity.	
Alzheimer disease	Most common cause of dementia in elderly. Down syndrome patients have ↑ risk of developing Alzheimer disease, as APP is located on chromosome 21. ↓ ACh. Associated with the following altered proteins: ■ ApoE-2: ↓ risk of sporadic form ■ ApoE-4: ↑ risk of sporadic form ■ APP, presenilin-1, presenilin-2: familial forms (10%) with earlier onset	Widespread cortical atrophy (normal cortex B; cortex in Alzheimer disease C), especially hippocampus (arrows in B and C). Narrowing of gyri and widening of sulci. Senile plaques D in gray matter: extracellular β-amyloid core; may cause amyloid angiopathy → intracranial hemorrhage; Aβ (amyloid-β) synthesized by cleaving amyloid precursor protein (APP). Neurofibrillary tangles E: intracellular, hyperphosphorylated tau protein = insoluble cytoskeletal elements; number of tangles correlates with degree of dementia. Hirano bodies—intracellular eosinophilic proteinaceous rods in hippocampus.	
Frontotemporal dementia	Formerly called Pick disease. Early changes in personality and behavior (behavioral variant), or aphasia (primary progressive aphasia). May have associated movement disorders.	Frontotemporal lobe degeneration F . Inclusions of hyperphosphorylated tau (round Pick bodies G) or ubiquitinated TDP-43.	

FAS1_2019_12-Neurol.indd 520 11/8/19 7:39 AM

Neurodegenerative disorders (continued)

DICEACE	DESCRIPTION	HICTOLOGIC (CDOCC FINDING)
DISEASE	DESCRIPTION	HISTOLOGIC/GROSS FINDINGS
Lewy body dementia	Visual hallucinations ("haLewycinations"), dementia with fluctuating cognition/ alertness, REM sleep behavior disorder, and parkinsonism. Called Lewy body dementia if cognitive and motor symptom onset < 1 year apart, otherwise considered dementia 2° to Parkinson disease.	Intracellular Lewy bodies A primarily in cortex.
Vascular dementia	Result of multiple arterial infarcts and/or chronic ischemia. Step-wise decline in cognitive ability with lateonset memory impairment. 2nd most common cause of dementia in elderly.	MRI or CT shows multiple cortical and/or subcortical infarcts.
Creutzfeldt-Jakob disease	Rapidly progressive (weeks to months) dementia with myoclonus ("startle myoclonus") and ataxia. Commonly see periodic sharp waves on EEG and † 14-3-3 protein in CSF.	 Spongiform cortex (vacuolization without inflammation). Prions (PrP^c → PrP^{sc} sheet [β-pleated sheet resistant to proteases])



Idiopathic intracranial hypertension

Also called pseudotumor cerebri. ↑ ICP with no obvious findings on imaging. Risk factors include **female** sex, Tetracyclines, Obesity, vitamin A excess, Danazol (**female TOAD**). Associated with cerebral venous sinus stenosis. Findings: headache, tinnitus, diplopia (usually from CN VI palsy), no change in mental status. Impaired optic nerve axoplasmic flow → papilledema. Visual field testing shows enlarged blind spot and peripheral constriction. Lumbar puncture reveals ↑ opening pressure and provides temporary headache relief.

Treatment: weight loss, acetazolamide, invasive procedures for refractory cases (eg, CSF shunt placement, optic nerve sheath fenestration surgery for visual loss).

FAS1_2019_12-Neurol.indd 521 11/8/19 7:39 AM

522 SECTION III NEUROLOGY AND SPECIAL SENSES NEUROLOGY—PATHOLOGY

Hydrocephalus	↑ CSF volume → ventricular dilation +/- ↑ ICP.		
Communicating			
Communicating hydrocephalus	↓ CSF absorption by arachnoid granulations (eg, arachnoid scarring post-meningitis) → ↑ ICP, papilledema, herniation.		
Normal pressure hydrocephalus	Affects the elderly; idiopathic; CSF pressure elevated only episodically; does not result in increased subarachnoid space volume. Expansion of ventricles ⚠ distorts the fibers of the corona radiata → triad of urinary incontinence, gait apraxia (magnetic gait), and cognitive dysfunction. "Wet, wobbly, and wacky." Symptoms potentially reversible with CSF drainage via lumbar puncture or shunt placement.		
Noncommunicating (o	bstructive)		
Noncommunicating hydrocephalus	Caused by structural blockage of CSF circulation within ventricular system (eg, stenosis of aqueduct of Sylvius, colloid cyst blocking foramen of Monro, tumor B).		
Hydrocephalus mimics			
Ex vacuo ventriculomegaly	Appearance of ↑ CSF on imaging C, but is actually due to ↓ brain tissue and neuronal atrophy (eg, Alzheimer disease, advanced HIV, Pick disease, Huntington disease). ICP is normal; NPH triad is not seen.		
	A C		

11/8/19 7:39 AM FAS1_2019_12-Neurol.indd 522

Multiple sclerosis

Autoimmune inflammation and demyelination of CNS (brain and spinal cord) with subsequent axonal damage. Can present with:

- Acute optic neuritis (painful unilateral visual loss associated with Marcus Gunn pupil)
- Brain stem/cerebellar syndromes (eg, diplopia, ataxia, scanning speech, intention tremor, nystagmus/INO [bilateral > unilateral])
- Pyramidal tract demyelination (eg, weakness, spasticity)
- Spinal cord syndromes (eg, electric shock-like sensation along cervical spine on neck flexion, neurogenic bladder, paraparesis, sensory manifestations affecting the trunk or one or more extremity)

Symptoms may exacerbate with increased body temperature (eg, hot bath, exercise). Relapsing and remitting is most common clinical course. Most often affects women in their 20s and 30s; more common in individuals living farther from equator and with low serum vitamin D levels.

FINDINGS



† IgG level and myelin basic protein in CSF. Oligoclonal bands are diagnostic. MRI is gold standard. Periventricular plaques A (areas of oligodendrocyte loss and reactive gliosis). Multiple white matter lesions disseminated in space and time.

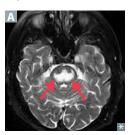
TREATMENT

Stop relapses and halt/slow progression with disease-modifying therapies (eg, β -interferon, glatiramer, natalizumab). Treat acute flares with IV steroids. Symptomatic treatment for neurogenic bladder (catheterization, muscarinic antagonists), spasticity (baclofen, GABA_B receptor agonists), pain (TCAs, anticonvulsants).

FAS1_2019_12-Neurol.indd 523 11/8/19 7:39 AM

Other demyelinating and dysmyelinating disorders

syndrome



Osmotic demyelination Also called central pontine myelinolysis. Massive axonal demyelination in pontine white matter A 2° to rapid osmotic changes, most commonly iatrogenic correction of hyponatremia but also rapid shifts of other osmolytes (eg, glucose). Acute paralysis, dysarthria, dysphagia, diplopia, loss of consciousness. Can cause "locked-in syndrome."

Correcting serum Na+ too fast:

- "From low to high, your pons will die" (osmotic demyelination syndrome)
- "From high to low, your brains will blow" (cerebral edema/herniation)

Acute inflammatory demyelinating polyradiculopathy

Most common subtype of Guillain-Barré syndrome.

Autoimmune condition that destroys Schwann cells via inflammation and demyelination of motor fibers, sensory fibers, peripheral nerves (including CN III-XII). Likely facilitated by molecular mimicry and triggered by inoculations or stress. Despite association with infections (eg, Campylobacter jejuni, viruses [eg, Zika]), no definitive causal link to any pathogen.

Results in symmetric ascending muscle weakness/paralysis and depressed/absent DTRs beginning in lower extremities. Facial paralysis (usually bilateral) and respiratory failure are common. May see autonomic dysregulation (eg, cardiac irregularities, hypertension, hypotension) or sensory abnormalities. Almost all patients survive: majority recover completely after weeks to months. † CSF protein with normal cell count (albuminocytologic dissociation).

Respiratory support is critical until recovery. Disease-modifying treatment: plasmapheresis or IV immunoglobulins. No role for steroids.

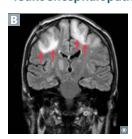
Acute disseminated (postinfectious) encephalomyelitis

Multifocal inflammation and demyelination after infection or vaccination. Presents with rapidly progressive multifocal neurologic symptoms, altered mental status.

Charcot-Marie-Tooth disease

Also called hereditary motor and sensory neuropathy. Group of progressive hereditary nerve disorders related to the defective production of proteins involved in the structure and function of peripheral nerves or the myelin sheath. Typically autosomal dominant and associated with foot deformities (eg, pes cavus, hammer toe), lower extremity weakness (eg, foot drop), and sensory deficits. Most common type, CMT1A, is caused by PMP22 gene duplication.

Progressive multifocal leukoencephalopathy



Demyelination of CNS B due to destruction of oligodendrocytes (2° to reactivation of latent JC virus infection). Seen in 2–4% of patients with AIDS. Rapidly progressive, usually fatal. Predominantly involves parietal and occipital areas; visual symptoms are common. † risk associated with natalizumab.

Other disorders

Krabbe disease, metachromatic leukodystrophy, adrenoleukodystrophy.

FAS1 2019 12-Neurol.indd 524 11/8/19 7:39 AM

Neurocutaneous disorders

DISORDER	GENETICS	PRESENTATION	NOTES
Sturge-Weber syndrome	Congenital nonhereditary anomaly of neural crest derivatives. Somatic mosaicism of an activating mutation in one copy of the GNAQ gene.	Capillary vascular malformation → portwine stain A (nevus flammeus or nonneoplastic birthmark) in CN V ₁ /V ₂ distribution; ipsilateral leptomeningeal angioma B → seizures/epilepsy; intellectual disability; episcleral hemangioma → † IOP → early-onset glaucoma.	Also called encephalotrigeminal angiomatosis. SSTURGGE-Weber: Sporadic, port-wine Stain, Tram track calcifications (opposing gyri), Unilateral, intellectual disability (Retardation), Glaucoma, GNAQ gene, Epilepsy.
Tuberous sclerosis	AD, variable expression. Mutation in tumor suppressor genes TS C1 on chromosome 9 (hamartin), TS C2 on chromosome 16 (tuberin).	Hamartomas in CNS and skin, Angiofibromas C, Mitral regurgitation, Ash-leaf spots D, cardiac Rhabdomyoma, (Tuberous sclerosis), autosomal dOminant; Mental retardation (intellectual disability), renal Angiomyolipoma E, Seizures, Shagreen patches.	HAMARTOMASS. † incidence of Subependymal giant cell astrocytomas and ungual fibromas.
Neurofibromatosis type I	AD, 100% penetrance. Mutation in <i>NF1</i> tumor suppressor gene on chromosome 17 (encodes neurofibromin, a negative RAS regulator).	Café-au-lait spots F, Intellectual disability, Cutaneous neurofibromas G, Lisch nodules (pigmented iris hamartomas H), Optic gliomas, Pheochromocytomas, Seizures/focal neurologic Signs (often from meningioma), bone lesions (eg, sphenoid dysplasia).	Also called von Recklinghausen disease. 17 letters in "von Recklinghausen." CICLOPSS.
Neurofibromatosis type II	AD. Mutation in <i>NF2</i> tumor suppressor gene (merlin) on chromosome 22.	Bilateral vestibular schwannomas, juvenile cataracts, meningiomas, ependymomas.	NF2 affects 2 ears, 2 eyes.
von Hippel-Lindau disease	AD. Deletion of <i>VHL</i> gene on chromosome 3 p. pVHL ubiquitinates hypoxia-inducible factor 1a.	Hemangioblastomas (high vascularity with hyperchromatic nuclei 1) in retina, brain stem, cerebellum, spine 1; Angiomatosis; bilateral Renal cell carcinomas; Pheochromocytomas.	Numerous tumors, benign and malignant. VHL = 3 letters. HARP.
F	B G	C D D	E

FAS1_2019_12-Neurol.indd 525 11/8/19 7:39 AM

Adult primary brain tumors

DESCRIPTION	Astrocyte origin, GFAP ①. "Pseudopalisading" pleomorphic tumor cells B border central areas of necrosis, hemorrhage, and/or microvascular proliferation.	
Grade IV astrocytoma. Common, highly malignant 1° brain tumor with ~ 1-year median survival. Found in cerebral hemispheres. Can cross corpus callosum ("butterfly glioma" A).		
Relatively rare, slow growing. Most often in frontal lobes . Often calcified.	Oligodendrocyte origin. "Fried egg" cells—round nuclei with clear cytoplasm D. "Chicken-wire" capillary pattern.	
Common, typically benign. Females > males. Most often occurs near surfaces of brain and in parasagittal region. Extra-axial (external to brain parenchyma) and may have a dural attachment ("tail" E). Often asymptomatic; may present with seizures or focal neurologic signs. Resection and/or radiosurgery. Arachnoid cell origin. Spind concentrically arranged in psammoma bodies (lamina psammoma bodies) psammoma bodies (lamina psammoma bodies) processor (lamina psammoma b		
Most often cerebellar G . Associated with von Hippel-Lindau syndrome when found with retinal angiomas. Can produce erythropoietin → 2° polycythemia.	Blood vessel origin. Closely arranged, thinwalled capillaries with minimal intervening parenchyma .	
	Grade IV astrocytoma. Common, highly malignant 1° brain tumor with ~ 1-year median survival. Found in cerebral hemispheres. Can cross corpus callosum ("butterfly glioma" A). Relatively rare, slow growing. Most often in frontal lobes C. Often calcified. Common, typically benign. Females > males. Most often occurs near surfaces of brain and in parasagittal region. Extra-axial (external to brain parenchyma) and may have a dural attachment ("tail" E). Often asymptomatic; may present with seizures or focal neurologic signs. Resection and/or radiosurgery. Most often cerebellar G. Associated with von Hippel-Lindau syndrome when found with retinal angiomas. Can produce erythropoietin	

FAS1_2019_12-Neurol.indd 526 11/8/19 7:39 AM

Adult primary brain tumors (continued)

TUMOR	DESCRIPTION	HISTOLOGY	
Pituitary adenoma	May be nonfunctioning (silent) or hyperfunctioning (hormone-producing). Nonfunctional tumors present with mass effect (eg, bitemporal hemianopia [due to pressure on optic chiasm]). Pituitary apoplexy → hyperor hypopituitarism. Prolactinoma classically presents as galactorrhea, amenorrhea, ↓ bone density due to suppression of estrogen in women and as ↓ libido, infertility in men. Treatment: dopamine agonists (eg, bromocriptine, cabergoline), transsphenoidal resection.	Hyperplasia of only one type of endocrine cells found in pituitary. Most commonly from lactotrophs (prolactin) → hyperprolactinemia. Less commonly, from somatotrophs (GH) → acromegaly, gigantism; corticotrophs (ACTH) → Cushing disease. Rarely, from thyrotrophs (TSH), gonadotrophs (FSH, LH).	
Schwannoma	Classically at the cerebellopontine angle K, benign, involving CNs V, VII, and VIII, but can be along any peripheral nerve. Often localized to CN VIII in internal acoustic meatus → vestibular schwannoma (can present as hearing loss and tinnitus). Bilateral vestibular schwannomas found in NF-2. Resection or stereotactic radiosurgery.	Schwann cell origin, S-100 ⊕. Biphasic, dense, hypercellular areas containing spindle cells alternating with hypocellular, myxoid areas □.	
	Patient		

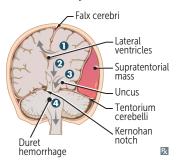
FAS1_2019_12-Neurol.indd 527 11/8/19 7:39 AM

Childhood primary brain tumors

TUMOR	DESCRIPTION	HISTOLOGY	
Pilocytic astrocytoma	Low-grade astrocytoma. Most common 1° brain tumor in childhood. Usually well circumscribed. In children, most often found in posterior fossa (eg, cerebellum). May be supratentorial. Benign; good prognosis.	Astrocyte origin, GFAP ⊕. Rosenthal fibers—eosinophilic, corkscrew fibers ■. Cystic + solid (gross).	
Medulloblastoma	Most common malignant brain tumor in childhood. Commonly involves cerebellum C. Can compress 4th ventricle, causing noncommunicating hydrocephalus → headaches, papilledema. Can involve the cerebellar vermis → truncal ataxia. Can send "drop metastases" to spinal cord.	Form of primitive neuroectodermal tumor (PNET). Homer-Wright rosettes, small blue cells □. Synaptophysin ⊕.	
Ependymoma	Most commonly found in 4th ventricle E . Can cause hydrocephalus. Poor prognosis.	Ependymal cell origin. Characteristic perivascular pseudorosettes F . Rod-shaped blepharoplasts (basal ciliary bodies) found near the nucleus.	
Craniopharyngioma	Most common childhood supratentorial tumor. May be confused with pituitary adenoma (both cause bitemporal hemianopia).	Derived from remnants of Rathke pouch (ectoderm). Calcification is common G. H. Cholesterol crystals found in "motor oil"-like fluid within tumor.	
Pinealoma	Tumor of pineal gland. Can cause Parinaud syndrome (compression of tectum → vertical gaze palsy); obstructive hydrocephalus (compression of cerebral aqueduct); precocious puberty in males (hCG production).	Similar to germ cell tumors (eg, testicular seminoma).	
	B F F		

FAS1_2019_12-Neurol.indd 528 11/8/19 7:39 AM

Herniation syndromes



Cingulate (subfalcine) herniation under falx cerebri

Can compress anterior cerebral artery.

2 Central/downward transtentorial herniation

Caudal displacement of brain stem → rupture of paramedian basilar artery branches → Duret hemorrhages. Usually fatal.

3 Uncal transtentorial herniation

Uncus = medial temporal lobe. Early herniation → ipsilateral blown pupil (unilateral CN III compression), contralateral hemiparesis. Late herniation → coma, Kernohan phenomenon (misleading contralateral blown pupil and ipsilateral hemiparesis due to contralateral compression against Kernohan notch).

4 Cerebellar tonsillar herniation into the foramen magnum

Coma and death result when these herniations compress the brain stem.

Motor neuron signs

SIGN	UMN LESION	LMN LESION	COMMENTS
Weakness	+	+	Lower motor neuron = everything lowered (less muscle mass, ↓ muscle tone, ↓ reflexes, downgoing toes) Upper motor neuron = everything up (tone, DTRs, toes) Fasciculations = muscle twitching Positive Babinski is normal in infants
Atrophy	_	+	
Fasciculations	_	+	
Reflexes	†	ţ	
Tone	†	ţ	
Babinski	+	_	
Spastic paresis	+	_	
Flaccid paralysis	_	+	
Clasp knife spasticity	+	_	

FAS1_2019_12-Neurol.indd 529 11/8/19 7:39 AM

Spinal lesions

DISEASE	CHARACTERISTICS
Spinal muscular atrophy	Congenital degeneration of anterior horns of spinal cord. LMN symptoms only, symmetric weakness. "Floppy baby" with marked hypotonia (Flaccid paralysis) and tongue Fasciculations. Autosomal recessive mutation in SMN1 → defective snRNP assembly. SMA type 1 is called Werdnig-Hoffmann disease.
Amyotrophic lateral sclerosis	Also called Lou Gehrig disease. Combined UMN (corticobulbar/corticospinal) and LMN (medullary and spinal cord) degeneration. No sensory or bowel/bladder deficits. Can be caused by defect in superoxide dismutase 1. LMN deficits: flaccid limb weakness, fasciculations, atrophy, bulbar palsy (dysarthria, dysphagia, tongue atrophy). UMN deficits: spastic limb weakness, hyperreflexia, clonus, pseudobulbar palsy (dysarthria, dysphagia, emotional lability). Fatal. Treatment: "riLouzole".
Complete occlusion of anterior spinal artery	Spares dorsal columns and Lissauer tract; mid- thoracic ASA territory is watershed area, as artery of Adamkiewicz supplies ASA below T8. Can be caused by aortic aneurysm repair. Presents with UMN deficit below the lesion (corticospinal tract), LMN deficit at the level of the lesion (anterior horn), and loss of pain and temperature sensation below the lesion (spinothalamic tract).
Tabes dorsalis	Caused by 3° syphilis. Results from degeneration/ demyelination of dorsal columns and roots → progressive sensory ataxia (impaired proprioception → poor coordination). ⊕ Romberg sign and absent DTRs. Associated with Charcot joints, shooting pain, Argyll Robertson pupils.
Syringomyelia	Syrinx expands and damages anterior white commissure of spinothalamic tract (2nd-order neurons) → bilateral symmetric loss of pain and temperature sensation in cape-like distribution. Seen with Chiari I malformation. Can affect other tracts.
Vitamin B ₁₂ deficiency	Subacute combined degeneration (SCD)— demyelination of Spinocerebellar tracts, lateral Corticospinal tracts, and Dorsal columns. Ataxic gait, paresthesia, impaired position/vibration sense, UMN symptoms.
Cauda equina syndrome	Compression of spinal roots L2 and below, often due to intervertebral disc herniation or tumor. Radicular pain, absent knee and ankle reflexes, loss of bladder and anal sphincter control, saddle anesthesia.
	Amyotrophic lateral sclerosis Complete occlusion of anterior spinal artery Tabes dorsalis Syringomyelia Vitamin B ₁₂ deficiency

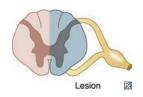
FAS1_2019_12-Neurol.indd 530 11/8/19 7:39 AM

Poliomyelitis

Caused by poliovirus (fecal-oral transmission). Replicates in oropharynx and small intestine before spreading via bloodstream to CNS. Infection causes destruction of cells in anterior horn of spinal cord (LMN death).

Signs of LMN lesion: asymmetric weakness (vs symmetric weakness in spinal muscular atrophy), hypotonia, flaccid paralysis, fasciculations, hyporeflexia, muscle atrophy. Respiratory muscle involvement leads to respiratory failure. Signs of infection: malaise, headache, fever, nausea, etc. CSF shows † WBCs (lymphocytic pleocytosis) and slight † of protein (with no change in CSF glucose). Virus recovered from stool or throat.

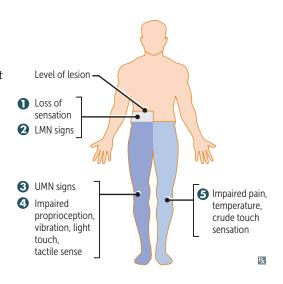
Brown-Séquard syndrome



Hemisection of spinal cord. Findings:

- Ipsilateral loss of all sensation at level of lesion
- 2 Ipsilateral LMN signs (eg, flaccid paralysis) at level of lesion
- 3 Ipsilateral UMN signs below level of lesion (due to corticospinal tract damage)
- 4 Ipsilateral loss of proprioception, vibration, light (2-point discrimination) touch, and tactile sense below level of lesion (due to dorsal column damage)
- **5** Contralateral loss of pain, temperature, and crude (non-discriminative) touch below level of lesion (due to spinothalamic tract damage)

If lesion occurs above T1, patient may present with ipsilateral Horner syndrome due to damage of oculosympathetic pathway.



Friedreich ataxia

Autosomal recessive trinucleotide repeat disorder (GAA)_n on chromosome 9 in gene that encodes frataxin (iron-binding protein). Leads to impairment in mitochondrial functioning. Degeneration of lateral corticospinal tract (spastic paralysis), spinocerebellar tract (ataxia), dorsal columns (↓ vibratory sense, proprioception), and dorsal root ganglia (loss of DTRs). Staggering gait, frequent falling, nystagmus, dysarthria, pes cavus, hammer toes, diabetes mellitus, hypertrophic cardiomyopathy (cause of death). Presents in childhood with kyphoscoliosis A B.

Friedreich is Fratastic (**frataxin**): he's your favorite frat brother, always staggering and falling but has a sweet, big heart. Ataxic **GAA**it.





FAS1 2019 12-Neurol.indd 531 11/8/19 7:39 AM

Common cranial nerve lesions

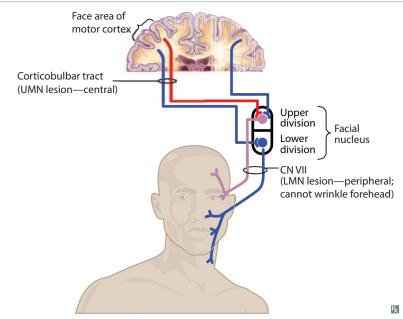
CN V motor lesion	Jaw deviates toward side of lesion due to unopposed force from the opposite pterygoid muscle.	
CN X lesion	Uvula deviates away from side of lesion. Weak side collapses and uvula points away.	
Weakness turning head to contralateral side of lesion (SCM). Shoulder droop on side (trapezius). The left SCM contracts to help turn the head to the right.		
CN XII lesion	LMN lesion. Tongue deviates toward side of lesion ("lick your wounds") due to weakened tongue muscles on affected side.	

Facial nerve lesions



Bell palsy is the most common cause of peripheral facial palsy A. Usually develops after HSV reactivation. Treatment: corticosteroids +/– acyclovir. Most patients gradually recover function, but aberrant regeneration can occur. Other causes of peripheral facial palsy include Lyme disease, herpes zoster (Ramsay Hunt syndrome), sarcoidosis, tumors (eg, parotid gland), diabetes mellitus.

	Upper motor neuron lesion	Lower motor neuron lesion	
LESION LOCATION	Motor cortex, connection from motor cortex to facial nucleus in pons	Facial nucleus, anywhere along CN VII	
AFFECTED SIDE	Contralateral	Ipsilateral	
MUSCLES INVOLVED	Lower muscles of facial expression	Upper and lower muscles of facial expression	
FOREHEAD INVOLVED?	Spared, due to bilateral UMN innervation	Affected	
OTHER SYMPTOMS	None	Incomplete eye closure (dry eyes, corneal ulceration), hyperacusis, loss of taste sensation to anterior tongue	



FAS1_2019_12-Neurol.indd 532 11/8/19 7:39 AM

Auditory physiology Outer ear Visible portion of ear (pinna), includes auditory canal and tympanic membrane. Transfers sound waves via vibration of tympanic membrane. Middle ear Air-filled space with three bones called the ossicles (malleus, incus, stapes). Ossicles conduct and amplify sound from tympanic membrane to inner ear. Inner ear Snail-shaped, fluid-filled cochlea. Contains basilar membrane that vibrates 2° to sound waves. Vibration transduced via specialized hair cells → auditory nerve signaling → brain stem. Each frequency leads to vibration at specific location on basilar membrane (tonotopy): Low frequency heard at apex near helicotrema (wide and flexible).

High frequency heard best at base of cochlea (thin and rigid).

Diagnosing hearing loss

	Normal	Conductive	Sensorineural
Weber test Tuning fork on vertex of skull	No localization	Localizes to affected ear	Localizes to unaffected ear
Rinne test Tuning fork in front of ear (air conduction, AC), Tuning fork on mastoid process (bone conduction, BC)	AC > BC	transmission of background noise	↓ transmission of all sound ((AC > BC

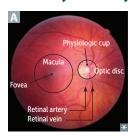
Types of hearing loss Noise-induced hearing loss Damage to stereociliated cells in organ of Corti. Loss of high-frequency hearing first. Sudden extremely loud noises can produce hearing loss due to tympanic membrane rupture. Presbycusis Aging-related progressive bilateral/symmetric sensorineural hearing loss (often of higher frequencies) due to destruction of hair cells at the cochlear base (preserved low-frequency hearing at apex). Cholesteatoma Overgrowth of desquamated keratin debris within the middle ear space (A, arrows); may erode ossicles, mastoid air cells → conductive hearing loss. Often presents with painless otorrhea.

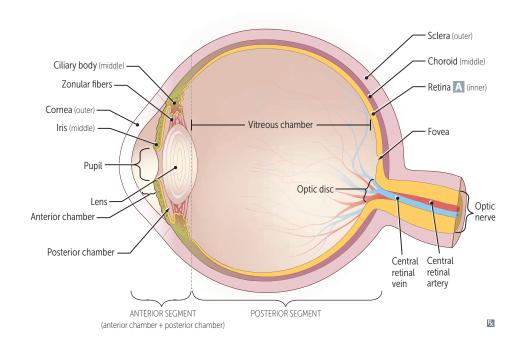
FAS1_2019_12-Neurol.indd 533 11/8/19 7:39 AM

Vertigo	Sensation of spinning while actually stationary. Subtype of "dizziness," but distinct from "lightheadedness."
Peripheral vertigo	More common. Inner ear etiology (eg, semicircular canal debris, vestibular nerve infection, Ménière disease [triad: sensorineural hearing loss, vertigo, tinnitus; endolymphatic hydrops → ↑ endolymph within the inner ear], benign paroxysmal positional vertigo [BPPV]). Treatment: antihistamines, anticholinergics, antiemetics (symptomatic relief); low-salt diet +/− diuretics (Ménière disease); Epley maneuver (BPPV).
Central vertigo	Brain stem or cerebellar lesion (eg, stroke affecting vestibular nuclei, demyelinating disease, or posterior fossa tumor). Findings: directional or purely vertical nystagmus, skew deviation (vertical misalignment of the eyes), diplopia, dysmetria. Focal neurologic findings.

▶ NEUROLOGY—OPHTHALMOLOGY

Normal eye anatomy





Conjunctivitis



Inflammation of the conjunctiva \rightarrow red eye \boxed{A} .

Allergic—itchy eyes, bilateral.

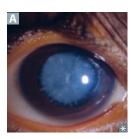
Bacterial—pus; treat with antibiotics.

Viral—most common, often adenovirus; sparse mucous discharge, swollen preauricular node, † lacrimation; self-resolving.

FAS1_2019_12-Neurol.indd 534 11/8/19 7:39 AM

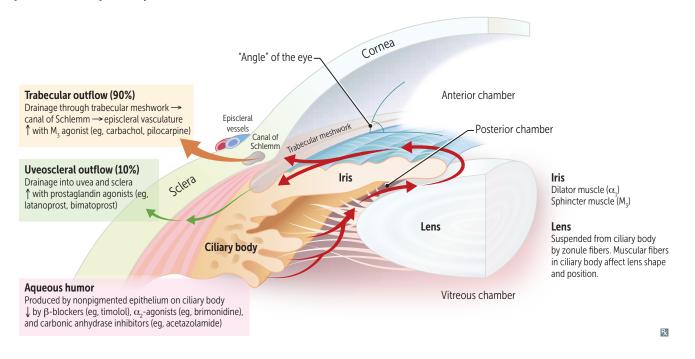
Refractive errors	Common cause of impaired vision, correctable with glasses. Also called "farsightedness." Eye too short for refractive power of cornea and lens → light focused behind retina. Correct with convex (converging) lenses.		
Hyperopia			
Myopia	Also called "nearsightedness." Eye too long for refractive power of cornea and lens → light focused in front of retina. Correct with concave (diverging) lens.		
Astigmatism	Abnormal curvature of cornea → different refractive power at different axes. Correct with cylindrical lens.		
Presbyopia	Aging-related impaired accommodation (focusing on near objects), primarily due to ↓ lens elasticity, changes in lens curvature, ↓ strength of the ciliary muscle. Patients often need "reading glasses" (magnifiers).		

Cataract



Painless, often bilateral, opacification of lens ⚠, often resulting in glare and ↓ vision, especially at night. Acquired risk factors: ↑ age, smoking, excessive alcohol use, excessive sunlight, prolonged corticosteroid use, diabetes mellitus, trauma, infection. Congenital risk factors: classic galactosemia, galactokinase deficiency, trisomies (13, 18, 21), TORCH infections (eg, rubella), Marfan syndrome, Alport syndrome, myotonic dystrophy, neurofibromatosis 2.

Aqueous humor pathway



FAS1_2019_12-Neurol.indd 535 11/8/19 7:39 AM

Glaucoma

Optic disc atrophy with characteristic cupping (normal A versus thinning of outer rim of optic nerve head B), usually with elevated intraocular pressure (IOP) and progressive peripheral visual field loss if untreated. Treatment is through pharmacologic or surgical lowering of IOP.

Open-angle glaucoma

Associated with † age, African-American race, family history. Painless, more common in US. Primary—cause unclear.

Secondary—blocked trabecular meshwork from WBCs (eg, uveitis), RBCs (eg, vitreous hemorrhage), retinal elements (eg, retinal detachment).

Closed- or narrowangle glaucoma

Primary—enlargement or anterior movement of lens against central iris (pupil margin)

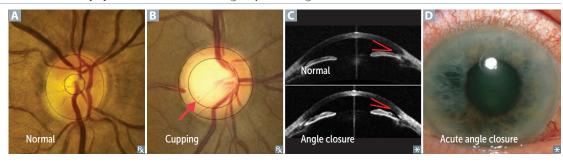
→ obstruction of normal aqueous flow through pupil → fluid builds up behind iris, pushing peripheral iris against cornea and impeding flow through trabecular meshwork.

Secondary—hypoxia from retinal disease (eg, diabetes mellitus, vein occlusion) induces vasoproliferation in iris that contracts angle.

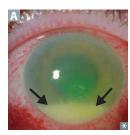
Chronic closure—often asymptomatic with damage to optic nerve and peripheral vision.

Acute closure—true ophthalmic emergency. ↑ IOP pushes iris forward → angle closes abruptly.

Very painful, red eye □, sudden vision loss, halos around lights, frontal headache, fixed and mid-dilated pupil, nausea and vomiting. Mydriatic agents contraindicated.



Uveitis



Inflammation of uvea; specific name based on location within affected eye. Anterior uveitis: iritis; posterior uveitis: choroiditis and/or retinitis. May have hypopyon (accumulation of pus in anterior chamber A) or conjunctival redness. Associated with systemic inflammatory disorders (eg, sarcoidosis, rheumatoid arthritis, juvenile idiopathic arthritis, HLA-B27–associated conditions).

Age-related macular degeneration



Degeneration of macula (central area of retina). Causes distortion (metamorphopsia) and eventual loss of central vision (scotomas).

- Dry (nonexudative, > 80%)—Deposition of yellowish extracellular material ("Drusen") in between Bruch membrane and retinal pigment epithelium ▲ with gradual ↓ in vision. Prevent progression with multivitamin and antioxidant supplements.
- Wet (exudative, 10–15%)—rapid loss of vision due to bleeding 2° to choroidal neovascularization. Treat with anti-VEGF (vascular endothelial growth factor) injections (eg, bevacizumab, ranibizumab).

FAS1_2019_12-Neurol.indd 536 11/8/19 7:39 AM

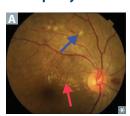
Diabetic retinopathy



Retinal damage due to chronic hyperglycemia. Two types:

- Nonproliferative—damaged capillaries leak blood → lipids and fluid seep into retina
 → hemorrhages (arrows in A) and macular edema. Treatment: blood sugar control.
- Proliferative—chronic hypoxia results in new blood vessel formation with resultant traction on retina → retinal detachment. Treatment: anti-VEGF injections, peripheral retinal photocoagulation, surgery.

Hypertensive retinopathy

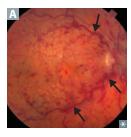


Retinal damage due to chronic uncontrolled HTN.

Flame-shaped retinal hemorrhages, arteriovenous nicking, microaneurysms, macular star (exudate, red arrow in A), cotton-wool spots (blue arrow in A). Presence of papilledema requires immediate lowering of BP.

Associated with † risk of stroke, CAD, kidney disease.

Retinal vein occlusion



Blockage of central or branch retinal vein due to compression from nearby arterial atherosclerosis. Retinal hemorrhage and venous engorgement ("blood and thunder appearance"; arrows in A), edema in affected area.

Retinal detachment



Separation of neurosensory layer of retina (photoreceptor layer with rods and cones) from outermost pigmented epithelium (normally shields excess light, supports retina) → degeneration of photoreceptors → vision loss. May be 2° to retinal breaks, diabetic traction, inflammatory effusions. Visualized on fundoscopy as crinkling of retinal tissue A and changes in vessel direction.

Breaks more common in patients with high myopia and/or history of head trauma. Often preceded by posterior vitreous detachment ("flashes" and "floaters") and eventual monocular loss of vision like a "curtain drawn down." Surgical emergency.

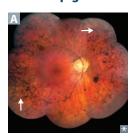
FAS1_2019_12-Neurol.indd 537 11/8/19 7:39 AM

Central retinal artery occlusion



Acute, painless monocular vision loss. Retina cloudy with attenuated vessels and "cherry-red" spot at fovea (center of macula) A. Evaluate for embolic source (eg, carotid artery atherosclerosis, cardiac vegetations, patent foramen ovale).

Retinitis pigmentosa



Inherited progressive retinal degeneration. Nyctalopia (night blindness) → peripheral vision loss. Bone spicule-shaped deposits A.

Papilledema



Optic disc swelling (usually bilateral) due to \uparrow ICP (eg, 2° to mass effect). Enlarged blind spot and elevated optic disc with blurred margins \blacksquare .

Leukocoria



Loss (whitening) of the red reflex. Important causes in children include retinoblastoma A, congenital cataract, toxocariasis.

FAS1_2019_12-Neurol.indd 538 11/8/19 7:39 AM

Pupillary control

Miosis

Constriction, parasympathetic:

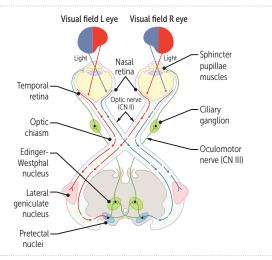
- 1st neuron: Edinger-Westphal nucleus to ciliary ganglion via CN III
- 2nd neuron: short ciliary nerves to sphincter pupillae muscles

Short ciliary nerves shorten the pupil diameter.

Pupillary light reflex

Light in either retina sends a signal via CN II to pretectal nuclei (dashed lines in image) in midbrain that activates bilateral Edinger-Westphal nuclei; pupils constrict bilaterally (direct and consensual reflex).

Result: illumination of 1 eye results in bilateral pupillary constriction.



Mydriasis

Dilation, sympathetic:

- 1st neuron: hypothalamus to ciliospinal center of Budge (C8–T2)
- 2nd neuron: exit at T1 to superior cervical ganglion (travels along cervical sympathetic chain near lung apex, subclavian vessels)
- 3rd neuron: plexus along internal carotid, through cavernous sinus; enters orbit as long ciliary nerve to pupillary dilator muscles. Sympathetic fibers also innervate smooth muscle of eyelids (minor retractors) and sweat glands of forehead and face.

Long ciliary nerves make the pupil diameter longer.

Marcus Gunn pupil

Also called relative afferent pupillary defect (RAPD). When the light shines into a normal eye, constriction of the ipsilateral (direct reflex) and contralateral eye (consensual reflex) is observed. When the light is then swung to the affected eye, both pupils dilate instead of constrict due to impaired conduction of light signal along the injured optic nerve. Associated with optic neuritis, early multiple sclerosis.

FAS1_2019_12-NeuroLindd 539 11/8/19 7:39 AM

NEUROLOGY AND SPECIAL SENSES → NEUROLOGY—OPHTHALMOLOGY

Horner syndrome

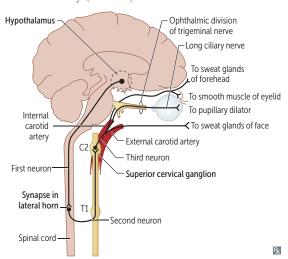
Sympathetic denervation of face →:

- Ptosis (slight drooping of eyelid: superior tarsal muscle)
- Anhidrosis (absence of sweating) and flushing of affected side of face
- Miosis (pupil constriction)

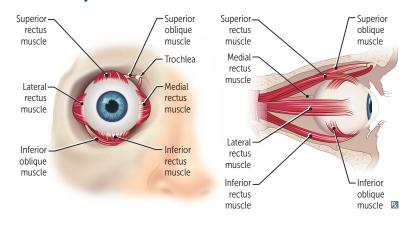
Associated with lesions along the sympathetic chain:

- Ist neuron: pontine hemorrhage, lateral medullary syndrome, spinal cord lesion above T1 (eg, Brown-Séquard syndrome, late-stage syringomyelia)
- 2nd neuron: stellate ganglion compression by Pancoast tumor
- 3rd neuron: carotid dissection (painful)

PAM is horny (Horner).



Ocular motility

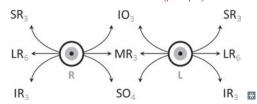


CN VI innervates the Lateral Rectus.

CN IV innervates the Superior Oblique.

CN III innervates the Rest.

The "chemical formula" LR₆SO₄R₃.



Obliques go Opposite (left SO and IO tested with patient looking right).

IOU: IO tested looking Up.

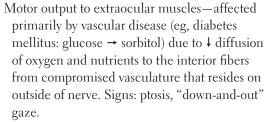
FAS1_2019_12-Neurol.indd 540 11/8/19 7:39 AM

CN III, IV, VI palsies

CN III damage

CN III has both motor (central) and parasympathetic (peripheral) components. Common causes include:

- Ischemia → pupil sparing (motor fibers affected more than parasympathetic fibers)
- Uncal herniation → coma
- PCom aneurysm → sudden-onset headache
- Cavernous sinus thrombosis → proptosis, involvement of CNs IV, V₁/V₂, VI
- Midbrain stroke → contralateral hemiplegia



Parasympathetic output—fibers on the periphery are first affected by compression (eg, PCom or absent pupillary light reflex, "blown pupil"

aneurysm, uncal herniation). Signs: diminished often with "down-and-out" gaze A. Pupil is higher in the affected eye B.



Characteristic head tilt to contralateral/ unaffected side to compensate for lack of intorsion in affected eye.

Can't see the floor with CN IV damage (eg, difficulty going down stairs, reading).



Affected eye unable to abduct and is displaced medially in primary position of gaze C.

Motor = Middle (central) Parasympathetic = Peripheral







FAS1_2019_12-Neurol.indd 541 11/8/19 7:39 AM

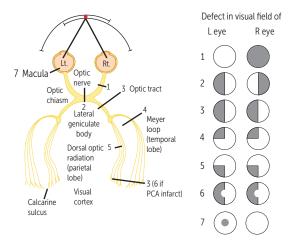
NEUROLOGY AND SPECIAL SENSES → NEUROLOGY—OPHTHALMOLOGY

Visual field defects

- 1. Right anopia (monocular vision loss)
- 2. Bitemporal hemianopia (pituitary lesion, chiasm)
- 3. Left homonymous hemianopia
- 4. Left upper quadrantanopia (right temporal lesion, MCA)
- 5. Left lower quadrantanopia (right parietal lesion, MCA)
- 6. Left hemianopia with macular sparing (right occipital lesion, PCA)
- 7. Central scotoma (eg, macular degeneration)

Meyer Loop—Lower retina; Loops around inferior horn of Lateral ventricle.

Dorsal optic radiation—superior retina; takes shortest path via internal capsule.



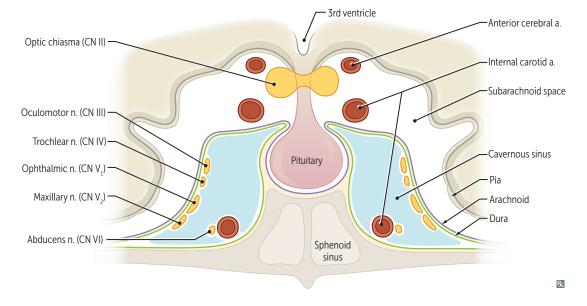
Note: When an image hits 1° visual cortex, it is upside down and left-right reversed.

Cavernous sinus

Collection of venous sinuses on either side of pituitary. Blood from eye and superficial cortex → cavernous sinus → internal jugular vein.

CNs III, IV, V₁, V₂, and VI plus postganglionic sympathetic pupillary fibers en route to orbit all pass through cavernous sinus. Cavernous portion of internal carotid artery is also here.

Cavernous sinus syndrome—presents with variable ophthalmoplegia, ↓ corneal sensation, Horner syndrome and occasional decreased maxillary sensation. 2° to pituitary tumor mass effect, carotid-cavernous fistula, or cavernous sinus thrombosis related to infection.

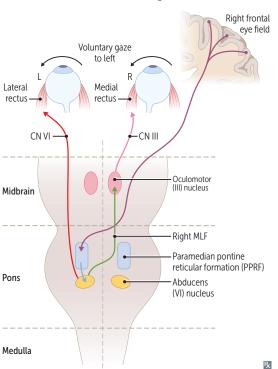


FAS1_2019_12-Neurol.indd 542 11/8/19 7:39 AM

Internuclear ophthalmoplegia

Medial longitudinal fasciculus (MLF): pair of tracts that allows for crosstalk between CN VI and CN III nuclei. Coordinates both eyes to move in same horizontal direction. Highly myelinated (must communicate quickly so eyes move at same time). Lesions may be unilateral or bilateral (latter classically seen in multiple sclerosis, stroke).

Lesion in MLF = internuclear ophthalmoplegia (INO), a conjugate horizontal gaze palsy. Lack of communication such that when CN VI nucleus activates ipsilateral lateral rectus, contralateral CN III nucleus does not stimulate medial rectus to contract. Abducting eye displays nystagmus (CN VI overfires to stimulate CN III). Convergence normal.

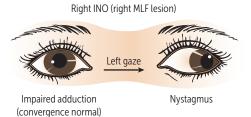


MLF in MS.

When looking left, the left nucleus of CN VI fires, which contracts the left lateral rectus and stimulates the contralateral (right) nucleus of CN III via the right MLF to contract the right medial rectus.

Directional term (eg, right INO, left INO) refers to the eye that is unable to adduct.

INO = Ipsilateral adduction failure, Nystagmus Opposite.



FAS1_2019_12-Neurol.indd 543 11/8/19 7:39 AM

► NEUROLOGY—PHARMACOLOGY

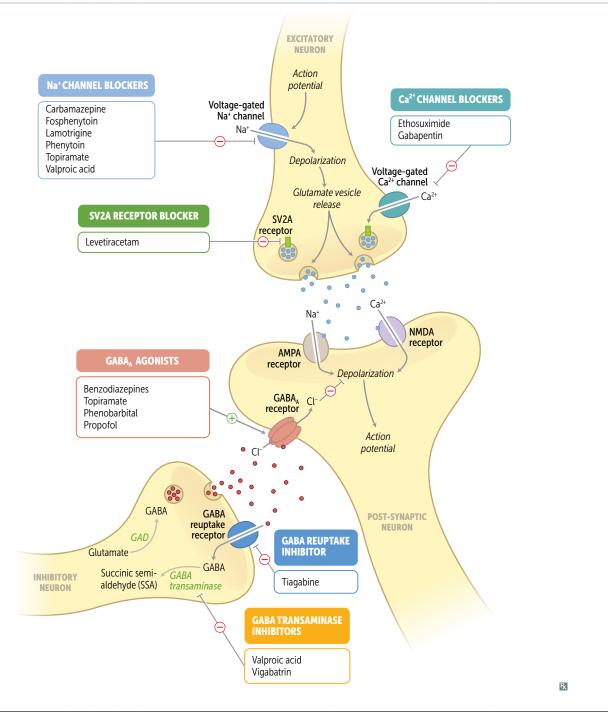
Epilepsy therapy

	GENERALIZED						
	PARTIAL (FOCAL)	TONIC-CLONIC	ABSENCE	STATUS EPILEPTICUS	MECHANISM	SIDE EFFECTS	NOTES
Benzodiazepines				** ✓	† GABA _A action	Sedation, tolerance, dependence, respiratory depression	Also for eclampsia seizures (1st line is MgSO ₄)
Carbamazepine	*	√			Blocks Na+ channels	Diplopia, ataxia, blood dyscrasias (agranulocytosis, aplastic anemia), liver toxicity, teratogenesis (cleft lip/palate, spina bifida), induction of cytochrome P-450, SIADH, SJS	1st line for trigeminal neuralgia
Ethosuximide			* /		Blocks thalamic T-type Ca ²⁺ channels	EFGHIJ—Ethosuximide causes Fatigue, GI distress, Headache, Itching (and urticaria), SJS	Sucks to have Silent (absence) Seizures
Gabapentin	1				Primarily inhibits high-voltage- activated Ca ²⁺ channels; designed as GABA analog	Sedation, ataxia	Also used for peripheral neuropathy, postherpetic neuralgia
Lamotrigine	✓	1	✓		Blocks voltage-gated Na ⁺ channels, inhibits the release of glutamate	SJS (must be titrated slowly), hemophagocytic lymphohistiocytosis (black box warning)	
Levetiracetam	✓	✓			SV2A receptor blocker; may modulate GABA and glutamate release, inhibit voltage-gated Ca ²⁺ channels	Neuropsychiatric symptoms (eg, personality change), fatigue, drowsiness, headache	
Phenobarbital	1	1		✓	↑ GABA _A action	Sedation, tolerance, dependence, induction of cytochrome P-450, cardiorespiratory depression	lst line in <mark>neonates</mark> ("pheno <mark>bab</mark> ytal")
Phenytoin, fosphenytoin	✓	* ✓		***	Blocks Na ⁺ channels; zero- order kinetics PHENYTOIN: cytochrome P-450 induction, Hirsutism, Enlarged gums, Nystagmus, Yellow-brown skin, Teratoger (fetal hydantoin syndrome), Osteopenia, Inhibited folate absorption, Neuropathy. Rare: SJS, DRESS syndrome, SLE-like syndrome. Toxicity leads to diplopia, ataxia, seda		ellow-brown skin, Teratogenicity steopenia, Inhibited folate SJS, DRESS syndrome,
Topiramate	✓	1			Blocks Na+ channels, † GABA action	Sedation, slow cognition, kidney stones, skinny (weight loss), sight threatened (glaucoma), speech (word- finding) difficulties	Also used for migraine prophylaxis
Valproic acid	√	* ✓	✓		↑ Na+ channel inactivation, ↑ GABA concentration by inhibiting GABA transaminase	GI distress, rare but fatal hepatotoxicity (measure LFTs), pancreatitis, neural tube defects, tremor, weight gain, contraindicated in pregnancy	Also used for myoclonic seizures, bipolar disorder, migraine prophylaxis
Vigabatrin	1				† GABA. Irreversible GABA transaminase inhibitor	Permanent visual loss (black box warning)	Vision gone all bad with Vigabatrin

^{* =} Common use, ** = 1st line for acute, *** = 1st line for recurrent seizure prophylaxis.

FAS1_2019_12-Neurol.indd 544 11/8/19 7:39 AM

Epilepsy therapy (continued)



FAS1_2019_12-Neurol.indd 545 11/8/19 7:39 AM

546 SECTION III NEUROLOGY AND SPECIAL SENSES > NEUROLOGY—PHARMACOLOGY

Barbiturates	Phenobarbital, pentobarbital, thiopental, secobarbital.		
MECHANISM	Facilitate GABA _A action by ↑ duration of Cl ⁻ channel opening, thus ↓ neuron firing (barbidurates ↑ duration).		
CLINICAL USE	Sedative for anxiety, seizures, insomnia, induction of anesthesia (thiopental).		
ADVERSE EFFECTS	Respiratory and cardiovascular depression (can be fatal); CNS depression (can be exacerbated by alcohol use); dependence; drug interactions (induces cytochrome P-450). Overdose treatment is supportive (assist respiration and maintain BP). Contraindicated in porphyria.		
Benzodiazepines	Diazepam, lorazepam, triazolam, temazepam, oxazepam, midazolam, chlordiazepoxide, alprazolam.		
MECHANISM	Facilitate GABA _A action by ↑ frequency of Cl ⁻ channel opening ("frenzodiazepines" ↑ frequency). ↓ REM sleep. Most have long half-lives and active metabolites (exceptions [ATOM]: Alprazolam, Triazolam, Oxazepam, and Midazolam are short acting → higher addictive potential).		
CLINICAL USE	Anxiety, panic disorder, spasticity, status epilepticus (lorazepam, diazepam, midazolam), eclampsia detoxification (especially alcohol withdrawal– DTs), night terrors, sleepwalking, general anesthetic (amnesia, muscle relaxation), hypnotic (insomnia). Lorazepam, Oxazepam, and Temazepam can be used for those with liver disease who drink a LOT due to minimal first-pass metabolism.		
ADVERSE EFFECTS	Dependence, additive CNS depression effects with alcohol and barbiturates (all bind the GABA receptor). Less risk of respiratory depression and coma than with barbiturates. Treat overdose wi flumazenil (competitive antagonist at GABA benzodiazepine receptor). Can precipitate seizures by causing acute benzodiazepine withdrawal.		
Nonbenzodiazepine hypnotics	Zolpidem, Zaleplon, esZopiclone. "These ZZZs put you to sleep."		
MECHANISM	Act via the BZ ₁ subtype of the GABA receptor. Effects reversed by flumazenil. Sleep cycle less affected as compared with benzodiazepine hypnotics.		
CLINICAL USE	Insomnia.		
ADVERSE EFFECTS	Ataxia, headaches, confusion. Short duration because of rapid metabolism by liver enzymes. Unlike older sedative-hypnotics, cause only modest day-after psychomotor depression and few amnestic effects. ↓ dependence risk than benzodiazepines.		

FAS1_2019_12-Neurol.indd 546 11/8/19 7:39 AM

CLINICAL USE

ADVERSE EFFECTS

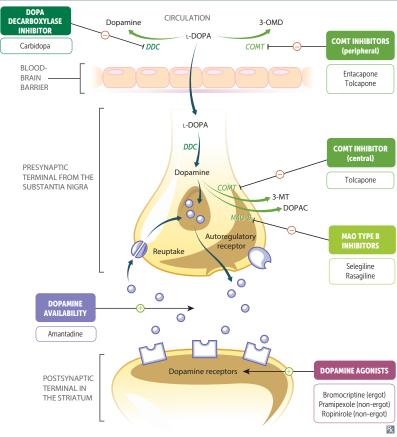
MECHANISM	Orexin (hypocretin) receptor antagonist.	Suvorexant is an orexin antagonist.	
CLINICAL USE	Insomnia.		
ADVERSE EFFECTS	CNS depression (somnolence), headache, abnormal sleep-related activities. Contraindications: narcolepsy, combination with strong CYP3A4 inhibitors. Not recommended in patients with liver disease. Limited physical dependence or abuse potential.		
Ramelteon			
MECHANISM	Melatonin receptor agonist; binds MT1 and MT2 in suprachiasmatic nucleus.	Ramelteon is a melatonin receptor agonist.	
CLINICAL USE	Insomnia.		
ADVERSE EFFECTS	Dizziness, nausea, fatigue, headache. No dependence (not a controlled substance).		
Triptans	Sumatriptan		
MECHANISM	5-HT _{1B/ID} agonists. Inhibit trigeminal nerve activation, prevent vasoactive peptide release, induce vasoconstriction.	A sumo wrestler trips and falls on his head	

Acute migraine, cluster **head**ache attacks.

Coronary vasospasm (contraindicated in patients with CAD or vasospastic angina), mild paresthesia, serotonin syndrome (in combination with other 5-HT agonists).

FAS1_2019_12-Neurol.indd 547 11/8/19 7:39 AM

Parkinson disease therapy	Parkinsonism is due to loss of dopaminergic neurons and excess cholinergic activity. Bromocriptine, Amantadine, Levodopa (with carbidopa), Selegiline (and COMT inhibitors), Antimuscarinics (BALSA).
STRATEGY	AGENTS
Dopamine agonists	Ergot—Bromocriptine. Non-ergot (preferred)—pramipexole, ropinirole; toxicity includes nausea, impulse control disorder (eg, gambling), postural hypotension, hallucinations, confusion.
† dopamine availability	Amantadine († dopamine release and ↓ dopamine reuptake); toxicity = peripheral edema, livedo reticularis, ataxia.
↑ L-DOPA availability	Agents prevent peripheral (pre-BBB) L-DOPA degradation → ↑ L-DOPA entering CNS → ↑ central L-DOPA available for conversion to dopamine. Levodopa (L-DOPA)/carbidopa—carbidopa blocks peripheral conversion of L-DOPA to dopamine by inhibiting DOPA decarboxylase. Also reduces side effects of peripheral L-DOPA conversion into dopamine (eg, nausea, vomiting). Entacapone and tolcapone prevent peripheral L-DOPA degradation to 3-O-methyldopa (3-OMD) by inhibiting COMT. Used in conjunction with levodopa.
Prevent dopamine breakdown	Agents act centrally (post-BBB) to inhibit breakdown of dopamine. Selegiline, rasagiline—block conversion of dopamine into DOPAC by selectively inhibiting MAO-B. Tolcapone—crosses BBB and blocks conversion of dopamine to 3-methoxytyramine (3-MT) in the brain by inhibiting central COMT.
Curb excess cholinergic activity	Benztropine, trihexyphenidyl (Antimuscarinic; improves tremor and rigidity but has little effect on bradykinesia in Parkinson disease). Park your Mercedes-Benz.



FAS1_2019_12-Neurol.indd 548 11/8/19 7:40 AM

Carbidopa/levodopa

MECHANISM	† dopamine in brain. Unlike dopamine, L-DOPA can cross blood-brain barrier and is converted by dopa decarboxylase in the CNS to dopamine. Carbidopa, a peripheral DOPA decarboxylase inhibitor, is given with L-DOPA to † bioavailability of L-DOPA in the brain and to limit peripheral side effects.
CLINICAL USE	Parkinson disease.
ADVERSE EFFECTS	Nausea, hallucinations, postural hypotension. With progressive disease, L-DOPA can lead to "onoff" phenomenon with improved mobility during "on" periods, then impaired motor function during "off" periods when patient responds poorly to L-DOPA or medication wears off.

Selegiline, rasagiline

o cicgiiiic, i abagiii	
MECHANISM	Selectively inhibit MAO-B (metabolize dopamine) → ↑ dopamine availability. Selegiline selectively inhibits MAO-B and is more commonly found in the Brain than in the periphery.
CLINICAL USE	Adjunctive agent to L-DOPA in treatment of Parkinson disease.
ADVERSE EFFECTS	May enhance adverse effects of L-DOPA.

Neurodegenerative disease therapy

DISEASE	AGENT	MECHANISM	NOTES
Alzheimer disease	Donepezil, rivastigmine, galantamine	AChE inhibitor	lst-line treatment Adverse effects: nausea, dizziness, insomnia Dona Riva dances at the gala
	Memantine	NMDA receptor antagonist; helps prevent excitotoxicity (mediated by Ca ²⁺)	Used for moderate to advanced dementia Adverse effects: dizziness, confusion, hallucinations
Amyotrophic lateral sclerosis	Riluzole	↓ neuron glutamate excitotoxicity	† survival Treat Lou Gehrig disease with rilouzole
Huntington disease	Tetrabenazine	Inhibit vesicular monoamine transporter (VMAT) → ↓ dopamine vesicle packaging and release	May be used for Huntington chorea and tardive dyskinesia

Anesthetics—general principles

CNS drugs must be lipid soluble (cross the blood-brain barrier) or be actively transported.

Drugs with \downarrow solubility in blood = rapid induction and recovery times.

Drugs with \uparrow solubility in lipids = \uparrow potency = $\frac{1}{MAC}$

MAC = Minimum Alveolar Concentration (of inhaled anesthetic) required to prevent 50% of subjects from moving in response to noxious stimulus (eg, skin incision).

Examples: nitrous oxide (N_2O) has \downarrow blood and lipid solubility, and thus fast induction and low potency. Halothane has \uparrow lipid and blood solubility, and thus high potency and slow induction.

FAS1_2019_12-Neurol.indd 549 11/8/19 7:40 AM

550 SECTION III NEUROLOGY AND SPECIAL SENSES > NEUROLOGY—PHARMACOLOGY

Inhaled anesthetics	Desflurane, halothane, enfluran	e, isoflurane, sevoflurane, metho	oxyflurane, N ₂ O.			
MECHANISM	Mechanism unknown.					
EFFECTS	Myocardial depression, respiratory depression, postoperative nausea/vomiting, † cerebral blood flow the cerebral metabolic demand.					
ADVERSE EFFECTS		Hepatotoxicity (halothane), nephrotoxicity (methoxyflurane), proconvulsant (enflurane, epileptogenic), expansion of trapped gas in a body cavity (N,O).				
	Malignant hyperthermia—rare, life-threatening condition in which inhaled anesthetics or succinylcholine induce severe muscle contractions and hyperthermia. Susceptibility is often inherited as autosomal dominant with variable penetrance. Mutations in voltage-sensitive ryanodine receptor (RYR1 gene) cause † Ca ²⁺ release from sarcoplasmic reticulum.					
	Treatment: dantrolene (a ryanodine receptor antagonist).					
Intravenous anestheti	cs					
AGENT	MECHANISM	ANESTHESIA USE	NOTES			
Thiopental	Facilitates GABA _A (barbiturate)	Anesthesia induction, short	↓ cerebral blood flow. High lipid			

and the second s	
Intravenou	s anesthetics

AGENT	MECHANISM	ANESTHESIA USE	NOTES
Thiopental	Facilitates GABA _A (barbiturate)	Anesthesia induction, short surgical procedures	 ↓ cerebral blood flow. High lipid solubility Effect terminated by rapid redistribution into tissue, fat
Midazolam	Facilitates GABA _A (benzodiazepine)	Procedural sedation (eg, endoscopy), anesthesia induction	May cause severe postoperative respiratory depression, ↓ BP, anterograde amnesia
Propofol	Potentiates GABA _A	Rapid anesthesia induction, short procedures, ICU sedation	May cause respiratory depression, hypotension
Ketamine	NMDA receptor antagonist	Dissociative anesthesia Sympathomimetic	† cerebral blood flow Emergence reaction possible with disorientation, hallucination, vivid dreams

Local anesthetics	Esters—procaine, tetracaine, benzocaine, chloroprocaine. Amides—lIdocaIne, mepIvacaIne, bupIvacaIne, ropIvacaIne (amIdes have 2 I's in name).			
MECHANISM	Block Na ⁺ channels by binding to specific receptors on inner portion of channel. Most effective in rapidly firing neurons. 3° amine local anesthetics penetrate membrane in uncharged form, then bind to ion channels as charged form. Can be given with vasoconstrictors (usually epinephrine) to enhance local action—↓ bleeding, ↑ anesthesia by ↓ systemic concentration. In infected (acidic) tissue, alkaline anesthetics are charged and cannot penetrate membrane effectively → need more anesthetic. Order of nerve blockade: small-diameter fibers > large diameter. Myelinated fibers > unmyelinated fibers. Overall, size factor predominates over myelination such that small myelinated fibers > small unmyelinated fibers > large myelinated fibers > large unmyelinated fibers. Order of loss: (1) pain, (2) temperature, (3) touch, (4) pressure.			
CLINICAL USE	Minor surgical procedures, spinal anesthesia. If allergic to esters, give amides.			
ADVERSE EFFECTS	CNS excitation, severe cardiovascular toxicity (bupivacaine), hypertension, hypotension, arrhythmias (cocaine), methemoglobinemia (benzocaine).			

11/8/19 7:40 AM FAS1_2019_12-Neurol.indd 550

Neuromuscular blocking drugs	Muscle paralysis in surgery or mechanical ventilation. Selective for Nm nicotinic receptors at neuromuscular junction but not autonomic Nn receptors.
Depolarizing neuromuscular blocking drugs	Succinylcholine—strong ACh receptor agonist; produces sustained depolarization and prevents muscle contraction. Reversal of blockade: Phase I (prolonged depolarization)—no antidote. Block potentiated by cholinesterase inhibitors. Phase II (repolarized but blocked; ACh receptors are available, but desensitized)—may be reversed with cholinesterase inhibitors. Complications include hypercalcemia, hyperkalemia, malignant hyperthermia.
Nondepolarizing neuromuscular blocking drugs	Atracurium, cisatracurium, pancuronium, rocuronium, tubocurarine, vecuronium—competitive ACh antagonist. Reversal of blockade—cholinesterase inhibitors (eg, neostigmine, edrophonium) are given with anticholinergics (eg, atrophine, glycopyrrolate) to prevent muscarinic effects, such as bradycardia.

Spasmolytics, antispasmodics

DRUG	MECHANISM	CLINICAL USE	NOTES
Baclofen	$GABA_{B}$ receptor agonist in spinal cord.	Muscle spasticity, dystonia, multiple sclerosis.	Acts on the bac k (spinal cord).
Cyclobenzaprine	Acts within CNS, mainly at the brain stem.	Muscle spasticity.	Centrally acting. Structurally related to TCAs. May cause anticholinergic side effects, sedation.
Dantrolene	Prevents release of Ca ²⁺ from sarcoplasmic reticulum of skeletal muscle by inhibiting the ryanodine receptor.	Malignant hyperthermia (toxicity of inhaled anesthetics and succinylcholine) and neuroleptic malignant syndrome (toxicity of antipsychotic drugs).	Acts Directly on muscle.
Tizanidine	α_2 agonist, acts centrally.	Muscle spasticity, multiple sclerosis, ALS, cerebral palsy.	

Opioid analgesics

MECHANISM	Act as agonists at opioid receptors ($\mu = \beta$ -endorphin, δ = enkephalin, κ = dynorphin) to modulate synaptic transmission—close presynaptic Ca ²⁺ channels, open postsynaptic K ⁺ channels \rightarrow \$\display\$ synaptic transmission. Inhibit release of ACh, norepinephrine, 5-HT, glutamate, substance P
EFFICACY	Full agonist: morphine, heroin, meperidine, methadone, codeine, fentanyl. Partial agonist: buprenorphine. Mixed agonist/antagonist: nalbuphine, pentazocine, butorphanol. Antagonist: naloxone, naltrexone, methylnaltrexone.
CLINICAL USE	Moderate to severe or refractory pain, diarrhea (loperamide, diphenoxylate), acute pulmonary edema, maintenance programs for heroin addicts (methadone, buprenorphine + naloxone).
ADVERSE EFFECTS	Nausea, vomiting, pruritus, addiction, respiratory depression, constipation, sphincter of Oddi spasm, miosis (except meperidine → mydriasis), additive CNS depression with other drugs. Tolerance does not develop to miosis and constipation. Treat toxicity with naloxone (competitive opioid receptor antagonist) and prevent relapse with naltrexone once detoxified.

FAS1_2019_12-Neurol.indd 551 11/8/19 7:40 AM

Mixed agonist and antagonist opioid analgesics

DRUG	MECHANISM	CLINICAL USE		NOTES	
Pentazocine	κ-opioid receptor agonist and μ-opioid receptor weak antagonist or partial agonist.	Analgesia for moderate to severe pain.		Can cause opioid withdrawal symptoms if patient is also taking full opioid agonist (due to competition for opio receptors).	
Butorphanol	κ-opioid receptor agonist and μ-opioid receptor partial agonist.	Severe pain (eg, migraine, labor).		Causes less respiratory depression than full opioid agonists. Use with full opioid agonist can precipitate withdrawal. Not easily reversed with naloxone.	
ramadol					
MECHANISM	Very weak opioid agonist; also in reuptake of norepinephrine an		Serotonin and	light opioid agonist, and a norepinephrine reuptake	
CLINICAL USE	Chronic pain.			used for Stubborn pain, but	
ADVERSE EFFECTS	Similar to opioids; decreases seiz serotonin syndrome.	zure threshold; can lower Seiz Serotonin Synd		ure threshold, and may cause drome.	
Glaucoma therapy	↓ IOP via ↓ amount of aqueous BAD humor may not be Politica	ally Correct.	nthesis/secretion o		
DRUG CLASS	EXAMPLES	MECHANISM	.1 .	ADVERSE EFFECTS	
β-blockers	Timolol, betaxolol, carteolol	↓ aqueous humo	•	No pupillary or vision changes	
α-agonists	Epinephrine (α_1) , apraclonidine, brimonidine (α_2)	 ↓ aqueous humor synthesis via vasoconstriction (epinephrine) ↓ aqueous humor synthesis (apraclonidine, brimonidine) 		Mydriasis (α ₁); do not use in closed-angle glaucoma Blurry vision, ocular hyperemia, foreign body sensation, ocular allergic reactions, ocular pruritus	
Diuretics	Acetazolamide	↓ aqueous humor synthesis via inhibition of carbonic anhydrase		No pupillary or vision changes	
Prostaglandins	Bimatoprost, latanoprost $(PGF_{2\alpha})$	↑ outflow of aqueous humor via ↓ resistance of flow through uveoscleral pathway		Darkens color of iris (browning), eyelash growth	
Cholinomimetics (M ₃)	Direct: pilocarpine, carbachol Indirect: physostigmine, echothiophate	† outflow of aqueous humor via contraction of ciliary muscle and opening of trabecular meshwork Use pilocarpine in acute angle closure glaucoma—very effective at opening meshwork into canal of Schlemm		Miosis (contraction of pupillary sphincter muscles) and cyclospasm (contraction of ciliary muscle)	

FAS1_2019_12-Neurol.indd 552 11/8/19 7:40 AM

HIGH-YIELD PRINCIPLES IN

Psychiatry

"Words of comfort, skillfully administered, are the oldest therapy known to man."

—Louis Nizer

"All men should strive to learn before they die what they are running from, and to, and why."

—James Thurber

"The sorrow which has no vent in tears may make other organs weep."

—Henry Maudsley

"It's no use going back to yesterday, because I was a different person then."

—Lewis Carroll, Alice in Wonderland

This chapter encompasses overlapping areas in psychiatry, psychology, sociology, and psychopharmacology. High-yield topics include schizophrenia, mood disorders, eating disorders, personality disorders, somatic symptom disorders, substance abuse, and antipsychotic agents. Know the DSM-5 criteria for diagnosing common psychiatric disorders.

▶ Psychology 554

▶ Pathology 556

▶ Pharmacology 572

553

FAS1_2019_13-Psych.indd 553 11/7/19 5:28 PM

ı	PSY	CHI	ATRY	′—Р	SYC	HOL	0GY

(salivation) is elicited by a conditioned, Pavlo		Pavlov's o	Jsually elicits involuntary responses. Pavlov's classical experiments with dogs— ringing the bell provoked salivation.			
Operant conditioning	Learning in which a particular action is elicited b Usually elicits voluntary responses.	pecause it p	oroduces a punishr	ment or reward.		
Reinforcement	Target behavior (response) is followed by desired reward (positive reinforcement) or removal of			tioning quadrants: Decrease behavior		
Punishment	Repeated application of aversive stimulus (positive punishment) or removal of desired reward (negative punishment) to extinguish unwanted behavior.	ve a Add a Ilus stimulus	Positive reinforcement Negative	Positive punishment Negative		
Extinction	Discontinuation of reinforcement (positive or negative) eventually eliminates behavior. Can occur in operant or classical conditioning.	프 reinforcement puni		punishment		
Transference and counte	Patient projects feelings about formative or other	important j	persons onto physi	cian (eg, psychiatrist		
Countertransference	is seen as parent). Doctor projects feelings about formative or other important persons onto patient (eg, patient reminds physician of younger sibling).					
Ego defenses	Thoughts and behaviors (voluntary or involuntary feelings (eg, anxiety, depression).	y) used to re	esolve conflict and	prevent undesirable		
Ego defenses IMMATURE DEFENSES		y) used to re	esolve conflict and	prevent undesirable		
	feelings (eg, anxiety, depression).	EXAMPLE A patient		ointments after deep		
IMMATURE DEFENSES	feelings (eg, anxiety, depression). DESCRIPTION Subconsciously coping with stressors or emotional conflict using actions rather than	A patient discommand A patient schedul	skips therapy app fort from dealing v	ointments after deep with his past. s a full-time work arned of significant		
Acting out	feelings (eg, anxiety, depression). DESCRIPTION Subconsciously coping with stressors or emotional conflict using actions rather than reflections or feelings.	A patient discommend d	skips therapy app fort from dealing v with cancer plans de despite being wa during chemother ng reprimanded b	ointments after deep with his past. s a full-time work arned of significant capy.		

11/7/19 5:28 PM FAS1_2019_13-Psych.indd 554

Ego defenses (continued)

IMMATURE DEFENSES	DESCRIPTION	EXAMPLE
Fixation	Partially remaining at a more childish level of development (vs regression).	A surgeon throws a tantrum in the operating room because the last case ran very late.
Idealization	Expressing extremely positive thoughts of self and others while ignoring negative thoughts.	A patient boasts about his physician and his accomplishments while ignoring any flaws.
Identification	Largely unconscious assumption of the characteristics, qualities, or traits of another person or group.	A resident starts putting his stethoscope in his pocket like his favorite attending, instead of wearing it around his neck like before.
Intellectualization	Using facts and logic to emotionally distance oneself from a stressful situation.	A patient diagnosed with cancer discusses the pathophysiology of the disease.
Isolation (of affect)	Separating feelings from ideas and events.	Describing murder in graphic detail with no emotional response.
Passive aggression	Demonstrating hostile feelings in a nonconfrontational manner; showing indirect opposition.	A disgruntled employee is repeatedly late to work, but won't admit it is a way to get back at the manager.
Projection	Attributing an unacceptable internal impulse to an external source (vs displacement).	A man who wants to cheat on his wife accuses his wife of being unfaithful.
Rationalization	Asserting plausible explanations for events that actually occurred for other reasons, usually to avoid self-blame.	A man who was recently fired claims that the job was not important anyway.
Reaction formation	Replacing a warded-off idea or feeling with an emphasis on its opposite (vs sublimation).	A stepmother treats a child she resents with excessive nurturing and overprotection.
Regression	Involuntarily turning back the maturational clock to behaviors previously demonstrated under stress (vs fixation).	A previously toilet-trained child begins bedwetting again following the birth of a sibling.
Repression	Involuntarily withholding an idea or feeling from conscious awareness (vs suppression).	A 20-year-old does not remember going to counseling during his parents' divorce 10 years earlier.
Splitting	Believing that people are either all good or all bad at different times due to intolerance of ambiguity. Common in borderline personality disorder.	A patient says that all the nurses are cold and insensitive, but the doctors are warm and friendly.
MATURE DEFENSES		
Sublimation	Replacing an unacceptable wish with a course of action that is similar to the wish but socially acceptable (vs reaction formation).	A teenager's aggression toward his parents because of their high expectations is channeled into excelling in sports.
Altruism	Alleviating negative feelings via unsolicited generosity, which provides gratification (vs reaction formation).	A mafia boss makes a large donation to charity.
Suppression	Intentionally withholding an idea or feeling from conscious awareness (vs repression); temporary.	An athlete focuses on other tasks to prevent worrying about an important upcoming match.
Humor	Lightheartedly expressing uncomfortable feelings to shift the internal focus away from the distress.	A nervous medical student jokes about the boards.
	Mature adults wear a SASH.	

FAS1_2019_13-Psych.indd 555 11/7/19 5:28 PM 556 SECTION III

PSYCHIATRY ▶ PSYCHIATRY—PATHOLOGY

▶ PSYCHIATRY—PATHOLOGY

Infant deprivation effects

Long-term deprivation of affection results in:

- Failure to thrive
- Poor language/socialization skills
- Lack of basic trust
- Reactive attachment disorder (infant withdrawn/unresponsive to comfort)
- Disinhibited social engagement (child indiscriminately attaches to strangers)

Deprivation for > 6 months can lead to irreversible changes.

Severe deprivation can result in infant death.

Child abuse

	Physical abuse	Sexual abuse	Emotional abuse	
SIGNS	Fractures, bruises, or burns. Injuries often in different stages of healing or in patterns resembling possible implements of injury. Includes abusive head trauma (shaken baby syndrome), characterized by subdural hematomas or retinal hemorrhages. Caregivers may delay seeking medical attention for the child or provide explanations inconsistent with the child's developmental stage or pattern of injury.	STIs, UTIs, and genital, anal, or oral trauma. Most often, there are no physical signs; sexual abuse should not be excluded from a differential diagnosis in the absence of physical trauma. Children often exhibit sexual knowledge or behavior incongruent with their age.	Babies or young children may lack a bond with the caregiver but are overly affectionate with less familiar adults. They may be aggressive toward children and animals or unusually anxious. Older children are often emotionally labile and prone to angry outbursts. They may distance themselves from caregivers and other children. They can experience vague somatic symptoms for which a medical cause cannot be found.	
EPIDEMIOLOGY	40% of deaths related to child abuse or neglect occur in children < 1 year old.	Peak incidence 9–12 years old.	~80% of young adult victims of child emotional abuse meet the criteria for ≥ 1 psychiatric illness by age 21.	
Child neglect	Most common form of child mimpaired social/emotional devo	dequate food, shelter, supervision, naltreatment. Signs: poor hygiene, elopment, failure to thrive. hild neglect must be reported to lo	malnutrition, withdrawal,	
Vulnerable child syndrome	Parents perceive the child as especially susceptible to illness or injury (vs factitious disorder imposed on another). Usually follows a serious illness or life-threatening event. Can result in missed school or overuse of medical services.			

FAS1_2019_13-Psych.indd 556 11/7/19 5:28 PM

Childhood and early-onset disorders Onset before age $12. \ge 6$ months of limited attention span and/or poor impulse control. **Attention-deficit** Characterized by hyperactivity, impulsivity, and/or inattention in ≥ 2 settings (eg, school, home, hyperactivity places of worship). Normal intelligence, but commonly coexists with difficulties in school. Often disorder persists into adulthood. Commonly coexists with oppositional defiant disorder. Treatment: stimulants (eg, methylphenidate) +/- behavioral therapy; alternatives include atomoxetine, guanfacine, clonidine. **Autism spectrum** Onset in early childhood. Social and communication deficits, repetitive/ritualized behaviors, restricted interests. May be accompanied by intellectual disability and/or above average abilities in disorder specific skills (eg, music). More common in boys. Associated with † head and/or brain size. Conduct disorder Repetitive, pervasive behavior violating societal norms or the basic rights of others (eg, aggression toward people and animals, destruction of property, theft). After age 18, often reclassified as antisocial personality disorder. Treatment: psychotherapy (eg, cognitive behavioral therapy [CBT]). Onset before age 10. Severe, recurrent temper outbursts out of proportion to situation. Child is Disruptive mood constantly angry and irritable between outbursts. Treatment: CBT, stimulants, antipsychotics. dysregulation disorder Intellectual disability Global cognitive deficits (vs specific learning disorder) that affect reasoning, memory, abstract thinking, judgment, language, learning. Adaptive functioning is impaired, leading to major difficulties with education, employment, communication, socialization, independence. Treatment: psychotherapy, occupational therapy, special education. Enduring pattern of anger and irritability with argumentative, vindictive, and defiant behavior **Oppositional defiant** disorder toward authority figures. Treatment: psychotherapy (eg, CBT). Onset before age 5. Anxiety disorder lasting ≥ 1 month involving refraining from speech in certain **Selective mutism** situations despite speaking in other, usually more comfortable situations. Development (eg., speech and language) not typically impaired. Interferes with social, academic, and occupational tasks. Commonly coexists with social anxiety disorder. Treatment: behavioral, family, and play therapy; SSRIs.

Separation anxiety Overwhelming fear of separation from home or attachment figure lasting ≥ 4 weeks. Can be normal behavior up to age 3–4. May lead to factitious physical complaints to avoid school. Treatment: CBT, play therapy, family therapy. Specific learning Onset during school-age years. Inability to acquire or use information from a specific subject

disorder Onset during school-age years. Inability to acquire or use information from a specific subject (eg, math, reading, writing) near age-expected proficiency for ≥ 6 months despite focused intervention. General functioning and intelligence are normal (vs intellectual disability). Treatment: academic support, counseling, extracurricular activities.

Tourette syndrome Onset before age 18. Sudden, Sudden, recurrent, nonrhythmic, stereotyped motor and vocal tics that persist for > 1 year. Coprolalia (involuntary obscene speech) found in some patients. Associated with OCD and ADHD. Treatment: psychoeducation, behavioral therapy. For intractable and distressing tics, high-potency antipsychotics (eg, haloperidol, fluphenazine), tetrabenazine, α_{σ} -agonists (eg, guanfacine, clonidine), or atypical antipsychotics.

Orientation Patients' ability to know the date and time, where they are, and who they are (order of loss: time → place → person). Common causes of loss of orientation: alcohol, drugs, fluid/electrolyte imbalance, head trauma, hypoglycemia, infection, nutritional deficiencies, hypoxia.

FAS1_2019_13-Psych.indd 557 11/7/19 5:28 PM

PSYCHIATRY ► PSYCHIATRY—PATHOLOGY

				•	
А	m	n	69	ŦБ	ıs

Retrograde amnesia	Inability to remember things that occurred before a CNS insult.				
Anterograde amnesia	Inability to remember things that occurred after a	a CNS insult (‡ acquisition of new memory).			
Korsakoff syndrome	Amnesia (anterograde > retrograde) and disorientation caused by vitamin B ₁ deficiency. Associated with disruption and destruction of the limbic system, especially mammillary bodies and anterior thalamus. Seen in alcoholics as a late neuropsychiatric manifestation of Wernicke encephalopathy. Confabulations are characteristic.				
Dissociative disorders					
Depersonalization/ derealization disorder	Persistent feelings of detachment or estrangement from one's own body, thoughts, perceptions, and actions (depersonalization) or one's environment (derealization). Intact reality testing (vs psychosis).				
Dissociative amnesia	Inability to recall important personal information, usually following severe trauma or stress. May be accompanied by dissociative fugue (abrupt, unexpected travelling away from home).				
Dissociative identity disorder	Formerly called multiple personality disorder. Presence of ≥ 2 distinct identities or personality states. More common in women. Associated with history of sexual abuse, PTSD, depression, substance abuse, borderline personality, somatic symptom disorders.				
Delirium	"Waxing and waning" level of consciousness with acute onset, ↓ attention span, ↓ level of arousal. Characterized by disorganized thinking, hallucinations (often visual), misperceptions (eg, illusions), disturbance in sleep-wake cycle, cognitive dysfunction, agitation. Reversible. Usually 2° to other identifiable illness (eg, CNS disease, infection, trauma, substance abuse/withdrawal, metabolic/electrolyte disturbances, hemorrhage, urinary/fecal retention), or medications (eg, anticholinergics), especially in the elderly. Most common presentation of altered mental status in inpatient setting, especially in the ICU or during prolonged hospital stays. EEG may show diffuse background rhythm slowing.	Delirium = changes in sensorium. Treatment: identification and management of underlying condition. Orientation protocols (eg, keeping a clock or calendar nearby), ↓ sleep disturbances, and ↑ cognitive stimulation to manage symptoms. Antipsychotics as needed. Avoid unnecessary restraints and drugs that may worsen delirium (eg, anticholinergics, benzodiazepines, opioids).			

FAS1_2019_13-Psych.indd 558 11/7/19 5:28 PM

Psychosis	Distorted perception of reality characterized by delusions, hallucinations, and/or disorganized thought/speech. Can occur in patients with medical illness, psychiatric illness, or both.	
Delusions	False, fixed, idiosyncratic beliefs that persist despite evidence to the contrary and are not typical of a patient's culture or religion (eg, a patient who believes that others are reading his thoughts). Types include erotomanic, grandiose, jealous, persecutory, somatic, mixed, and unspecified.	
Disorganized thought	Speech may be incoherent ("word salad"), tangential, or derailed ("loose associations").	
Hallucinations	 Perceptions in the absence of external stimuli (eg, seeing a light that is not actually present). Contrast with misperceptions (eg, illusions) of real external stimuli. Types include: Auditory—more commonly due to psychiatric illness (eg, schizophrenia) than medical illness. Visual—more commonly due to medical illness (eg, drug intoxication, delirium) than psychiatric illness. Tactile—common in alcohol withdrawal and stimulant use (eg, "cocaine crawlies," a type of delusional parasitosis). Olfactory—often occur as an aura of temporal lobe epilepsy (eg, burning rubber) and in brain tumors. Gustatory—rare, but seen in epilepsy. Hypnagogic—occurs while going to sleep. Sometimes seen in narcolepsy. Hypnopompic—occurs while waking from sleep ("get pomped up in the morning"). Sometimes seen in narcolepsy. 	

FAS1_2019_13-Psych.indd 559 11/7/19 5:28 PM

Schizophrenia spectrum disorders

Schizophrenia

Chronic illness causing profound functional impairment. Symptom categories include:

- Positive—hallucinations, delusions, unusual thought processes, disorganized speech, bizarre behavior
- Negative—flat or blunted affect, apathy, anhedonia, alogia, social withdrawal
- Cognitive—reduced ability to understand or make plans, diminished working memory, inattention

Diagnosis requires ≥ 2 of the following active symptoms, including ≥ 1 from symptoms #1-3:

- 1. Delusions
- 2. Hallucinations, often auditory
- 3. Disorganized speech
- 4. Disorganized or catatonic behavior
- 5. Negative symptoms

Requires ≥ 1 month of active symptoms over the past 6 months; onset ≥ 6 months prior to diagnosis.

Schizophreniform disorder ≥ 2 symptoms lasting 1–6 months.

Associated with altered dopaminergic activity,

↑ serotonergic activity, and ↓ dendritic
branching. Ventriculomegaly on brain
imaging. Lifetime prevalence—1.5% (males
> females). Presents earlier in men (late teens
to early 20s) than in women (late 20s to early
30s). ↑ suicide risk.

Heavy cannabis use in adolescence is associated with † incidence and worsened course of psychotic, mood, and anxiety disorders.

Treatment: atypical antipsychotics (eg, risperidone) are first line.

Negative symptoms often persist after treatment, despite resolution of positive symptoms.

Schizoaffective disorder

Shares symptoms with both schizophrenia and mood disorders (major depressive or bipolar disorder). To differentiate from a mood disorder with psychotic features, patient must have > 2 weeks of psychotic symptoms without a manic or depressive episode.

Brief psychotic disorder ≥ 1 positive symptom(s) lasting < 1 month, usually stress-related.

Delusional disorder

≥ 1 delusion(s) lasting > 1 month, but without a mood disorder or other psychotic symptoms. Daily functioning, including socialization, may be impacted by the pathological, fixed belief but is otherwise unaffected. Can be shared by individuals in close relationships (folie à deux).

Schizotypal personality disorder

Cluster A personality disorder that also falls on the schizophrenia spectrum. May include brief psychotic episodes (eg, delusions) that are less frequent and severe than in schizophrenia.

Mood disorder

Characterized by an abnormal range of moods or internal emotional states and loss of control over them. Severity of moods causes distress and impairment in social and occupational functioning. Includes major depressive, bipolar, dysthymic, and cyclothymic disorders. Episodic superimposed psychotic features (delusions, hallucinations, disorganized speech/behavior) may be present.

Manic episode

Distinct period of abnormally and persistently elevated, expansive, or irritable mood and \uparrow activity or energy lasting ≥ 1 week. Diagnosis requires hospitalization or marked functional impairment with ≥ 3 of the following (manics **DIG FAST**):

- Distractibility
- Impulsivity/Indiscretion—seeks pleasure without regard to consequences (hedonistic)
- Grandiosity—inflated self-esteem
- Flight of ideas—racing thoughts
- † goal-directed Activity/psychomotor Agitation
- ↓ need for Sleep
- Talkativeness or pressured speech

FAS1_2019_13-Psych.indd 560 11/7/19 5:28 PM

Hypomanic episode

Similar to a manic episode except mood disturbance is not severe enough to cause marked impairment in social and/or occupational functioning or to necessitate hospitalization. Abnormally ↑ activity or energy usually present. No psychotic features. Lasts ≥ 4 consecutive days.

Bipolar disorder

Bipolar I—≥ 1 manic episode +/– a hypomanic or depressive episode (may be separated by any length of time).

Bipolar II—a hypomanic and a depressive episode (no history of manic episodes).

Patient's mood and functioning usually normalize between episodes. Use of antidepressants can destabilize mood. High suicide risk. Treatment: mood stabilizers (eg, lithium, valproic acid, carbamazepine, lamotrigine), atypical antipsychotics.

Cyclothymic disorder—milder form of bipolar disorder fluctuating between mild depressive and hypomanic symptoms. Must last ≥ 2 years with symptoms present at least half of the time, with any remission lasting ≤ 2 months.

Major depressive disorder

Recurrent episodes lasting ≥ 2 weeks characterized by ≥ 5 of 9 diagnostic symptoms (must include depressed mood or anhedonia) (DIGS SPACE):

- Depressed mood (or irritability in children)
- ↓ Interest (anhedonia)
- Guilt or feelings of worthlessness
- Sleep disturbances
- Suicidal ideation
- Psychomotor retardation or agitation
- Appetite/weight changes
- Concentration
- ↓ Energy

Screen for previous manic or hypomanic episodes to rule out bipolar disorder.

Treatment: CBT and SSRIs are first line. Also SNRIs, mirtazapine, bupropion, electroconvulsive therapy (ECT).

MDD with psychotic features

MDD + hallucinations or delusions. Psychotic features are typically mood congruent (eg, depressive themes of inadequacy, guilt, punishment, nihilism, disease, or death) and occur only in the context of major depressive episode (vs schizoaffective disorder). Treatment: antidepressant with atypical antipsychotic, ECT.

Persistent depressive disorder (dysthymia)

Often milder than MDD; ≥ 2 depressive symptoms lasting ≥ 2 years (≥ 1 year in children), with any remission lasting ≤ 2 months.

MDD with seasonal pattern

Formerly called seasonal affective disorder. Major depressive episodes occurring only during a particular season (usually winter) in ≥ 2 consecutive years and in most years across a lifetime. Atypical symptoms common.

Depression with atypical features

Characterized by mood reactivity (transient improvement in response to a positive event), hypersomnia, hyperphagia, leaden paralysis (heavy feeling in arms and legs), long-standing interpersonal rejection sensitivity. Most common subtype of depression. Treatment: CBT and SSRIs are first line. MAO inhibitors (MAOIs) are effective but not first line because of their risk profile.

FAS1 2019 13-Psych.indd 561 11/7/19 5:28 PM

562 SECTION III PSYCHIATRY ► PSYCHIATRY—PATHOLOGY

Peripartum mood disturbances	Onset during or shortly after pregnancy or disorders.	within 4 weeks of delivery. † risk with history of mood	
Maternal (postpartum) blues	50–85% incidence rate. Characterized by depressed affect, tearfulness, and fatigue starting 2–3 days after delivery. Usually resolves within 2 weeks. Treatment: supportive. Follow up to assess for possible MDD with peripartum onset.		
MDD with peripartum onset	10–15% incidence rate. Formerly called postpartum depression. Meets MDD criteria with onset no later than 1 year after delivery. Treatment: CBT and SSRIs are first line.		
Postpartum psychosis	0.1–0.2% incidence rate. Characterized by mood-congruent delusions, hallucinations, and thoughts of harming the baby or self. Risk factors include first pregnancy, family history, bipolar disorder, psychotic disorder, recent medication change. Treatment: hospitalization and initiation of atypical antipsychotic; if insufficient, ECT may be used.		
Grief	The five stages of grief per the Kübler-Ross model are denial, anger, bargaining, depression, and acceptance (may occur in any order). Other normal grief symptoms include shock, guilt, sadness, anxiety, yearning, and somatic symptoms that usually occur in waves. Simple hallucinations of the deceased person are common (eg, hearing the deceased speaking). Any thoughts of dying are limited to joining the deceased (vs complicated grief). Duration varies widely; usually resolves within 6–12 months. Persistent complex bereavement disorder involves obsessive preoccupation with the deceased and causes functional impairment, lasting at least 12 months (6 months in children). Can also meet criteria for major depressive episode.		
Electroconvulsive therapy	Rapid-acting method to treat refractory depression, depression with psychotic symptoms, catatonia, and acute suicidality. Induces tonic-clonic seizure under anesthesia and neuromuscular blockade. Adverse effects include disorientation, headache, partial anterograde/retrograde amnesia usually resolving in 6 months. No absolute contraindications. Safe in pregnant and elderly individuals.		
Risk factors for suicide completion	Sex (male) Age (young adult or elderly) Depression Previous attempt (highest risk factor) Ethanol or drug use Rational thinking loss (psychosis) Sickness (medical illness) Organized plan No spouse or other social support Stated future intent	SAD PERSONS are more likely to complete suicide. Most common method in US is firearms; access to guns † risk of suicide completion. Women try more often; men complete more often. Other risk factors include recent psychiatric hospitalization and family history of completed suicide.	
Anxiety disorders	Inappropriate experiences of fear/worry and their physical manifestations incongruent with the magnitude of the stressors. Symptoms are not attributable to another psychiatric disorder, medica condition (eg, hyperthyroidism), or substance abuse. Includes panic disorder, phobias, generalized anxiety disorder, and selective mutism.		

FAS1_2019_13-Psych.indd 562 11/7/19 5:28 PM

Panic disorder

Recurrent panic attacks involving intense fear and discomfort +/− a known trigger.

Attacks typically peak in 10 minutes with ≥ 4 of the following: palpitations, paresthesias, depersonalization or derealization, abdominal pain, nausea, intense fear of dying, intense fear of losing control, lightheadedness, chest pain, chills, choking, sweating, shaking, shortness of breath. Strong genetic component. † risk of suicide.

Diagnosis requires attack followed by ≥ 1 month of ≥ 1 of the following:

- Persistent concern of additional attacks
- Worrying about consequences of attack
- Behavioral change related to attacks

Symptoms are systemic manifestations of fear. Treatment: CBT, SSRIs, and venlafaxine are first line. Benzodiazepines occasionally used in acute setting.

Phobias

Severe, persistent (≥ 6 months) fear or anxiety due to presence or anticipation of a specific object or situation. Person often recognizes fear is excessive. Treatment: CBT with exposure therapy.

Social anxiety disorder—exaggerated fear of embarrassment in social situations (eg, public speaking, using public restrooms). Treatment: CBT, SSRIs, venlafaxine. For performance type (eg, anxiety restricted to public speaking), use β -blockers or benzodiazepines as needed.

Agoraphobia—irrational fear/anxiety while facing or anticipating ≥ 2 specific situations (eg, open/closed spaces, lines, crowds, public transport). If severe, patients may refuse to leave their homes. Associated with panic disorder. Treatment: CBT, SSRIs.

Generalized anxiety disorder

Excessive anxiety and worry about different aspects of daily life (eg, work, school, children) for most days of ≥ 6 months. Associated with ≥ 3 of the following for adults (≥ 1 for kids): restlessness, irritability, sleep disturbance, fatigue, muscle tension, difficulty concentrating. Treatment: CBT, SSRIs, SNRIs are first line. Buspirone, TCAs, benzodiazepines are second line.

Obsessive-compulsive disorders

Obsessions (recurring intrusive thoughts, feelings, or sensations) that cause severe distress, relieved in part by compulsions (performance of repetitive, often time-consuming actions). Ego-dystonic: behavior inconsistent with one's beliefs and attitudes (vs obsessive-compulsive personality disorder, ego-syntonic). Associated with Tourette syndrome. Treatment: CBT and SSRIs; clomipramine and venlafaxine are second line.

Body dysmorphic disorder—preoccupation with minor or imagined defects in appearance. Causes significant emotional distress and repetitive appearance-related behaviors (eg, mirror checking, excessive grooming). Common in eating disorders. Treatment: CBT.

Trichotillomania



Compulsively pulling out one's hair. Causes significant distress and persists despite attempts to stop. Presents with areas of thinning hair or baldness on any area of the body, most commonly the scalp A. Incidence highest in childhood but spans all ages. Treatment: psychotherapy.

FAS1_2019_13-Psych.indd 563 11/7/19 5:28 PM

Trauma and stress-related disorders

Adjustment disorder

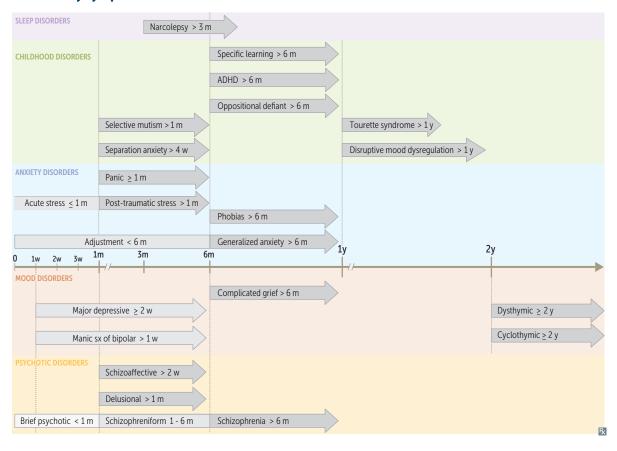
Emotional or behavioral symptoms (eg, anxiety, outbursts) that occur within 3 months of an identifiable psychosocial stressor (eg, divorce, illness) lasting < 6 months once the stressor has ended. If symptoms persist > 6 months after stressor ends, it is GAD. Symptoms do not meet criteria for MDD. Treatment: CBT is first line; antidepressants and anxiolytics may be considered.

Post-traumatic stress disorder

Experiencing, or discovering that a loved one has experienced, a life-threatening situation (eg, serious injury, rape, witnessing death) → persistent Hyperarousal, Avoidance of associated stimuli, intrusive Re-experiencing of the event (eg, nightmares, flashbacks), changes in cognition or mood (eg, fear, horror, Distress) (having PTSD is HARD). Disturbance lasts > 1 month with significant distress or impaired functioning. Treatment: CBT, SSRIs, and venlafaxine are first line. Prazosin can reduce nightmares.

Acute stress disorder—lasts between 3 days and 1 month. Treatment: CBT; pharmacotherapy is usually not indicated.

Diagnostic criteria by symptom duration



FAS1_2019_13-Psych.indd 564 11/7/19 5:28 PM

Personality trait	An enduring, repetitive pattern of perceiving, relating to, and thinking about the environment and oneself. Inflexible, maladaptive, and rigidly pervasive pattern of behavior causing subjective distress and/or impaired functioning; person is usually not aware of problem (ego-syntonic). Usually presents by early adulthood. Three clusters: A, B, C; remember as Weird, Wild, and Worried, respectively, based on symptoms.		
Personality disorder			
Cluster A personality disorders	Odd or eccentric; inability to develop meaningful social relationships. No psychosis; genetic association with schizophrenia.	Cluster A: Accusatory, Aloof, Awkward. "Weird."	
Paranoid	Pervasive distrust (Accusatory), suspiciousness, hypervigilance, and a profoundly cynical view of the world.		
Schizoid	Voluntary social withdrawal (Aloof), limited emotional expression, content with social isolation (vs avoidant).		
Schizotypal	Eccentric appearance, odd beliefs or magical thinking, interpersonal A wkwardness.	Included on the schizophrenia spectrum. Pronounce schizo-type-al: odd-type thoughts.	
Cluster B personality disorders	Dramatic, emotional, or erratic; genetic association with mood disorders and substance abuse.	Cluster B: Bad, Borderline, flamBoyant, must be the Best. "Wild."	
Antisocial	Disregard for the rights of others with lack of remorse. Involves criminality, impulsivity, hostility, and manipulation. Males > females. Must be ≥ 18 years old with evidence of conduct disorder onset before age 15. Diagnosis is conduct disorder if < 18 years old.	Antisocial = sociopath. Bad.	
Borderline	Unstable mood and interpersonal relationships, fear of abandonment, impulsivity, selfmutilation, suicidality, sense of emotional emptiness. Females > males. Splitting is a major defense mechanism.	Treatment: dialectical behavior therapy. Borderline.	
Histrionic	Attention-seeking, dramatic speech and emotional expression, shallow and labile emotions, sexually provocative. May use physical appearance to draw attention.	Flam <mark>B</mark> oyant.	
Narcissistic	Grandiosity, sense of entitlement; lacks empathy and requires excessive admiration; often demands the "best" and reacts to criticism with rage and/or defensiveness. Fragile selfesteem. Often envious of others.	Must be the B est.	

FAS1_2019_13-Psych.indd 565 11/7/19 5:28 PM

566 SECTION III PSYCHIATRY ► PSYCHIATRY—PATHOLOGY

Cluster C personality disorders	Anxious or fearful; genetic association with anxiety disorders.	Cluster C: Cowardly, obsessive-Compulsive, Clingy. "Worried."	
Avoidant	Hypersensitive to rejection and criticism, socially inhibited, timid, feelings of inadequacy, desires relationships with others (vs schizoid).	Cowardly.	
Obsessive- Compulsive	Preoccupation with order, perfectionism, and control; ego-syntonic: behavior consistent with one's own beliefs and attitudes (vs OCD).		
Dependent	Excessive need for support, low self-confidence. Patients often get stuck in abusive relationships.	Submissive and Clingy.	
Malingering	Symptoms are intentional , motivation is intentional . Patient consciously fakes, profoundly exaggerates, or claims to have a disorder in order to attain a specific 2° (external) gain (eg, avoiding work, obtaining compensation). Poor compliance with treatment or follow-up of diagnostic tests. Complaints cease after gain (vs factitious disorder).		
Factitious disorders	Symptoms are intentional , motivation is unconscious . Patient consciously creates physical and/or psychological symptoms in order to assume "sick role" and to get medical attention and sympathy (1° [internal] gain).		
Factitious disorder imposed on self	Formerly called Munchausen syndrome. Chronic factitious disorder with predominantly physical signs and symptoms. Characterized by a history of multiple hospital admissions and willingness to undergo invasive procedures. More common in women and healthcare workers.		
Factitious disorder imposed on another	Formerly called Munchausen syndrome by proxy. Illness in a child or elderly patient is caused or fabricated by the caregiver. Motivation is to assume a sick role by proxy. Form of child/elder abuse		
Somatic symptom and related disorders	Symptoms are unconscious , motivation is unconscious . Category of disorders characterized by physical symptoms causing significant distress and impairment. Symptoms not intentionally produced or feigned.		
Somatic symptom disorder	≥ 1 bodily complaints (eg, abdominal pain, fatigue) lasting months to years. Associated with excessive, persistent thoughts and anxiety about symptoms. May co-occur with medical illness. Treatment: regular office visits with the same physician in combination with psychotherapy.		
Conversion disorder	Also called functional neurologic symptom disorder. Loss of sensory or motor function (eg, paralysis blindness, mutism), often following an acute stressor; patient may be aware of but indifferent toward symptoms (<i>la belle indifférence</i>); more common in females, adolescents, and young adults.		
Illness anxiety disorder	Preoccupation with acquiring or having a serious illness, often despite medical evaluation and reassurance; minimal to no somatic symptoms.		

11/7/19 5:28 PM FAS1_2019_13-Psych.indd 566

Eating disorders Most common in young women.		
Anorexia nervosa	Intense fear of weight gain, overvaluation of thinness, and body image distortion leading to calorie restriction and severe weight loss resulting in inappropriately low body weight. Binge-eating/purging type—recurring purging behaviors (eg, laxative or diuretic abuse, self-induced vomiting) or binge eating over the last 3 months. Restricting type—primary disordered behaviors include dieting, fasting, and/or over-exercising. No recurring purging behaviors or binge eating over the last 3 months. Refeeding syndrome—often occurs in significantly malnourished patients with sudden ↑ calorie intake → ↑ insulin → ↓ PO ₄ ³⁻ , ↓ K ⁺ , ↓ Mg ²⁺ → cardiac complications, rhabdomyolysis, seizures. Treatment: psychotherapy, nutritional rehabilitation, antidepressants (eg, SSRIs).	
Bulimia nervosa	Recurring episodes of binge eating with compensatory purging behaviors at least weekly over the last 3 months. BMI often normal or slightly overweight (vs anorexia). Associated with parotid gland hypertrophy (may see † serum amylase), enamel erosion, Mallory-Weiss syndrome, electrolyte disturbances (eg, ↓ K+, ↓ Cl-), metabolic alkalosis, dorsal hand calluses from induced vomiting (Russell sign). Treatment: psychotherapy, nutritional rehabilitation, antidepressants (eg, SSRIs). Bupropion is contraindicated due to seizure risk.	
Binge-eating disorder	Recurring episodes of binge eating without purging behaviors at least weekly over the last 3 months. † diabetes risk. Most common eating disorder in adults. Treatment: psychotherapy (first line); SSRIs; lisdexamfetamine.	
Pica	Recurring episodes of eating non-food substances (eg, dirt, hair, paint chips) over ≥ 1 month that are not culturally or developmentally recognized as normal. May provide temporary emotional relief. Common in children and during pregnancy. Associated with malnutrition, iron deficiency anemia, developmental disabilities, emotional trauma. Treatment: psychotherapy and nutritional rehabilitation (first line); SSRIs (second line).	
Gender dysphoria	Significant incongruence between one's experienced gender and the gender assigned at birth, lasting > 6 months and leading to persistent distress. Individuals may self-identify as another gender, pursue surgery or hormone treatment to rid self of primary/secondary sex characteristics, and/or live as another gender. Gender nonconformity itself is not a mental disorder.	
	Transgender —desiring and often making lifestyle changes to live as a different gender . Medical interventions (eg, hormone therapy, sex reassignment surgery) may be utilized during the transition to enable the individual's appearance to match their gender identity.	
	Transvestism —deriving pleasure from wearing clothes (eg, a vest) of the opposite sex (cross-dressing). Transvestic disorder —transvestism that causes significant distress/functional impairment. It is a paraphilia (psychosexual disorder), not part of gender dysphoria.	
Sexual dysfunction	Includes sexual desire disorders (hypoactive sexual desire or sexual aversion), sexual arousal disorders (erectile dysfunction), orgasmic disorders (anorgasmia, premature ejaculation), sexual pain disorders (dyspareunia, vaginismus). Differential diagnosis includes (PENIS): Psychological (if nighttime erections still occur) Endocrine (eg, diabetes, low testosterone) Neurogenic (eg, postoperative, spinal cord injury) Insufficient blood flow (eg, atherosclerosis) Substances (eg, antihypertensives, antidepressants, ethanol)	

FAS1_2019_13-Psych.indd 567 11/7/19 5:28 PM

568 SECTION III

PSYCHIATRY ▶ PSYCHIATRY—PATHOLOGY

Sleep terror disorder

Periods of inconsolable terror with screaming in the middle of the night. Most common in children. Occurs during slow-wave/deep (stage N3) non-REM sleep with no memory of the arousal episode, as opposed to nightmares that occur during **REM** sleep (remembering a scary dream). Triggers include emotional stress, fever, and lack of sleep. Usually self limited.

Enuresis

Nighttime urinary incontinence ≥ 2 times/week for ≥ 3 months in person > 5 years old. First-line treatment: behavioral modification (eg, scheduled voids, nighttime fluid restriction) and positive reinforcement. For refractory cases: bedwetting alarm, oral desmopressin (ADH analog; preferred over imipramine due to fewer side effects).

Narcolepsy

Excessive daytime sleepiness (despite awakening well-rested) with recurrent episodes of rapid-onset, overwhelming sleepiness ≥ 3 times/week for the last 3 months. Due to ↓ orexin (hypocretin) production in lateral hypothalamus and dysregulated sleep-wake cycles. Associated with:

- Hypnagogic (just before going to sleep) or hypnopompic (just before awakening; get pomped up in the morning) hallucinations.
- Nocturnal and narcoleptic sleep episodes that start with REM sleep (sleep paralysis).
- Cataplexy (loss of all muscle tone following strong emotional stimulus, such as laughter).

Treatment: good sleep hygiene (scheduled naps, regular sleep schedule), daytime stimulants (eg, amphetamines, modafinil) and/or nighttime sodium oxybate (GHB).

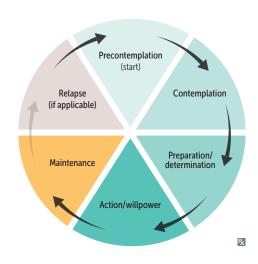
Substance use disorder

Maladaptive pattern of substance use involving ≥ 2 of the following in the past year:

- Tolerance
- Withdrawal
- Intense, distracting cravings
- Using more, or longer, than intended
- Persistent desire but inability to cut down
- Time-consuming substance acquisition, use, or recovery
- Impaired functioning at work, school, or home
- Social or interpersonal conflicts
- Reduced recreational activities
- > l episode of use involving danger (eg, unsafe sex, driving while impaired)
- Continued use despite awareness of harm

Stages of change in overcoming addiction

- 1. **Precontemplation**—denying problem
- 2. **Contemplation**—acknowledging problem, but unwilling to change
- Preparation/determination—preparing for behavioral changes
- 4. Action/willpower—changing behaviors
- 5. **Maintenance**—maintaining changes
- 6. **Relapse**—(if applicable) returning to old behaviors and abandoning changes



FAS1_2019_13-Psych.indd 568 11/7/19 5:28 PM

Psychiatric emergencies

	CAUSE	MANIFESTATION	TREATMENT
Serotonin syndrome	Any drug that † 5-HT. Psychiatric drugs: MAOIs, SSRIs, SNRIs, TCAs, vilazodone, vortioxetine, buspirone Nonpsychiatric drugs: tramadol, ondansetron, triptans, linezolid, MDMA, dextromethorphan, meperidine, St. John's wort	3 A's: † Activity (neuromuscular; eg, clonus, hyperreflexia, hypertonia, tremor, seizure), Autonomic instability (eg, hyperthermia, diaphoresis, diarrhea), Altered mental status	Cyproheptadine (5-HT ₂ receptor antagonist)
Hypertensive crisis	Eating tyramine-rich foods (eg, aged cheeses, cured meats, wine, chocolate) while taking MAOIs	Hypertensive crisis (tyramine displaces other neurotransmitters [eg, NE] in the synaptic cleft → ↑ sympathetic stimulation)	Phentolamine
Neuroleptic malignant syndrome	Antipsychotics (typical > atypical) + genetic predisposition	Malignant FEVER: Myoglobinuria, Fever, Encephalopathy, Vitals unstable, † Enzymes (eg, CK), muscle Rigidity ("lead pipe")	Dantrolene, dopamine agonist (eg, bromocriptine), discontinue causative agent
Delirium tremens	Alcohol withdrawal; occurs 2–4 days after last drink Classically seen in hospital setting when inpatient cannot drink	Altered mental status, hallucinations, autonomic hyperactivity, anxiety, seizures, tremors, psychomotor agitation, insomnia, nausea	Benzodiazepines (eg, chlordiazepoxide, lorazepam, diazepam)
Acute dystonia	Typical antipsychotics, anticonvulsants (eg, carbamazepine), metoclopramide	Sudden onset of muscle spasms, stiffness, and/or oculogyric crisis occurring hours to days after medication use; can lead to laryngospasm requiring intubation	Benztropine or diphenhydramine
Lithium toxicity	† lithium dosage, ‡ renal elimination (eg, acute kidney injury), medications affecting clearance (eg, ACE inhibitors, thiazide diuretics, NSAIDs). Narrow therapeutic window.	Nausea, vomiting, slurred speech, hyperreflexia, seizures, ataxia, nephrogenic diabetes insipidus	Discontinue lithium, hydrate aggressively with isotonic sodium chloride, consider hemodialysis
Tricyclic antidepressant toxicity	TCA overdose	Respiratory depression, hyperpyrexia, prolonged QT Tri-CyCliC's: Convulsions, Coma, Cardiotoxicity (arrhythmia due to Na+ channel inhibition)	Supportive treatment, monitor ECG, NaHCO ₃ (prevents arrhythmia), activated charcoal

FAS1_2019_13-Psych.indd 569 11/7/19 5:28 PM

Psychoactive drug intoxication and withdrawal

DRUG	INTOXICATION	WITHDRAWAL	
Depressants			
	Nonspecific: mood elevation, ↓ anxiety, sedation, behavioral disinhibition, respiratory depression.	Nonspecific: anxiety, tremor, seizures, insomnia.	
Alcohol	Emotional lability, slurred speech, ataxia, coma, blackouts. Serum γ-glutamyltransferase (GGT)—sensitive indicator of alcohol use. AST value is 2 × AL T value ("To AST 2 AL cohol"). Treatment: benzodiazepines.	Alcoholic hallucinosis (usually visual) Withdrawal seizures Tremors, insomnia, diaphoresis, agitation, Gl upset 0 3 6 12 24 36 48 96 Time from last drink (hours)	
Barbiturates	Low safety margin, marked respiratory depression. Treatment: symptom management (eg, assist respiration, † BP).	Delirium, life-threatening cardiovascular collapse.	
Benzodiazepines	Greater safety margin. Ataxia, minor respiratory depression. Treatment: flumazenil (benzodiazepine receptor antagonist, but rarely used as it can precipitate seizures).	Sleep disturbance, depression.	
Opioids	Euphoria, respiratory and CNS depression, ↓ gag reflex, pupillary constriction (pinpoint pupils), seizures. Most common cause of drug overdose death. Treatment: naloxone.	Sweating, dilated pupils, piloerection ("cold turkey"), rhinorrhea, lacrimation, yawning, nausea, stomach cramps, diarrhea ("flu-like" symptoms). Treatment: symptom management, methadone, buprenorphine.	
Inhalants	Disinhibition, euphoria, slurred speech, disturbed gait, disorientation, drowsiness.	Irritability, dysphoria, sleep disturbance, headache.	
Stimulants			
	Nonspecific: mood elevation, ↓ appetite, psychomotor agitation, insomnia, cardiac arrhythmias, tachycardia, anxiety.	Nonspecific: post-use "crash," including depression, lethargy, † appetite, sleep disturbance, vivid nightmares.	
Amphetamines	Euphoria, grandiosity, pupillary dilation, prolonged wakefulness, hyperalertness, hypertension, paranoia, fever, fractured teeth. Skin excoriations with methamphetamine use. Severe: cardiac arrest, seizures. Treatment: benzodiazepines for agitation and seizures.		
Caffeine	Palpitation, agitation, tremor, insomnia.	Headache, difficulty concentrating, flu-like symptoms.	

FAS1_2019_13-Psych.indd 570 11/7/19 5:28 PM

Psychoactive drug intoxication and withdrawal (continued)

DRUG	INTOXICATION	WITHDRAWAL
Cocaine	Impaired judgment, pupillary dilation, hallucinations (including tactile), paranoia, angina, sudden cardiac death. Chronic use may lead to perforated nasal septum due to vasoconstriction and resulting ischemic necrosis. Treatment: benzodiazepines; consider mixed α-/β-blocker (eg, labetalol) for hypertension and tachycardia. Pure β-blocker usage is controversial as a first-line therapy.	
Nicotine	Restlessness.	Irritability, anxiety, restlessness, ↓ concentration, ↑ appetite/weight. Treatment: nicotine patch, gum, or lozenges; bupropion/varenicline.
Hallucinogens	_	
Lysergic acid diethylamide	Perceptual distortion (visual, auditory), depersonalization, anxiety, paranoia, psychosis, flashbacks (usually nondisturbing).	
Marijuana (can <mark>nabino</mark> id)	Euphoria, anxiety, paranoid delusions, perception of slowed time, impaired judgment, social withdrawal, † appetite, dry mouth, conjunctival injection, hallucinations. Pharmaceutical form is dronabinol: used as antiemetic (chemotherapy) and appetite stimulant (in AIDS).	Irritability, anxiety, depression, insomnia, restlessness, ↓ appetite.
MDMA (ecstasy)	Hallucinogenic stimulant: euphoria, hallucinations, disinhibition, hyperactivity, † thirst, bruxism, distorted sensory and time perception. Life-threatening effects include hypertension, tachycardia, hyperthermia, hyponatremia, serotonin syndrome.	Depression, fatigue, change in appetite, difficulty concentrating, anxiety.
Phencyclidine	Violence, impulsivity, psychomotor agitation, nystagmus, tachycardia, hypertension, analgesia, psychosis, delirium, seizures. Trauma is most common complication.	
Alcohol use disorder	Physiologic tolerance and dependence on alcohol interrupted. Complications: vitamin B ₁ (thiamine) deficiency, peripheral neuropathy, testicular atrophy. Treatment: naltrexone (reduces cravings), acampr abstain from alcohol use). Support groups such a abstinence and supporting patient and family.	alcoholic cirrhosis, hepatitis, pancreatitis,
Wernicke-Korsakoff syndrome	Results from vitamin B ₁ deficiency. Symptoms car	noplegia, ataxia (Wernicke encephalopathy). May

FAS1_2019_13-Psych.indd 571 11/7/19 5:28 PM

Psychotherapy			
Behavioral therapy	Teaches patients how to identify and change maladaptive behaviors or reactions to stimuli. Examples include systematic desensitization for treatment of phobia.		
Cognitive behavioral therapy	Teaches patients to recognize distortions in their thought processes, develop constructive coping skills, and ↓ maladaptive coping behaviors → greater emotional control and tolerance of distress. Examples include recognizing triggers for alcohol consumption.		
Dialectical behavioral therapy	Designed for use in borderline personali as well (eg, depression).	ty disorder, but can be used in other psychiatric conditions	
Interpersonal therapy	Focused on improving interpersonal rela	tionships and communication skills.	
Supportive therapy	Utilizes empathy to help individuals dur	ing a time of hardship to maintain optimism or hope.	
Preferred medications	PSYCHIATRIC CONDITION	PREFERRED DRUGS	
for selected	ADHD	Stimulants (methylphenidate, amphetamines)	
psychiatric conditions	Alcohol withdrawal	Benzodiazepines (eg, chlordiazepoxide, lorazepam, diazepam)	
	Bipolar disorder	Lithium, valproic acid, carbamazepine, lamotrigine, atypical antipsychotics	
	Bulimia nervosa	SSRIs	
	Depression	SSRIs	
	Generalized anxiety disorder	SSRIs, SNRIs	
	Obsessive-compulsive disorder	SSRIs, venlafaxine, clomipramine	
	Panic disorder	SSRIs, venlafaxine, benzodiazepines	
	PTSD	SSRIs, venlafaxine	
	Schizophrenia	Atypical antipsychotics	
	Social anxiety disorder	SSRIs, venlafaxine Performance only: β-blockers, benzodiazepines	
	Tourette syndrome	Antipsychotics (eg, fluphenazine, risperidone), tetrabenazine	
Central nervous system stimulants	Methylphenidate, dextroamphetamine, 1	methamphetamine, lisdexamfetamine.	
MECHANISM	† catecholamines in the synaptic cleft, especially norepinephrine and dopamine.		
CLINICAL USE	ADHD, narcolepsy, binge-eating disorder.		
ADVERSE EFFECTS	Nervousness, agitation, anxiety, insomnia, anorexia, tachycardia, hypertension, weight loss, tics, bruxism.		

FAS1_2019_13-Psych.indd 572 11/7/19 5:28 PM

Typical antipsychotics	Haloperidol, pimozide, trifluoperazine, fluphenazine, thioridazine, chlorpromazine.		
MECHANISM	Block dopamine D ₂ receptor († cAMP).		
CLINICAL USE	Schizophrenia (1° positive symptoms), psychosis, bipolar disorder, delirium, Tourette syndrome, Huntington disease, OCD. Use with caution in dementia.		
POTENCY	 High potency: Haloperidol, Trifluoperazine, Fluphenazine (Hal Tries to Fly High)—more neurologic side effects (eg, extrapyramidal symptoms [EPS]). Low potency: Chlorpromazine, Thioridazine (Cheating Thieves are low)—more anticholinergic, antihistamine, α₁-blockade effects. 		
ADVERSE EFFECTS	Lipid soluble → stored in body fat → slow to be removed from body. Endocrine: dopamine receptor antagonism → hyperprolactinemia → galactorrhea, oligomenorrhea, gynecomastia. Metabolic: dyslipidemia, weight gain, hyperglycemia. Antimuscarinic: dry mouth, constipation. Antihistamine: sedation. α₁-blockade: orthostatic hypotension. Cardiac: QT prolongation. Ophthalmologic: Chlorpromazine—Corneal deposits; Thioridazine—reTinal deposits. Neuroleptic malignant syndrome. Extrapyramidal symptoms— ADAPT: Hours to days: Acute Dystonia (muscle spasm, stiffness, oculogyric crisis). Treatment: benztropine, diphenhydramine. Days to months: Akathisia (restlessness). Treatment: β-blockers, benztropine, benzodiazepines. Parkinsonism (bradykinesia). Treatment: benztropine, amantadine. Months to years: Tardive dyskinesia (chorea, especially orofacial). Treatment: atypical antipsychotics (eg, clozapine), valbenazine, deutetrabenazine.		
Atypical antipsychotics	Aripiprazole, asenapine, clozapine, olanzapine, quetiapine, iloperidone, paliperidone, risperidone, lurasidone, ziprasidone.		
MECHANISM	Not completely understood. Most are 5-HT ₂ and D ₂ antagonists; aripiprazole is a D ₂ partial agonist. Varied effects on α and H ₁ receptors.		
CLINICAL USE	Schizophrenia—both positive and negative symptoms. Also used for bipolar disorder, OCD, anxiety disorders, depression, mania, Tourette syndrome.	Use clozapine for treatment-resistant schizophrenia or schizoaffective disorder and for suicidality in schizophrenia.	
ADVERSE EFFECTS	All—prolonged QT, fewer EPS and anticholinergic side effects than typical antipsychotics. "-apines"—metabolic syndrome (weight gain, diabetes, dyslipidemia). Clozapine—agranulocytosis (monitor WBCs frequently) and seizures (dose related). Risperidone—hyperprolactinemia (amenorrhea, galactorrhea, gynecomastia).	Olanzapine, clOzapine → Obesity Must watch bone marrow clozely with clozapine.	

FAS1_2019_13-Psych.indd 573 11/7/19 5:28 PM

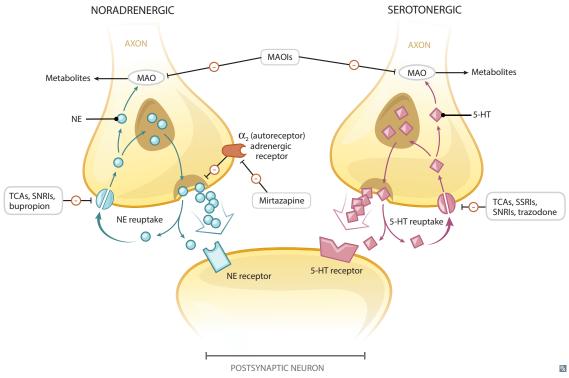
Lithium

MECHANISM	Not established; possibly related to inhibition of phosphoinositol cascade.	LiTHIUM: Low Thyroid (hypothyroidism)
CLINICAL USE	Mood stabilizer for bipolar disorder; treats acute manic episodes and prevents relapse.	Heart (Ebstein anomaly) Insipidus (nephrogenic diabetes insipidus)
ADVERSE EFFECTS	Tremor, thyroid abnormalities (eg, hypothyroidism), polyuria (causes nephrogenic diabetes insipidus), teratogenesis. Causes Ebstein anomaly in newborn if taken by pregnant mother. Narrow therapeutic window requires close monitoring of serum levels. Almost exclusively excreted by kidneys; most is reabsorbed at PCT via Na ⁺ channels. Thiazides, NSAIDs, and other drugs affecting clearance are implicated in lithium toxicity.	Unwanted Movements (tremor)

Buspirone

MECHANISM	Stimulates 5-HT _{1A} receptors.	I get anxious if the bus doesn't arrive at one, so
CLINICAL USE	Generalized anxiety disorder. Does not cause sedation, addiction, or tolerance. Begins to take effect after 1–2 weeks. Does not interact with alcohol (vs barbiturates, benzodiazepines).	I take <mark>buspirone</mark> .

Antidepressants



FAS1_2019_13-Psych.indd 574 11/7/19 5:28 PM

Selective serotonin reuptake inhibitors	Fluoxetine, fluvoxamine, paroxetine, sertraline, es	scitalopram, citalopram.	
MECHANISM	Inhibit 5-HT reuptake.	It normally takes 4–8 weeks for antidepressants	
CLINICAL USE	Depression, generalized anxiety disorder, panic disorder, OCD, bulimia, binge-eating disorder, social anxiety disorder, PTSD, premature ejaculation, premenstrual dysphoric disorder.	to show appreciable effect.	
ADVERSE EFFECTS	Fewer than TCAs. Serotonin syndrome, GI distress, SIADH, sexual dysfunction (anorgasmia, ↓ libido).		
Serotonin- norepinephrine reuptake inhibitors	Venlafaxine, desvenlafaxine, duloxetine, levomiln	acipran, milnacipran.	
MECHANISM	Inhibit 5-HT and NE reuptake.		
CLINICAL USE	Depression, generalized anxiety disorder, diabetic neuropathy. Venlafaxine is also indicated for social anxiety disorder, panic disorder, PTSD, OCD. Duloxetine and milnacipran are also indicated for fibromyalgia.		
ADVERSE EFFECTS	† BP, stimulant effects, sedation, nausea.		
Tricyclic antidepressants	Amitriptyline, nortriptyline, imipramine, desiprar	nine, clomipramine, doxepin, amoxapine.	
MECHANISM	TCAs inhibit 5-HT and NE reuptake.		
CLINICAL USE	MDD, peripheral neuropathy, chronic neuropathic pain, migraine prophylaxis, OCD (clomipramine), nocturnal enuresis (imipramine, although adverse effects may limit use).		
ADVERSE EFFECTS	Sedation, α_1 -blocking effects including postural hypotension, and atropine-like (anticholinergic) side effects (tachycardia, urinary retention, dry mouth). 3° TCAs (amitriptyline) have more anticholinergic effects than 2° TCAs (nortriptyline). Can prolong QT interval. Tri-CyCliC's: Convulsions, Coma, Cardiotoxicity (arrhythmia due to Na+ channel inhibition); also respiratory depression, hyperpyrexia. Confusion and hallucinations are more common in the elderly due to anticholinergic side effects (2° amines [eg, nortriptyline] better tolerated). Treatment: NaHCO $_3$ to prevent arrhythmia.		
Monoamine oxidase inhibitors	Tranylcypromine, Phenelzine, Isocarboxazid, Selegiline (selective MAO-B inhibitor). (MAO Takes Pride In Shanghai).		
MECHANISM	Nonselective MAO inhibition → ↑ levels of amine neurotransmitters (norepinephrine, 5-HT, dopamine).		
CLINICAL USE	Atypical depression, anxiety. Parkinson disease (se	elegiline).	
ADVERSE EFFECTS	CNS stimulation; hypertensive crisis, most notably with ingestion of tyramine. Contraindicated with SSRIs, TCAs, St. John's wort, meperidine, dextromethorphan, linezolid (to avoid precipitating serotonin syndrome). Wait 2 weeks after stopping MAOIs before starting serotonergic drugs or stopping dietary restrictions.		

FAS1_2019_13-Psych.indd 575 11/7/19 5:28 PM

Atypical antidepressants

Bupropion	Inhibits NE and DA reuptake. Also used for smoking cessation. Toxicity: stimulant effects (tachycardia, insomnia), headache, seizures in patients with bulimia and anorexia nervosa. Favorable sexual side effect profile.		
Mirtazapine	 α₂-antagonist († release of NE and 5-HT), potent 5-HT₂ and 5-HT₃ receptor antagonist, and H₁ antagonist. Toxicity: sedation (which may be desirable in depressed patients with insomnia), † appetite, weight gain (which may be desirable in underweight patients), dry mouth. 		
Trazodone	Primarily blocks 5-HT ₂ , α_1 -adrenergic, and H ₁ receptors; also weakly inhibits 5-HT reuptake. Use primarily for insomnia, as high doses are needed for antidepressant effects. Toxicity: sedation, nausea, priapism, postural hypotension. Think tra ZZZobone due to sedative and male-specific side effects.		
Varenicline	Nicotinic ACh receptor partial agonist. Used for smoking cessation. Toxicity: sleep disturbance, depressed mood, suicidal ideation. Varenicline helps nicotine cravings decline.		
Vilazodone	Inhibits 5-HT reuptake; 5-HT _{IA} receptor partial agonist. Used for MDD. Toxicity: headache, diarrhea, nausea, anticholinergic effects. May cause serotonin syndrome if taken with other serotonergic agents.		
Vortioxetine	Inhibits 5-HT reuptake; 5-HT _{1A} receptor agonist and 5-HT ₃ receptor antagonist. Used for MDD. Toxicity: nausea, sexual dysfunction, sleep disturbances, anticholinergic effects. May cause serotonin syndrome if taken with other serotonergic agents.		
Opioid detoxification and relapse prevention	n Intravenous drug users at ↑ risk for hepatitis, HIV, abscesses, bacteremia, right-heart endocarditis		
Methadone	Long-acting oral opiate used for heroin detoxification or long-term maintenance therapy.		
Buprenorphine	Sublingual form (partial agonist) used to prevent relapse.		
Naloxone	Short-acting opioid antagonist given IM, IV, or as a nasal spray to treat acute opioid overdose, particularly to reverse respiratory and CNS depression.		
Naltrexone	Long-acting oral opioid antagonist used after detoxification to prevent relapse. Use naltrexone for the long trex back to sobriety.		

FAS1_2019_13-Psych.indd 576 11/7/19 5:28 PM

HIGH-YIELD SYSTEMS

Renal

"But I know all about love already. I know precious little still about kidneys."

—Aldous Huxley, Antic Hay

"This too shall pass. Just like a kidney stone."

-Hunter Madsen

"I drink too much. The last time I gave a urine sample it had an olive in it."

—Rodney Dangerfield

Being able to understand and apply renal physiology will be critical for the exam. Important topics include electrolyte disorders, acid-base derangements, glomerular disorders (including histopathology), acute and chronic kidney disease, urine casts, diuretics, ACE inhibitors, and AT-II receptor blockers. Renal anomalies associated with various congenital defects are also high-yield associations to think about when evaluating pediatric vignettes.

▶Embryology	578
▶ Anatomy	580
▶ Physiology	581
▶ Pathology	594
▶ Pharmacology	607

FAS1_2019_14-Renal.indd 577 11/7/19 5:42 PM

▶ RENAL—EMBRYOLOGY

Kidney embryology

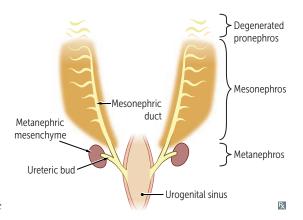
Pronephros—week 4; then degenerates. Mesonephros—functions as interim kidney for 1st trimester; later contributes to male genital system.

Metanephros—permanent; first appears in 5th week of gestation; nephrogenesis continues through weeks 32–36 of gestation.

- Ureteric bud (metanephric diverticulum) derived from caudal end of mesonephric duct; gives rise to ureter, pelvises, calyces, collecting ducts; fully canalized by 10th week
- Metanephric mesenchyme (ie, metanephric blastema)—ureteric bud interacts with this tissue; interaction induces differentiation and formation of glomerulus through to distal convoluted tubule (DCT)
- Aberrant interaction between these 2 tissues may result in several congenital malformations of the kidney (eg, renal agenesis, multicystic dysplastic kidney)

Ureteropelvic junction—last to canalize

→ congenital obstruction. Most common
cause of prenatal hydronephrosis. Detected by
prenatal ultrasound.



Potter sequence (syndrome)



Oligohydramnios → compression of developing fetus → limb deformities, facial anomalies (eg, low-set ears and retrognathia A, flattened nose), compression of chest and lack of amniotic fluid aspiration into fetal lungs → pulmonary hypoplasia (cause of death).

Causes include ARPKD, obstructive uropathy (eg, posterior urethral valves), bilateral renal agenesis, chronic placental insufficiency.

Babies who can't "Pee" in utero develop Potter sequence.

POTTER sequence associated with:

Pulmonary hypoplasia

Oligohydramnios (trigger)

Twisted face

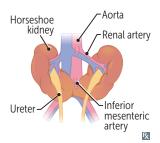
Twisted skin

Extremity defects

Renal failure (in utero)

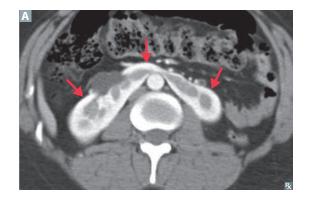
FAS1_2019_14-Renal.indd 578

Horseshoe kidney



Inferior poles of both kidneys fuse abnormally A. As they ascend from pelvis during fetal development, horseshoe kidneys get trapped under inferior mesenteric artery and remain low in the abdomen. Kidneys function normally. Associated with hydronephrosis (eg, ureteropelvic junction obstruction), renal stones, infection, † risk of renal cancer.

Higher incidence in chromosomal aneuploidy (eg, Turner syndrome, trisomies 13, 18, 21).



Congenital solitary functioning kidney

Condition of being born with only one functioning kidney. Majority asymptomatic with compensatory hypertrophy of contralateral kidney, but anomalies in contralateral kidney are common. Often diagnosed prenatally via ultrasound.

Unilateral renal agenesis

Ureteric bud fails to develop and induce differentiation of metanephric mesenchyme → complete absence of kidney and ureter.

Multicystic dysplastic kidney

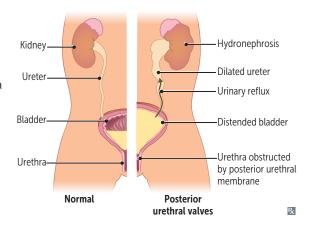
Ureteric bud fails to induce differentiation of metanephric mesenchyme → nonfunctional kidney consisting of cysts and connective tissue. Predominantly nonhereditary and usually unilateral; bilateral leads to Potter sequence.

Duplex collecting system

Bifurcation of ureteric bud before it enters the metanephric blastema creates a Y-shaped bifid ureter. Duplex collecting system can alternatively occur through two ureteric buds reaching and interacting with metanephric blastema. Strongly associated with vesicoureteral reflux and/or ureteral obstruction, † risk for UTIs.

Posterior urethral valves

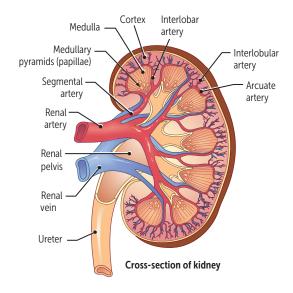
Membrane remnant in the posterior urethra in males; its persistence can lead to urethral obstruction. Can be diagnosed prenatally by bilateral hydronephrosis and dilated or thickwalled bladder on ultrasound. Most common cause of bladder outlet obstruction in male infants. Associated with oligohydramnios in cases of severe obstruction.

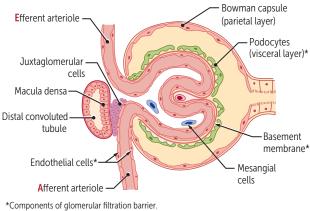


FAS1 2019 14-Renal.indd 579 11/7/19 5:42 PM

▶ RENAL—ANATOMY

Kidney anatomy and glomerular structure





Cross-section of glomerulus

Left kidney is taken during living donor transplantation because it has a longer renal vein.

Afferent = Arriving.

 \mathbf{E} fferent = \mathbf{E} xiting.

Renal blood flow: renal artery → segmental artery → interlobar artery → arcuate artery

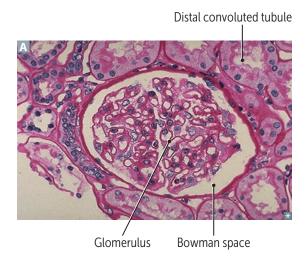
ightarrow interlobular artery ightarrow afferent arteriole

→ glomerulus A → efferent arteriole → vasa recta/peritubular capillaries → venous outflow.

Left renal vein receives two additional veins: left suprarenal and left gonadal veins.

Despite high overall renal blood flow, renal medulla receives significantly less blood flow than renal cortex → very sensitive to hypoxia

→ vulnerable to ischemic damage.



FAS1_2019_14-Renal.indd 580 11/7/19 5:42 PM

Ŗ

Course of ureters



Course of ureter A: arises from renal pelvis, travels under gonadal arteries → over common iliac artery → under uterine artery/vas deferens (retroperitoneal).

Gynecologic procedures (eg, ligation of uterine or ovarian vessels) may damage ureter → ureteral obstruction or leak.

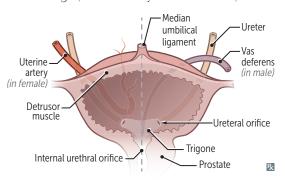
Bladder contraction compresses the intravesical ureter, preventing urine reflux.

Blood supply to ureter:

- Proximal—renal arteries
- Middle—gonadal artery, aorta, common and internal iliac arteries
- Distal—internal iliac and superior vesical arteries

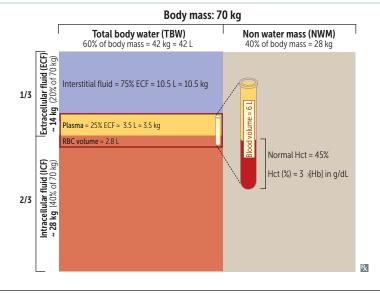
3 common points of ureteral obstruction: ureteropelvic junction, pelvic inlet, ureterovesical junction.

Water (ureters) flows **over** the iliacs and **under** the bridge (uterine artery or vas deferens).



▶ RENAL—PHYSIOLOGY

Fluid compartments



HIKIN': HIgh K+ INtracellularly.

60–40–20 rule (% of body weight for average person):

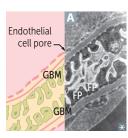
- 60% total body water
- 40% ICF, mainly composed of K⁺, Mg²⁺, organic phosphates (eg, ATP)
- 20% ECF, mainly composed of Na⁺, Cl⁻, HCO₃⁻, albumin

Plasma volume can be measured by radiolabeling albumin.

Extracellular volume can be measured by inulin or mannitol.

Serum osmolality = 285-295 mOsm/kg H₂O. Plasma volume = TBV × (1 – Hct).

Glomerular filtration barrier



Responsible for filtration of plasma according to size and charge selectivity.

Composed of:

- Fenestrated capillary endothelium
- Basement membrane with type IV collagen chains and heparan sulfate
- Visceral epithelial layer consisting of podocyte foot processes (FPs)

Charge barrier—all 3 layers contain ⊖ charged glycoproteins that prevent entry of ⊖ charged molecules (eg, albumin).

Size barrier—fenestrated capillary endothelium (prevents entry of > 100 nm molecules/blood cells); podocyte foot processes interpose with glomerular basement membrane (GBM); slit diaphragm (prevents entry of molecules > 50–60 nm).

FAS1_2019_14-Renal.indd 581 11/7/19 5:42 PM

582

SECTION III

RENAL ▶ RENAL—PHYSIOLOGY

Renal clearance

 $C_x = (U_x V)/P_x = \text{volume of plasma from which}$ the substance is completely cleared in the urine per unit time.

If C_x < GFR: net tubular reabsorption and/or not freely filtered.

If $C_y > GFR$: net tubular secretion of X.

If $C_v = GFR$: no net secretion or reabsorption.

 $C_y = \text{clearance of X (mL/min)}.$

 U_x = urine concentration of X (eg, mg/mL).

P = plasma concentration of X (eg, mg/mL).

 \vec{V} = urine flow rate (mL/min).

Glomerular filtration rate

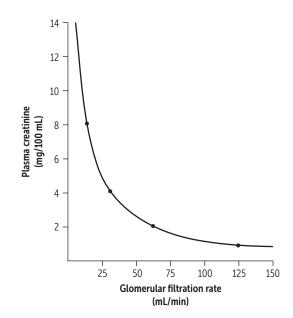
Inulin clearance can be used to calculate GFR because it is freely filtered and is neither reabsorbed nor secreted.

$$\begin{split} \boldsymbol{C}_{\mathrm{inulin}} &= \boldsymbol{GFR} = \boldsymbol{U}_{\mathrm{inulin}} \times \boldsymbol{V/P}_{\mathrm{inulin}} \\ &= \boldsymbol{K}_{f} \left[(\boldsymbol{P}_{\mathrm{GC}} - \boldsymbol{P}_{\mathrm{BS}}) - (\boldsymbol{\pi}_{\mathrm{GC}} - \boldsymbol{\pi}_{\mathrm{BS}}) \right] \end{split}$$

(GC = glomerular capillary; BS = Bowman space; $\pi_{\rm BS}$ normally equals zero; $K_{\rm f}$ = filtration coefficient).

Normal GFR ≈ 100 mL/min.

Creatinine clearance is an approximate measure of GFR. Slightly overestimates GFR because creatinine is moderately secreted by renal tubules.



Effective renal plasma flow

Effective renal plasma flow (eRPF) can be estimated using *para*-aminohippuric acid (PAH) clearance. Between filtration and secretion, there is nearly 100% excretion of all PAH that enters the kidney.

$$eRPF = U_{PAH} \times V/P_{PAH} = C_{PAH}.$$

Renal blood flow (RBF) = RPF/(1 - Hct). Usually 20–25% of cardiac output.

eRPF underestimates true renal plasma flow (RPF) slightly.

Filtration

Filtration fraction (FF) = GFR/RPF. Normal FF = 20%. Filtered load (mg/min) = GFR (mL/m

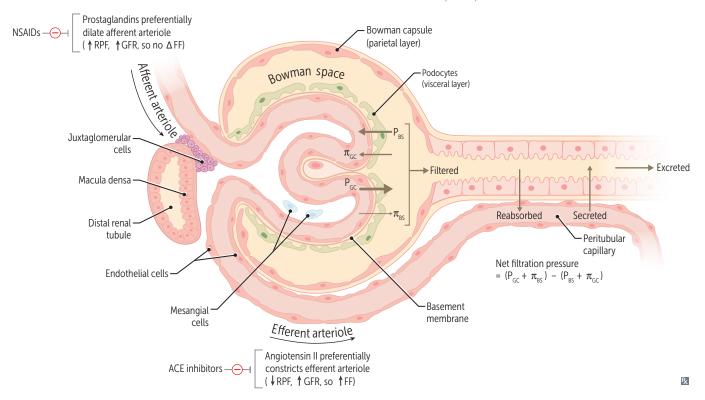
Filtered load (mg/min) = GFR (mL/min) × plasma concentration (mg/mL).

GFR can be estimated with creatinine clearance.

RPF is best estimated with PAH clearance.

Prostaglandins Dilate Afferent arteriole (PDA).

Angiotensin II Constricts Efferent arteriole (ACE).



Changes in glomerular dynamics

	GFR	RPF	FF (GFR/RPF)
Afferent arteriole constriction	1	Į.	_
Efferent arteriole constriction	†	ţ	†
† plasma protein concentration	↓	_	↓
↓ plasma protein concentration	†	_	†
Constriction of ureter	1	_	↓
Dehydration	1	↓ ↓	†

FAS1_2019_14-Renal.indd 583 11/7/19 5:42 PM

Calculation of reabsorption and secretion rate

Filtered load = $GFR \times P_x$. Excretion rate = $V \times U_y$.

Reabsorption rate = filtered - excreted. Secretion rate = excreted - filtered. Fe_{Na} = fractional excretion of sodium.

$$Fe_{Na} = \frac{Na^+ \ excreted}{Na^+ \ filtered} = \frac{V \times U_{Na}}{GFR \ \times P_{Na}} = \frac{P_{Cr} \times U_{Na}}{U_{Cr} \times P_{Na}} \ \ where \ GFR = \frac{U_{Cr} \times V}{P_{Cr}}$$

Glucose clearance

Glucose at a normal plasma level (range 60–120 mg/dL) is completely reabsorbed in proximal convoluted tubule (PCT) by Na+/glucose cotransport.

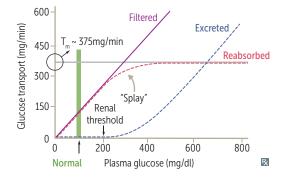
In adults, at plasma glucose of ~ 200 mg/dL, glucosuria begins (threshold). At rate of ~ 375 mg/min, all transporters are fully saturated ($T_{\rm m}$).

Normal pregnancy is associated with ↑ GFR. With ↑ filtration of all substances, including glucose, the glucose threshold occurs at lower plasma glucose concentrations → glucosuria at normal plasma glucose levels.

Sodium-glucose cotransporter 2 (SGLT2) inhibitors (eg, -flozin drugs) result in glucosuria at plasma concentrations < 200 mg/dL.

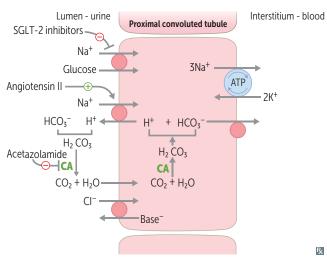
Glucosuria is an important clinical clue to diabetes mellitus.

Splay phenomenon— T_m for glucose is reached gradually rather than sharply due to the heterogeneity of nephrons (ie, different T_m points); represented by the portion of the titration curve between threshold and T_m .



FAS1_2019_14-Renal.indd 584 11/7/19 5:42 PM

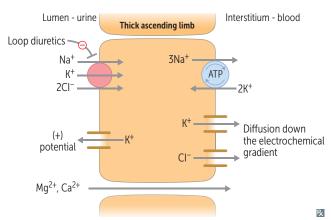
Nephron transport physiology



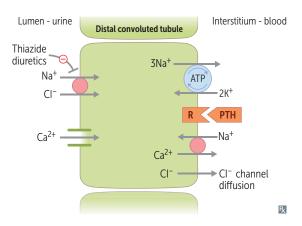
Early PCT—contains brush border. Reabsorbs all glucose and amino acids and most HCO₃⁻, Na⁺, Cl⁻, PO₄³⁻, K⁺, H₂O, and uric acid. Isotonic absorption. Generates and secretes NH₃, which enables the kidney to secrete more H⁺.

PTH—inhibits Na⁺/PO₄³⁻ cotransport → † PO₄³⁻ excretion. AT II—stimulates Na⁺/H⁺ exchange → † Na⁺, H₂O, and HCO₃⁻ reabsorption (permitting contraction alkalosis). 65–80% Na⁺ and H₂O reabsorbed.

Thin descending loop of Henle—passively reabsorbs H₂O via medullary hypertonicity (impermeable to Na⁺). Concentrating segment. Makes urine hypertonic.

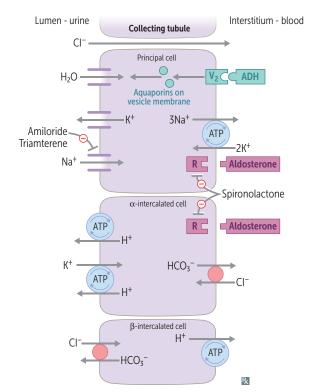


Thick ascending loop of Henle—reabsorbs Na⁺, K⁺, and Cl[−]. Indirectly induces paracellular reabsorption of Mg²⁺ and Ca²⁺ through ⊕ lumen potential generated by K⁺ backleak. Impermeable to H₂O. Makes urine less concentrated as it ascends. 10–20% Na⁺ reabsorbed.



Early DCT—reabsorbs Na⁺, Cl⁻. Impermeable to H₂O. Makes urine fully dilute (hypotonic).

PTH—† Ca²⁺/Na⁺ exchange → † Ca²⁺ reabsorption.
5–10% Na⁺ reabsorbed.



Collecting tubule—reabsorbs Na⁺ in exchange for secreting K⁺ and H⁺ (regulated by aldosterone).

Aldosterone—acts on mineralocorticoid receptor → mRNA → protein synthesis. In principal cells: † apical K⁺ conductance, † Na⁺/K⁺ pump, † epithelial Na⁺ channel (FNaC) activity → lumen pegativity → K⁺ secretion. In

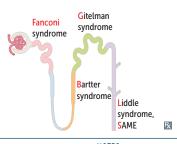
conductance, \uparrow Na⁺/K⁺ pump, \uparrow epithelial Na⁺ channe (ENaC) activity \rightarrow lumen negativity \rightarrow K⁺ secretion. In α -intercalated cells: lumen negativity \rightarrow \uparrow H⁺ ATPase activity \rightarrow \uparrow H⁺ secretion \rightarrow \uparrow HCO₃⁻/Cl⁻ exchanger activity.

ADH—acts at V_2 receptor \rightarrow insertion of aquaporin H_2O channels on apical side.

3-5% Na+ reabsorbed.

FAS1_2019_14-Renal.indd 585 11/7/19 5:42 PM

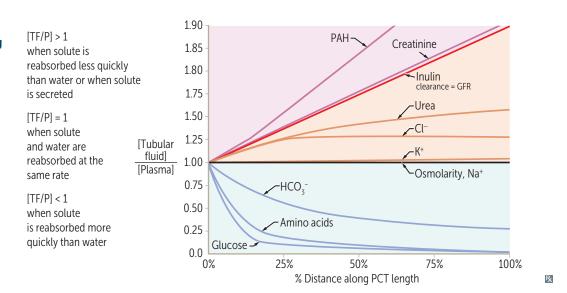
Renal tubular defects Order: Fanconi's BaGeLS



				SAME 🕟
	DEFECTS	EFFECTS	CAUSES	NOTES
Fanconi syndrome	Generalized reabsorption defect in PCT → † excretion of amino acids, glucose, HCO ₃ -, and PO ₄ ³⁻ , and all substances reabsorbed by the PCT	May lead to metabolic acidosis (proximal RTA), hypophosphatemia, osteopenia	Hereditary defects (eg, Wilson disease, tyrosinemia, glycogen storage disease), ischemia, multiple myeloma, nephrotoxins/drugs (eg, ifosfamide, cisplatin), lead poisoning	
Bartter syndrome	Reabsorption defect in thick ascending loop of Henle (affects Na+/K+/2Cl- cotransporter)	Metabolic alkalosis, hypokalemia, hypercalciuria	Autosomal recessive	Presents similarly to chronic loop diuretic use
Gitelman syndrome	Reabsorption defect of NaCl in DCT	Metabolic alkalosis, hypomagnesemia, hypokalemia, hypocalciuria	Autosomal recessive	Presents similarly to lifelong thiazide diuretic use Less severe than Bartter syndrome
Liddle syndrome	Gain of function mutation → ↓ Na ⁺ channel degradation → ↑ Na ⁺ reabsorption in collecting tubules	Metabolic alkalosis, hypokalemia, hypertension, ↓ aldosterone	Autosomal dominant	Presents similarly to hyperaldosteronism, but aldosterone is nearly undetectable Treatment: amiloride
Syndrome of Apparent Mineralocorticoid Excess	Cortisol activates mineralocorticoid receptors. 11β-HSD converts cortisol to cortisone (inactive on these receptors) Hereditary 11β-HSD deficiency → ↑ cortisol → ↑ mineralocorticoid receptor activity	Metabolic alkalosis, hypokalemia, hypertension ↓ serum aldosterone level; cortisol tries to be the SAME as aldosterone	Autosomal recessive Can acquire disorder from glycyrrhetinic acid (present in licorice), which blocks activity of 11β-hydroxysteroid dehydrogenase	Treatment: K+-sparing diuretics (↓ mineralocorticoid effects) or corticosteroids (exogenous corticosteroid ↓ endogenous cortisol production → ↓ mineralocorticoid receptor activation)

FAS1_2019_14-Renal.indd 586 11/7/19 5:42 PM

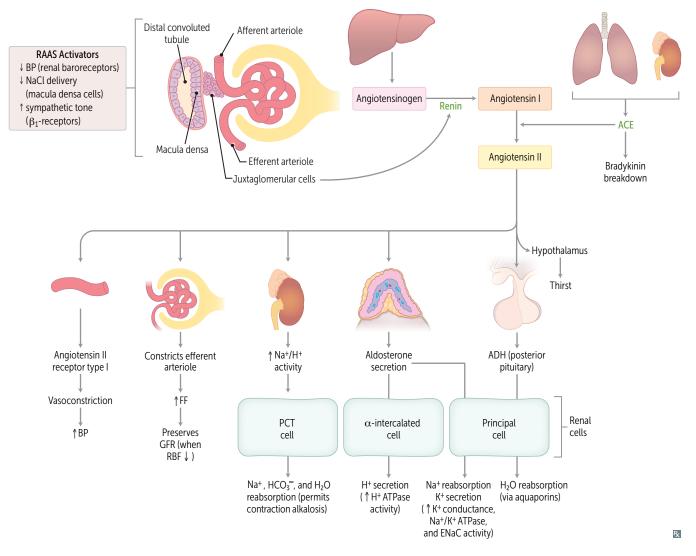
Relative concentrations along proximal convoluted tubules



Tubular inulin † in concentration (but not amount) along the PCT as a result of water reabsorption. Cl⁻ reabsorption occurs at a slower rate than Na⁺ in early PCT and then matches the rate of Na⁺ reabsorption more distally. Thus, its relative concentration † before it plateaus.

FAS1_2019_14-Renal.indd 587 11/7/19 5:42 PM

Renin-angiotensin-aldosterone system



Renin	Secreted by JG cells in response to \downarrow renal perfusion pressure (detected by renal baroreceptors in afferent arteriole), \uparrow renal sympathetic discharge (β_1 effect), and \downarrow NaCl delivery to macula densa cells.
AT II	Helps maintain blood volume and blood pressure. Affects baroreceptor function; limits reflex bradycardia, which would normally accompany its pressor effects.
ANP, BNP	Released from atria (ANP) and ventricles (BNP) in response to \uparrow volume; inhibits renin-angiotensin-aldosterone system; relaxes vascular smooth muscle via cGMP $\rightarrow \uparrow$ GFR, \downarrow renin. Dilates afferent arteriole, promotes natriuresis.
ADH	Primarily regulates serum osmolality; also responds to low blood volume states. Stimulates reabsorption of water in collecting ducts. Also stimulates reabsorption of urea in collecting ducts to maximizes corticopapillary osmotic gradient.
Aldosterone	Primarily regulates ECF volume and Na ⁺ content; ↑ release in ↓ blood volume states. Responds to hyperkalemia by ↑ K ⁺ excretion.

FAS1_2019_14-Renal.indd 588 11/7/19 5:42 PM

Juxtaglomerular apparatus

Consists of mesangial cells, JG cells (modified smooth muscle of afferent arteriole), and the macula densa (NaCl sensor, located at distal end of loop of Henle). JG cells secrete renin in response to ↓ renal blood pressure and † sympathetic tone (β_1). Macula densa cells sense ↓ NaCl delivery to DCT → ↑ renin release → efferent arteriole vasoconstriction → † GFR.

JGA maintains GFR via renin-angiotensinaldosterone system.

In addition to vasodilatory properties, β -blockers can decrease BP by inhibiting β_1 -receptors of the JGA \rightarrow \downarrow renin release.

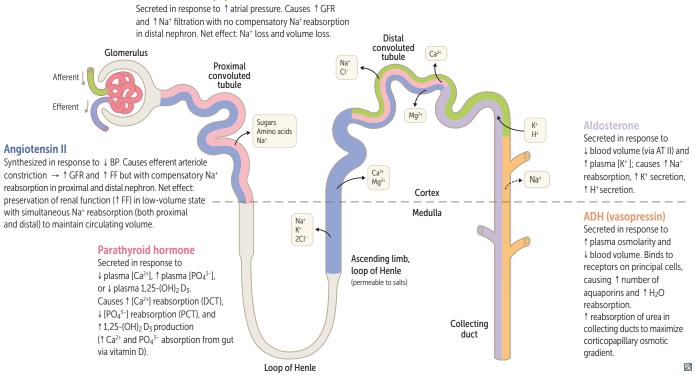
Kidney endocrine functions

Erythropoietin	Released by interstitial cells in peritubular capillary bed in response to hypoxia.	Stimulates RBC proliferation in bone marrow. Administered for anemia secondary to chronic kidney disease. † risk of HTN.	
Calciferol (vitamin D)	PCT cells convert 25-OH vitamin D_3 to 1,25- ${\rm (OH)}_2$ vitamin D_3 (calcitriol, active form).	25-OH D ₃ \longrightarrow 1,25-(OH) ₂ D ₃ (calcidiol) 1α -hydroxylase (calcitriol) \uparrow	
Prostaglandins	Paracrine secretion vasodilates the afferent arterioles to † RBF.	NSAIDs block renal-protective prostaglandin synthesis → constriction of afferent arteriole and ↓ GFR; this may result in acute kidney injury in low renal blood flow states.	
Dopamine	Secreted by PCT cells, promotes natriuresis. At low doses; dilates interlobular arteries, afferent arterioles, efferent arterioles → ↑ RBF, little or no change in GFR. At higher doses; acts as vasoconstrictor.		

FAS1_2019_14-Renal.indd 589 11/7/19 5:42 PM

Hormones acting on kidney

Atrial natriuretic peptide



Potassium shifts

SHIFTS K+ INTO CELL (CAUSING HYPOKALEMIA)	SHIFTS K+ OUT OF CELL (CAUSING HYPERKALEMIA)	
	Digitalis (blocks Na+/K+ ATPase)	
Hypo-osmolarity	Hyper <mark>O</mark> smolarity	
	Lysis of cells (eg, crush injury, rhabdomyolysis, tumor lysis syndrome)	
Alkalosis	Acidosis	
β-adrenergic agonist († Na+/K+ ATPase)	β-blocker	
Insulin († Na+/K+ ATPase)	High blood Sugar (insulin deficiency)	
Insulin shifts K ⁺ into cells	Succinylcholine († risk in burns/muscle trauma)	
	Hyperkalemia? DO LAβSS	

FAS1_2019_14-Renal.indd 590 11/7/19 5:42 PM

Electrolyte disturbances

LOW SERUM CONCENTRATION	HIGH SERUM CONCENTRATION	
Nausea, malaise, stupor, coma, seizures	Irritability, stupor, coma Wide QRS and peaked T waves on ECG, kness arrhythmias, muscle weakness	
U waves and flattened T waves on ECG, arrhythmias, muscle cramps, spasm, weakness		
Tetany, seizures, QT prolongation, twitching (eg, Chvostek sign), spasm (eg, Trousseau sign)	Stones (renal), bones (pain), groans (abdominal pain), thrones († urinary frequency), psychiatric overtones (anxiety, altered mental status)	
Tetany, torsades de pointes, hypokalemia, hypocalcemia (when $[\mathrm{Mg^{2+}}] < 1.0~\mathrm{mEq/L})$	↓ DTRs, lethargy, bradycardia, hypotension, cardiac arrest, hypocalcemia	
Bone loss, osteomalacia (adults), rickets (children)	Renal stones, metastatic calcifications, hypocalcemia	
	Nausea, malaise, stupor, coma, seizures U waves and flattened T waves on ECG, arrhythmias, muscle cramps, spasm, weakness Tetany, seizures, QT prolongation, twitching (eg, Chvostek sign), spasm (eg, Trousseau sign) Tetany, torsades de pointes, hypokalemia, hypocalcemia (when [Mg ²⁺] < 1.0 mEq/L) Bone loss, osteomalacia (adults), rickets	

Features of renal disorders

CONDITION	BLOOD PRESSURE	PLASMA RENIN	ALDOSTERONE	SERUM Mg ²⁺	URINE Ca ²⁺
SIADH	—/ †	↓	1		
Primary hyperaldosteronism	†	ţ	†		
Renin-secreting tumor	†	†	†		
Bartter syndrome		†	†		†
Gitelman syndrome		†	†	1	↓
Liddle syndrome, syndrome of apparent mineralocorticoid excess	†	1	↓		

 $[\]uparrow \downarrow$ = important differentiating feature.

FAS1_2019_14-Renal.indd 591 11/7/19 5:42 PM

Acid-base physiology

	рН	Pco ₂	[HCO ₃ ⁻]	COMPENSATORY RESPONSE
Metabolic acidosis	1	↓	↓	Hyperventilation (immediate)
Metabolic alkalosis	†	†	†	Hypoventilation (immediate)
Respiratory acidosis	1	†	†	↑ renal [HCO ₃ -] reabsorption (delayed)
Respiratory alkalosis	†	↓	†	↓ renal [HCO₃⁻] reabsorption (delayed)

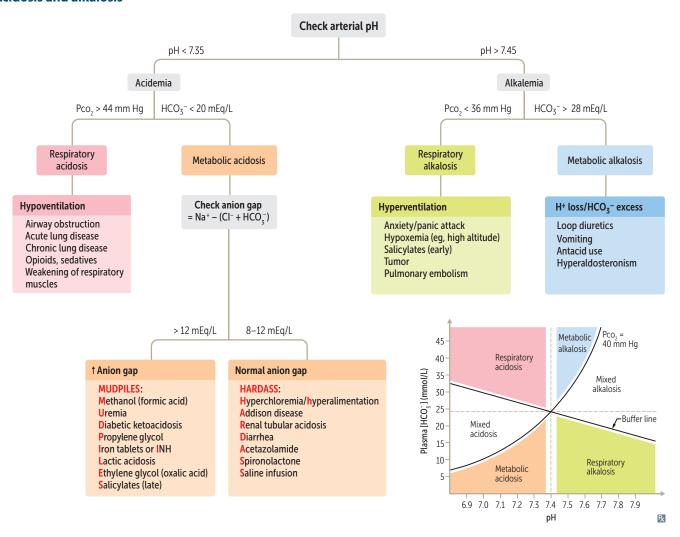
Key: $\downarrow \uparrow$ = compensatory response.

Henderson-Hasselbalch equation: pH = 6.1 +
$$\log \frac{[HCO_3^-]}{0.03 \text{ Pco}_2}$$

Predicted respiratory compensation for a simple metabolic acidosis can be calculated using the Winters formula. If measured Pco₂ > predicted Pco₂ → concomitant respiratory acidosis; if measured Pco₂ < predicted Pco₂ → concomitant respiratory alkalosis:

$$Pco_{2} = 1.5 [HCO_{3}^{-}] + 8 \pm 2$$

Acidosis and alkalosis



FAS1_2019_14-Renal.indd 592 11/7/19 5:42 PM

Renal tubular acidosis

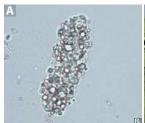
Disorder of the renal tubules that causes normal anion gap (hyperchloremic) metabolic acidosis.

RTA TYPE	DEFECT	URINE PH	SERUM K ⁺	CAUSES	ASSOCIATIONS
Distal renal tubular acidosis (type 1)	Inability of α-intercalated cells to secrete H ⁺ → no new HCO ₃ ⁻ is generated → metabolic acidosis	> 5.5	1	Amphotericin B toxicity, analgesic nephropathy, congenital anomalies (obstruction) of urinary tract, autoimmune diseases (eg, SLE)	† risk for calcium phosphate kidney stones (due to † urine pH and † bone turnover related to buffering)
Proximal renal tubular acidosis (type 2)	Defect in PCT HCO ₃ ⁻ reabsorption → ↑ excretion of HCO ₃ ⁻ in urine → metabolic acidosis Urine can be acidified by α-intercalated cells in collecting duct, but not enough to overcome ↑ HCO ₃ ⁻ excretion	> 5.5 when resorptive threshold for serum HCO ₃ ⁻ exceeded; < 5.5 when HCO ₃ ⁻ depleted below resorptive threshold	1	Fanconi syndrome, multiple myeloma, carbonic anhydrase inhibitors	† risk for hypophosphatemic rickets (in Fanconi syndrome)
Hyperkalemic tubular acidosis (type 4)	Hypoaldosteronism or aldosterone resistance; hyperkalemia → ↓ NH ₃ synthesis in PCT → ↓ NH ₄ ⁺ excretion	< 5.5 (or variable)	1	↓ aldosterone production (eg, diabetic hyporeninism, ACE inhibitors, ARBs, NSAIDs, heparin, cyclosporine, adrenal insufficiency) or aldosterone resistance (eg, K+-sparing diuretics, nephropathy due to obstruction, TMP-SMX)	

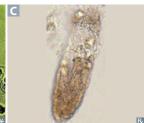
11/7/19 5:42 PM FAS1_2019_14-Renal.indd 593

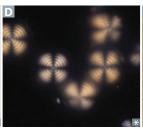
KENAL-	—PATHULUGY

Casts in urine	Presence of casts indicates that hematuria/pyuria is of glomerular or renal tubular origin.
	Bladder cancer, kidney stones → hematuria, no casts.
	Acute cystitis → pyuria, no casts.
RBC casts A	Glomerulonephritis, hypertensive emergency.
WBC casts B	Tubulointerstitial inflammation, acute pyelonephritis, transplant rejection.
Granular casts C	Acute tubular necrosis (ATN). Can be "muddy brown" in appearance.
Fatty casts ("oval fat bodies")	Nephrotic syndrome. Associated with "Maltese cross" sign D.
Waxy casts	End-stage renal disease/chronic kidney disease.
Hyaline casts E	Nonspecific, can be a normal finding. Form via solidification of Tamm–Horsfall mucoprotein (secreted by renal tubular cells).









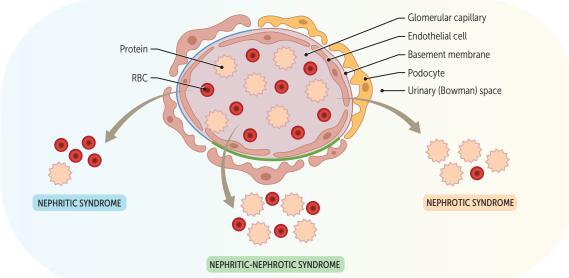


Nomenclature of glomerular disorders

ТҮРЕ	CHARACTERISTICS	EXAMPLE
Focal	< 50% of glomeruli are involved	Focal segmental glomerulosclerosis
Diffuse	> 50% of glomeruli are involved	Diffuse proliferative glomerulonephritis
Proliferative	Hypercellular glomeruli	Membranoproliferative glomerulonephritis
Membranous	Thickening of glomerular basement membrane (GBM)	Membranous nephropathy
Primary glomerular disease	l° disease of the kidney specifically impacting the glomeruli	Minimal change disease
Secondary glomerular disease	Systemic disease or disease of another organ system that also impacts the glomeruli	SLE, diabetic nephropathy

FAS1_2019_14-Renal.indd 594 11/7/19 5:42 PM

Glomerular diseases



			₽.
ТҮРЕ	ETIOLOGY	CLINICAL PRESENTATION	EXAMPLES
Nephritic syndrome	Glomerular inflammation → GBM damage → loss of RBCs into urine → hematuria	Hematuria, RBC casts in urine ↓ GFR → oliguria, azotemia, ↑ renin release, HTN Proteinuria often in the subnephrotic range (< 3.5 g/ day) but in severe cases may be in nephrotic range	 Acute poststreptococcal glomerulonephritis Rapidly progressive glomerulonephritis IgA nephropathy (Berger disease) Alport syndrome Membranoproliferative glomerulonephritis
Nephrotic syndrome	Podocyte damage → impaired charge barrier → proteinuria	Massive proteinuria (> 3.5 g/ day) with hypoalbuminemia, edema Frothy urine with fatty casts Associated with hypercoagulable state due to antithrombin III loss in urine and † risk of infection (loss of IgGs in urine and soft tissue compromise by edema)	May be 1° (eg, direct podocyte damage) or 2° (podocyte damage from systemic process): • Focal segmental glomerulosclerosis (1° or 2°) • Minimal change disease (1° or 2°) • Membranous nephropathy (1° or 2°) • Amyloidosis (2°) • Diabetic glomerulonephropathy (2°)
Nephritic-nephrotic syndrome	Severe GBM damage → loss of RBCs into urine + impaired charge barrier → hematuria + proteinuria	Nephrotic-range proteinuria (> 3.5 g/day) and concomitant features of nephrotic syndrome	Can occur with any form of nephritic syndrome, but is most common with: Diffuse proliferative glomerulonephritis Membranoproliferative glomerulonephritis

FAS1_2019_14-Renal.indd 595 11/7/19 5:42 PM

596 SECTION III

RENAL ▶ RENAL—PATHOLOGY

Nephritic syndrome NephrItic syndrome = Inflammatory process. Most frequently seen in children. ~ 2–4 weeks after group A streptococcal infection of pharynx or **Acute** skin. Resolves spontaneously in most children; may progress to renal insufficiency in adults. Type poststreptococcal glomerulonephritis III hypersensitivity reaction. Presents with peripheral and periorbital edema, tea or cola-colored urine, HTN. ⊕ strep titers/serologies, ↓ complement levels (C3) due to consumption. LM—glomeruli enlarged and hypercellular A • IF—("starry sky") granular appearance ("lumpy-bumpy") B due to IgG, IgM, and C3 deposition along GBM and mesangium EM—subepithelial IC humps Poor prognosis, rapidly deteriorating renal function (days to weeks). Rapidly progressive (crescentic) LM—crescent moon shape C. Crescents consist of fibrin and plasma proteins (eg, C3b) with glomerulonephritis glomerular parietal cells, monocytes, macrophages Several disease processes may result in this pattern which may be delineated via IF pattern. Linear IF due to antibodies to GBM and alveolar basement membrane: Goodpasture syndrome—hematuria/hemoptysis; type II hypersensitivity reaction. Treatment: plasmapheresis Negative IF/Pauci-immune (no Ig/C3 deposition): granulomatosis with polyangiitis (Wegener)—PR3-ANCA/c-ANCA, eosinophilic granulomatosis with polyangiitis (Churg-Strauss) or Microscopic polyangiitis—MPO-ANCA/p-ANCA Granular IF—PSGN or DPGN Diffuse proliferative Often due to SLE (think "wire lupus"). DPGN and MPGN often present as nephrotic syndrome glomerulonephritis and nephritic syndrome concurrently. ■ LM—"wire looping" of capillaries D IF—granular; EM—subendothelial, sometimes subepithelial or intramembranous IgG-based ICs often with C3 deposition IgA nephropathy Episodic hematuria that usually occurs concurrently with respiratory or GI tract infections (IgA is (Berger disease) secreted by mucosal linings). Renal pathology of IgA vasculitis (HSP). LM—mesangial proliferation IF—IgA-based IC deposits in mesangium; EM—mesangial IC deposition Alport syndrome Mutation in type IV collagen → thinning and splitting of glomerular basement membrane. Most commonly X-linked dominant. Eye problems (eg, retinopathy, anterior lenticonus), glomerulonephritis, sensorineural deafness; "can't see, can't pee, can't hear a bee." EM—"basket-weave" appearance due to irregular thickening of GBM Membrano-MPGN is a nephritic syndrome that often co-presents with nephrotic syndrome. proliferative Type I may be 2° to hepatitis B or C infection. May also be idiopathic. Subendothelial IC deposits with granular IF glomerulonephritis Type II is associated with C3 nephritic factor (IgG autoantibody that stabilizes C3 convertase → persistent complement activation → ↓ C3 levels). Intramembranous deposits, also called dense deposit disease Both types: mesangial ingrowth → GBM splitting → "tram-track" on H&E and PAS **E** stains.

FAS1_2019_14-Renal.indd 596 11/7/19 5:42 PM

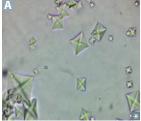
Nephrotic syndrome	NephrOtic syndrome—massive prOteinuria (> 3.5 g/day)	
Minimal change disease	Also known as lipoid nephrosis. Most common cause of nephrotic syndrome in children. Often 1° (Idiopathic) and may be triggered by recent Infection, Immunization, Immune stimulus (4 I's of MCD). Rarely, may be 2° to lymphoma (eg, cytokine-mediated damage). 1° disease has excellent response to corticosteroids. ■ LM—Normal glomeruli (lipid may be seen in PCT cells) ■ IF—⊝ ■ EM—effacement of podocyte foot processes A	
Focal segmental glomerulosclerosis	Most common cause of nephrotic syndrome in African-Americans and Hispanics. Can be 1° (idiopathic) or 2° to other conditions (eg, HIV infection, sickle cell disease, heroin abuse, massive obesity, interferon treatment, or congenital malformations). 1° disease has inconsistent response to steroids. May progress to CKD. LM—segmental sclerosis and hyalinosis B IF—often ⊕ but may be ⊕ for nonspecific focal deposits of IgM, C3, C1 EM—effacement of foot processes similar to minimal change disease	
Membranous nephropathy	Also known as membranous glomerulonephritis. Can be 1° (eg, antibodies to phospholipase A₂ receptor) or 2° to drugs (eg, NSAIDs, penicillamine, gold), infections (eg, HBV, HCV, syphilis), SLE, or solid tumors. 1° disease has poor response to steroids. May progress to CKD. ■ LM—diffuse capillary and GBM thickening ■ ■ IF—granular due to immune complex (IC) deposition ■ EM—"Spike and dome" appearance of subepithelial deposits	
Amyloidosis	Kidney is the most commonly involved organ (systemic amyloidosis). Associated with chronic conditions that predispose to amyloid deposition (eg, AL amyloid, AA amyloid). • LM—Congo red stain shows apple-green birefringence under polarized light due to amyloid deposition in the mesangium	
Diabetic glomerulo- nephropathy	Most common cause of ESRD in the United States. Hyperglycemia → nonenzymatic glycation of tissue proteins → mesangial expansion; GBM thickening and ↑ permeability. Hyperfiltration (glomerular HTN and ↑ GFR) → glomerular hypertrophy and glomerular scarring (glomerulosclerosis) → further progression of nephropathy. ■ LM—Mesangial expansion, GBM thickening, eosinophilic nodular glomerulosclerosis (Kimmelstiel-Wilson lesions □)	
	A D D X X X X X X X X X X X X X X X X X	

FAS1_2019_14-Renal.indd 597 11/7/19 5:42 PM

Kidney stones

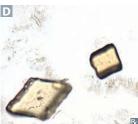
Can lead to severe complications such as hydronephrosis, pyelonephritis, and acute kidney injury. Obstructed stone presents with unilateral flank tenderness, colicky pain radiating to groin, hematuria. Treat and prevent by encouraging fluid intake.

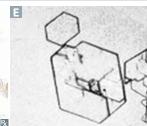
CONTENT	PRECIPITATES WITH	X-RAY FINDINGS	CT FINDINGS	URINE CRYSTAL	NOTES
Calcium	Calcium oxalate: hypocitraturia	Radiopaque	Radiopaque	Shaped like envelope A or dumbbell	Calcium stones most common (80%); calcium oxalate more common than calcium phosphate stones. Can result from ethylene glycol (antifreeze) ingestion, vitamin C abuse, hypocitraturia (associated with ↓ urine pH), malabsorption (eg, Crohn disease). Treatment: thiazides, citrate, low-sodium diet.
	Calcium phosphate: † pH	Radiopaque	Radiopaque	Wedge- shaped prism	Treatment: low-sodium diet, thiazides.
Ammonium magnesium phosphate (struvite)	↑ pH	Radiopaque	Radiopaque	Coffin lid B	Account for 15% of stones. Caused by infection with urease ⊕ bugs (eg, Proteus mirabilis, Staphylococcus saprophyticus, Klebsiella) that hydrolyze urea to ammonia → urine alkalinization. Commonly form staghorn calculi . Treatment: eradication of underlying infection, surgical removal of stone.
Uric acid	↓ pH	Radiol U cent	Minimally visible	Rhomboid or rosettes	About 5% of all stones. Risk factors: ↓ urine volume, arid climates, acidic pH. Strong association with hyperuricemia (eg, gout). Often seen in diseases with ↑ cell turnover (eg, leukemia). Treatment: alkalinization of urine, allopurinol.
Cystine	↓ pH	Faintly radiopaque	Moderately radiopaque	Hexagonal E	Hereditary (autosomal recessive) condition in which Cystine-reabsorbing PCT transporter loses function, causing cystinuria. Transporter defect also results in poor reabsorption of Ornithine, Lysine, Arginine (COLA). Cystine is poorly soluble, thus stones form in urine. Usually begins in childhood. Can form staghorn calculi. Sodium cyanide nitroprusside test ⊕. "SIXtine" stones have SIX sides. Treatment: low sodium diet, alkalinization of urine, chelating agents (eg, penicillamine) if refractory.











FAS1_2019_14-Renal.indd 598 11/7/19 5:42 PM

Hydronephrosis



Distention/dilation of renal pelvis and calvees A. Usually caused by urinary tract obstruction (eg, renal stones, severe BPH, congenital obstructions, cervical cancer, injury to ureter); other causes include retroperitoneal fibrosis, vesicoureteral reflux. Dilation occurs proximal to site of pathology. Serum creatinine becomes elevated if obstruction is bilateral or if patient has an obstructed solitary kidney. Leads to compression and possible atrophy of renal cortex and medulla.

Urinary incontinence	Mixed incontinence has features Stress incontinence	Urgency incontinence	Overflow incontinence Incomplete emptying (detrusor underactivity or outlet obstruction) → leak with overfilling, † postvoid residual on catheterization or ultrasound	
MECHANISM	Outlet incompetence (urethral hypermobility or intrinsic sphincter deficiency) → leak with † intra-abdominal pressure (eg, sneezing, lifting) ⊕ bladder stress test (directly observed leakage from urethra upon coughing or Valsalva maneuver)	Detrusor overactivity → leak with urge to void immediately		
ASSOCIATIONS	Obesity, vaginal delivery, prostate surgery	UTI	Polyuria (eg, diabetes), bladder outlet obstruction (eg, BPH), neurogenic bladder (eg, MS)	
TREATMENT	Pelvic floor muscle strengthening (Kegel) exercises, weight loss, pessaries	Kegel exercises, bladder training (timed voiding, distraction or relaxation techniques), antimuscarinics (eg, oxybutynin for overactive bladder), mirabegron	Catheterization, relieve obstruction (eg, α-blockers for BPH)	

FAS1_2019_14-Renal.indd 599 11/7/19 5:42 PM

600 SECTION III

RENAL ▶ RENAL—PATHOLOGY

Acute cystitis

Inflammation of urinary bladder. Presents as suprapubic pain, dysuria, urinary frequency, urgency. Systemic signs (eg, high fever, chills) are usually absent.

Risk factors include female sex (short urethra), sexual intercourse, indwelling catheter, diabetes mellitus, impaired bladder emptying.

Causes:

- *E coli* (most common)
- Staphylococcus saprophyticus—seen in sexually active young women (E coli is still more common in this group)
- Klebsiella
- Proteus mirabilis—urine has ammonia scent

Labs: ⊕ leukocyte esterase. ⊕ nitrites (indicate gram ⊖ organisms). Sterile pyuria (pyuria with ⊖ urine cultures) could suggest urethritis by *Neisseria gonorrhoeae* or *Chlamydia trachomatis*. Treatment: antibiotics (eg, TMP-SMX, nitrofurantoin).

Pyelonephritis

Acute pyelonephritis

Neutrophils infiltrate renal interstitium A. Affects cortex with relative sparing of glomeruli/vessels. Presents with fevers, flank pain (costovertebral angle tenderness), nausea/vomiting, chills. Causes include ascending UTI (*E coli* is most common), hematogenous spread to kidney. Presents with WBCs in urine +/– WBC casts. CT would show striated parenchymal enhancement B. Risk factors include indwelling urinary catheter, urinary tract obstruction, vesicoureteral reflux, diabetes mellitus, pregnancy.

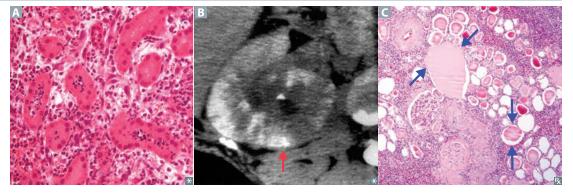
Complications include chronic pyelonephritis, renal papillary necrosis, perinephric abscess, urosepsis.

Treatment: antibiotics.

Chronic pyelonephritis

The result of recurrent or inadequately treated episodes of acute pyelonephritis. Typically requires predisposition to infection such as vesicoureteral reflux or chronically obstructing kidney stones. Coarse, asymmetric corticomedullary scarring, blunted calyx. Tubules can contain eosinophilic casts resembling thyroid tissue (thyroidization of kidney).

Xanthogranulomatous pyelonephritis—rare; grossly orange nodules that can mimic tumor nodules; characterized by widespread kidney damage due to granulomatous tissue containing foamy macrophages. Associated with *Proteus* infection.



FAS1_2019_14-Renal.indd 600 11/7/19 5:42 PM

Acute kidney injury

	Prerenal azotemia	Intrinsic renal failure	Postrenal azotemia
ETIOLOGY	Hypovolemia ↓ cardiac output ↓ effective circulating volume (eg, HF, liver failure)	Tubules and interstitium: Acute tubular necrosis (ischemia, sepsis, infection, nephrotoxins) Acute interstitial nephritis Glomerulus: Acute glomerulonephritis Vascular: Vasculitis Malignant hypertension TTP-HUS	Stones BPH Neoplasm Congenital anomalies
PATHOPHYSIOLOGY	↓ RBF → ↓ GFR → ↑ reabsorption of Na+/H ₂ O and urea	In ATN, patchy necrosis → debris obstructing tubules and fluid backflow → ↓ GFR In ATN, epithelial/granular casts	Outflow obstruction (bilateral
URINE OSMOLALITY (mOsm/kg)	>500	<350	<350
URINE Na+ (mEq/L)	<20	>40	Varies
FE _{Na}	<1%	>2%	Varies
SERUM BUN/Cr	>20	<15	Varies

Acute interstitial nephritis

Also called tubulointerstitial nephritis. Acute interstitial renal inflammation. Pyuria (classically eosinophils) and azotemia occurring after administration of drugs that act as haptens, inducing hypersensitivity (eg, diuretics, NSAIDs, penicillin derivatives, proton pump inhibitors, rifampin, quinolones, sulfonamides). Less commonly may be 2° to other processes such as systemic infections (eg, *Mycoplasma*) or autoimmune diseases (eg, Sjögren syndrome, SLE, sarcoidosis).

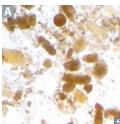
Associated with fever, rash, hematuria, pyuria, and costovertebral angle tenderness, but can be asymptomatic.

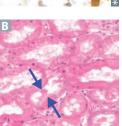
Remember these **5 P'S**:

- Pee (diuretics)
- Pain-free (NSAIDs)
- Penicillins and cephalosporins
- Proton pump inhibitors
- RifamPin
- Sulfa drugs

FAS1_2019_14-Renal.indd 601 11/7/19 5:42 PM

Acute tubular necrosis





Most common cause of acute kidney injury in hospitalized patients. Spontaneously resolves in many cases. Can be fatal, especially during initial oliguric phase. † ${\rm FE_{Na}}$.

Key finding: granular casts (often muddy brown in appearance) A.

3 stages:

- 1. Inciting event
- 2. Maintenance phase—oliguric; lasts 1–3 weeks; risk of hyperkalemia, metabolic acidosis, uremia
- 3. Recovery phase—polyuric; BUN and serum creatinine fall; risk of hypokalemia and renal wasting of other electrolytes and minerals

Can be caused by ischemic or nephrotoxic injury:

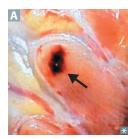
- Nephrotoxic—2° to injury resulting from toxic substances (eg, aminoglycosides, radiocontrast agents, lead, cisplatin, ethylene glycol), crush injury (myoglobinuria), hemoglobinuria. Proximal tubules are particularly susceptible to injury.

Diffuse cortical necrosis

Acute generalized cortical infarction of both kidneys. Likely due to a combination of vasospasm and DIC.

Associated with obstetric catastrophes (eg, abruptio placentae), septic shock.

Renal papillary necrosis



Sloughing of necrotic renal papillae A → gross hematuria and proteinuria. May be triggered by recent infection or immune stimulus.

Associated with: Sickle cell disease or trait,
Acute pyelonephritis, Analgesics (NSAIDs),
Diabetes mellitus (SAAD papa with
papillary necrosis).

FAS1_2019_14-Renal.indd 602 11/7/19 5:42 PM

Consequences of renal failure

Decline in renal filtration can lead to excess retained nitrogenous waste products and electrolyte disturbances.

Consequences (MAD HUNGER):

- Metabolic Acidosis
- Dyslipidemia (especially † triglycerides)
- High potassium
- Uremia—clinical syndrome marked by:
 - Nausea and anorexia
 - Pericarditis
 - Asterixis
 - Encephalopathy
 - Platelet dysfunction
- Na+/H₂O retention (HF, pulmonary edema, hypertension)
- Growth retardation and developmental delay
- Erythropoietin deficiency (anemia)
- Renal osteodystrophy

2 forms of renal failure: acute (eg, ATN) and chronic (eg, hypertension, diabetes mellitus, congenital anomalies).

Incremental reductions in GFR define the stages of chronic kidney disease.

Renal osteodystrophy

Hypocalcemia, hyperphosphatemia, and failure of vitamin D hydroxylation associated with chronic kidney disease \rightarrow 2° hyperparathyroidism \rightarrow 3° hyperparathyroidism (if 2° poorly managed). High serum phosphate can bind with $Ca^{2+} \rightarrow t$ issue deposits $\rightarrow \downarrow$ serum Ca^{2+} . $\downarrow 1,25$ -(OH), D_2 → ↓ intestinal Ca²⁺ absorption. Causes subperiosteal thinning of bones.

FAS1_2019_14-Renal.indd 603 11/7/19 5:42 PM 604

SECTION III

RENAL ▶ RENAL—PATHOLOGY

Renal cyst disorders

Autosomal dominant polycystic kidney disease

Numerous cysts in cortex and medulla \blacksquare causing bilateral enlarged kidneys ultimately destroy kidney parenchyma. Presents with flank pain, hematuria, hypertension, urinary infection, progressive renal failure in $\sim 50\%$ of individuals.

Mutation in *PKD1* (85% of cases, chromosome 16) or *PKD2* (15% of cases, chromosome 4). Complications include chronic kidney disease and hypertension (caused by † renin production). Associated with berry aneurysms, mitral valve prolapse, benign hepatic cysts, diverticulosis. Treatment: If hypertension or proteinuria develops, treat with ACE inhibitors or ARBs.

Autosomal recessive polycystic kidney disease

Cystic dilation of collecting ducts **B**. Often presents in infancy. Associated with congenital hepatic fibrosis. Significant oliguric renal failure in utero can lead to Potter sequence. Concerns beyond neonatal period include systemic hypertension, progressive renal insufficiency, and portal hypertension from congenital hepatic fibrosis.

Autosomal dominant tubulointerstitial kidney disease

Also called medullary cystic kidney disease. Causes tubulointerstitial fibrosis and progressive renal insufficiency with inability to concentrate urine. Medullary cysts usually not visualized; smaller kidneys on ultrasound. Poor prognosis.

Simple vs complex renal cysts

Simple cysts are filled with ultrafiltrate (anechoic on ultrasound **(**). Very common and account for majority of all renal masses. Found incidentally and typically asymptomatic.

Complex cysts, including those that are septated, enhanced, or have solid components on imaging require follow-up or removal due to risk of renal cell carcinoma.







Renovascular disease

Renal impairment due to ischemia from renal artery stenosis or microvascular disease.

↓ renal perfusion (one or both kidneys)

 \rightarrow † renin \rightarrow † angiotensin \rightarrow HTN.

Main causes of renal artery stenosis:

- Atherosclerotic plaques—proximal 1/3 of renal artery, usually in older males, smokers.
- Fibromuscular dysplasia—distal 2/3 of renal artery or segmental branches, usually young or middle-aged females.

Clinically, patients can have refractory HTN with negative family history of HTN, asymmetric renal size, epigastric/flank bruits. Most common cause of 2° HTN in adults. Other large vessels are often involved.

FAS1_2019_14-Renal.indd 604 11/7/19 5:42 PM

Renal cell carcinoma

Polygonal clear cells A filled with accumulated lipids and carbohydrate. Often golden-yellow B due to † lipid content.

Originates from PCT → invades renal vein (may develop varicocele if left sided) → IVC → hematogenous spread → metastasis to lung and bone.

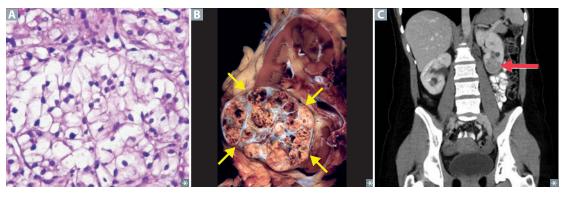
Manifests with hematuria, palpable masses, 2° polycythemia, flank pain, fever, weight loss. Treatment: surgery/ablation for localized disease. Immunotherapy (eg, aldesleukin) or targeted

therapy for metastatic disease, rarely curative. Resistant to chemotherapy and radiation therapy.

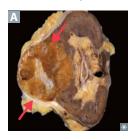
Most common 1° renal malignancy C. Most common in men 50-70 years old, † incidence with smoking and obesity. Associated with paraneoplastic syndromes, eg, PTHrP, Ectopic EPO, ACTH, Renin ("PEAR"-aneoplastic).

Clear cell (most common subtype) associated with gene deletion on chromosome 3 (sporadic, or inherited as von Hippel-Lindau syndrome).

RCC = 3 letters = chromosome 3.

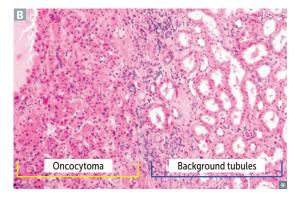


Renal oncocytoma



Benign epithelial cell tumor arising from collecting ducts (arrows in A point to wellcircumscribed mass with central scar). Large eosinophilic cells with abundant mitochondria without perinuclear clearing **B** (vs chromophobe renal cell carcinoma). Presents with painless hematuria, flank pain, abdominal mass.

Often resected to exclude malignancy (eg, renal cell carcinoma).



FAS1_2019_14-Renal.indd 605 11/7/19 5:42 PM

Nephroblastoma



Also called Wilms tumor. Most common renal malignancy of early childhood (ages 2–4). Contains embryonic glomerular structures. Presents with large, palpable, unilateral flank mass A and/or hematuria and possible HTN.

"Loss of function" mutations of tumor suppressor genes WT1 or WT2 on chromosome 11. May be a part of several syndromes:

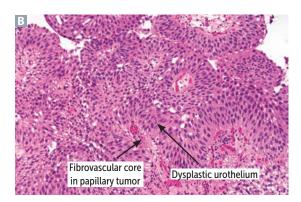
- WAGR complex—Wilms tumor, Aniridia (absence of iris), Genitourinary malformations, mental Retardation/intellectual disability (WT1 deletion)
- Denys-Drash syndrome—Wilms tumor, Diffuse mesangial sclerosis (early-onset nephrotic syndrome), Dysgenesis of gonads (male pseudohermaphroditism), WT1 mutation
- Beckwith-Wiedemann syndrome—Wilms tumor, macroglossia, organomegaly, hemihyperplasia (WT2 mutation), omphalocele

Urothelial carcinoma of the bladder



Also called transitional cell carcinoma. Most common tumor of urinary tract system (can occur in renal calyces, renal pelvis, ureters, and bladder) A B. Can be suggested by painless hematuria (no casts).

Associated with problems in your Pee SAC:
Phenacetin, Smoking, Aniline dyes, and
Cyclophosphamide.



Squamous cell carcinoma of the bladder

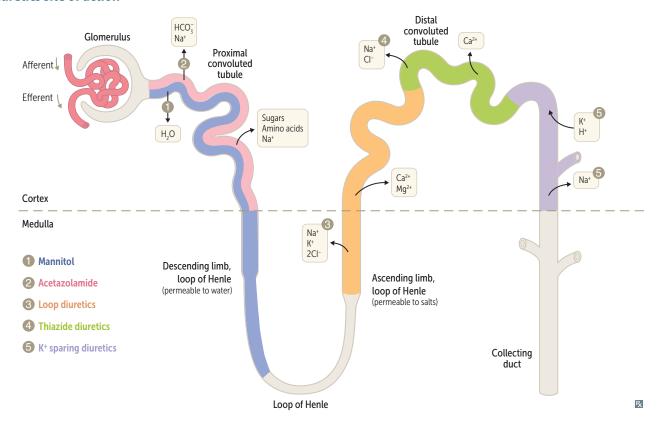
Chronic irritation of urinary bladder → squamous metaplasia → dysplasia and squamous cell carcinoma.

Risk factors include *Schistosoma haematobium* infection (Middle East), chronic cystitis, smoking, chronic nephrolithiasis. Presents with painless hematuria (no casts).

FAS1_2019_14-Renal.indd 606 11/7/19 5:42 PM

► RENAL—PHARMACOLOGY

Diuretics site of action



Mannitol

MECHANISM	Osmotic diuretic. ↑ tubular fluid osmolarity → ↑ urine flow, ↓ intracranial/intraocular pressure.
CLINICAL USE	Drug overdose, elevated intracranial/intraocular pressure.
ADVERSE EFFECTS	Pulmonary edema, dehydration, hypo- or hypernatremia. Contraindicated in anuria, HF.

FAS1_2019_14-Renal.indd 607 11/7/19 5:42 PM

Acetazolamide

MECHANISM	Carbonic anhydrase inhibitor. Causes self- limited NaHCO₃ diuresis and ↓ total body HCO₃⁻ stores. Alkalinizes urine.	
CLINICAL USE	Glaucoma, metabolic alkalosis, altitude sickness, idiopathic intracranial hypertension.	
ADVERSE EFFECTS	Proximal renal tubular acidosis, paresthesias, NH, toxicity, sulfa allergy, hypokalemia. Promotes calcium phosphate stone formation (insoluble at high pH).	"Acid" azolamide causes Acidosis.

Loop diuretics

Furosemide, bume	etanide, torsemide	
MECHANISM	Sulfonamide loop diuretics. Inhibit cotransport system (Na+/K+/2Cl-) of thick ascending limb of loop of Henle. Abolish hypertonicity of medulla, preventing concentration of urine. Associated with † PGE (vasodilatory effect on afferent arteriole); inhibited by NSAIDs. † Ca ²⁺ excretion. Loops Lose Ca ²⁺ .	
CLINICAL USE	Edematous states (HF, cirrhosis, nephrotic syndrome, pulmonary edema), hypertension, hypercalcemia.	
ADVERSE EFFECTS	Ototoxicity, Hypokalemia, Hypomagnesemia, Dehydration, Allergy (sulfa), metabolic Alkalosis, Nephritis (interstitial), Gout.	OHH DAANG!
Ethacrynic acid		
MECHANISM	Nonsulfonamide inhibitor of cotransport system (Na ⁺ /K ⁺ /2Cl ⁻) of thick ascending limb of loop of Henle.	
CLINICAL USE	Diuresis in patients allergic to sulfa drugs.	
ADVERSE EFFECTS	Similar to furosemide, but more ototoxic.	Loop earrings hurt your ears.

FAS1_2019_14-Renal.indd 608 11/7/19 5:42 PM

Thiazide diuretics	Hydrochlorothiazide, chlorthalidone, metolazone.	
MECHANISM	Inhibit NaCl reabsorption in early DCT → ↓ diluting capacity of nephron. ↓ Ca ²⁺ excretion.	
CLINICAL USE	Hypertension, HF, idiopathic hypercalciuria, nephrogenic diabetes insipidus, osteoporosis.	
ADVERSE EFFECTS	Hypokalemic metabolic alkalosis, hyponatremia, hyperGlycemia, hyperLipidemia, hyperUricemia, hyperCalcemia. Sulfa allergy.	HyperGLUC.
Potassium-sparing diuretics	Spironolactone, Eplerenone, Amiloride, Triamterene.	Keep your SEAT
MECHANISM	Spironolactone and eplerenone are competitive aldosterone receptor antagonists in cortical	

Potassium-sparing diuretics	Spironolactone, Eplerenone, Amiloride, Triamterene.	Keep your SEAT
MECHANISM	Spironolactone and eplerenone are competitive aldosterone receptor antagonists in cortical collecting tubule. Triamterene and amiloride block Na ⁺ channels at the same part of the tubule.	
CLINICAL USE	Hyperaldosteronism, K ⁺ depletion, HF, hepatic ascites (spironolactone), nephrogenic DI (amiloride), antiandrogen.	
ADVERSE EFFECTS	Hyperkalemia (can lead to arrhythmias), endocrine effects with spironolactone (eg, gynecomastia, antiandrogen effects).	

Diuretics: electrolyte changes

Urine NaCl	† with all diuretics (strength varies based on potency of diuretic effect). Serum NaCl may decrease as a result.
Urine K ⁺	† especially with loop and thiazide diuretics. Serum K+ may decrease as a result.
Blood pH	 ↓ (acidemia): carbonic anhydrase inhibitors: ↓ HCO₃⁻ reabsorption. K⁺ sparing: aldosterone blockade prevents K⁺ secretion and H⁺ secretion. Additionally, hyperkalemia leads to K⁺ entering all cells (via H⁺/K⁺ exchanger) in exchange for H⁺ exiting cells. ↑ (alkalemia): loop diuretics and thiazides cause alkalemia through several mechanisms: ■ Volume contraction → ↑ AT II → ↑ Na⁺/H⁺ exchange in PCT → ↑ HCO₃⁻ reabsorption ("contraction alkalosis") ■ K⁺ loss leads to K⁺ exiting all cells (via H⁺/K⁺ exchanger) in exchange for H⁺ entering cells ■ In low K⁺ state, H⁺ (rather than K⁺) is exchanged for Na⁺ in cortical collecting tubule → alkalosis and "paradoxical aciduria"
Urine Ca ²⁺	↑ with loop diuretics: ↓ paracellular Ca²+ reabsorption → hypocalcemia. ↓ with thiazides: enhanced Ca²+ reabsorption.

FAS1_2019_14-Renal.indd 609 11/7/19 5:42 PM

610 SECTION III RENAL → RENAL—PHARMACOLOGY

Angiotensin- converting enzyme inhibitors	Captopril, enalapril, lisinopril, ramipril.	
MECHANISM	Inhibit ACE → ↓ AT II → ↓ GFR by preventing constriction of efferent arterioles. ↑ renin due to loss of negative feedback. Inhibition of ACE also prevents inactivation of bradykinin, a potent vasodilator.	
CLINICAL USE	Hypertension, HF (\dagger mortality), proteinuria, diabetic nephropathy. Prevent unfavorable heart remodeling as a result of chronic hypertension.	In chronic kidney disease (eg, diabetic nephropathy), ↓ intraglomerular pressure, slowing GBM thickening.
ADVERSE EFFECTS	Cough, Angioedema (both due to † bradykinin; contraindicated in C1 esterase inhibitor deficiency), Teratogen (fetal renal malformations), † Creatinine (↓ GFR), Hyperkalemia, and Hypotension. Used with caution in bilateral renal artery stenosis because ACE inhibitors will further ↓ GFR → renal failure.	Captopril's CATCHH.
Angiotensin II receptor olockers	Losartan, candesartan, valsartan.	
MECHANISM	Selectively block binding of angiotensin II to ${\rm AT_1}$ ARBs do not increase bradykinin.	receptor. Effects similar to ACE inhibitors, but
CLINICAL USE	Hypertension, HF, proteinuria, or chronic kidney intolerance to ACE inhibitors (eg, cough, angio	
ADVERSE EFFECTS	Hyperkalemia, ↓ GFR, hypotension; teratogen.	
Aliskiren		
MECHANISM	Direct renin inhibitor, blocks conversion of angio Ren in.	tensinogen to angiotensin I. Alis <mark>kiren Ki</mark> lls
CLINICAL USE	Hypertension.	
ADVERSE EFFECTS	Hyperkalemia, ↓ GFR, hypotension, angioedema taking ACE inhibitors or ARBs and contraindica	*

11/7/19 5:42 PM FAS1_2019_14-Renal.indd 610

HIGH-YIELD SYSTEMS

Reproductive

"Artificial insemination is when the farmer does it to the cow instead of the bull."

Student essay

Make no mistake about why these babies are here - they are here to replace us.

—Jerry Seinfeld

"Whoever called it necking was a poor judge of anatomy."

—Groucho Marx

"See, the problem is that God gives men a brain and a penis, and only enough blood to run one at a time."

-Robin Williams

The reproductive system can be intimidating at first but is manageable once you organize the concepts into the pregnancy, endocrinologic, embryologic, and oncologic aspects of reproduction. Study the endocrine and reproductive chapters together, because mastery of the hypothalamic-pituitary-gonadal axis is key to answering questions on ovulation, menstruation, disorders of sexual development, contraception, and many pathologies.

Embryology is a nuanced subject that covers multiple organ systems. Approaching it from a clinical perspective will allow for better understanding. For instance, make the connection between the presentation of DiGeorge syndrome and the 3rd/4th pharyngeal pouch, and between the Müllerian/Wolffian systems and disorders of sexual development.

As for oncology, don't worry about remembering screening or treatment guidelines. It is more important to know how these cancers present (eg, signs and symptoms) and their associated labs, histopathology, and risk factors. In addition, some of the testicular and ovarian cancers have distinct patterns of hCG, AFP, LH, or FSH derangements that serve as helpful clues in exam questions.

▶ Embryology	612
▶ Anatomy	624
▶ Physiology	629
▶ Pathology	638
▶ Pharmacology	655

FAS1_2019_15-Repro.indd 611 11/7/19 5:52 PM

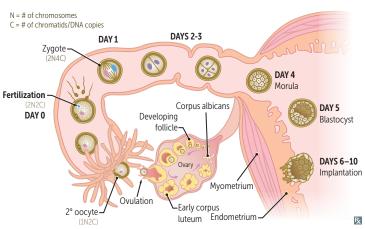
▶ REPRODUCTIVE—EMBRYOLOGY

Important genes of embryogenesis

GENE	LOCATION	FUNCTION	NOTES
Sonic hedgehog (SHH) gene	Zone of polarizing activity at base of limb buds	Anterior-posterior axis patterning, CNS development	Mutations → holoprosencephaly
Wnt-7 gene	Apical ectodermal ridge at distal end of each limb	Dorsal-ventral axis patterning, limb development	
Fibroblast growth factor (<i>FGF</i>) gene	Apical ectodermal ridge	Limb lengthening (via mitosis of mesoderm)	"Look at that Fetus, Growing Fingers"
Homeobox (<i>Hox</i>) genes	Multiple	Segmental organization in cranial-caudal direction, transcription factor coding	Mutations → appendages in wrong locations. Isotretinoin → † Hox gene expression

Early fetal development

Early embryonic development



Within week 1 hCG secretion begins around the time of implantation of blastocyst. Blastocyst "sticks" at day 6. Within week 2 Bilaminar disc (epiblast, hypoblast). 2 weeks = 2 layers. Within week 3 Gastrulation forms trilaminar embryonic disc. Cells from epiblast invaginate → primitive streak → endoderm, mesoderm, ectoderm. Notochord arises from midline mesoderm; overlying ectoderm becomes neural plate. 3 weeks = 3 layers. Weeks 3-8 (embryonic period) Neural tube formed by neuroectoderm and closes by week 4. Extremely susceptible to teratogous closes by week 4.	
Within week 3 Gastrulation forms trilaminar embryonic disc. Cells from epiblast invaginate → primitive streak → endoderm, mesoderm, ectoderm. Notochord arises from midline mesoderm; overlying ectoderm becomes neural plate. Weeks 3–8 Neural tube formed by neuroectoderm and Extremely susceptible to teratog	
Cells from epiblast invaginate → primitive streak → endoderm, mesoderm, ectoderm. Notochord arises from midline mesoderm; overlying ectoderm becomes neural plate. Weeks 3–8 Neural tube formed by neuroectoderm and Extremely susceptible to teratog	
,	
Organogenesis.	ogens.
Week 4 Heart begins to beat. 4 weeks = 4 limbs and 4 heart of Upper and lower limb buds begin to form.	chambers.
Week 6 Fetal cardiac activity visible by transvaginal ultrasound.	
Week 8 Fetal movements start. Gait at week 8.	
Week 10 Genitalia have male/female characteristics. Tenitalia.	

FAS1_2019_15-Repro.indd 612 11/7/19 5:52 PM

Embryologic derivatives

Ectoderm		External/outer layer	
Surface ectoderm	Epidermis; adenohypophysis (from Rathke pouch); lens of eye; epithelial linings of oral cavity, sensory organs of ear, and olfactory epithelium; anal canal below the pectinate line; parotid, sweat, mammary glands.	Craniopharyngioma—benign Rathke pouch tumor with cholesterol crystals, calcifications	
Neural tube	Brain (neurohypophysis, CNS neurons, oligo- dendrocytes, astrocytes, ependymal cells, pineal gland), retina, spinal cord.	Neuroectoderm—think CNS.	
Neural crest	Melanocytes, Odontoblasts, Tracheal cartilage, Enterochromaffin cells, Leptomeninges (arachnoid, pia), PNS ganglia (cranial, dorsal root, autonomic), Adrenal medulla, Schwann cells, Spiral membrane (aorticopulmonary septum), Endocardial cushions (also derived partially from mesoderm), Skull bones.	MOTEL PASSES Neural crest—think PNS and non-neural structures nearby.	
Mesoderm	Muscle, bone, connective tissue, serous linings of body cavities (eg, peritoneum, pericardium, pleura), spleen (develops within foregut mesentery), cardiovascular structures, lymphatics, blood, wall of gut tube, upper vagina, kidneys, adrenal cortex, dermis, testes, ovaries, microglia. Notochord induces ectoderm to form neuroectoderm (neural plate); its only postnatal derivative is the nucleus pulposus of the intervertebral disc.	Middle/"meat" layer. Mesodermal defects = VACTERL: Vertebral defects Anal atresia Cardiac defects Tracheo-Esophageal fistula Renal defects Limb defects (bone and muscle)	
Endoderm	Gut tube epithelium (including anal canal above the pectinate line), most of urethra and lower vagina (derived from urogenital sinus), luminal epithelial derivatives (eg, lungs, liver, gallbladder, pancreas, eustachian tube, thymus, parathyroid, thyroid follicular and parafollicular [C] cells).	"Enternal" layer.	

Types of errors in morphogenesis

Agenesis	Absent organ due to absent primordial tissue.	
Aplasia	Absent organ despite presence of primordial tissue.	
Hypoplasia	Incomplete organ development; primordial tissue present.	
Disruption	2° breakdown of previously normal tissue or structure (eg, amniotic band syndrome).	
Deformation	Extrinsic disruption (eg, multiple gestations → crowding → foot deformities); occurs after embryonic period.	
Malformation	Intrinsic disruption; occurs during embryonic period (weeks 3–8).	
Sequence	Abnormalities result from a single 1° embryologic event (eg, oligohydramnios → Potter sequence).	

FAS1_2019_15-Repro.indd 613 11/7/19 5:52 PM

Teratogens	Most susceptible in 3rd–8th weeks (embryonic pe 3, "all-or-none" effects. After week 8, growth and	
TERATOGEN	EFFECTS ON FETUS	NOTES
Medications		
ACE inhibitors	Renal failure, oligohydramnios, hypocalvaria.	
Alkylating agents	Absence of digits, multiple anomalies.	
Aminoglycosides	Ototoxicity.	A mean guy hit the baby in the ear.
Antiepileptic drugs	Neural tube defects, cardiac defects, cleft palate, skeletal abnormalities (eg, phalanx/nail hypoplasia, facial dysmorphism).	High-dose folate supplementation recommended. Most commonly valproate, carbamazepine, phenytoin, phenobarbital.
Diethylstilbestrol (DES)	Vaginal clear cell adenocarcinoma, congenital Müllerian anomalies.	
Fluoroquinolones	Cartilage damage.	
Folate antagonists	Neural tube defects.	Antiepileptics, trimethoprim, methotrexate.
Isotretinoin	Multiple severe birth defects.	Contraception mandatory. Iso TERAT inoin.
Lithium	Ebstein anomaly.	
Methimazole	Aplasia cutis congenita (congenital absence of skin, particularly on scalp).	
Tetracyclines	Discolored teeth, inhibited bone growth.	"Teethracyclines."
Thalidomide	Limb defects (phocomelia, micromelia— "flipper" limbs).	Limb defects with "tha-limb-domide."
Warfarin	Bone and cartilage deformities (stippled epiphyses, nasal and limb hypoplasia), optic nerve atrophy, fetal cerebral hemorrhage.	Do not wage warfare on the baby; keep it heppy with heparin (does not cross placenta).
Substance abuse		
Alcohol	Fetal alcohol syndrome.	
Cocaine	Low birth weight, preterm birth, IUGR, placental abruption.	Cocaine → vasoconstriction.
Smoking (nicotine, CO)	Low birth weight (leading cause in developed countries), preterm labor, placental problems, IUGR, SIDS, ADHD.	Nicotine \rightarrow vasoconstriction. CO \rightarrow impaired O ₂ delivery.
Other		
lodine (lack or excess)	Congenital goiter or hypothyroidism (cretinism).	
Maternal diabetes	Caudal regression syndrome, cardiac defects (eg, VSD), neural tube defects, macrosomia, neonatal hypoglycemia (due to islet cell hyperplasia), polycythemia.	
Methylmercury	Neurotoxicity.	Highest in swordfish, shark, tilefish, king mackerel.
Vitamin A excess	Extremely high risk for spontaneous abortions and birth defects (cleft palate, cardiac).	
X-rays	Microcephaly, intellectual disability.	Minimized by lead shielding.

FAS1_2019_15-Repro.indd 614 11/7/19 5:52 PM

SECTION III

Fetal alcohol syndrome



One of the leading preventable causes of intellectual disability in the US. Newborns of mothers who consumed alcohol during any stage of pregnancy have † incidence of congenital abnormalities, including pre- and postnatal developmental retardation, microcephaly, facial abnormalities A (eg, smooth philtrum, thin vermillion border, small palpebral fissures), limb dislocation, heart defects. Heart-lung fistulas and holoprosencephaly in most severe form. One mechanism is due to impaired migration of neuronal and glial cells.

Neonatal abstinence syndrome

Complex disorder involving CNS, ANS, and GI systems. Secondary to maternal substance use/ abuse (most commonly opioids).

Universal screening for substance abuse is recommended in all pregnant patients.

Newborns may present with uncoordinated sucking reflexes, irritability, high-pitched crying, tremors, tachypnea, sneezing, diarrhea, and possibly seizures.

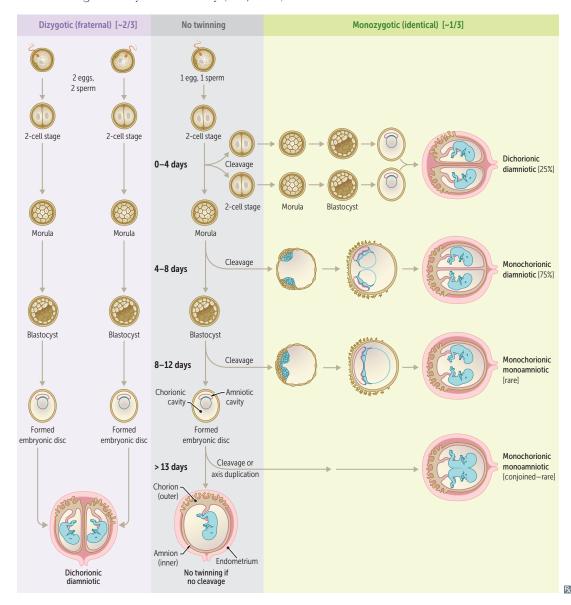
Treatment (for opiate abuse): methadone, morphine, buprenorphine.

FAS1_2019_15-Repro.indd 615 11/7/19 5:52 PM

Twinning

Dizygotic ("fraternal") twins arise from 2 eggs that are separately fertilized by 2 different sperm (always 2 zygotes) and will have 2 separate amniotic sacs and 2 separate placentas (chorions). Monozygotic ("identical") twins arise from 1 fertilized egg (1 egg + 1 sperm) that splits in early pregnancy. The timing of cleavage determines chorionicity (number of chorions) and amnionicity (number of amnions) (SCAB):

- Cleavage 0–4 days: Separate chorion and amnion
- Cleavage 4–8 days: shared Chorion
- Cleavage 8–12 days: shared Amnion
- Cleavage 13+ days: shared Body (conjoined)



FAS1_2019_15-Repro.indd 616 11/7/19 5:52 PM

Placenta 1° site of nutrient and gas exchange between mother and fetus. Fetal component Cytotrophoblast Inner layer of chorionic villi. Cytotrophoblast makes Cells. Syncytiotrophoblast Outer layer of chorionic villi; synthesizes and Syncytiotrophoblast synthesizes hormones. secretes hormones, eg, hCG (structurally Lacks MHC-I expression → ↓ chance of attack similar to LH; stimulates corpus luteum to by maternal immune system. secrete progesterone during first trimester). Maternal component **Decidua** basalis Derived from endometrium. Maternal blood in lacunae. circulation Endometrial artery Branch villus Umbilical vein-Maternal circulation (O₂ rich) Umbilical arteries H₂O, electrolytes (O₂ poor) Nutrients Hormones lgG Drugs Fetal circulation Viruses CO₂ H₂O Urea, waste products Hormones Syncytiotrophoblast Cytotrophoblast -Endothelial cell Amnion Chorionic plate Maternal blood Decidua basalis Ŗ

FAS1_2019_15-Repro.indd 617 11/7/19 5:52 PM

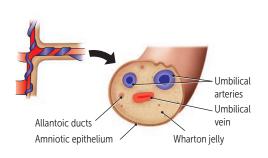
REPRODUCTIVE ▶ REPRODUCTIVE—EMBRYOLOGY

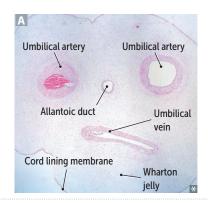
Umbilical cord

Two umbilical arteries return deoxygenated blood from fetal internal iliac arteries to placenta A.

One umbilical vein supplies oxygenated blood from placenta to fetus; drains into IVC via liver or via ductus venosus. Single umbilical artery (2-vessel cord) is associated with congenital and chromosomal anomalies.

Umbilical arteries and vein are derived from allantois.





Urachus

Allantois forms from hindgut and extends into urogenital sinus. Allantois becomes the urachus, a duct between fetal bladder and umbilicus. Failure of urachus to involute can lead to anomalies that may increase risk of infection and/or malignancy (eg, adenocarcinoma) if not treated. Obliterated urachus is represented by the median umbilical ligament after birth, which is covered by median umbilical fold of the peritoneum.

Patent urachus

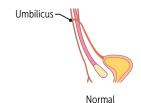
Total failure of urachus to obliterate \rightarrow urine discharge from umbilicus.

Urachal cyst

Partial failure of urachus to obliterate; fluid-filled cavity lined with uroepithelium, between umbilicus and bladder. Cyst can become infected and present as painful mass below umbilicus.

Vesicourachal diverticulum

Slight failure of urachus to obliterate → outpouching of bladder.









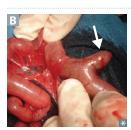
Vitelline duct

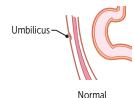
7th week—obliteration of vitelline duct (omphalomesenteric duct), which connects yolk sac to midgut lumen.

Vitelline fistula Meckel diverticulum

Vitelline duct fails to close → meconium discharge from umbilicus.

Partial closure of vitelline duct, with patent portion attached to ileum (true diverticulum, white arrow in ■). May be asymptomatic. May have heterotopic gastric and/or pancreatic tissue → melena, hematochezia, abdominal pain.









Vitelline fistula

Meckel diverticulum

FAS1_2019_15-Repro.indd 618 11/7/19 5:52 PM

Aortic arch derivatives	Develop into arterial system.	
1st	Part of maxillary artery (branch of external carotid)	lst arch is maximal
2nd	Stapedial artery and hyoid artery	Second = Stapedial
3rd	Common Carotid artery and proximal part of internal Carotid artery	C is 3rd letter of alphabet
4th	On left, aortic arch; on right, proximal part of right subclavian artery	4th arch (4 limbs) = systemic
6th	Proximal part of pulmonary arteries and (on left only) ductus arteriosus	6th arch = pulmonary and the pulmonary-to- systemic shunt (ductus arteriosus)
	3rd 4th Ath Right recurrent	3rd 4th Left recurrent laryngeal nerve

Pharyngeal apparatus

Composed of pharyngeal clefts, arches, pouches.

Pharyngeal clefts—derived from ectoderm. Also called pharyngeal grooves.

laryngeal nerve

loops around right

subclavian artery

Truncus arteriosus

6 months postnatal

Pharyngeal arches—derived from mesoderm (muscles, arteries) and neural crest (bones, cartilage).

Pharyngeal pouches—derived from endoderm.

CAP covers outside to inside:

Clefts = ectoderm

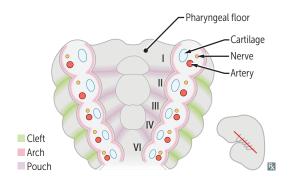
Descending aorta

Arches = mesoderm + neural crest

loops around aortic arch distal

to ductus arteriosus

Pouches = endoderm



Pharyngeal cleft derivatives

1st cleft develops into external auditory meatus.

2nd through 4th clefts form temporary cervical sinuses, which are obliterated by proliferation of 2nd arch mesenchyme.

Persistent cervical sinus → pharyngeal cleft cyst within lateral neck, anterior to sternocleidomastoid muscle (does not move with swallowing, vs thyroglossal duct cyst).

FAS1_2019_15-Repro.indd 619 11/7/19 5:52 PM

Pharyngeal arch derivatives

ARCH	CARTILAGE	MUSCLES	NERVESª	NOTES
1st pharyngeal arch	Maxillary process → Maxilla, zygoMatic bone Mandibular process → Meckel cartilage → Mandible, Malleus and incus, sphenoMandibular ligament	Muscles of Mastication (temporalis, Masseter, lateral and Medial pterygoids), Mylohyoid, anterior belly of digastric, tensor tympani, anterior 2/3 of tongue, tensor veli palatini	CN V ₃ chew	Pierre Robin sequence— micrognathia, glossoptosis, cleft palate, airway obstruction Treacher Collins syndrome—autosomal dominant neural crest dysfunction
2nd pharyngeal arch	Reichert cartilage: Stapes, Styloid process, leSSer horn of hyoid, Stylohyoid ligament	Muscles of facial expression, Stapedius, Stylohyoid, platySma, posterior belly of digastric	CN VII (facial expression) smile	crest dysfunction → craniofacial abnormalities (eg, zygomatic bone and mandibular hypoplasia), hearing loss, airway compromise
3rd pharyngeal arch	Greater horn of hyoid	Stylopharyngeus (think of stylopharyngeus innervated by glossopharyngeal nerve)	CN IX (stylo- pharyngeus) swallow stylishly	
4th and 6th pharyngeal arches	Arytenoids, Cricoid, Corniculate, Cuneiform, Thyroid (used to sing and ACCCT)	4th arch: most pharyngeal constrictors; cricothyroid, levator veli palatini 6th arch: all intrinsic muscles of larynx except cricothyroid	4th arch: CN X (superior laryngeal branch) simply swallow 6th arch: CN X (recurrent/ inferior laryngeal branch) speak	Arches 3 and 4 form posterior 1/3 of tongue Arch 5 makes no major developmental contributions

^a Sensory and motor nerves are not pharyngeal arch derivatives. They grow into the arches and are derived from neural crest (sensory) and neuroectoderm (motor).

FAS1_2019_15-Repro.indd 620 11/7/19 5:52 PM

When at the restaurant of the golden arches, children tend to first chew (1), then smile (2), then swallow stylishly (3) or simply swallow (4), and then speak (6).

Pharyngeal pouch derivatives

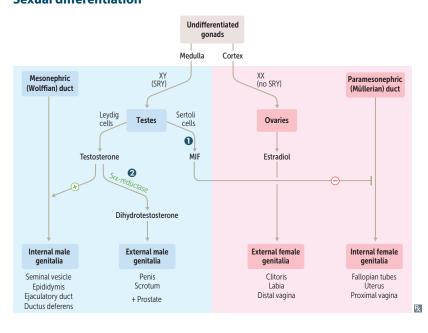
	DERIVATIVES	NOTES		MNEMONIC
1st pharyngeal pouch	Middle ear cavity, eustachian tube, mastoid air cells	lst pouch contribute endoderm-lined st of ear		Ear, tonsils, bottom-to-top: 1 (ear) 2 (tonsils)
2nd pharyngeal pouch	Epithelial lining of palatine tonsil			3 dorsal (bottom for inferior parathyroids)
3rd pharyngeal pouch	Dorsal wings → inferior parathyroids Ventral wings → thymus	3rd pouch contribut structures (thymus right inferior parat 3rd-pouch structure below 4th-pouch s	, left and hyroids) s end up	3 ventral (to = thymus)4 (top = superior parathyroids)
4th pharyngeal pouch	Dorsal wings → superior parathyroids Ventral wings → ultimopharyngeal body → parafollicular (C) cells of thyroid			
Cleft lip and cleft palate	Distinct, multifactorial etiologic	es, but often occur togo	ether.	
•	Distinct, multifactorial etiologic Due to failure of fusion of the merged medial nasal processe 1° palate).	naxillary and	ether.	

FAS1_2019_15-Repro.indd 621 11/7/19 5:52 PM

Genital embryology

7 . 37		
Female	Default development. Mesonephric duct degenerates and paramesonephric duct develops.	Indifferent gonad
Male	SRY gene on Y chromosome—produces testis- determining factor → testes development. Sertoli cells secrete Müllerian inhibitory factor (MIF, also called antimullerian hormone) that suppresses development of paramesonephric ducts.	Mesonephros ——Gubernaculum Paramesonephric duct Urogenital sinus
	Leydig cells secrete androgens that stimulate development of mesonephric ducts.	Testis-determining factor Androgens MIF
Paramesonephric (Müllerian) duct	Develops into female internal structures— fallopian tubes, uterus, upper portion of vagina (lower portion from urogenital sinus). Male remnant is appendix testis. Müllerian agenesis (Mayer-Rokitansky- Küster-Hauser syndrome)—may present as 1° amenorrhea (due to a lack of uterine development) in females with fully developed 2° sexual characteristics (functional ovaries).	Epididymis Ovary Metanephric kidney Oviduct Urinary bladder Degenerated mesonephric
Mesonephric (Wolffian) duct	Develops into male internal structures (except prostate)—Seminal vesicles, Epididymis, Ejaculatory duct, Ductus deferens (SEED). Female remnant is Gartner duct.	Degenerated duct paramesonephric duct Vas deferens Vagina
		R _k

Sexual differentiation



- ◆ Absence of Sertoli cells or lack of Müllerian inhibitory factor → develop both male and female internal genitalia and male external genitalia (streak gonads)
- 2 5α-reductase deficiency—inability to convert testosterone into DHT → male internal genitalia, ambiguous external genitalia until puberty (when ↑ testosterone levels cause masculinization)

In the testes:

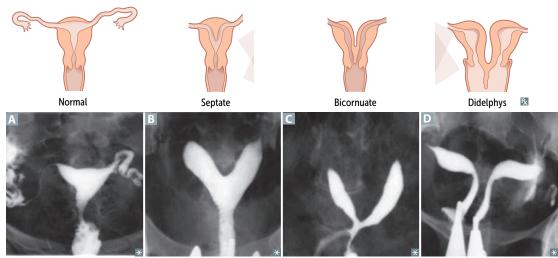
Leydig Leads to male (internal and external) sexual differentiation.

Sertoli Shuts down female (internal) sexual differentiation.

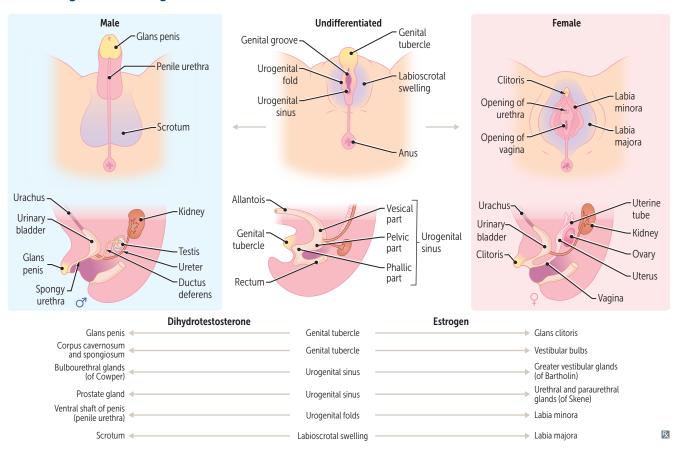
FAS1_2019_15-Repro.indd 622 11/7/19 5:52 PM

Uterine (Müllerian duct) anomalies

Septate uterus	Common anomaly vs normal uterus A. Incomplete resorption of septum B. \(\psi\) fertility and early miscarriage/pregnancy loss. Treat with septoplasty.
Bicornuate uterus	Incomplete fusion of Müllerian ducts . † risk of complicated pregnancy, early pregnancy loss, malpresentation, prematurity.
Uterus didelphys	Complete failure of fusion → double uterus, cervix, vagina D. Pregnancy possible.



Male/female genital homologs



FAS1_2019_15-Repro.indd 623 11/7/19 5:52 PM

Congenital penile abnormalities

Hypospadias



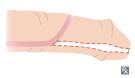
Abnormal opening of penile urethra on ventral surface of penis due to failure of urethral folds to fuse.

Hypospadias is more common than epispadias. Associated with inguinal hernia, cryptorchidism, chordee (downward or upward bending of penis).

Hypo is below.

Can be seen in 5α -reductase deficiency.

Epispadias



Abnormal opening of penile urethra on dorsal surface of penis due to faulty positioning of genital tubercle.

Exstrophy of the bladder is associated with Epispadias.

When you have **E**pispadias, you hit your **E**ye when you p**E**E.

Descent of testes and ovaries

	DESCRIPTION	MALE REMNANT	FEMALE REMNANT
Gubernaculum	Band of fibrous tissue	Anchors testes within scrotum	Ovarian ligament + round ligament of uterus
Processus vaginalis	Evagination of peritoneum	Forms tunica vaginalis Persistent patent processus vaginalis → hydrocele	Obliterated

▶ REPRODUCTIVE—ANATOMY

Gonadal drainage

Venous drainage

Left ovary/testis → left gonadal vein → left renal vein → IVC.

Right ovary/testis → right gonadal vein → IVC.

Because the left spermatic vein enters the left renal vein at a 90° angle, flow is less laminar on left than on right → left venous pressure > right venous pressure → varicocele more common on the left.

Lymphatic drainage

Ovaries/testes → para-aortic lymph nodes.

Body of uterus/cervix/superior part of bladder

→ external iliac nodes.

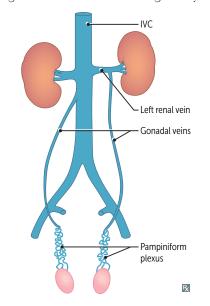
Prostate/cervix/corpus cavernosum/proximal vagina → internal iliac nodes.

Distal vagina/vulva/scrotum/distal anus

→ superficial inguinal nodes.

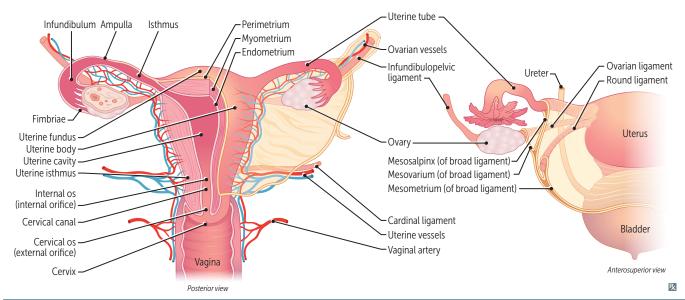
Glans penis → deep inguinal nodes.

"Left gonadal vein takes the Longest way."



FAS1_2019_15-Repro.indd 624 11/7/19 5:52 PM

Female reproductive anatomy



LIGAMENT	CONNECTS	STRUCTURES CONTAINED	NOTES
Infundibulopelvic (suspensory) ligament	Ovaries to lateral pelvic wall	Ovarian vessels	Ligate vessels during oophorectomy to avoid bleeding Ureter courses retroperitoneally, close to gonadal vessels → at risk of injury during ligation of ovarian vessels
Cardinal (transverse cervical) ligament	Cervix to side wall of pelvis	Uterine vessels	Ureter at risk of injury during ligation of uterine vessels in hysterectomy
Round ligament of the uterus	Uterine horn to labia majora		Derivative of gubernaculum. Travels through round inguinal canal; above the artery of Sampson
Broad ligament	Uterus, fallopian tubes, and ovaries to pelvic side wall	Ovaries, fallopian tubes, round ligaments of uterus	Fold of peritoneum that comprises the mesosalpinx, mesometrium, and mesovarium
Ovarian ligament	Medial pole of ovary to uterine horn		Derivative of gubernaculum Ovarian ligament latches to lateral uterus

Adnexal torsion

Twisting of ovary and fallopian tube around infundibulopelvic ligament and ovarian ligament → compression of ovarian vessels in infundibulopelvic ligament → blockage of lymphatic and venous outflow. Continued arterial perfusion → ovarian edema → complete blockage of arterial inflow → necrosis, local hemorrhage.

Associated with ovarian masses. Presents with acute pelvic pain, adnexal mass, nausea/vomiting.

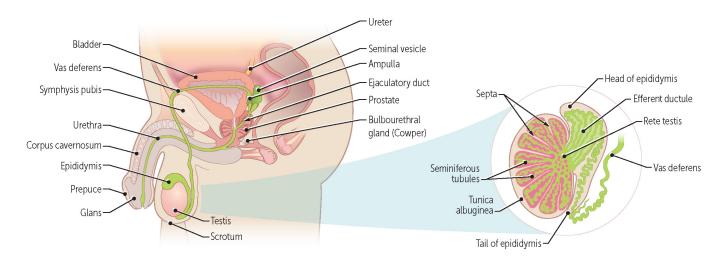
FAS1_2019_15-Repro.indd 625 11/7/19 5:52 PM

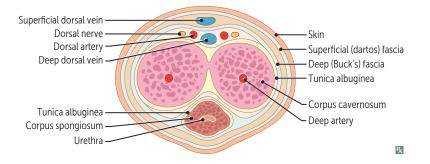
Female reproductive epithelial histology



TISSUE	HISTOLOGY/NOTES	
Vulva	Stratified squamous epithelium	
Vagina	Stratified squamous epithelium, nonkeratinized	
Ectocervix	Stratified squamous epithelium, nonkeratinized	
Transformation zone	Squamocolumnar junction A (most common area for cervical cancer)	
Endocervix	Simple columnar epithelium	
Uterus	Simple columnar epithelium with long tubular glands in proliferative phase; coiled glands in secretory phase	
Fallopian tube	Simple columnar epithelium, ciliated	
Ovary, outer surface	Simple cuboidal epithelium (germinal epithelium covering surface of ovary)	

Male reproductive anatomy





Pathway of sperm during ejaculation—

SEVEN UP:

Seminiferous tubules

Epididymis

Vas deferens

Ejaculatory ducts

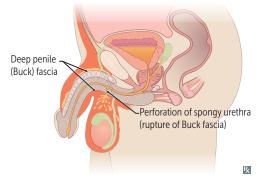
(Nothing)

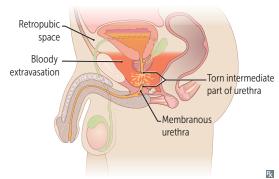
Urethra

Penis

FAS1_2019_15-Repro.indd 626 11/7/19 5:52 PM

Urethral injury Occurs almost exclusively in men. Suspect if blood seen at urethral meatus. Urethral catheterization is relatively contraindicated. Anterior urethral injury Posterior urethral injury PART OF URETHRA Membranous urethra Bulbar (spongy) urethra MECHANISM Pelvic fracture Perineal straddle injury LOCATION OF URINE LEAK/BLOOD Blood accumulates in scrotum Urine leaks into retropubic space ACCUMULATION If Buck fascia is torn, urine escapes into perineal space **PRESENTATION** Blood at urethral meatus and scrotal hematoma Blood at urethral meatus and high-riding prostate





Autonomic innervation of male sexual response

Erection—Parasympathetic nervous system (pelvic splanchnic nerves, S2-S4):

- NO → † cGMP → smooth muscle relaxation → vasodilation → proerectile.
- Norepinephrine → ↑ [Ca²⁺]_{in} → smooth muscle contraction → vasoconstriction → antierectile.

Emission—Sympathetic nervous system (hypogastric nerve, T11-L2).

Expulsion—visceral and Somatic nerves (pudendal nerve).

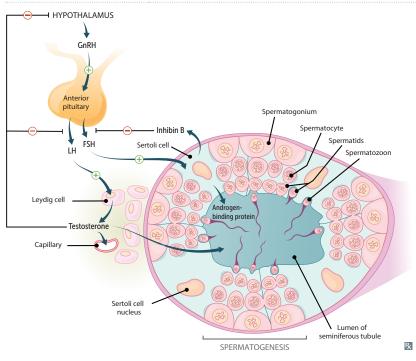
Point, Squeeze, and Shoot. S2, 3, 4 keep the penis off the floor.

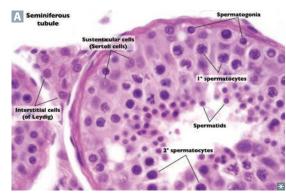
PDE-5 inhibitors (eg, sildenafil) → ↓ cGMP breakdown.

FAS1_2019_15-Repro.indd 627 11/7/19 5:52 PM

Seminiferous tubules

CELL	FUNCTION	LOCATION/NOTES
Spermatogonia	Maintain germ cell pool and produce 1° spermatocytes	Line seminiferous tubules A Germ cells
Sertoli cells	Secrete inhibin B → inhibit FSH	Line seminiferous tubules
	Secrete androgen-binding protein → maintain	Non-germ cells
	local levels of testosterone Produce MIF	Convert testosterone and androstenedione to estrogens via aromatase
	Tight junctions between adjacent Sertoli cells form blood-testis barrier → isolate gametes	Sertoli cells are inSide Seminiferous tubules, Support Sperm Synthesis, and inhibit FSH
	from autoimmune attack Support and nourish developing spermatozoa Regulate spermatogenesis	Homolog of female granulosa cells
	Temperature sensitive; ↓ sperm production and ↓ inhibin B with ↑ temperature	† temperature seen in varicocele, cryptorchidism
Leydig cells	Secrete testosterone in the presence of L H; testosterone production unaffected by temperature	Interstitium Endocrine cells Homolog of female theca interna cells Leydies (ladies) dig testosterone





FAS1_2019_15-Repro.indd 628 11/7/19 5:52 PM

▶ REPRODUCTIVE—PHYSIOLOGY

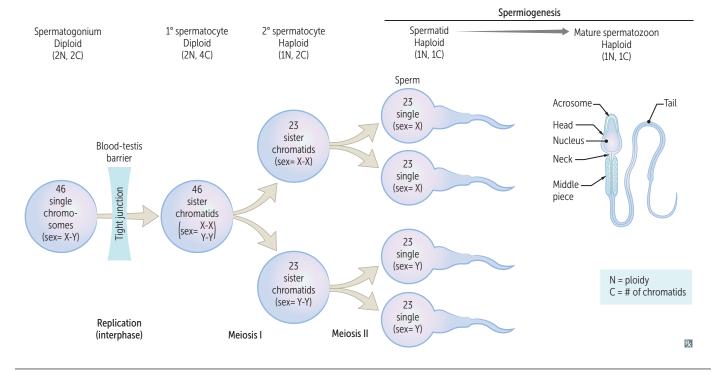
Spermatogenesis

Begins at puberty with spermatogonia. Full development takes 2 months. Occurs in seminiferous tubules. Produces spermatids that undergo spermiogenesis (loss of cytoplasmic contents, gain of acrosomal cap) to form mature spermatozoa.

"Conium" is going to be a sperm; "Zoon" is "Zooming" to egg.

Tail mobility impaired in ciliary dyskinesia/ Kartagener syndrome → infertility. Tail mobility normal in cystic fibrosis (in CF,

absent vas deferens → infertility).



FAS1_2019_15-Repro.indd 629 11/7/19 5:52 PM

630 **SECTION III**

REPRODUCTIVE ► REPRODUCTIVE—PHYSIOLOGY

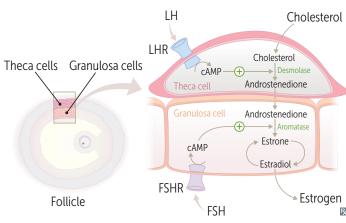
Estrogen

SOURCE	Ovary (17β-estradiol), placenta (estriol), adipose tissue (estrone via aromatization).	Potency
FUNCTION	Development of genitalia and breast, female fat distribution. Growth of follicle, endometrial proliferation, † myometrial excitability. Upregulation of estrogen, LH, and progesterone receptors; feedback inhibition of FSH and LH, then LH surge; stimulation of prolactin secretion. † transport proteins, SHBG; † HDL; ↓ LDL.	Pregnar 50-fe 1000 bein Estroger transle
		Н

y: estradiol > estrone > estriol.

- fold † in estradiol and estrone
- 00-fold † in estriol (indicator of fetal well-

en receptors expressed in cytoplasm; ocate to nucleus when bound by gen.



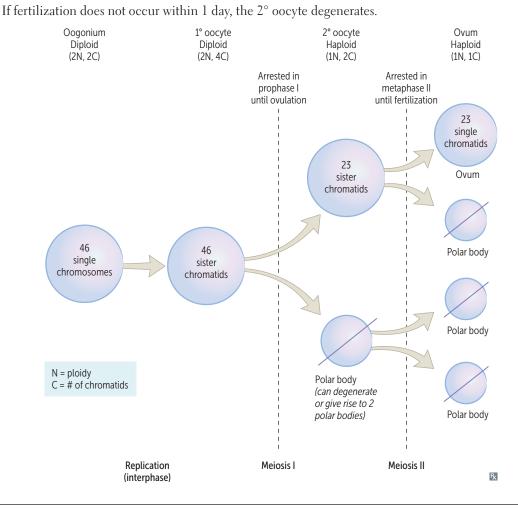
Progesterone

SOURCE	Corpus luteum, placenta, adrenal cortex, testes.	Fall in progesterone after delivery disinhibits
UNCTION	 During luteal phase, prepares uterus for implantation of fertilized egg: Stimulation of endometrial glandular secretions and spiral artery development Production of thick cervical mucus inhibits sperm entry into uterus Prevention of endometrial hyperplasia † body temperature destrogen receptor expression destrogen receptor expression Jonadotropin (LH, FSH) secretion During pregnancy: Maintenance of pregnancy myometrial excitability → department of the contraction frequency and intensity prolactin action on breasts 	prolactin → lactation. ↑ progesterone is indicative of ovulation. Progesterone is pro-gestation. Prolactin is pro-lactation.

FAS1_2019_15-Repro.indd 630 11/7/19 5:52 PM

Oogenesis

1° oocytes begin meiosis I during fetal life and complete meiosis I just prior to ovulation. Meiosis I is arrested in prOphase I for years until Ovulation (1° oocytes). Meiosis II is arrested in metaphase II until fertilization (2° oocytes). "An egg met a sperm."



Ovulation

↑ estrogen, ↑ GnRH receptors on anterior pituitary. Estrogen surge then stimulates LH release → ovulation (rupture of follicle). ↑ temperature (progesterone induced).

Mittelschmerz—transient mid-cycle ovulatory pain ("Middle hurts"); classically associated with peritoneal irritation (eg, follicular swelling/rupture, fallopian tube contraction). Can mimic appendicitis.

FAS1_2019_15-Repro.indd 631 11/7/19 5:52 PM

Menstrual cycle

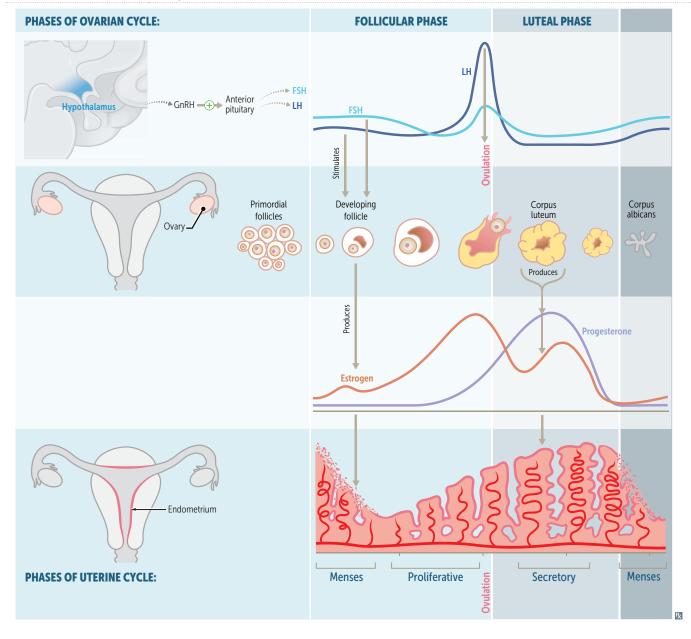
Follicular phase can vary in length. Luteal phase is 14 days. Ovulation day + 14 days = menstruation.

Follicular growth is fastest during 2nd week of the follicular phase.

Estrogen stimulates endometrial proliferation.

Progesterone maintains endometrium to support implantation.

↓ progesterone → ↓ fertility.



FAS1_2019_15-Repro.indd 632 11/7/19 5:52 PM

Abnormal uterine bleeding

Characterized as either heavy menstrual bleeding (AUB/HMB) or intermenstrual bleeding (AUB/IMB).

These are further subcategorized by **PALM-COEIN**:

- Structural causes (PALM): Polyp,
 Adenomyosis, Leiomyoma, or Malignancy/ hyperplasia
- Non-structural causes (COEIN):
 Coagulopathy, Ovulatory, Endometrial,
 Iatrogenic, Not yet classified

Terms such as dysfunctional uterine bleeding, menorrhagia, oligomenorrhea are no longer recommended.

Pregnancy

Fertilization most commonly occurs in upper end of fallopian tube (the ampulla). Occurs within 1 day of ovulation.

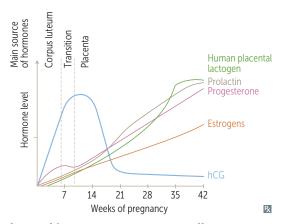
Implantation within the wall of the uterus occurs 6 days after fertilization.

Syncytiotrophoblasts secrete hCG, which is detectable in blood 1 week after conception and on home test in urine 2 weeks after conception.

Gestational age—calculated from date of last menstrual period.

Physiologic adaptations in pregnancy:

- ↑ GFR → ↓ BUN and creatinine,
 ↓ glucosuria threshold
- ↑ cardiac output (↑ preload, ↓ afterload,
 ↑ HR → ↑ placental and uterus perfusion)
- Anemia (†† plasma, † RBCs)
- Hypercoagulability (to ↓ blood loss at delivery)
- Hyperventilation (eliminate fetal CO₂)
- ↑ lipolysis and fat utilization (due to maternal hypoglycemia and insulin resistance) → preserves glucose and amino acids for utilization by the fetus



Placental hormone secretion generally increases over the course of pregnancy, but hCG peaks at 8–10 weeks.

Human chorionic gonadotropin

SOURCE

Syncytiotrophoblast of placenta.

FUNCTION

Maintains corpus luteum (and thus progesterone) for first 8–10 weeks of pregnancy by acting like LH (otherwise no luteal cell stimulation → abortion). After 8–10 weeks, placenta synthesizes its own estriol and progesterone and corpus luteum degenerates.

Used to detect pregnancy because it appears early in urine (see above).

Has identical α subunit as LH, FSH, TSH (states of † hCG can cause hyperthyroidism). β subunit is unique (pregnancy tests detect β subunit). hCG is † in multiple gestations, hydatidiform moles, choriocarcinomas, and Down syndrome; hCG is ‡ in ectopic/failing pregnancy, Edwards syndrome, and Patau syndrome.

FAS1_2019_15-Repro.indd 633 11/7/19 5:52 PM

634

SECTION III

REPRODUCTIVE → REPRODUCTIVE—PHYSIOLOGY

Human placental lactogen	Also called chorionic somatomammotropin.
SOURCE	Syncytiotrophoblast of placenta.
FUNCTION	Stimulates insulin production; overall † insulin resistance. Gestational diabetes can occur if maternal pancreatic function cannot overcome the insulin resistance.

Apgar score

	Score 2	Score 1	Score 0
Appearance	Pink	Extremities blue	Pale or blue
Pulse	≥ 100 bpm	< 100 bpm	No pulse
G rimace	Cries and pulls away	Grimaces or weak cry	No response to stimulation
Activity	Active movement	Arms, legs flexed	No movement
	Active movement	Arms, tegs flexed	No movement
Respiration	Strong cry	Slow, irregular	No breathing 及

Assessment of newborn vital signs following delivery via a 10-point scale evaluated at 1 minute and 5 minutes. Apgar score is based on Appearance, Pulse, Grimace, Activity, and Respiration. Apgar scores < 7 may require further evaluation. If Apgar score remains low at later time points, there is † risk the child will develop long-term neurologic damage.

FAS1_2019_15-Repro.indd 634 11/7/19 5:52 PM

SECTION III

Infant and child development

Milestone dates are ranges that have been approximated and vary by source. Children not meeting milestones may need assessment for potential developmental delay.

AGE	MOTOR	SOCIAL	VERBAL/COGNITIVE
Infant	Parents	Start	Observing,
0–12 mo	Primitive reflexes disappear— Moro (by 3 mo), rooting (by 4 mo), palmar (by 6 mo), Babinski (by 12 mo) Posture—lifts head up prone (by 1 mo), rolls and sits (by 6 mo), crawls (by 8 mo), stands (by 10 mo), walks (by 12–18 mo) Picks—passes toys hand to hand (by 6 mo), Pincer grasp (by 10 mo) Points to objects (by 12 mo)	Social smile (by 2 mo) Stranger anxiety (by 6 mo) Separation anxiety (by 9 mo)	Orients—first to voice (by 4 mo), then to name and gestures (by 9 mo) Object permanence (by 9 mo) Oratory—says "mama" and "dada" (by 10 mo)
Toddler	Child	Rearing	Working,
12–36 mo	Cruises, takes first steps (by 12 mo) Climbs stairs (by 18 mo) Cubes stacked—number = age (yr) × 3 Cutlery—feeds self with fork and spoon (by 20 mo) Kicks ball (by 24 mo)	Recreation—parallel play (by 24–36 mo) Rapprochement—moves away from and returns to mother (by 24 mo) Realization—core gender identity formed (by 36 mo)	Words—uses 50-200 words by 2 yr, uses 300+ words by 3 yr.
Preschool	Don't	Forget, they're still	Learning!
3–5 yr	Drive—tricycle (3 wheels at 3 yr) Drawings—copies line or circle, stick figure (by 4 yr) Dexterity—hops on one foot (by 4 yr), uses buttons or zippers, grooms self (by 5 yr)	Freedom—comfortably spends part of day away from mother (by 3 yr) Friends—cooperative play, has imaginary friends (by 4 yr)	Language—understands 1000 words by 3 yr (3 zeros), uses complete sentences and prepositions (by 4 yr) Legends—can tell detailed stories (by 4 yr)

Low birth weight

Defined as < 2500 g. Caused by prematurity or intrauterine growth restriction (IUGR). Associated with † risk of sudden infant death syndrome (SIDS) and with † overall mortality.

FAS1_2019_15-Repro.indd 635 11/7/19 5:52 PM 636 **SECTION III**

REPRODUCTIVE ▶ REPRODUCTIVE—PHYSIOLOGY

Lactation

After parturition and delivery of placenta, rapid ↓ in progesterone disinhibits prolactin → initiation of lactation. Suckling is required to maintain milk production and ejection, since † nerve stimulation $\rightarrow \uparrow$ oxytocin and prolactin.

Prolactin—induces and maintains lactation and ↓ reproductive function.

Oxytocin—assists in milk letdown; also promotes uterine contractions.

Breast milk is the ideal nutrition for infants < 6 months old. Contains maternal immunoglobulins (conferring passive immunity; mostly IgA), macrophages, lymphocytes. Breast milk reduces infant infections and is associated with \(\frac{1}{2}\) risk for child to develop asthma, allergies, diabetes mellitus, and obesity. Guidelines recommend exclusively breastfed infants get vitamin D and possibly iron supplementation.

Breastfeeding ↓ maternal risk of breast and ovarian cancer and facilitates mother-child bonding.

Menopause

Diagnosed by amenorrhea for 12 months. ↓ estrogen production due to age-linked decline in number of ovarian follicles. Average age at onset is 51 years (earlier in smokers).

Usually preceded by 4-5 years of abnormal menstrual cycles. Source of estrogen (estrone) after menopause becomes peripheral conversion of androgens, † androgens → hirsutism.

†† FSH is specific for menopause (loss of negative feedback on FSH due to ↓ estrogen). Hormonal changes: ↓ estrogen, ↑↑ FSH, ↑ LH (no surge), † GnRH.

Causes **HAVOCS**: Hot flashes, Atrophy of the Vagina, Osteoporosis, Coronary artery disease, Sleep disturbances.

Menopause before age 40 suggests 1° ovarian insufficiency (premature ovarian failure); may occur in women who have received chemotherapy and/or radiation therapy.

Androgens

Testosterone, dihydrotestosterone (DHT), androstenedione.

SOURCE

DHT and testosterone (testis), AnDrostenedione (ADrenal)

Potency: DHT > testosterone > androstenedione.

FUNCTION

Testosterone:

- Differentiation of epididymis, vas deferens, seminal vesicles (internal genitalia, except prostate)
- Growth spurt: penis, seminal vesicles, sperm, muscle, RBCs
- Deepening of voice
- Closing of epiphyseal plates (via estrogen converted from testosterone)
- Libido

DHT:

- Early—differentiation of penis, scrotum,
- Late—prostate growth, balding, sebaceous gland activity

Testosterone is converted to DHT by

 5α -reductase, which is inhibited by finasteride. In the male, androgens are converted to estrogen by cytochrome P-450 aromatase (primarily in adipose tissue and testis).

Aromatase is the key enzyme in conversion of androgens to estrogen.

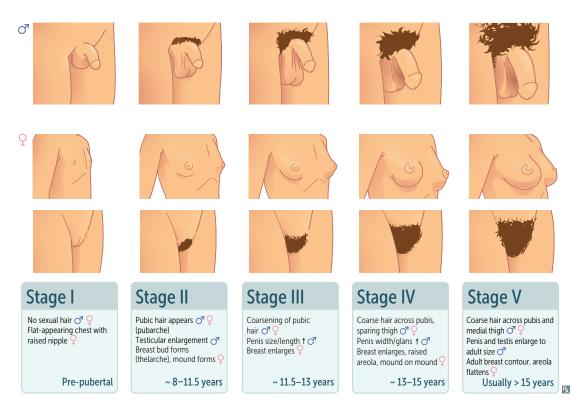
Androgenic steroid abuse—abuse of anabolic steroids to † fat-free mass, muscle strength, and performance. Suspect in men who present with changes in behavior (eg, aggression), acne, gynecomastia, † Hb and Hct, small testes (exogenous testosterone → hypothalamicpituitary-gonadal axis inhibition

→ ↓ intratesticular testosterone → ↓ testicular size, ↓ sperm count, azoospermia). Women may present with virilization (eg, hirsutism, acne, breast atrophy, male pattern baldness).

FAS1 2019 15-Repro.indd 636 11/7/19 5:52 PM

Tanner stages of sexual development

Tanner stage is assigned independently to genitalia, pubic hair, and breast (eg, a person can have Tanner stage 2 genitalia, Tanner stage 3 pubic hair). Earliest detectable secondary sexual characteristic is breast bud development in girls, testicular enlargement in boys.



Precocious puberty

Appearance of 2° sexual characteristics (eg, adrenarche, thelarche, menarche) before age 8 years in girls and 9 years in boys. ↑ sex hormone exposure or production → ↑ linear growth, somatic and skeletal maturation (eg, premature closure of epiphyseal plates → short stature). Types include:

- Central precocious puberty († GnRH secretion): idiopathic (most common; early activation of hypothalamic-pituitary gonadal axis), CNS tumors.
- Peripheral precocious puberty (GnRH-independent; † sex hormone production or exposure to exogenous sex steroids): congenital adrenal hyperplasia, estrogen-secreting ovarian tumor (eg, granulosa cell tumor), Leydig cell tumor, McCune-Albright syndrome.

FAS1_2019_15-Repro.indd 637 11/7/19 5:52 PM

▶ REPRODUCTIVE—PATHOLOGY

Sex chromosome disorders

Aneuploidy most commonly due to meiotic nondisjunction.

Klinefelter syndrome



Male, 47,XXY.

Testicular atrophy, eunuchoid body shape, tall, long extremities, gynecomastia, female hair distribution A. May present with developmental delay. Presence of inactivated X chromosome (Barr body). Common cause of hypogonadism seen in infertility work-up.

Dysgenesis of seminiferous tubules

 $\rightarrow \downarrow$ inhibin B $\rightarrow \uparrow$ FSH.

Abnormal Leydig cell function → ↓ testosterone → ↑ LH → ↑ estrogen.

Turner syndrome



Female, 45,XO.

Short stature (associated with SHOX gene, preventable with growth hormone therapy), ovarian dysgenesis (streak ovary), shield chest **B**, bicuspid aortic valve, coarctation of the aorta (femoral < brachial pulse), lymphatic defects (result in webbed neck or cystic hygroma; lymphedema in feet, hands), horseshoe kidney, high-arched palate, shortened 4th metacarpals.

Most common cause of 1° amenorrhea. No Barr body.

Menopause before menarche.

↓ estrogen leads to ↑ LH, FSH.

Sex chromosome (X, or rarely Y) loss often due to nondisjunction during meiosis or mitosis.

Meiosis errors usually occur in paternal gametes

→ sperm missing the sex chromosome.

Mitosis errors occur after zygote formation → loss of sex chromosome in some but not all cells

→ mosaic karyotype (eg. 45,X/46XX).

(45,X/46,XY) mosaicism associated with increased risk for gonadoblastoma.

Pregnancy is possible in some cases (IVF, exogenous estradiol- 17β and progesterone).

Double Y males

47, XYY.

Phenotypically normal (usually undiagnosed), very tall. Normal fertility. May be associated with severe acne, learning disability, autism spectrum disorders.

Ovotesticular disorder of sex development

46,XX > 46,XY.

Both ovarian and testicular tissue present (ovotestis); ambiguous genitalia. Previously called true hermaphroditism.

FAS1_2019_15-Repro.indd 638 11/7/19 5:52 PM

Diagnosing disorders	Testoste	rone	LH	Diagnosis			
of sex hormones	†		†	Defective androgen receptor			
	1		ţ	Testosterone-secreting tumor, exogenous steroids			
	Ţ		1	Hypergonadotropic hypogonadism (1°)			
	ţ		ţ	Hypogonadotropic hypogonadism (2°)			
Other disorders of sex development	Disagreement between the phenotypic sex (external genitalia, influenced by hormonal levels) and the gonadal sex (testes vs ovaries, corresponds with Y chromosome). Includes the terms pseudohermaphrodite, hermaphrodite, and intersex.						
46,XX DSD	Ovaries present, but external genitalia are virilized or ambiguous. Due to excessive and inappropriate exposure to androgenic steroids during early gestation (eg, congenital adrenal hyperplasia or exogenous administration of androgens during pregnancy).						
46,XY DSD	Testes present, but external genitalia are female or ambiguous. Most common form is androgen insensitivity syndrome (testicular feminization).						
Disorders by physical	UTERUS	BREASTS	DISORDERS				
characteristics	\oplus	Θ	pure gonadal d	pic hypogonadism (eg, Turner syndrome, genetic mosaicism, lysgenesis) pic hypogonadism (eg, CNS lesions, Kallmann syndrome)			
	\ominus	\oplus	Uterovaginal ago genotypic malo	enesis in genotypic female or androgen insensitivity in			
	Θ	Θ	Male genotype	with insufficient production of testosterone			
Placental aromatase deficiency	Inability to synthesize estrogens from androgens. Masculinization of female (46,XX DSD) infants (ambiguous genitalia), † serum testosterone and androstenedione. Can present with maternal virilization during pregnancy (fetal androgens cross the placenta).						
Androgen insensitivity syndrome	Defect in androgen receptor resulting in normal-appearing female (46,XY DSD); female external genitalia with scant axillary and pubic hair, rudimentary vagina; uterus and fallopian tubes absent due to persistence of anti-Müllerian hormone from testes. Patients develop normal functioning testes (often found in labia majora; surgically removed to prevent malignancy). † testosterone, estrogen, LH (vs sex chromosome disorders).						
5α-reductase deficiency	Autosomal recessive; sex limited to genetic males (46,XY DSD). Inability to convert testosterone to DHT. Ambiguous genitalia until puberty, when † testosterone causes masculinization/† growth of external genitalia. Testosterone/estrogen levels are normal; LH is normal or †. Internal genitalia are normal.						
Kallmann syndrome	Failure to complete puberty; a form of hypogonadotropic hypogonadism. Defective migration of neurons and subsequent failure of olfactory bulbs to develop → ↓ synthesis of GnRH in the hypothalamus; hyposmia/anosmia; ↓ GnRH, FSH, LH, testosterone. Infertility (low sperm count in males; amenorrhea in females).						

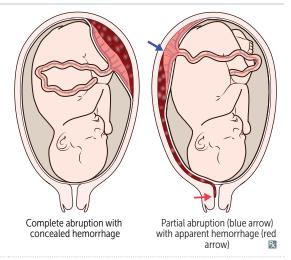
FAS1_2019_15-Repro.indd 639 11/7/19 5:52 PM

Pregnancy complications

Abruptio placentae

Premature separation (partial or complete) of placenta from uterine wall before delivery of infant. Risk factors: trauma (eg, motor vehicle accident), smoking, hypertension, preeclampsia, cocaine abuse.

Presentation: abrupt, painful bleeding (concealed or apparent) in third trimester; possible DIC (mediated by tissue factor activation), maternal shock, fetal distress. May be life threatening for mother and fetus.



Morbidly adherent placenta

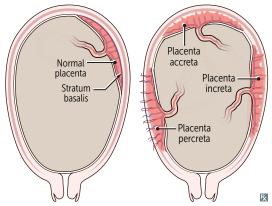
Defective decidual layer → abnormal attachment and separation after delivery. Risk factors: prior C-section or uterine surgery involving myometrium, inflammation, placenta previa, advanced maternal age, multiparity. Three types distinguishable by the depth of penetration:

Placenta accreta—placenta attaches to myometrium without penetrating it; most common type.

Placenta **increta**—placenta penetrates **into** myometrium.

Placenta percreta—placenta penetrates ("perforates") through myometrium and into uterine serosa (invades entire uterine wall); can result in placental attachment to rectum or bladder (can result in hematuria).

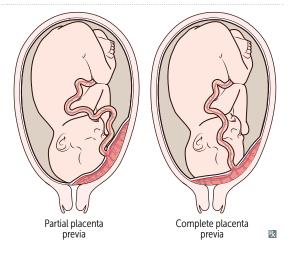
Presentation: often detected on ultrasound prior to delivery. No separation of placenta after delivery → postpartum bleeding (can cause Sheehan syndrome).



Placenta previa

Attachment of placenta over internal cervical os. Risk factors: multiparity, prior C-section. Associated with painless third-trimester bleeding. A "preview" of the placenta is visible through cervix.

Low-lying placenta (< 2 cm from internal cervical os, but not over it) is managed differently from placenta previa.

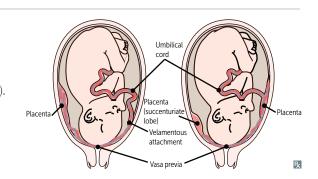


FAS1_2019_15-Repro.indd 640 11/7/19 5:52 PM

Pregnancy complications (continued)

Vasa previa

Fetal vessels run over, or in close proximity to, cervical os. May result in vessel rupture, exsanguination, fetal death. Presents with triad of membrane rupture, painless vaginal bleeding, fetal bradycardia (< 110 beats/min). Emergency C-section usually indicated. Frequently associated with velamentous umbilical cord insertion (cord inserts in chorioamniotic membrane rather than placenta → fetal vessels travel to placenta unprotected by Wharton jelly).



Postpartum hemorrhage

Due to 4 T's: Tone (uterine atony; most common), Trauma (lacerations, incisions, uterine rupture), Thrombin (coagulopathy), Tissue (retained products of conception). Treatment: uterine massage, oxytocin. If refractory, surgical ligation of uterine or internal iliac artery (will preserve fertility since ovarian arteries provide collateral circulation).

Ectopic pregnancy

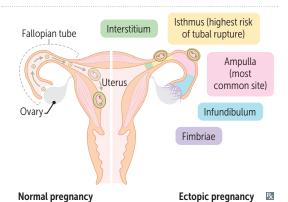


Implantation of fertilized ovum in a site other than the uterus, most often in ampulla of fallopian tube A. Suspect with history of amenorrhea, lower-than-expected rise in hCG based on dates, and sudden lower abdominal pain; confirm with ultrasound, which may show extraovarian adnexal mass. Often clinically mistaken for appendicitis.

Pain +/- bleeding.

Risk factors:

- Prior ectopic pregnancy
- History of infertility
- Salpingitis (PID)
- Ruptured appendix
- Prior tubal surgery
- Smoking
- Advanced maternal age



Amniotic fluid abnormalities

Polyhydramnios

Too much amniotic fluid. Often idiopathic, but associated with fetal malformations (eg, esophageal/duodenal atresia, anencephaly; both result in inability to swallow amniotic fluid), maternal diabetes, fetal anemia, multiple gestations.

Oligohydramnios

Too little amniotic fluid. Associated with placental insufficiency, bilateral renal agenesis, posterior urethral valves (in males) and resultant inability to excrete urine. Any profound oligohydramnios can cause Potter sequence.

FAS1 2019 15-Repro.indd 641 11/7/19 5:52 PM

Hydatidiform mole



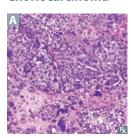


Cystic swelling of chorionic villi and proliferation of chorionic epithelium (only trophoblast). Presents with vaginal bleeding, emesis, uterine enlargement more than expected, pelvic pressure/pain. Associated with hCG-mediated sequelae: early preeclampsia (before 20 weeks), theca-lutein cysts, hyperemesis gravidarum, hyperthyroidism.

Treatment: dilation and curettage and methotrexate. Monitor hCG.

	Complete mole	Partial mole
KARYOTYPE	46,XX; 46,XY	69,XXX; 69,XXY; 69,XYY
COMPONENTS	Most commonly enucleated egg + single sperm (subsequently duplicates paternal DNA)	2 sperm + 1 egg
HISTOLOGY	Hydropic villi, circumferential and diffuse trophoblastic proliferation	Only some villi are hydropic, focal/minimal trophoblastic proliferation
FETAL PARTS	No	Yes (partial = fetal parts)
STAINING FOR P57 PROTEIN	\bigcirc (paternally imprinted)	⊕ (maternally expressed)
UTERINE SIZE	<u>†</u>	-
hCG	1111	†
IMAGING	"Honeycombed" uterus or "clusters of grapes" A, "snowstorm" B on ultrasound	Fetal parts
RISK OF INVASIVE MOLE	15–20%	< 5%
RISK OF CHORIOCARCINOMA	2%	Rare

Choriocarcinoma



Rare; can develop during or after pregnancy in mother or baby. Malignancy of trophoblastic tissue A (cytotrophoblasts, syncytiotrophoblasts); no chorionic villi present. † frequency of bilateral/multiple theca-lutein cysts. Presents with abnormal † hCG, shortness of breath, hemoptysis. Hematogenous spread to lungs → "cannonball" metastases B.

Treatment: methotrexate.



FAS1_2019_15-Repro.indd 642 11/7/19 5:52 PM

Hypertension in pregnancy

Gestational hypertension	BP > 140/90 mm Hg after 20th week of gestation. No pre-existing hypertension. No proteinuria or end-organ damage.	Treatment: antihypertensives (Hydralazine, α-Methyldopa, Labetalol, Nifedipine), deliver at 37–39 weeks. Hypertensive Moms Love Nifedipine.		
Preeclampsia	New-onset hypertension with either proteinuria or end-organ dysfunction after 20th week of gestation (< 20 weeks suggests molar pregnancy). Caused by abnormal placental spiral arteries → endothelial dysfunction, vasoconstriction, ischemia. Incidence ↑ in patients with pre-existing hypertension, diabetes, chronic kidney disease, autoimmune disorders (eg, antiphospholipid antibody syndrome), age > 40 years. Complications: placental abruption, coagulopathy, renal failure, pulmonary edema, uteroplacental insufficiency; may lead to eclampsia (+ seizures) and/or HELLP syndrome.	Treatment: antihypertensives, IV magnesium sulfate (to prevent seizure); definitive is delivery of fetus. Proteinuria, Rising BP (new-onset HTN), End-organ dysfunction (eg, pulmonary edema).		
Eclampsia	Preeclampsia + maternal seizures. Maternal death due to stroke, intracranial hemorrhage, or ARDS.	Treatment: IV magnesium sulfate, antihypertensives, immediate delivery.		
HELLP syndrome	Hemolysis, Elevated Liver enzymes, Low Platelets. A manifestation of severe preeclampsia. Blood smear shows schistocytes. Can lead to DIC (due to release of tissue factor from injured placenta) and hepatic subcapsular hematomas → rupture → severe hypotension.	Treatment: immediate delivery.		
Gynecologic tumor epidemiology Incidence (US)—endometrial > ovarian > cervical; cervical cancer is more common worldwide due to lack of screening or HPV vaccination. Prognosis: Cervical (best prognosis, diagnosed < 45 years old) > Endometrial (middle- aged, about 55 years old) > Ovarian (worst prognosis, > 65 years).		CEOs often go from best to worst as they get older.		

FAS1_2019_15-Repro.indd 643 11/7/19 5:52 PM

Vulvar pathology

Non-neoplastic	
Bartholin cyst and abscess	Due to blockage of Bartholin gland duct causing accumulation of gland fluid. May lead to abscess 2° to obstruction and inflammation A. Usually in reproductive-age females.
Lichen sclerosus	Thinning of epidermis with fibrosis/sclerosis of dermis. Presents with porcelain-white plaques with a red or violet border. Skin fragility with erosions can be observed B . Most common in postmenopausal women. Benign, but slightly increased risk for SCC.
Lichen simplex chronicus	Hyperplasia of vulvar squamous epithelium. Presents with leathery, thick vulvar skin with enhanced skin markings due to chronic rubbing or scratching. Benign, no risk of SCC.
Neoplastic	
Vulvar carcinoma	Carcinoma from squamous epithelial lining of vulva . Rare. Presents with leukoplakia, biopsy often required to distinguish carcinoma from other causes. HPV-related vulvar carcinoma—associated with high-risk HPV types 16, 18. Risk factors: multiple partners, early coitarche. Usually in reproductive-age females. Non-HPV vulvar carcinoma—usually from long-standing lichen sclerosus. Females > 70 years old.
Extramammary Paget disease	Intraepithelial adenocarcinoma. Carcinoma in situ, low risk of underlying carcinoma (vs Paget disease of the breast, which is always associated with underlying carcinoma). Presents with pruritus, erythema, crusting, ulcers D.









Imperforate hymen

Incomplete degeneration of the central portion of the hymen. Accumulation of vaginal mucus at birth → self-resolving bulge in introitus. If untreated, leads to 1° amenorrhea, cyclic abdominal pain, hematocolpos (accumulation of menstrual blood in vagina → bulging and bluish hymenal membrane).

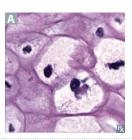
Vaginal tumors

Vaginal squamous cell carcinoma	Usually 2° to cervical SCC; 1° vaginal carcinoma rare.
Clear cell adenocarcinoma	Affects women who had exposure to DES in utero.
Sarcoma botryoides	Embryonal rhabdomyosarcoma variant. Affects girls < 4 years old; spindle-shaped cells; desmin ⊕. Presents with clear, grape-like, polypoid mass emerging from vagina.

FAS1_2019_15-Repro.indd 644 11/7/19 5:52 PM

Cervical pathology

Dysplasia and carcinoma in situ



Disordered epithelial growth; begins at basal layer of squamocolumnar junction (transformation zone) and extends outward. Classified as CIN 1, CIN 2, or CIN 3 (severe, irreversible dysplasia or carcinoma in situ), depending on extent of dysplasia. Associated with HPV-16 and HPV-18, which produce both the E6 gene product (inhibits TP53) and E7 gene product (inhibits pRb) (6 before 7; P before R). Koilocytes A are pathognomonic of HPV infection. May progress slowly to invasive carcinoma if left untreated. Typically asymptomatic (detected with Pap smear) or presents as abnormal vaginal bleeding (often postcoital).

Risk factors: multiple sexual partners, HPV, smoking, early coitarche, DES exposure, immunocompromise (eg, HIV, transplant).

Invasive carcinoma

Often squamous cell carcinoma. Pap smear can detect cervical dysplasia before it progresses to invasive carcinoma. Diagnose via colposcopy and biopsy. Lateral invasion can block ureters → hydronephrosis → renal failure.

Primary ovarian insufficiency

Also called premature ovarian failure.

Premature atresia of ovarian follicles in women of reproductive age. Most often idiopathic; associated with chromosomal abnormalities (especially in females < 30 years), autoimmunity. Need karyotype screening. Patients present with signs of menopause after puberty but before age 40. ↓ estrogen, † LH, † FSH.

Most common causes of anovulation

Pregnancy, polycystic ovarian syndrome, obesity, HPO axis abnormalities/immaturity, premature ovarian failure, hyperprolactinemia, thyroid disorders, eating disorders, competitive athletics, Cushing syndrome, adrenal insufficiency, chromosomal abnormalities (eg, Turner syndrome).

Functional hypothalamic amenorrhea

Also called exercise-induced amenorrhea. Severe caloric restriction, † energy expenditure, and/or stress → functional disruption of pulsatile GnRH secretion → ↓ LH, FSH, estrogen. Pathogenesis includes ↓ leptin (due to ↓ fat) and ↑ cortisol (stress, excessive exercise).

Associated with eating disorders and "female athlete triad" (4 calorie availability/excessive exercise, ↓ bone mineral density, menstrual dysfunction).

Polycystic ovarian syndrome



Hyperinsulinemia and/or insulin resistance hypothesized to alter hypothalamic hormonal feedback response → ↑ LH:FSH, ↑ androgens (eg, testosterone) from theca interna cells, ↓ rate of follicular maturation → unruptured follicles (cysts) + anovulation. Common cause of ↓ fertility in women. Enlarged, bilateral cystic ovaries A; presents with amenorrhea/oligomenorrhea, hirsutism, acne, ↓ fertility. Associated with obesity, acanthosis nigricans. ↑ risk of endometrial cancer 2° to

Treatment: cycle regulation via weight reduction (\$\frac{1}{2}\$ peripheral estrone formation), OCPs (prevent endometrial hyperplasia due to unopposed estrogen); clomiphene (ovulation induction); spironolactone, finasteride, flutamide to treat hirsutism.

Primary dysmenorrhea Painful menses, caused by uterine contractions to ↓ blood loss → ischemic pain. Mediated by prostaglandins. Treatment: NSAIDs.

FAS1 2019 15-Repro.indd 645 11/7/19 5:52 PM

unopposed estrogen from repeated anovulatory cycles.

Ovarian cysts

Follicular cyst	Distention of unruptured Graafian follicle. May be associated with hyperestrogenism, endometrial hyperplasia. Most common ovarian mass in young women.
Theca-lutein cyst	Often bilateral/multiple. Due to gonadotropin stimulation. Associated with choriocarcinoma and hydatidiform moles.

Ovarian neoplasms

Most common adnexal mass in women >55 years old. Present with abdominal distention, bowel obstruction, pleural effusion.

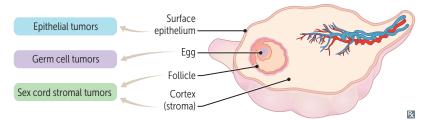
Risk † with advanced age, infertility, endometriosis, PCOS, genetic predisposition (eg, *BRCA1* or *BRCA2* mutations, Lynch syndrome, strong family history).

Risk ↓ with previous pregnancy, history of breastfeeding, OCPs, tubal ligation.

Epithelial tumors are typically serous (lined by serous epithelium natively found in fallopian tubes, and often bilateral) or mucinous (lined by mucinous epithelium natively found in cervix). Monitor response to therapy/relapse by measuring CA 125 levels (not good for screening).

Germ cell tumors can differentiate into somatic structures (eg, teratomas), or extra-embryonic structures (eg, yolk sac tumors), or can remain undifferentiated (eg, dysgerminoma).

Sex cord stromal tumors develop from embryonic sex cord (develops into theca and granulosa cells of follicle, Sertoli and Leydig cells of seminiferous tubules) and stromal (ovarian cortex) derivatives.

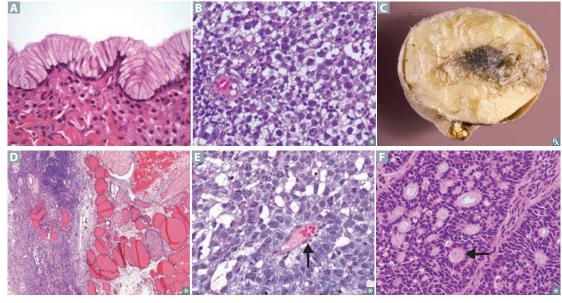


TYPE	MALIGNANT?	CHARACTERISTICS	
Epithelial tumors			
Serous cystadenoma	Benign	Most common ovarian neoplasm.	
Serous cystadenocarcinoma	Malignant	Most common malignant ovarian neoplasm. Psammoma bodies.	
Mucinous cystadenoma	Benign	Multiloculated, large. Lined by mucus-secreting epithelium A.	
Mucinous cystadenocarcinoma	Malignant	Rare. May be metastatic from appendiceal or GI tumors. Can result in pseudomyxoma peritonei (intraperitoneal accumulation of mucinous material)	
Brenner tumor	Usually benign	Solid, pale yellow-tan tumor that appears encapsulated. "Coffee bean" nuclei on H&E stain.	

FAS1_2019_15-Repro.indd 646 11/7/19 5:52 PM

Ovarian neoplasms (continued)

o rantamino piasimo (con	,		
Germ cell tumors			
Dysgerminoma	Malignant	Most common in adolescents. Equivalent to male seminoma but rarer. Sheets of uniform "fried egg" cells B . Tumor markers: † hCG, LDH.	
Mature cystic teratoma	Benign	Also called dermoid cyst. Most common ovarian tumor in young females. Cystic mass with elements from all 3 germ layers (eg, teeth, hair, sebum) . May be painful 2° to ovarian enlargement or torsion. Monodermal form with thyroid tissue (struma ovarii) may present with hyperthyroidism. Malignan transformation rare (usually to squamous cell carcinoma).	
Immature teratoma	Malignant, aggressive	Contains fetal tissue, neuroectoderm. Commonly diagnosed before age 20. Typically represented by immature/embryonic-like neural tissue.	
Yolk sac (endodermal sinus) tumor	Malignant, aggressive	Occur in ovaries and sacrococcygeal area in children. Yellow, friable (hemorrhagic) mass. 50% have Schiller-Duval bodies (resemble glomeruli, arrow in E). Tumor marker: † AFP.	
Sex cord stromal tumors	5		
Thecoma	Benign	May produce estrogen. Usually presents as abnormal uterine bleeding in a postmenopausal woman.	
Granulosa cell tumor	Malignant	Most common malignant sex cord stromal tumor. Predominantly women in their 50s. Often produces estrogen and/or progesterone and presents with postmenopausal bleeding, endometrial hyperplasia, sexual precocity (in preadolescents), breast tenderness. Histology shows Call-Exner bodies (granulosa cells arranged haphazardly around collections of eosinophilic fluid, resembling primordial follicles; arrow in F). "Give Granny a Call!"	
Sertoli-Leydig cell tumor	Benign	Small, grey to yellow-brown mass. Resembles testicular histology with tubules/ cords lined by pink Sertoli cells. May produce androgens → virilization (eg, hirsutism, male pattern baldness, clitoral enlargement).	
Fibromas	Benign	Bundles of spindle-shaped fibroblasts. Meigs syndrome—triad of ovarian fibroma, ascites, pleural effusion. "Pulling" sensation in groin.	
	Δ	D 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	



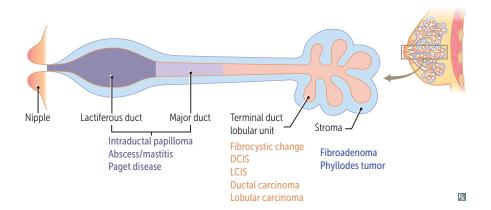
FAS1_2019_15-Repro.indd 647 11/7/19 5:52 PM

Uterine conditions

Non-neoplastic uterine	conditions		
Adenomyosis	Extension of endometrial tissue (glandular) into uterine myometrium. Caused by hyperplasia of basal layer of endometrium. Presents with dysmenorrhea, AUB/HMB, and uniformly enlarged, soft, globular uterus. Treatment: GnRH agonists, hysterectomy, excision of an organized adenomyoma.		
Asherman syndrome	Adhesions and/or fibrosis of the endometrium. Presents with ↓ fertility, recurrent pregnancy loss, AUB, pelvic pain. Often associated with dilation and curettage of intrauterine cavity.		
Endometrial hyperplasia	Abnormal endometrial gland proliferation usually stimulated by excess estrogen. † risk for endometrial carcinoma (especially with nuclear atypia). Presents as postmenopausal vaginal bleeding. † risk with anovulatory cycles, hormone replacement therapy, PCOS, granulosa cell tumors.		
Endometriosis	Endometrium-like glands/stroma outside endometrial cavity, most commonly in the ovary (frequently bilateral), pelvis, peritoneum (yellow-brown "powder burn" lesions). In ovary, appears as endometrioma (blood-filled "chocolate cysts" [oval structures above and below asterisks in A]). May be due to retrograde flow, metaplastic transformation of multipotent cells, transportation of endometrial tissue via lymphatic system. Characterized by cyclic pelvic pain, bleeding, dysmenorrhea, dyspareunia, dyschezia (pain with defecation), infertility; normal-sized uterus. Treatment: NSAIDs, OCPs, progestins, GnRH agonists, danazol, laparoscopic removal.		
Endometritis	Inflammation of endometrium B associated with retained products of conception following delivery, miscarriage, abortion, or with foreign body (eg, IUD). Retained material is nidus for bacteria from vagina or GI tract. Chronic endometritis shows plasma cells on histology. Treatment: gentamicin + clindamycin +/- ampicillin.		
Uterine neoplasms			
Endometrial carcinoma	Most common gynecologic malignancy . Presents with irregular vaginal bleeding. Two types: Endometrioid—most cases caused by unopposed estrogen exposure due to obesity, but also associated with early menarche, late menopause, nulliparity. Histology shows abnormally arranged endometrial glands. Early pathogenic events include loss of PTEN or mismatch repair proteins. Serous—associated with endometrial atrophy in postmenopausal women. Aggressive. Psammoma bodies often seen on histology. Characterized by formation of papillae and tufts.		
Leiomyoma (fibroid)	Most common tumor in females. Often presents with multiple discrete tumors □. ↑ incidence in African Americans. Benign smooth muscle tumor; malignant transformation to leiomyosarcoma is rare. Estrogen sensitive; tumor size ↑ with pregnancy and ↓ with menopause. Peak occurrence at 20-40 years of age. May be asymptomatic, cause AUB, or result in miscarriage. Severe bleeding may lead to iron deficiency anemia. Whorled pattern of smooth muscle bundles with well-demarcated borders on histology ■.		
Leiomyosarcoma	Malignant proliferation of smooth muscle arising from myometrium; arises de novo (not from leiomyomas), usually in postmenopausal women. Exam shows single lesion with areas of necrosis.		
**	B C C C C C C C C C C C C C C C C C C C		

FAS1_2019_15-Repro.indd 648 11/7/19 5:52 PM

Breast pathology



Benign breast diseases

Fibrocystic changes

Most common in premenopausal women 20-50 years old. Present with premenstrual breast pain or lumps; often bilateral and multifocal. Nonproliferative lesions include simple cysts (fluid-filled duct dilation, blue dome), papillary apocrine change/metaplasia, stromal fibrosis. Risk of cancer is usually not increased. Subtypes include:

- Sclerosing adenosis—acini and stromal fibrosis, associated with calcifications. Slight † risk for
- **Epithelial hyperplasia**—cells in terminal ductal or lobular epithelium. ↑ risk of carcinoma with atypical cells.

Inflammatory processes

Fat necrosis—benign, usually painless, lump due to injury to breast tissue. Calcified oil cyst on mammography; necrotic fat and giant cells on biopsy. Up to 50% of patients may not report trauma. **Lactational mastitis**—occurs during breastfeeding, ↑ risk of bacterial infection through cracks in nipple. S aureus is most common pathogen. Treat with antibiotics and continue breastfeeding.

Benign tumors

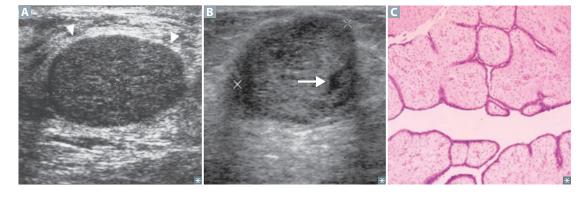
Fibroadenoma—most common in women < 35 years old. Small, well-defined, mobile mass A. Tumor composed of fibrous tissue and glands. † size and tenderness with † estrogen (eg, pregnancy, prior to menstruation). Risk of cancer is usually not increased.

Intraductal papilloma—small fibroepithelial tumor within lactiferous ducts, typically beneath areola. Most common cause of nipple discharge (serous or bloody). Slight † risk for cancer.

Phyllodes tumor—large mass B of connective tissue and cysts with "leaf-like" lobulations C. Most common in 5th decade. Some may become malignant.

Gynecomastia

Breast enlargement in males due to † estrogen compared with androgen activity. Physiologic in newborn, pubertal, and elderly males, but may persist after puberty. Other causes include cirrhosis, hypogonadism (eg, Klinefelter syndrome), testicular tumors, and drugs (Spironolactone, Hormones, Cimetidine, Finasteride, Ketoconazole: "Some Hormones Create Funny Knockers").



FAS1 2019 15-Repro.indd 649 11/7/19 5:52 PM **Breast cancer**

REPRODUCTIVE → REPRODUCTIVE—PATHOLOGY

Commonly postmenopausal. Often presents as a Risk factors in women: † age; history of atypical palpable hard mass A most often in the upper hyperplasia; family history of breast cancer; race outer quadrant. Invasive cancer can become (Caucasians at highest risk, African Americans at fixed to pectoral muscles, deep fascia, Cooper ↑ risk for triple ⊖ breast cancer); BRCA1/BRCA2 ligaments, and overlying skin → nipple mutations; † estrogen exposure (eg, nulliparity); retraction/skin dimpling. postmenopausal obesity (adipose tissue converts Usually arises from terminal duct lobular unit. androstenedione to estrone); † total number of Amplification/overexpression of estrogen/ menstrual cycles; absence of breastfeeding; later progesterone receptors or c-erbB2 (HER2, an age of first pregnancy; alcohol intake. In men: EGF receptor) is common; triple negative BRCA2 mutation, Klinefelter syndrome. $(ER \ominus, PR \ominus, and HER2/neu \ominus)$ form more Axillary lymph node metastasis most important aggressive. prognostic factor in early-stage disease. TYPE CHARACTERISTICS NOTES Noninvasive carcinomas Fills ductal lumen (black arrow in B indicates Early malignancy without basement membrane **Ductal carcinoma in** neoplastic cells in duct; blue arrow shows penetration. Usually does not produce a mass. situ Comedocarcinoma—Subtype of DCIS. Cells engorged blood vessel). Arises from ductal atypia. Often seen early as microcalcifications have high-grade nuclei with extensive central on mammography. necrosis **C** and dystrophic calcification. Extension of underlying DCIS/invasive breast Paget cells = intraepithelial adenocarcinoma Paget disease cancer up the lactiferous ducts and into the cells. contiguous skin of nipple → eczematous patches over nipple and areolar skin D. Lobular carcinoma in ↓ E-cadherin expression. No mass or † risk of cancer in either breast (vs DCIS, same situ calcifications → incidental biopsy finding. breast and quadrant). Invasive carcinomas^a **Invasive ductal** Firm, fibrous, "rock-hard" mass with sharp margins and small, glandular, duct-like cells in desmoplastic stroma. Invasive lobular ↓ E-cadherin expression → orderly row of cells Often bilateral with multiple lesions in the same location. ("single file" 🔳 and no duct formation. Often lacks desmoplastic response. Lines of cells = Lobular. Well-circumscribed tumor can mimic Medullary Large, anaplastic cells growing in sheets with associated lymphocytes and plasma cells. fibroadenoma. Inflammatory Dermal lymphatic space invasion → breast pain Poor prognosis (50% survival at 5 years). with warm, swollen, erythematous skin around Often mistaken for mastitis or Paget disease. exaggerated hair follicles, peau d'orange F Usually lacks a palpable mass.

^aAll types of invasive breast carcinoma can be either of tubular subtype (well-differentiated tubules that lack myoepithelium) or mucinous subtype (abundant extracellular mucin, seen in older women).

FAS1 2019 15-Repro.indd 650 11/7/19 5:52 PM

Penile pathology

Peyronie disease



Abnormal curvature of penis A due to fibrous plaque within tunica albuginea. Associated with erectile dysfunction. Can cause pain, anxiety. Consider surgical repair or treatment with collagenase injections once curvature stabilizes. Distinct from penile fracture (rupture of corpora cavernosa due to forced bending).

Ischemic priapism

Painful sustained erection lasting > 4 hours. Associated with sickle cell disease (sickled RBCs block venous drainage of corpus cavernosum vascular channels), medications (eg, sildenafil, trazodone). Treat immediately with corporal aspiration, intracavernosal phenylephrine, or surgical decompression to prevent ischemia.

Squamous cell carcinoma



Seen in the US, but more common in Asia, Africa, South America. Precursor in situ lesions:

Bowen disease (in penile shaft, presents as leukoplakia "white plaque"), erythroplasia of Queyrat (carcinoma in situ of the glans B, presents as erythroplakia "red plaque"). Bowenoid papulosis (carcinoma in situ of unclear malignant potential, presenting as reddish papules). Associated with uncircumcised males and HPV.

Cryptorchidism



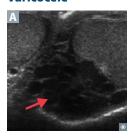
Descent failure of one or both testes; impaired spermatogenesis (since sperm develop best at temperatures < 37°C); can have normal testosterone levels (Leydig cells are mostly unaffected by temperature); associated with † risk of germ cell tumors. Prematurity † risk of cryptorchidism. ↓ inhibin B, † FSH, † LH; testosterone ↓ in bilateral cryptorchidism, normal in unilateral. Most cases resolve spontaneously; otherwise, orchiopexy performed before 2 years of age.

Testicular torsion

Rotation of testicle around spermatic cord and vascular pedicle. Commonly presents in males 12–18 years old. May occur after an inciting event (eg, trauma) or spontaneously. Characterized by acute, severe pain, high-riding testis, and absent cremasteric reflex.

Treatment: surgical correction (orchiopexy) within 6 hours, manual detorsion if surgical option unavailable in timeframe. If testis is not viable, orchiectomy. Orchiopexy, when performed, should be bilateral because the contralateral testis is at risk for subsequent torsion.

Varicocele



Dilated veins in pampiniform plexus due to † venous pressure; most common cause of scrotal enlargement in adult males; most often on left side because of † resistance to flow from left gonadal vein drainage into left renal vein; can cause infertility because of † temperature; diagnosed by standing clinical exam/Valsalva maneuver (distension on inspection and "bag of worms" on palpation; augmented by Valsalva) or ultrasound A; does not transilluminate. Treatment: consider surgical ligation or embolization if associated with pain or infertility.

FAS1_2019_15-Repro.indd 651 11/7/19 5:52 PM

tumors

Extragonadal germ cell Arise in midline locations. In adults, most commonly in retroperitoneum, mediastinum, pineal, and suprasellar regions. In infants and young children, sacrococcygeal teratomas are most common.

Scrotal masses

Benign scrotal lesions present as testicular masses that can be transilluminated (vs solid testicular tumors).

Congenital hydrocele



Common cause of scrotal swelling A in infants, due to incomplete obliteration of processus vaginalis. Most spontaneously resolve within l year.

Transilluminating swelling.

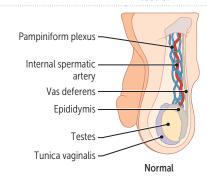
Acquired hydrocele

Scrotal fluid collection usually 2° to infection, trauma, tumor. If bloody → hematocele.

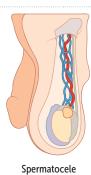
Spermatocele

Cyst due to dilated epididymal duct or rete testis.

Paratesticular fluctuant nodule.



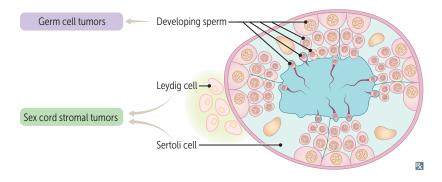








Testicular tumors



Germ cell tumors account for ~ 95% of all testicular tumors. Arise from germ cells that produce sperm. Most often occur in young men. Risk factors: cryptorchidism, Klinefelter syndrome. Can present as a mixed germ cell tumor. Do not transilluminate. Usually not biopsied (risk of seeding scrotum), removed via radical orchiectomy.

Sex cord stromal tumors develop from embryonic sex cord (develops into Sertoli and Leydig cells of seminiferous tubules, theca and granulosa cells of follicle) derivatives. 5% of all testicular tumors. Mostly benign.

FAS1_2019_15-Repro.indd 652 11/7/19 5:52 PM

Testicular tumors (continued)

Germ cell tumors			
Seminoma	Malignant	Painless, homogenous testicular enlargement. Most common testicular tumor. Analogous to ovarian dysgerminoma. Does not occur in infancy Large cells in lobules with watery cytoplasm and "fried egg" appearance on histology, † placental ALP (PALP). Highly radiosensitive. Late metastasis, excellent prognosis.	
Teratoma	May be malignant	Unlike in females, <mark>M</mark> ature teratoma in adult M ales may be M alignant. Benign in children.	
Embryonal carcinoma	Malignant	Painful, hemorrhagic mass with necrosis. Often glandular/papillary morphology. "Pure" embryonal carcinoma is rare; most commonly mixed with other tumor types. May present with metastases. May be associated with † hCG and normal AFP levels when pure († AFP wher mixed). Worse prognosis than seminoma.	
Yolk sac (endodermal sinus) tumor	Malignant, aggressive	Yellow, mucinous. Analogous to ovarian yolk sac tumor. Schiller-Duval bodies resemble primitive glomeruli. † AFP is highly characteristic. Most common testicular tumor in boys < 3 years old.	
Choriocarcinoma	Malignant	Disordered syncytiotrophoblastic and cytotrophoblastic elements. Hematogenous metastases to lungs and brain. † hCG, may produce gynecomastia, symptoms of hyperthyroidism (α-subunit of hCG is identical to LH, FSH, TSH).	
Non-germ cell tumors			
Sertoli cell tumor	Mostly benign	Androblastoma from sex cord stroma.	
Leydig cell tumor	Mostly benign	Golden brown color; contains Reinke crystals (eosinophilic cytoplasmic inclusions). Produces androgens or estrogens → gynecomastia in men, precocious puberty in boys.	
Testicular lymphoma	Malignant, aggressive	Most common testicular cancer in older men. Not a 1° cancer; arises from metastatic lymphoma to testes.	

Hormone levels in germ cell tumors

	SEMINOMA	YOLK SAC TUMOR	CHORIOCARCINOMA	TERATOMA	EMBRYONAL CARCINOMA
PALP	†	_	_	_	_
AFP	_	† †	_	_	-/ ↑ (when mixed)
β- hCG	_/↑	_/ ↑	† †	-	†

FAS1_2019_15-Repro.indd 653 11/7/19 5:52 PM

654

SECTION III

REPRODUCTIVE ▶ REPRODUCTIVE—PATHOLOGY

Epididymitis and orchitis

Most common causes:

- C trachomatis and N gonorrhoeae (young men)
- E coli and Pseudomonas (elderly, associated with UTI and BPH)
- Autoimmune (eg, granulomas involving seminiferous tubules)

Epididymitis

Inflammation of epididymis. Presents with localized pain and tenderness over posterior testis.

Prehn sign (pain relief with scrotal elevation). May progress to involve testis.

Orchitis

Inflammation of testis. Presents with testicular pain and swelling. Mumps orchitis † infertility risk. Rare in boys < 10 years old.

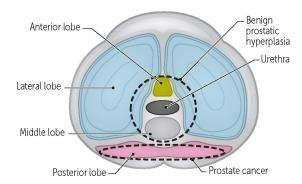
Benign prostatic hyperplasia

Common in men > 50 years old. Characterized by smooth, elastic, firm nodular enlargement (hyperplasia not hypertrophy) of periurethral (lateral and middle) lobes, which compress the urethra into a vertical slit. Not premalignant. Often presents with † frequency of urination, nocturia, difficulty starting and stopping urine

nocturia, difficulty starting and stopping urine stream, dysuria. May lead to distention and hypertrophy of bladder, hydronephrosis, UTIs.

† free prostate-specific antigen (PSA).

Treatment: α_1 -antagonists (terazosin, tamsulosin), which cause relaxation of smooth muscle; 5α -reductase inhibitors (eg, finasteride); PDE-5 inhibitors (eg, tadalafil); surgical resection (eg, TURP, ablation).



Prostatitis

Characterized by dysuria, frequency, urgency, low back pain. Warm, tender, enlarged prostate. Acute bacterial prostatitis—in older men most common bacterium is *E coli*; in young men consider *C trachomatis*, *N gonorrhoeae*.

Chronic prostatitis—either bacterial or nonbacterial (eg, 2° to previous infection, nerve problems, chemical irritation).

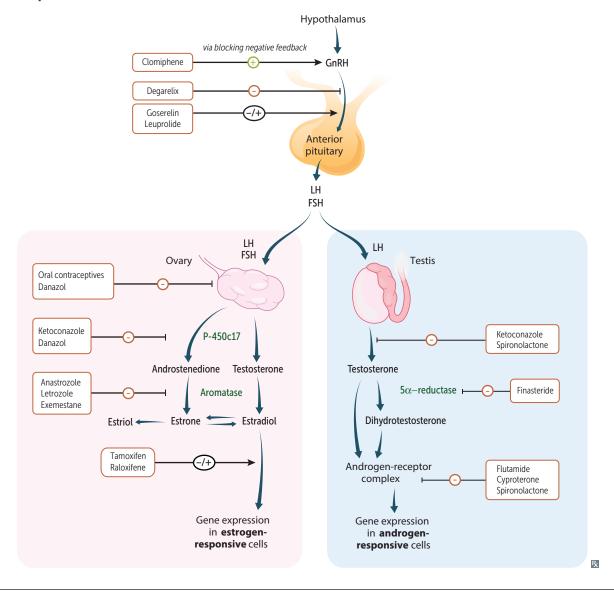
Prostatic adenocarcinoma

Common in men > 50 years old. Arises most often from posterior lobe (peripheral zone) of prostate gland and is most frequently diagnosed by ↑ PSA and subsequent needle core biopsies. Prostatic acid phosphatase (PAP) and PSA are useful tumor markers (↑ total PSA, with ↓ fraction of free PSA). Osteoblastic metastases in bone may develop in late stages, as indicated by lower back pain and ↑ serum ALP and PSA. Metastasis to the spine often occurs via Batson (vertebral) venous plexus.

FAS1_2019_15-Repro.indd 654 11/7/19 5:52 PM

▶ REPRODUCTIVE—PHARMACOLOGY

Control of reproductive hormones



FAS1_2019_15-Repro.indd 655 11/7/19 5:52 PM

Gosere	lin, l	leupi	olide
--------	--------	-------	-------

MECHANISM	GnRH analogs. When used in pulsatile fashion act as GnRH agonists. When used in continuous fashion first transiently act as GnRH agonists (tumor flare), but subsequently act as GnRH antagonists (downregulate GnRH receptor in pituitary → ↓ FSH and ↓ LH).			
CLINICAL USE	Uterine fibroids, endometriosis, precocious puberty, prostate cancer, infertility.			
ADVERSE EFFECTS	Hypogonadism, ↓ libido, erectile dysfunction, nausea, vomiting.			
Degarelix				
MECHANISM	GnRH antagonist. No start-up flare.			
CLINICAL USE	Prostate cancer.			
ADVERSE EFFECTS	Hot flashes, liver toxicity.			
Estrogens	Ethinyl estradiol, DES, mestranol.			
MECHANISM	Bind estrogen receptors.			
CLINICAL USE	Hypogonadism or ovarian failure, menstrual abnormalities (combined OCPs), hormone replacement therapy in postmenopausal women.			
ADVERSE EFFECTS	† risk of endometrial cancer (when given without progesterone), bleeding in postmenopausal women, clear cell adenocarcinoma of vagina in females exposed to DES in utero, † risk of thrombi. Contraindications—ER ⊕ breast cancer, history of DVTs, tobacco use in women > 35 years old.			
Selective estrogen rece	ptor modulators			
Clomiphene	Antagonist at estrogen receptors in hypothalamus. Prevents normal feedback inhibition and † release of LH and FSH from pituitary, which stimulates ovulation. Used to treat infertility due to anovulation (eg, PCOS). May cause hot flashes, ovarian enlargement, multiple simultaneous pregnancies, visual disturbances.			
Tamoxifen	Antagonist at breast; agonist at bone, uterus; ↑ risk of thromboembolic events (especially with smoking) and endometrial cancer. Used to treat and prevent recurrence of ER/PR ⊕ breast cancer.			
Raloxifene	Antagonist at breast, uterus; agonist at bone; † risk of thromboembolic events (especially with smoking) but no increased risk of endometrial cancer (vs tamoxifen); used primarily to treat osteoporosis.			
Aromatase inhibitors	Anastrozole, letrozole, exemestane.			
MECHANISM	Inhibit peripheral conversion of androgens to estrogen.			
CLINICAL USE	ER \oplus breast cancer in postmenopausal women.			

11/7/19 5:52 PM FAS1_2019_15-Repro.indd 656

Hormone replacement therapy	Used for relief or prevention of menopausal symptoms (eg, hot flashes, vaginal atrophy), osteoporosis († estrogen, ↓ osteoclast activity). Unopposed estrogen replacement therapy † risk of endometrial cancer, progesterone/proges added. Possible increased cardiovascular risk.	
Progestins	Levonorgestrel, medroxyprogesterone, etonogestrel, norethindrone, megestrol.	
MECHANISM	Bind progesterone receptors, ↓ growth and ↑ vascularization of endometrium, thicken cervical mucus.	
CLINICAL USE	Contraception (forms include pill, intrauterine device, implant, depot injection), endometrial cancer, abnormal uterine bleeding. Progestin challenge: presence of withdrawal bleeding excludes anatomic defects (eg, Asherman syndrome) and chronic anovulation without estrogen.	
Antiprogestins	Mifepristone, ulipristal.	
MECHANISM	Competitive inhibitors of progestins at progesterone receptors.	
CLINICAL USE	Termination of pregnancy (mifepristone with misoprostol); emergency contraception (ulipristal).	
Combined contraception	Progestins and ethinyl estradiol; forms include pill, patch, vaginal ring. Estrogen and progestins inhibit LH/FSH and thus prevent estrogen surge. No estrogen surge → no LH surge → no ovulation. Progestins cause thickening of cervical mucus, thereby limiting access of sperm to uterus. Progestins also inhibit endometrial proliferation → endometrium is less suitable to the implantation of an embryo. Adverse effects: breakthrough menstrual bleeding, breast tenderness, VTE, hepatic adenomas. Contraindications: smokers > 35 years old († risk of cardiovascular events), patients with † risk of cardiovascular disease (including history of venous thromboembolism, coronary artery disease, stroke), migraine (especially with aura), breast cancer, liver disease.	
Copper intrauterine dev	vice	
MECHANISM	Produces local inflammatory reaction toxic to sperm and ova, preventing fertilization and implantation; hormone free.	
CLINICAL USE	Long-acting reversible contraception. Most effective emergency contraception.	
ADVERSE EFFECTS	Heavier or longer menses, dysmenorrhea. Risk of PID with insertion (contraindicated in active pelvic infection).	
Tocolytics Medications that relax the uterus; include terbutaline (β_2 -agonist action), nifedipoleocker), indomethacin (NSAID). Used to \downarrow contraction frequency in preterm time for administration of steroids (to promote fetal lung maturity) or transfer medical center with obstetrical care.		

FAS1_2019_15-Repro.indd 657 11/7/19 5:52 PM

MECHANISM	Synthetic androgen that acts as partial agonist a	t androgen receptors.	
CLINICAL USE	Endometriosis, hereditary angioedema.		
ADVERSE EFFECTS	Weight gain, edema, acne, hirsutism, masculinization, ↓ HDL levels, hepatotoxicity, idiopathic intracranial hypertension.		
Testosterone, methy	ltestosterone		
MECHANISM	Agonists at androgen receptors.		
CLINICAL USE	Treat hypogonadism and promote development promote recovery after burn or injury.	of 2° sex characteristics; stimulate anabolism to	
ADVERSE EFFECTS	Masculinization in females; ↓ intratesticular testosterone in males by inhibiting release of LH (via negative feedback) → gonadal atrophy. Premature closure of epiphyseal plates. ↑ LDL, ↓ HDL.		
Antiandrogens			
Finasteride	5α-reductase inhibitor (\$\frac{1}{2}\$ conversion of testosterone to DHT). Used for BPH and male-pattern baldness. Adverse effects: gynecomastia and sexual dysfunction.	Testosterone $\xrightarrow{5\alpha\text{-reductase}}$ DHT (more potent).	
Flutamide, bicalutamide, apalutamide, enzalutamide	Nonsteroidal competitive inhibitors at androgen receptors. Used for prostate carcinoma.		
Ketoconazole	Inhibits steroid synthesis (inhibits 17,20 desmolase/17α-hydroxylase).	Used in PCOS to reduce androgenic symptoms.	
Spironolactone	Inhibits steroid binding, 17,20 desmolase/17α-hydroxylase.	Both can cause gynecomastia and amenorrhea	
Tamsulosin	$\alpha_{_{\! 1}}$ -antagonist used to treat BPH by inhibiting sn receptors (found on prostate) vs vascular $\alpha_{_{1B}}$ re-		
Minoxidil			
MECHANISM	Direct arteriolar vasodilator.		
CLINICAL USE	Androgenetic alopecia (pattern baldness), severe refractory hypertension.		

FAS1_2019_15-Repro.indd 658 11/7/19 5:52 PM

HIGH-YIELD SYSTEMS

Respiratory

"There's so much pollution in the air now that if it weren't for our lungs, there'd be no place to put it all."

-Robert Orben

"Freedom is the oxygen of the soul."

-Moshe Dayan

"Whenever I feel blue, I start breathing again."

-L. Frank Baum

"Life is not the amount of breaths you take; it's the moments that take your breath away."

-Will Smith, Hitch

Group key respiratory, cardiovascular, and renal concepts together for study whenever possible. Know obstructive vs restrictive lung disorders, $\dot{V}\dot{Q}$ mismatch, lung volumes, mechanics of respiration, and hemoglobin physiology. Lung cancers and other causes of lung masses are high yield. Be comfortable reading basic chest x-rays, CT scans, and PFTs.

▶ Embryology 660
▶ Anatomy 662
▶ Physiology 664
▶ Pathology 671

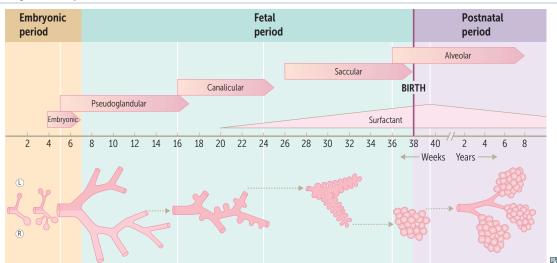
686

▶ Pharmacology

FAS1_2019_16-Respiratory.indd 659 11/8/19 7:33 AM

▶ RESPIRATORY—EMBRYOLOGY

Lung development	Occurs in five stages. Initial development includes development of lung bud from distal end of respiratory diverticulum during week 4. Every Pulmonologist Can See Alveoli.		
STAGE	STRUCTURAL DEVELOPMENT	NOTES	
Embryonic (weeks 4–7)	Lung bud → trachea → bronchial buds → mainstem bronchi → secondary (lobar) bronchi → tertiary (segmental) bronchi.	Errors at this stage can lead to tracheoesophageal fistula.	
Pseudoglandular (weeks 5–17)	Endodermal tubules → terminal bronchioles. Surrounded by modest capillary network.	Respiration impossible, incompatible with life.	
Canalicular (weeks 16–25)	Terminal bronchioles → respiratory bronchioles → alveolar ducts. Surrounded by prominent capillary network.	Airways increase in diameter. Respiration capable at 25 weeks. Pneumocytes develop starting at 20 weeks.	
Saccular (week 26-birth)	Alveolar ducts → terminal sacs. Terminal sacs separated by 1° septae.		
Alveolar (week 36–8 years)	Terminal sacs → adult alveoli (due to 2° septation). In utero, "breathing" occurs via aspiration and expulsion of amniotic fluid → ↑ vascular resistance through gestation. At birth, fluid gets replaced with air → ↓ in pulmonary vascular resistance.	At birth: 20–70 million alveoli. By 8 years: 300–400 million alveoli.	



Congenital lung malformations

Pulmonary hypoplasia	Poorly developed bronchial tree with abnormal histology. Associated with congenital diaphragmatic hernia (usually left-sided), bilateral renal agenesis (Potter sequence).
Bronchogenic cysts	Caused by abnormal budding of the foregut and dilation of terminal or large bronchi. Discrete, round, sharply defined, fluid-filled densities on CXR (air-filled if infected). Generally asymptomatic but can drain poorly, causing airway compression and/or recurrent respiratory infections.

FAS1_2019_16-Respiratory.indd 660 11/8/19 7:33 AM

Club cells

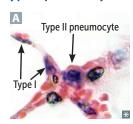
Nonciliated; low columnar/cuboidal with secretory granules. Located in bronchioles. Degrade toxins; secrete component of surfactant; act as reserve cells.

Alveolar cell types

Type I pneumocytes

Squamous. 97% of alveolar surfaces. Thinly line the alveoli (two black arrows in A) for optimal gas exchange.

Type II pneumocytes



Cuboidal and clustered A.

2 functions:

- 1. Serve as stem cell precursors for 2 cell types (type I and type II cells); proliferate during lung damage.
- 2. Secrete surfactant from lamellar bodies (arrowheads in **B**)

Surfactant— ↓ alveolar surface tension, ↓ alveolar collapse, ↓ lung recoil, and ↑ compliance.

Composed of multiple lecithins, mainly dipalmitoylphosphatidylcholine (DPPC). Synthesis begins ~week 20 of gestation and achieves mature levels ~week 35. Corticosteroids important for fetal surfactant synthesis and lung development.

LD N

Alveolar macrophages

Phagocytose foreign materials; release cytokines and alveolar proteases. Hemosiderin-laden macrophages ("HF cells") may be found in the setting of pulmonary edema or alveolar hemorrhage.

Neonatal respiratory distress syndrome



Surfactant deficiency → ↑ surface tension → alveolar collapse ("ground-glass" appearance of lung fields) A.

Risk factors: prematurity, maternal diabetes (due to † fetal insulin), C-section delivery (‡ release of fetal glucocorticoids; less stressful than vaginal delivery).

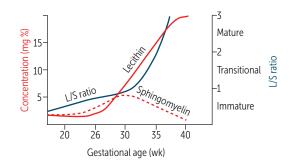
Treatment: maternal steroids before birth; exogenous surfactant for infant.

Therapeutic supplemental O₂ can result in Retinopathy of prematurity, Intraventricular hemorrhage, Bronchopulmonary dysplasia (RIB).

Collapsing pressure $(P) = \frac{2 \text{ (surface tension)}}{\text{radius}}$

Law of Laplace—Alveoli have ↑ tendency to collapse on expiration as radius ↓.

Screening tests for fetal lung maturity: lecithinsphingomyelin (L/S) ratio in amniotic fluid (≥ 2 is healthy; < 1.5 predictive of NRDS), foam stability index, surfactant-albumin ratio. Persistently low O₂ tension → risk of PDA.



FAS1_2019_16-Respiratory.indd 661 11/8/19 7:33 AM

► RESPIRATORY — ANATOMY

Respiratory tree

Conducting zone

Large airways consist of nose, pharynx, larynx, trachea, and bronchi. Airway resistance highest in the large- to medium-sized bronchi. Small airways consist of bronchioles that further divide into terminal bronchioles (large numbers in parallel → least airway resistance).

Warms, humidifies, and filters air but does not participate in gas exchange → "anatomic dead space." Cartilage and goblet cells extend to the end of bronchi.

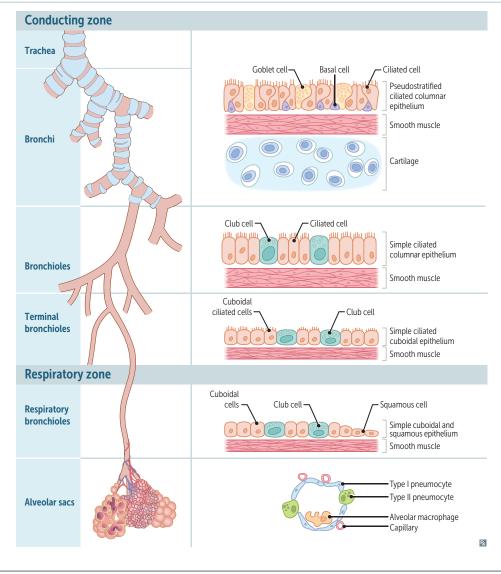
Pseudostratified ciliated columnar cells primarily make up epithelium of bronchus and extend to beginning of terminal bronchioles, then transition to cuboidal cells. Clear mucus and debris from lungs (mucociliary escalator).

Airway smooth muscle cells extend to end of terminal bronchioles (sparse beyond this point).

Respiratory zone

Lung parenchyma; consists of respiratory bronchioles, alveolar ducts, and alveoli. Participates in gas exchange.

Mostly cuboidal cells in respiratory bronchioles, then simple squamous cells up to alveoli. Cilia terminate in respiratory bronchioles. Alveolar macrophages clear debris and participate in immune response.



FAS1_2019_16-Respiratory.indd 662 11/8/19 7:34 AM

Lung anatomy

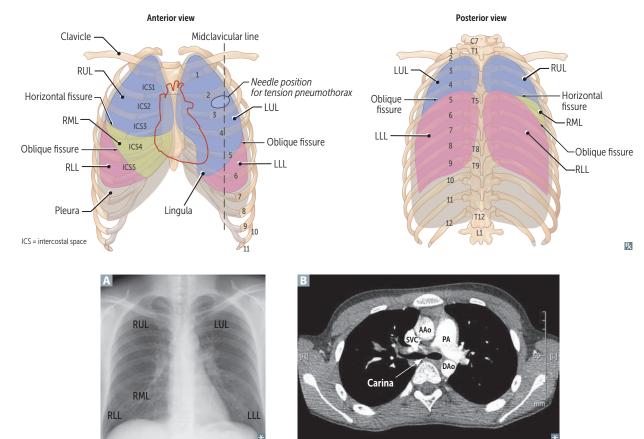


Right lung has 3 lobes; Left has Less Lobes (2) and Lingula (homolog of right middle lobe). Instead of a middle lobe, left lung has a space occupied by the heart A.

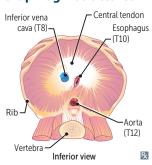
Relation of the pulmonary artery to the bronchus at each lung hilum is described by RALS—Right Anterior; Left Superior. Carina is posterior to ascending aorta and anteromedial to descending aorta B.

Right lung is a more common site for inhaled foreign bodies because right main stem bronchus is wider, more vertical, and shorter than the left. If you aspirate a peanut:

- While supine—usually enters superior segment of right lower lobe.
- While lying on right side—usually enters right upper lobe.
- While upright—usually enters right lower lobe.



Diaphragm structures



Structures perforating diaphragm:

- At T8: IVC, right phrenic nerve
- At T10: esophagus, vagus (CN 10; 2 trunks)
- At T12: aorta (red), thoracic duct (white), azygos vein (blue) ("At T-1-2 it's the red, white, and blue")

Diaphragm is innervated by C3, 4, and 5 (phrenic nerve). Pain from diaphragm irritation (eg, air, blood, or pus in peritoneal cavity) can be referred to shoulder (C5) and trapezius ridge (C3, 4).

Number of letters = T level:

T8: vena cava (IVC)

T10: (O)esophagus

T12: aortic hiatus

I ate (8) ten eggs at twelve.

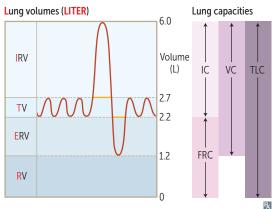
C3, 4, 5 keeps the diaphragm alive. Other bifurcations:

- The common carotid bifourcates at C4.
- The trachea bifourcates at T4.
- The abdominal aorta bifourcates at L4.

FAS1_2019_16-Respiratory.indd 663 11/8/19 7:34 AM

▶ RESPIRATORY—PHYSIOLOGY

Lung volumes	Note: a capacity is a sum of \geq 2 physiologic volumes .		
Inspiratory reserve volume	Air that can still be breathed in after normal inspiration	Lung	
Tidal volume	Air that moves into lung with each quiet inspiration, typically 500 mL	I	
Expiratory reserve volume	Air that can still be breathed out after normal expiration	7	
Residual volume	Air in lung after maximal expiration; RV and any lung capacity that includes RV cannot be measured by spirometry	E	
Inspiratory capacity	IRV + TV Air that can be breathed in after normal exhalation	··· F	
Functional residual capacity	RV + ERV Volume of gas in lungs after normal expiration		
Vital capacity TV + IRV + ERV Maximum volume of gas that can be expired after a maximal inspiration			
Total lung capacity	IRV + TV + ERV + RV Volume of gas present in lungs after a maximal inspiration		



Determination of physiologic dead space

 $V_D = V_T \times \frac{\mathbf{Paco}_2 - \mathbf{Peco}_2}{\mathbf{Paco}_2}$

V_D = physiologic dead space = anatomic dead space of conducting airways plus alveolar dead space; apex of healthy lung is largest contributor of alveolar dead space. Volume of inspired air that does not take part in gas exchange.

 V_T = tidal volume. $Paco_2$ = arterial Pco_2 . $Peco_2$ = expired air Pco_2 . Taco, Paco, Peco, Paco (refers to order of variables in equation)

Physiologic dead space—approximately equivalent to anatomic dead space in normal lungs. May be greater than anatomic dead space in lung diseases with \dot{V}/\dot{Q} defects.

Ventilation

Minute ventilation	Total volume of gas entering lungs per minute $V_{\rm E} = V_{\rm T} \times RR$	Normal values: Respiratory rate (RR) = 12–20 breaths/min
Alveolar ventilation	Volume of gas that reaches alveoli each minute $V_{\rm A} = (V_{\rm T} - V_{\rm D}) \times {\rm RR}$	$V_T = 500 \text{ mL/breath}$ $V_D = 150 \text{ mL/breath}$

FAS1_2019_16-Respiratory.indd 664 11/8/19 7:34 AM

Lung and chest wall

Elastic recoil

Tendency for lungs to collapse inward and chest wall to spring outward.

At FRC, airway and alveolar pressures equal atmospheric pressure (called zero), and intrapleural pressure is negative (preventing atelectasis). The inward pull of the lung is balanced by the outward pull of the chest wall. System pressure is atmospheric. Pulmonary vascular resistance (PVR) is at a minimum.

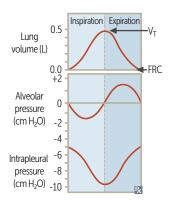
Compliance

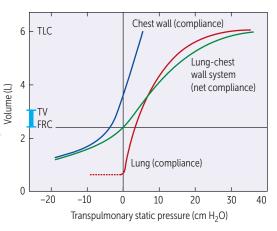
Change in lung volume for a change in pressure $(\Delta V/\Delta P)$. Inversely proportional to wall stiffness and increased by surfactant.

- † compliance = lung easier to fill (eg, emphysema, aging)
- I compliance = lung harder to fill (eg, pulmonary fibrosis, pneumonia, ARDS, pulmonary edema)

Hysteresis

Lung inflation follows a different pressurevolume curve than lung deflation due to need to overcome surface tension forces in inflation.



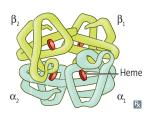


Respiratory system changes in the elderly

Aging is associated with progressive \$\diams\$ in lung function. TLC remains the same.

INCREASED	DECREASED
Lung compliance (loss of elastic recoil)	Chest wall compliance († chest wall stiffness)
RV	${ m FVC}$ and ${ m FEV}_1$
Ú∕Q mismatch	Respiratory muscle strength (can impair cough)
A-a gradient	Ventilatory response to hypoxia/hypercapnia

Hemoglobin



Normal adult hemoglobin (Hb) is composed of 4 polypeptide subunits (2 α and 2 β) and exists in 2 forms:

- Deoxygenated form has low affinity for O₂, thus promoting release/unloading of O₂.
- Oxygenated form has high affinity for O₂ (300×). Hb exhibits positive cooperativity and positive allostery.

Hemoglobin acts as buffer for H⁺ ions. Myoglobin is composed of a single polypeptide chain associated with one heme moiety. Higher affinity for oxygen than Hb.

FAS1_2019_16-Respiratory.indd 665 11/8/19 7:34 AM

Oxygen content of blood

 O_2 content = $(1.34 \times Hb \times Sao_2) + (0.003 \times Pao_2)$ Hb = hemoglobin concentration; Sao_2 = arterial O_2 saturation Pao_2 = partial pressure of O_2 in arterial blood

Normally 1 g Hb can bind 1.34 mL O₂; normal Hb amount in blood is 15 g/dL.

 O_2 binding capacity ≈ 20 mL O_2 /dL of blood.

With \downarrow Hb there is \downarrow O₂ content of arterial blood, but no change in O₂ saturation and Pao₂.

 O_2 delivery to tissues = cardiac output $\times O_2$ content of blood.

	Hb CONCENTRATION	% O ₂ SAT OF Hb	DISSOLVED O ₂ (Pao ₂)	TOTAL O ₂ CONTENT
CO poisoning	Normal	↓ (CO competes with O ₂)	Normal	ţ
Anemia	1	Normal	Normal	†
Polycythemia	†	Normal	Normal	†

Methemoglobin

Iron in Hb is normally in a reduced state (ferrous Fe²⁺; "just the 2 of us").

Oxidized form of Hb (ferric, Fe³⁺) does not bind O_2 as readily as Fe²⁺, but has † affinity for cyanide \rightarrow tissue hypoxia from $\downarrow O_2$ saturation and $\downarrow O_3$ content.

Methemoglobinemia may present with cyanosis and chocolate-colored blood.

Nitrites (eg, from dietary intake or polluted/ high-altitude water sources) and benzocaine cause poisoning by oxidizing Fe²⁺ to Fe³⁺. **Meth**emoglobinemia can be treated with

methylene blue and vitamin C.

Oxygen-hemoglobin dissociation curve

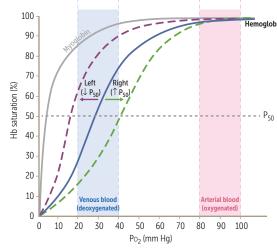
ODC has sigmoidal shape due to positive cooperativity (ie, tetrameric Hb molecule can bind 4 O₂ molecules and has higher affinity for each subsequent O₂ molecule bound). Myoglobin is monomeric and thus does not show positive cooperativity; curve lacks sigmoidal appearance.

Shifting ODC to the right $\rightarrow \downarrow$ Hb affinity for O₂ (facilitates unloading of O₂ to tissue) $\rightarrow \uparrow$ P₅₀ (higher Po₂ required to maintain 50% saturation).

Shifting ODC to the left $\rightarrow \downarrow O_2$ unloading

- → renal hypoxia → † EPO synthesis
- → compensatory erythrocytosis.

Fetal Hb (2 α and 2 γ subunits) has higher affinity for O₂ than adult Hb (due to \downarrow affinity for 2,3-BPG) \rightarrow dissociation curve is shifted left, driving diffusion of O₂ across the placenta from mother to fetus.



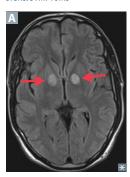
Left shift $(\downarrow O_2 \text{ unloading to tissue})$ Left = Lower	Right shift (↑ O ₂ unloading to tissues) ACE BATs right handed
↓ H ⁺ (↑ pH, base) ↓ Pco ₂ ↓ 2,3-BPG ↓ Temperature ↑ CO ↑ MetHb ↑ HbF	↑H ⁺ (↓ pH, Acid) ↑Pco ₂ Exercise ↑2,3-BPG High Altitude ↑ Temperature

ľχ

FAS1_2019_16-Respiratory.indd 666 11/8/19 7:34 AM

Cyanide vs carbon Both inhibit aerobic metabolism via inhibition of complex IV (cytochrome c oxidase) → hypoxia monoxide poisoning that does not fully correct with supplemental O₂ and † anaerobic metabolism. Both can lead to pink or cherry red skin (usually postmortem finding), seizures, and coma. Cyanide Carbon monoxide SOURCE Byproduct of synthetic product combustion, Odorless gas from fires, car exhaust, or gas ingestion of amygdalin (cyanogenic glucoside heaters. found in apricot seeds) or cyanide. TREATMENT Hydroxocobalamin (binds cyanide 100% O₂, hyperbaric O₂. → cyanocobalamin → renal excretion). Nitrites (oxidize Hb → methemoglobin → binds cyanide → cyanomethemoglobin → less toxicity). Sodium thiosulfate († cyanide conversion to

SIGNS/SYMPTOMS



Breath has bitter almond odor; cardiovascular collapse.

thiocyanate → renal excretion).

Headache, dizziness.

Multiple individuals may be involved (eg, family with similar symptoms in winter).

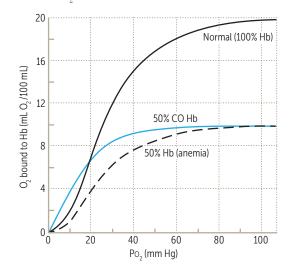
Classically associated with bilateral globus pallidus lesions on MRI A, although rarely seen with cyanide toxicity as well.

EFFECT ON OXYGEN-HEMOGLOBIN DISSOCIATION CURVE

Curve normal; oxygen saturation may appear normal initially.

Left shift in curve $\rightarrow \uparrow$ affinity for $O_2 \rightarrow \downarrow O_2$ unloading in tissues.

Binds competitively to Hb with 200× greater affinity than O₂ to form carboxyhemoglobin → ↓ %O₂ saturation of Hb.



FAS1_2019_16-Respiratory.indd 667 11/8/19 7:34 AM

Pulmonary circulation

Normally a low-resistance, high-compliance system. A ↓ in PAO₂ causes a hypoxic vasoconstriction that shifts blood away from poorly ventilated regions of lung to well-ventilated regions of lung.

Perfusion limited— O_2 (normal health), CO_2 , N_2O . Gas equilibrates early along the length of the capillary. Exchange can be † only if blood flow †.

Diffusion limited—O₂ (emphysema, fibrosis, exercise), CO. Gas does not equilibrate by the time blood reaches the end of the capillary.

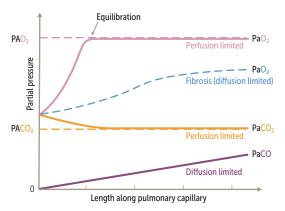
A consequence of pulmonary hypertension is cor pulmonale and subsequent right ventricular failure.

Diffusion:
$$\dot{V}_{gas} = A \times D_k \times \frac{P_1 - P_2}{\Delta_v}$$
 where

A = area, Δ_x = alveolar wall thickness, D_k = diffusion coefficient of gas, $P_1 - P_2$ = difference in partial pressures.

- A ↓ in emphysema.
- Δ_x † in pulmonary fibrosis.

DLCO is the extent to which CO passes from air sacs of lungs into blood.



Pa = partial pressure of gas in pulmonary capillary blood PA = partial pressure of gas in alveolar air

Ŗ

Pulmonary vascular resistance

$$PVR = \frac{P_{pulm \ artery} - P_{L \ atrium}}{Q}$$

Remember: $\Delta P = Q \times R$, so $R = \Delta P / Q$

$$R=\frac{8\eta l}{\pi r^4}$$

 $P_{\text{pulm artery}} = \text{pressure in pulmonary artery}$ $P_{\text{Latrium}} \approx \text{pulmonary capillary wedge pressure}$

Q = cardiac output (flow)

R = resistance

 η = viscosity of blood

l = vessel length

r = vessel radius

Alveolar gas equation

$$PAO_2 = PIO_2 - \frac{Paco_2}{R}$$

$$\approx 150 \text{ mm Hg}^{a} - \frac{\text{Paco}_{2}}{0.8}$$

^aAt sea level breathing room air

PAO₂ = alveolar Po₂ (mm Hg)

 $PIo_2 = Po_2$ in inspired air (mm Hg)

 $Paco_2 = arterial Pco_2 (mm Hg)$

 $R = respiratory quotient = CO_2 produced/$

 O_2 consumed

A-a gradient = PAO₂ - PaO₂. Normal A-a gradient estimated as (age/4) + 4 (eg, for a person <40 years old, gradient should be <14).

FAS1_2019_16-Respiratory.indd 668

Oxygen deprivation

Hypoxia (↓ O₂ delivery to tissue)	Hypoxemia (↓ Pao₂)	Ischemia (loss of blood flow)
↓ cardiac output	Normal A-a gradient	Impeded arterial flow
Hypoxemia	 High altitude 	↓ venous drainage
Ischemia	 Hypoventilation (eg, opioid use, 	
Anemia	obesity hypoventilation syndrome)	
CO poisoning	↑ A-a gradient	
	 V/Q mismatch 	
	 Diffusion limitation (eg, fibrosis) 	
	 Right-to-left shunt 	

Ventilation/perfusion mismatch

Ideally, ventilation is matched to perfusion (ie, $\dot{V} | \dot{Q} = 1$) for adequate gas exchange.

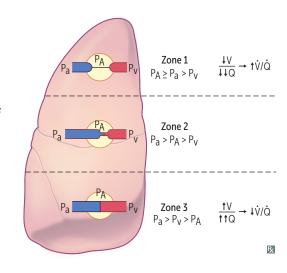
Lung zones:

- \dot{V}/\dot{Q} at apex of lung = 3 (wasted ventilation)
- V/Q at base of lung = 0.6 (wasted perfusion)
 Both ventilation and perfusion are greater at the base of the lung than at the apex of the lung.
 With exercise († cardiac output), there is vasodilation of apical capillaries → V/Q ratio approaches 1.

Certain organisms that thrive in high O_2 (eg, TB) flourish in the apex.

 $\dot{V}/\dot{Q} = 0$ = "oirway" obstruction (shunt). In shunt, 100% O₂ does not improve Pao₂ (eg, foreign body aspiration).

 $\dot{V}/\dot{Q} = \infty = blood$ flow obstruction (physiologic dead space). Assuming < 100% dead space, 100% O_2 improves Pao_2 (eg, pulmonary embolus).



FAS1_2019_16-Respiratory.indd 669 11/8/19 7:34 AM

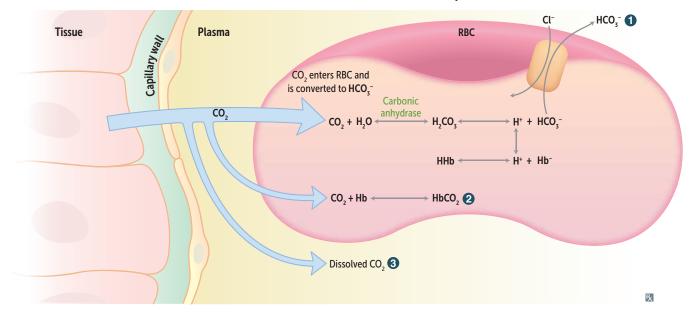
Carbon dioxide transport

CO₂ is transported from tissues to lungs in 3 forms:

- 1 HCO₃- (70%).
- 2 Carbaminohemoglobin or HbCO₂ (21–25%). CO₂ bound to Hb at N-terminus of globin (not heme). CO₂ favors deoxygenated form (O₂ unloaded).
- **3** Dissolved CO₂ (5–9%).

In lungs, oxygenation of Hb promotes dissociation of H⁺ from Hb. This shifts equilibrium toward CO₂ formation; therefore, CO₂ is released from RBCs (Haldane effect). In peripheral tissue, † H⁺ from tissue metabolism shifts curve to right, unloading O₂ (Bohr effect).

Majority of blood CO₂ is carried as HCO₃⁻ in the plasma.



Response to high altitude

↓ atmospheric oxygen (PiO_2) → ↓ Pao_2 → ↑ ventilation → ↓ $Paco_2$ → respiratory alkalosis → altitude sickness.

Chronic † in ventilation.

↑ erythropoietin → ↑ Het and Hb (due to chronic hypoxia).

† 2,3-BPG (binds to Hb causing rightward shift of the ODC so that Hb releases more O₂).

Cellular changes († mitochondria).

† renal excretion of HCO₃⁻ to compensate for respiratory alkalosis (can augment with acetazolamide).

Chronic hypoxic pulmonary vasoconstriction results in pulmonary hypertension and RVH.

Response to exercise

† CO, production.

† O, consumption.

Right shift of ODC.

† ventilation rate to meet O, demand.

V/Q ratio from apex to base becomes more uniform.

† pulmonary blood flow due to † cardiac output.

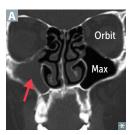
↓ pH during strenuous exercise (2° to lactic acidosis).

No change in Pao, and Paco₂, but † in venous CO₂ content and ↓ in venous O₂ content.

FAS1_2019_16-Respiratory.indd 670 11/8/19 7:34 AM

▶ RESPIRATORY—PATHOLOGY

Rhinosinusitis



Obstruction of sinus drainage into nasal cavity → inflammation and pain over affected area. Typically affects maxillary sinuses, which drain against gravity due to ostia located superomedially (red arrow points to fluid-filled right maxillary sinus in A).

Superior meatus—drains sphenoid, posterior ethmoid; middle meatus—drains frontal, maxillary, and anterior ethmoid; inferior meatus—drains nasolacrimal duct.

Most common acute cause is viral URI; may lead to superimposed bacterial infection, most commonly *H influenzae*, *S pneumoniae*, *M catarrhalis*.

Paranasal sinus infections may extend to the orbits, cavernous sinus, and brain, causing complications (eg, orbital cellulitis, cavernous sinus syndrome, meningitis).

Epistaxis

Nose bleed. Most commonly occurs in anterior segment of nostril (Kiesselbach plexus). Life-threatening hemorrhages occur in posterior segment (sphenopalatine artery, a branch of maxillary artery). Common causes include foreign body, trauma, allergic rhinitis, and nasal angiofibromas (common in adolescent males).

Kiesselbach drives his Lexus with his LEGS: superior Labial artery, anterior and posterior Ethmoidal arteries, Greater palatine artery, Sphenopalatine artery.

Head and neck cancer

Mostly squamous cell carcinoma. Risk factors include tobacco, alcohol, HPV-16 (oropharyngeal), EBV (nasopharyngeal). Field cancerization: carcinogen damages wide mucosal area → multiple tumors that develop independently after exposure.

Deep venous thrombosis



Blood clot within a deep vein → swelling, redness A, warmth, pain. Predisposed by Virchow triad (SHE):

- Stasis (eg, post-op, long drive/flight)
- Hypercoagulability (eg, defect in coagulation cascade proteins, such as factor V Leiden; oral contraceptive use; pregnancy)
- Endothelial damage (exposed collagen triggers clotting cascade)

Most pulmonary emboli arise from proximal deep veins of lower extremity.

D-dimer lab test used clinically to rule out DVT in low-to-moderate risk patients (high sensitivity, low specificity).

Imaging test of choice is compression ultrasound with Doppler.

Use unfractionated heparin or low-molecular weight heparins (eg, enoxaparin) for prophylaxis and acute management.

Use oral anticoagulants (eg, rivaroxaban, apixaban) for treatment and long-term prevention.

FAS1_2019_16-Respiratory.indd 671 11/8/19 7:34 AM

Pulmonary emboli

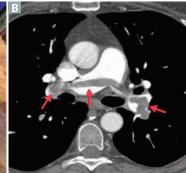
V/Q mismatch, hypoxemia, respiratory alkalosis. Sudden-onset dyspnea, pleuritic chest pain, tachypnea, tachycardia. Large emboli or saddle embolus A may cause sudden death due to electromechanical dissociation (pulseless electrical activity). CT pulmonary angiography is imaging test of choice for PE (look for filling defects) B. May have S1Q3T3 abnormality on ECG.

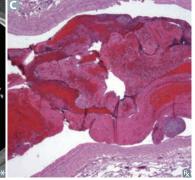
Lines of Zahn c are interdigitating areas of pink (platelets, fibrin) and red (RBCs) found only in thrombi formed before death; help distinguish pre- and postmortem thrombi.

Types: Fat, Air, Thrombus, Bacteria, Amniotic fluid, Tumor. An embolus moves like a FAT BAT. Fat emboli—associated with long bone fractures and liposuction; classic triad of hypoxemia, neurologic abnormalities, petechial rash.

Air emboli—nitrogen bubbles precipitate in ascending divers (caisson disease/decompression sickness); treat with hyperbaric O₂; or, can be iatrogenic 2° to invasive procedures (eg, central line placement). Amniotic fluid emboli—typically occurs during labor or postpartum, but can be due to uterine trauma. Can lead to DIC. Rare, but high mortality.







Mediastinal pathology

Normal mediastinum contains heart, thymus, lymph nodes, esophagus, and aorta.

Mediastinal masses

Some pathologies (eg, lymphoma, lung cancer, abscess) can occur in any compartment, but there are common associations:

- Anterior—4T's: Thyroid (substernal goiter), Thymic neoplasm, Teratoma, "Terrible" lymphoma.
- Middle—esophageal carcinoma, metastases, hiatal hernia, bronchogenic cysts.
- Posterior—neurogenic tumor (eg, neurofibroma), multiple myeloma.

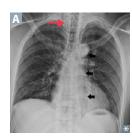
Mediastinitis

Inflammation of mediastinal tissues. Commonly due to postoperative complications of cardiothoracic procedures (≤ 14 days), esophageal perforation, or contiguous spread of odontogenic/retropharyngeal infection.

Chronic mediastinitis—also known as fibrosing mediastinitis; due to † proliferation of connective tissue in mediastinum. *Histoplasma capsulatum* is common cause.

Clinical features: fever, tachycardia, leukocytosis, chest pain, and sternal wound drainage.

Pneumomediastinum



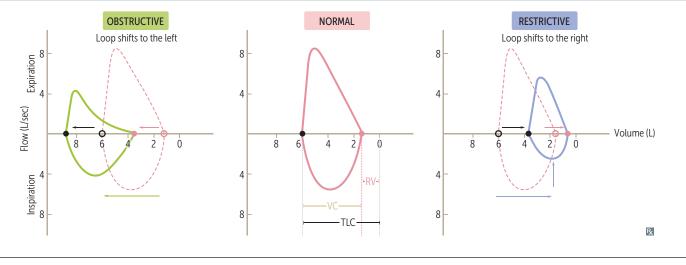
Presence of gas (usually air) in the mediastinum (black arrows show air around the aorta, red arrow shows air dissecting into the neck A). Can either be spontaneous (due to rupture of pulmonary bleb) or 2° (eg, trauma, iatrogenic, Boerhaave syndrome).

Ruptured alveoli allow tracking of air into the mediastinum via peribronchial and perivascular sheaths. Clinical features: chest pain, dyspnea, voice change, subcutaneous emphysema, \oplus Hamman sign (crepitus on cardiac auscultation).

FAS1_2019_16-Respiratory.indd 672 11/8/19 7:34 AM

Flow-volume loops

Obstructive lung disease	Restrictive lung disease
t	↓
†	↓
t	↓
↓↓	↓
↓	↓
1	Normal or † FEV, decreased proportionately to FVC
	Obstructive lung disease



FAS1_2019_16-Respiratory.indd 673 11/8/19 7:34 AM

Obstructive lung diseases

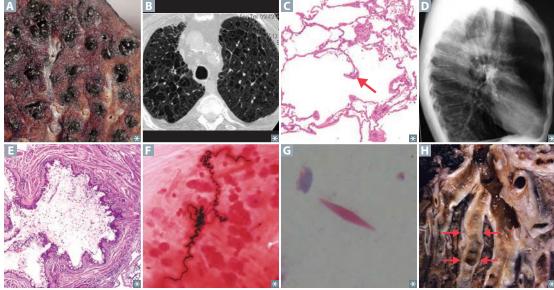
Obstruction of air flow \rightarrow air trapping in lungs. Airways close prematurely at high lung volumes \rightarrow † FRC, † RV, † TLC. PFTs: ‡‡ FEV₁, ‡ FVC \rightarrow ‡ FEV₁/FVC ratio (hallmark), $\dot{V}\dot{Q}$ mismatch. Chronic hypoxic pulmonary vasoconstriction can lead to cor pulmonale. Chronic obstructive pulmonary disease (COPD) includes chronic bronchitis and emphysema. "FRiCkin' RV needs some increased TLC, but it's hard with COPD!"

ТҮРЕ	PRESENTATION PRESENTATION	PATHOLOGY	OTHER
Chronic bronchitis ("blue bloater")	Findings: wheezing, crackles, cyanosis (hypoxemia due to shunting), dyspnea, CO ₂ retention, 2° polycythemia.	Hypertrophy and hyperplasia of mucus-secreting glands in bronchi → Reid index (thickness of mucosal gland layer to thickness of wall between epithelium and cartilage) > 50%. DLCO usually normal.	Diagnostic criteria: productive cough for ≥ 3 months in a year for > 2 consecutive years.
Emphysema ("pink puffer") Normal Centriacinar emphysema Panacinar emphysema	Findings: barrel-shaped chest , exhalation through pursed lips (increases airway pressure and prevents airway collapse).	Centriacinar—affects respiratory bronchioles while sparing distal alveoli, associated with smoking A ■. Frequently in upper lobes (smoke rises up). Panacinar—affects respiratory bronchioles and alveoli, associated with α₁-antitrypsin deficiency. Frequently in lower lobes. Enlargement of air spaces ↓ recoil, ↑ compliance, ↓ DLCO from destruction of alveolar walls (arrow in C) and ↓ blood volume in pulmonary capillaries. Imbalance of proteases and antiproteases → ↑ elastase activity → ↑ loss of elastic fibers → ↑ lung compliance.	CXR: † AP diameter, flattened diaphragm, † lung field lucency.
Asthma	Findings: cough, wheezing, tachypnea, dyspnea, hypoxemia, ↓ inspiratory/ expiratory ratio, pulsus paradoxus, mucus plugging ■. Triggers: viral URIs, allergens, stress.	Hyperresponsive bronchi → reversible bronchoconstriction. Smooth muscle hypertrophy and hyperplasia, Curschmann spirals F (shed epithelium forms whorled mucous plugs), and Charcot-Leyden crystals G (eosinophilic, hexagonal, double-pointed crystals formed from breakdown of eosinophils in sputum). DLCO normal or ↑ .	Type I hypersensitivity reaction. Diagnosis supported by spirometry and methacholine challenge. NSAID-exacerbated respiratory disease is a combination of COX inhibition (leukotriene overproduction → airway constriction), chronic sinusitis with nasal polyps, and asthma symptoms.

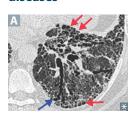
FAS1_2019_16-Respiratory.indd 674 11/8/19 7:34 AM

Obstructive lung diseases (continued)

ТҮРЕ	PRESENTATION	PATHOLOGY	OTHER
Bronchiectasis	Findings: purulent sputum, recurrent infections (most often <i>P aeruginosa</i>), hemoptysis, digital clubbing.	Chronic necrotizing infection of bronchi or obstruction → permanently dilated airways.	Associated with bronchial obstruction, poor ciliary motility (eg, smoking, Kartagener syndrome), cystic fibrosis H, allergic bronchopulmonary aspergillosis.
	A B	C 1949	D



Restrictive lung diseases



Restricted lung expansion causes \$\frac{1}{2}\$ lung volumes (\$\frac{1}{2}\$ FVC and TLC). PFTs: \$\frac{1}{2}\$ FEV_1/FVC ratio. Patient presents with short, shallow breaths.

Types:

- Poor breathing mechanics (extrapulmonary, normal D_{LCO}, normal A-a gradient):
 - Poor muscular effort—polio, myasthenia gravis, Guillain-Barré syndrome
 - Poor structural apparatus—scoliosis, morbid obesity
- Interstitial lung diseases (pulmonary, \downarrow D_{LCO}, \uparrow A-a gradient):
 - Pneumoconioses (eg, coal workers' pneumoconiosis, silicosis, asbestosis)
 - Sarcoidosis: bilateral hilar lymphadenopathy, noncaseating granulomas; ↑ ACE and Ca²⁺
 - Idiopathic pulmonary fibrosis (repeated cycles of lung injury and wound healing with
 † collagen deposition, "honeycomb" lung appearance [red arrows in A], traction
 bronchiectasis [blue arrow in A] and digital clubbing).
 - Granulomatosis with polyangiitis (Wegener)
 - Pulmonary Langerhans cell histiocytosis (eosinophilic granuloma)
 - Hypersensitivity pneumonitis
 - Drug toxicity (eg, bleomycin, busulfan, amiodarone, methotrexate)

Hypersensitivity pneumonitis—mixed type III/IV hypersensitivity reaction to environmental antigen. Causes dyspnea, cough, chest tightness, fever, headache. Often seen in farmers and those exposed to birds. Reversible in early stages if stimulus is avoided.

FAS1_2019_16-Respiratory.indd 675 11/8/19 7:34 AM

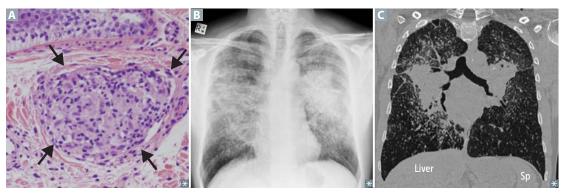
RESPIRATORY ▶ RESPIRATORY—PATHOLOGY

Sarcoidosis

Characterized by immune-mediated, widespread noncaseating granulomas A, elevated serum ACE levels, and elevated CD4/CD8 ratio in bronchoalveolar lavage fluid. More common in African-American females. Often asymptomatic except for enlarged lymph nodes. CXR shows bilateral adenopathy and coarse reticular opacities B; CT of the chest better demonstrates the extensive hilar and mediastinal adenopathy .

Associated with **Bell palsy**, **U**veitis, **G**ranulomas (noncaseating epithelioid, containing microscopic Schaumann and asteroid bodies), **L**upus pernio (skin lesions on face resembling lupus), **I**nterstitial fibrosis (restrictive lung disease), **E**rythema nodosum, **R**heumatoid arthritis-like arthropathy, hypercalcemia (due to † 1α -hydroxylase–mediated vitamin D activation in macrophages). A **facial droop** is **UGLIER**.

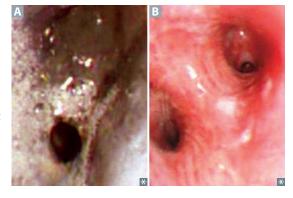
Treatment: steroids (if symptomatic).



Inhalation injury and sequelae

Complication of inhalation of noxious stimuli (eg, smoke). Caused by heat, particulates (< 1 µm diameter), or irritants (eg, NH₃) → chemical tracheobronchitis, edema, pneumonia, ARDS. Many patients present 2° to burns, CO inhalation, cyanide poisoning, or arsenic poisoning. Singed nasal hairs or soot in oropharynx common on exam.

Bronchoscopy shows severe edema, congestion of bronchus, and soot deposition (A, 18 hours after inhalation injury; B, resolution at 11 days after injury).



FAS1_2019_16-Respiratory.indd 676 11/8/19 7:34 AM

Pneumoconioses	Asbestos is from the roof (was common in insulation), but affects the base (lower lobes). Silica and coal are from the base (earth), but affect the roof (upper lobes).			
Asbestosis	Associated with shipbuilding, roofing, plumbing. "Ivory white," calcified, supradiaphragmatic A and pleural B plaques are pathognomonic of asbestosis. Risk of bronchogenic carcinoma > risk of mesothelioma. † risk of Caplan syndrome (rheumatoid arthritis and pneumoconioses with intrapulmonary nodules).	Affects lower lobes. Asbestos (ferruginous) bodies are golden-brown fusiform rods resembling dumbbells , found in alveolar sputum sample, visualized using Prussian blue stain, often obtained by bronchoalveolar lavage. † risk of pleural effusions.		
Berylliosis	Associated with exposure to beryllium in aerospace and manufacturing industries. Granulomatous (noncaseating) on histology and therefore occasionally responsive to steroids. † risk of cancer and cor pulmonale.	Affects upper lobes.		
Coal workers' pneumoconiosis	Prolonged coal dust exposure → macrophages laden with carbon → inflammation and fibrosis. Also known as black lung disease. ↑ risk of Caplan syndrome.	Affects upper lobes. Small, rounded nodular opacities seen on imaging. Anthracosis—asymptomatic condition found in many urban dwellers exposed to sooty air.		
Silicosis	Associated with sandblasting, foundries, mines. Macrophages respond to silica and release fibrogenic factors, leading to fibrosis. It is thought that silica may disrupt phagolysosomes and impair macrophages, increasing susceptibility to TB. † risk of cancer, cor pulmonale, and Caplan syndrome.	Affects upper lobes. "Eggshell" calcification of hilar lymph nodes on CXR. The silly egg sandwich I found is mine!		
	A B B S S S S S S S S S S S S S S S S S	C X		

11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 677

Mesothelioma



Malignancy of the pleura associated with asbestosis. May result in hemorrhagic pleural effusion (exudative), pleural thickening A.

Psammoma bodies seen on histology. Calretinin and cytokeratin $5/6 \oplus$ in almost all mesotheliomas, \bigcirc in most carcinomas. Smoking not a risk factor.

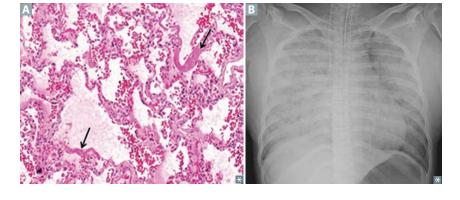
Acute respiratory distress syndrome

	· · ·
PATHOPHYSIOLOGY	Alveolar insult → release of pro-inflammatory cytokines → neutrophil recruitment, activation, and release of toxic mediators (eg, reactive oxygen species, proteases, etc) → capillary endothelial damage and ↑ vessel permeability → leakage of protein-rich fluid into alveoli → formation of intra-alveolar hyaline membranes (arrows in A) and noncardiogenic pulmonary edema (normal PCWP). Loss of surfactant also contributes to alveolar collapse.
CAUSES	Sepsis (most common), aspiration, pneumonia, trauma, pancreatitis.
DIAGNOSIS	Diagnosis of exclusion with the following criteria (ARDS): Abnormal chest X-ray (bilateral lung opacities) Respiratory failure within 1 week of alveolar insult Decreased Pao ₂ /Fio ₂ (ratio < 300, hypoxemia due to † intrapulmonary shunting and diffusion abnormalities)

• Symptoms of respiratory failure are not due to HF/fluid overload

CONSEQUENCES Impaired gas exchange, I lung compliance; pulmonary hypertension. Treat the underlying cause. MANAGEMENT

Mechanical ventilation: ↓ tidal volume, ↑ PEEP.



FAS1_2019_16-Respiratory.indd 678 11/8/19 7:34 AM

Sleep apnea	Repeated cessation of breathing > 10 seconds during sleep → disrupted sleep → daytime somnolence. Diagnosis confirmed by sleep study. Nocturnal hypoxia → systemic/pulmonary hypertension, arrhythmias (atrial fibrillation/flutter), sudden death.
	Hypoxia → ↑ EPO release → ↑ erythropoiesis.
Obstructive sleep apnea	Respiratory effort against airway obstruction. Normal Pao ₂ during the day. Associated with obesity, loud snoring, daytime sleepiness. Caused by excess parapharyngeal tissue in adults, adenotonsillar hypertrophy in children. Treatment: weight loss, CPAP, dental devices.
Central sleep apnea	Impaired respiratory effort due to CNS injury/toxicity, HF, opioids. May be associated with Cheyne-Stokes respirations (oscillations between apnea and hyperpnea). Think 3 C's: Congestive HF, CNS toxicity, Cheyne-Stokes respirations. Treat with positive airway pressure.
Obesity hypoventilation syndrome	Obesity (BMI ≥ 30 kg/m²) → hypoventilation → ↑ Paco ₂ during waking hours (retention); ↓ Pao ₂ and ↑ Paco ₂ during sleep. Also known as Pickwickian syndrome.
Pulmonary hypertension	Normal mean pulmonary artery pressure = 10–14 mm Hg; pulmonary hypertension ≥ 25 mm Hg at rest. Results in arteriosclerosis, medial hypertrophy, intimal fibrosis of pulmonary arteries, plexiform lesions. Course: severe respiratory distress → cyanosis and RVH → death from decompensated cor pulmonale.
ETIOLOGIES	
Pulmonary arterial hypertension	Often idiopathic. Heritable PAH can be due to an inactivating mutation in <i>BMPR2</i> gene (normally inhibits vascular smooth muscle proliferation); poor prognosis. Pulmonary vasculature endothelial dysfunction results in ↑ vasoconstrictors (eg, endothelin) and ↓ vasodilators (eg, NO and prostacyclins). Other causes include drugs (eg, amphetamines, cocaine), connective tissue disease, HIV infection, portal hypertension, congenital heart disease, schistosomiasis.
Left heart disease	Causes include systolic/diastolic dysfunction and valvular disease.
Lung diseases or hypoxia	Destruction of lung parenchyma (eg, COPD), lung inflammation/fibrosis (eg, interstitial lung diseases), hypoxemic vasoconstriction (eg, obstructive sleep apnea, living in high altitude).
Chronic thromboembolic	Recurrent microthrombi → ↓ cross-sectional area of pulmonary vascular bed.
Multifactorial	Causes include hematologic, systemic, and metabolic disorders, along with compression of the pulmonary vasculature by a tumor.

11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 679

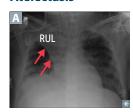
680 SECTION III

RESPIRATORY ▶ RESPIRATORY—PATHOLOGY

Physical findings in select lung diseases

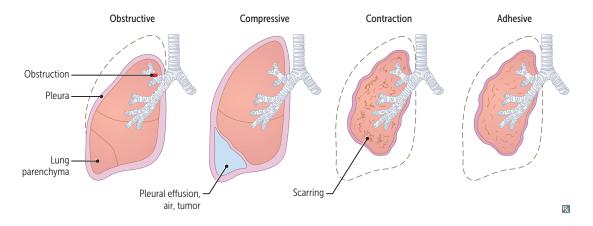
ABNORMALITY	BREATH SOUNDS	PERCUSSION	FREMITUS	TRACHEAL DEVIATION
Pleural effusion	ţ	Dull	1	None if small Away from side of lesion if large
Atelectasis	ļ	Dull	†	Toward side of lesion
Simple pneumothorax	Ţ	Hyperresonant	†	None
Tension pneumothorax	1	Hyperresonant	ţ	Away from side of lesion
Consolidation (lobar pneumonia, pulmonary edema)	Bronchial breath sounds; late inspiratory crackles, egophony, whispered pectoriloquy	Dull	1	None

Atelectasis



Alveolar collapse (right upper lobe collapse against mediastinum in A). Multiple causes:

- Obstructive—airway obstruction prevents new air from reaching distal airways, old air is resorbed (eg, foreign body, mucous plug, tumor)
- Compressive—external compression on lung decreases lung volumes (eg, space-occupying lesion, pleural effusion)
- Contraction (cicatrization)—scarring of lung parenchyma that distorts alveoli (eg, sarcoidosis)
- Adhesive—due to lack of surfactant (eg, NRDS in premature babies)



FAS1_2019_16-Respiratory.indd 680 11/8/19 7:34 AM

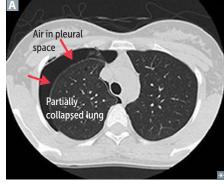
Pleural effusions	Excess accumulation of fluid ⚠ between pleural layers → restricted lung expansion during inspiration. Can be treated with thoracentesis to remove/reduce fluid ▶.				
Lymphatic	Also known as chylothorax. Due appearing fluid; † triglycerides.	to thoracic duct injury from traur	na or malignancy. Milky-		
Exudate	† protein content (> 2.9 g/dL), cloudy (cellular). Due to malignancy, inflammation/infection (eg, pneumonia, collagen vascular disease), trauma (occurs in states of † vascular permeability). Must be drained due to risk of infection.				
Transudate ↓ protein content (< 2.5 g/dL), clear (hypocellular). Due to ↑ hydrostatic pressure (eg, Herention) or ↓ oncotic pressure (eg, nephrotic syndrome, cirrhosis).			1		
	Normal	Exudate	Transudate		
	Hydrostatic pressure		Increased hydrostatic pressure		
	Colloid osmotic pressure	Fluid and protein leakage	Decreased colloid osmotic pressure		
	♥ Plasma proteins		Fluid leakage		
	Pretreatment	Pretreatment Post-treatment	ent Post-treatment **		

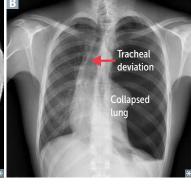
11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 681

682 SECTION III

RESPIRATORY → RESPIRATORY—PATHOLOGY

Pneumothorax	Accumulation of air in pleural space A. Dyspnea, uneven chest expansion. Chest pain, ‡ tactile fremitus, hyperresonance, and diminished breath sounds, all on the affected side.
Primary spontaneous pneumothorax	Due to rupture of apical subpleural bleb or cysts. Occurs most frequently in tall, thin, young males and smokers.
Secondary spontaneous pneumothorax	Due to diseased lung (eg, bullae in emphysema, infections), mechanical ventilation with use of high pressures → barotrauma.
Traumatic pneumothorax	Caused by blunt (eg, rib fracture), penetrating (eg, gunshot), or iatrogenic (eg, central line placement, lung biopsy, barotrauma due to mechanical ventilation) trauma.
Tension pneumothorax	Can be from any of the above. Air enters pleural space but cannot exit. Increasing trapped air → tension pneumothorax. Trachea deviates away from affected lung May lead to increased intrathoracic pressure → mediastinal displacement → kinking of IVC → ↓ venous return → ↓ cardiac output. Needs immediate needle decompression and chest tube placement.





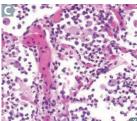
FAS1_2019_16-Respiratory.indd 682 11/8/19 7:34 AM

Pneumonia

ТҮРЕ	TYPICAL ORGANISMS	CHARACTERISTICS
Lobar pneumonia	S pneumoniae most frequently, also Legionella, Klebsiella	Intra-alveolar exudate → consolidation A; may involve entire lobe B or the whole lung.
Bronchopneumonia	S pneumoniae, S aureus, H influenzae, Klebsiella	Acute inflammatory infiltrates c from bronchioles into adjacent alveoli; patchy distribution involving ≥ 1 lobe D .
Interstitial (atypical) pneumonia	Mycoplasma, Chlamydophila pneumoniae, Chlamydophila psittaci, Legionella, viruses (RSV, CMV, influenza, adenovirus)	Diffuse patchy inflammation localized to interstitial areas at alveolar walls; CXR shows bilateral multifocal opacities E . Generally follows a more indolent course ("walking" pneumonia).
Cryptogenic organizing pneumonia	Etiology unknown. Secondary organizing pneumonia is caused by chronic inflammatory diseases (eg, rheumatoid arthritis) or medication side effects (eg, amiodarone).	Formerly known as bronchiolitis obliterans organizing pneumonia (BOOP). Noninfectious pneumonia characterized by inflammation of bronchioles and surrounding structure.











Natural history of lobar pneumonia

	Congestion	Red hepatization	Gray hepatization	Resolution
DAYS	1–2	3–4	5–7	8+
FINDINGS	Red-purple, partial consolidation of parenchyma Exudate with mostly bacteria	Red-brown consolidation Exudate with fibrin, bacteria, RBCs, WBCs Reversible	Uniformly gray Exudate full of WBCs, lysed RBCs, and fibrin	Enzymatic digestior of exudate by macrophages

11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 683

684 SECTI<u>on III</u>

RESPIRATORY ▶ RESPIRATORY—PATHOLOGY

Lung cancer

Leading cause of cancer death.

prostate, and bladder cancer.

Presentation: cough, hemoptysis, bronchial obstruction, wheezing, pneumonic "coin" lesion on CXR or noncalcified nodule on CT. Sites of metastases from lung cancer: Liver (jaundice, hepatomegaly), Adrenals, Bone (pathologic fracture), Brain; "Lung 'mets' Love Affective Boneheads and Brainiacs." In the lung, metastases (usually multiple lesions) are more common than 1° neoplasms. Most often from breast, colon,

SPHERE of complications:

Superior vena cava/thoracic outlet syndromes

Pancoast tumor

Horner syndrome

Endocrine (paraneoplastic)

Recurrent laryngeal nerve compression (hoarseness)

Effusions (pleural or pericardial)

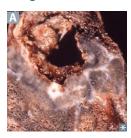
Risk factors include smoking, secondhand smoke, radon, asbestos, family history.

Squamous and Small cell carcinomas are Sentral (central) and often caused by Smoking.

	P,	d bladder cancer. (central) and often caus	ed by billouing.
ТҮРЕ	LOCATION	CHARACTERISTICS	HISTOLOGY
Small cell			
Small cell (oat cell) carcinoma	Central	Undifferentiated → very aggressive. May produce ACTH (Cushing syndrome), ADH (SIADH), or Antibodies against presynaptic Ca²+ channels (Lambert-Eaton myasthenic syndrome) or neurons (paraneoplastic myelitis, encephalitis, subacute cerebellar degeneration). Amplification of <i>myc</i> oncogenes common. Managed with chemotherapy +/- radiation.	Neoplasm of neuroendocrine Kulchitsky cells → small dark blue cells A. Chromogranin A ⊕, neuron-specific enolase ⊕, synaptophysin ⊕.
Non-small cell			
Adenocarcinoma	Peripheral	Most common 1° lung cancer. More common in women than men, most likely to arise in nonsmokers. Activating mutations include <i>KRAS</i> , <i>EGFR</i> , and <i>ALK</i> . Associated with hypertrophic osteoarthropathy (clubbing). Bronchioloalveolar subtype (adenocarcinoma in situ): CXR often shows hazy infiltrates similar to pneumonia; better prognosis.	Glandular pattern on histology, often stains mucin ⊕ B. Bronchioloalveolar subtype: grows along alveolar septa → apparent "thickening" of alveolar walls. Tall, columnar cells containing mucus.
Squamous cell carcinoma	Central	Hilar mass arising from bronchus; Cavitation; Cigarettes; hyperCalcemia (produces PTHrP).	Keratin pearls D and intercellular bridges.
Large cell carcinoma	Peripheral	Highly anaplastic undifferentiated tumor; poor prognosis. Less responsive to chemotherapy; removed surgically. Strong association with smoking.	Pleomorphic giant cells E .
Bronchial carcinoid tumor	Central or peripheral	Excellent prognosis; metastasis rare. Symptoms due to mass effect or carcinoid syndrome (flushing, diarrhea, wheezing).	Nests of neuroendocrine cells; chromogranin $A \oplus$.
	B		

FAS1_2019_16-Respiratory.indd 684 11/8/19 7:34 AM

Lung abscess





Localized collection of pus within parenchyma A. Caused by aspiration of oropharyngeal contents (especially in patients predisposed to loss of consciousness [eg, alcoholics, epileptics]) or bronchial obstruction (eg, cancer).

Air-fluid levels **B** often seen on CXR; presence suggests cavitation. Due to anaerobes (eg, *Bacteroides*, *Fusobacterium*, *Peptostreptococcus*) or *S aureus*. Treatment: antibiotics, drainage, or surgery.

Lung abscess 2° to aspiration is most often found in right lung. Location depends on patient's position during aspiration: RLL if upright, RUL or RML if recumbent.

Pancoast tumor



Also known as superior sulcus tumor. Carcinoma that occurs in the apex of lung A may cause Pancoast syndrome by invading/compressing local structures.

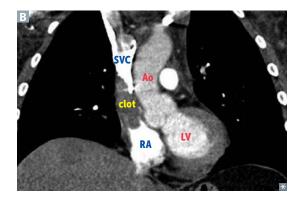
Compression of locoregional structures may cause array of findings:

- Recurrent laryngeal nerve → hoarseness
- Stellate ganglion → Horner syndrome (ipsilateral ptosis, miosis, anhidrosis)
- Superior vena cava → SVC syndrome
- Brachiocephalic vein → brachiocephalic syndrome (unilateral symptoms)
- Brachial plexus → sensorimotor deficits
- Phrenic nerve → hemidiaphragm paralysis (hemidiaphragm elevation on CXR)

Superior vena cava syndrome



An obstruction of the SVC that impairs blood drainage from the head ("facial plethora"; note blanching after fingertip pressure in ♠), neck (jugular venous distention), and upper extremities (edema). Commonly caused by malignancy (eg, mediastinal mass, Pancoast tumor) and thrombosis from indwelling catheters ▶ Medical emergency. Can raise intracranial pressure (if obstruction is severe) → headaches, dizziness, ↑ risk of aneurysm/rupture of intracranial arteries.



FAS1_2019_16-Respiratory.indd 685 11/8/19 7:34 AM

686 SECTION III RESPIRATORY > RESPIRATORY—PHARMACOLOGY

Histamine-1 blockers	Reversible inhibitors of H ₁ histamine receptors.		
First generation	Diph <mark>en</mark> hydram <mark>ine</mark> , dim <mark>en</mark> hydrin <mark>ate</mark> , chlorph <mark>en</mark> iram <mark>ine</mark> , doxylam <mark>ine</mark> .	Names usually contain "-en/-ine" or "-en/-ate."	
CLINICAL USE	Allergy, motion sickness, sleep aid.		
ADVERSE EFFECTS	Sedation, antimuscarinic, anti- $lpha$ -adrenergic.		
Second generation	Loratadine, fexofenadine, desloratadine, cetirizine.	Names usually end in "-adine."	
CLINICAL USE	Allergy.		
ADVERSE EFFECTS	Far less sedating than 1st generation because of ↓ entry into CNS.		
Guaifenesin	Expectorant—thins respiratory secretions; does n	not suppress cough reflex.	
N-acetylcysteine	Mucolytic—liquifies mucus in chronic bronchor disulfide bonds. Also used as an antidote for according to the control of the co	oulmonary diseases (eg, COPD, CF) by disrupting etaminophen overdose.	
Dextromethorphan		otors). Synthetic codeine analog. Has mild opioid	
	serotonin syndrome if combined with other ser	±	
Pseudoephedrine, phe	serotonin syndrome if combined with other ser	±	
Pseudoephedrine, phe	serotonin syndrome if combined with other ser	±	
Pseudoephedrine, phe MECHANISM CLINICAL USE	serotonin syndrome if combined with other ser	otonergic agents.	
MECHANISM	serotonin syndrome if combined with other ser nylephrine α-adrenergic agonists. Reduce hyperemia, edema (used as nasal decong	otonergic agents. gestants); open obstructed eustachian tubes.	
MECHANISM CLINICAL USE	nylephrine α-adrenergic agonists. Reduce hyperemia, edema (used as nasal decong Hypertension. Rebound congestion if used more anxiety (pseudoephedrine).		
MECHANISM CLINICAL USE ADVERSE EFFECTS Pulmonary hypertension	nylephrine α-adrenergic agonists. Reduce hyperemia, edema (used as nasal decong Hypertension. Rebound congestion if used more anxiety (pseudoephedrine).	gestants); open obstructed eustachian tubes. than 4–6 days. Can also cause CNS stimulation/	
MECHANISM CLINICAL USE ADVERSE EFFECTS Pulmonary hypertension DRUG Endothelin receptor antagonists	nylephrine α-adrenergic agonists. Reduce hyperemia, edema (used as nasal decong Hypertension. Rebound congestion if used more anxiety (pseudoephedrine).	gestants); open obstructed eustachian tubes. than 4–6 days. Can also cause CNS stimulation/ CLINICAL NOTES Hepatotoxic (monitor LFTs). Example: bosentan.	
MECHANISM CLINICAL USE ADVERSE EFFECTS Pulmonary hypertension DRUG Endothelin receptor	nylephrine α-adrenergic agonists. Reduce hyperemia, edema (used as nasal decong Hypertension. Rebound congestion if used more anxiety (pseudoephedrine). on drugs MECHANISM Competitively antagonizes endothelin-1	gestants); open obstructed eustachian tubes. than 4–6 days. Can also cause CNS stimulation/	

11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 686

Asthma drugs	Bronchoconstriction is mediated by (1) inflammatory processes and (2) parasympathetic tone; therapy is directed at these 2 pathways.		
β_2 -agonists	 Albuterol—relaxes bronchial smooth muscle (short acting β₂-agonist). For acute exacerbations. Can cause tremor, arrhythmia. Salmeterol, formoterol—long-acting agents for prophylaxis. Can cause tremor, arrhythmia. 		
Inhaled corticosteroids	Fluticasone, budesonide—inhibit the synthesis of virtually all cytokines. Inactivate NF- κ B, the transcription factor that induces production of TNF- α and other inflammatory agents. Ist-line therapy for chronic asthma. Use a spacer or rinse mouth after use to prevent oral thrush.		
Muscarinic antagonists	Tiotropium, ipratropium —competitively block muscarinic receptors, preventing bronchoconstriction. Also used for COPD. Tiotropium is long acting.		
Anti <mark>leu</mark> kotrienes	Montelukast, zafirlukast—block leukotriene receptors (CysLTl). Especially good for aspirin-induced and exercise-induced asthma. Zileuton—5-lipoxygenase pathway inhibitor. Blocks conversion of arachidonic acid to leukotrienes. Hepatotoxic.	Exposure to antigen (dust, pollen, etc)	
Anti-IgE monoclonal therapy	Omalizumab—binds mostly unbound serum IgE and blocks binding to FcεRI. Used in allergic asthma with † IgE levels resistant to inhaled steroids and long-acting β ₂ -agonists.	Antigen and IgE ——— Omalizumab on mast cells ——— Steroids Chromones	
Methylxanthines	Theophylline—likely causes bronchodilation by inhibiting phosphodiesterase → † cAMP levels due to ↓ cAMP hydrolysis. Limited use due to narrow therapeutic index (cardiotoxicity, neurotoxicity); metabolized by cytochrome P-450. Blocks actions of adenosine.	Mediators (leukotrienes, histamine, interleukins, etc) β-agonists Theophylline Muscarinic Steroids Antileukotrienes	
Chromones	Cromolyn —prevents mast cell degranulation. Prevents acute asthma symptoms. Rarely used.	Antileukotrienes antagonists Anti-IL-5 monoclonal antibodies	
Anti-IL-5 monoclonal therapy	Prevents eosinophil differentiation, maturation, activation, and survival mediated by IL-5 stimulation. For maintenance therapy in severe eosinophilic asthma. Mepolizumab, reslizumab—against IL-5. Benralizumab—against IL-5 receptor α. Bronchodilation ATP AC ATP AC AC ATP AC AMP	Early response: bronchoconstriction Symptoms Late response: inflammation Bronchial hyperreactivity	
ACI Muscarin antagoni:	ic Theophylline		

11/8/19 7:34 AM FAS1_2019_16-Respiratory.indd 687

688 SECTION II

RESPIRATORY → RESPIRATORY—PHARMACOLOGY

► NOTES	

FAS1_2019_16-Respiratory.indd 688 11/8/19 7:34 AM

HIGH-YIELD SYSTEMS

Rapid Review

"Study without thought is vain: thought without study is dangerous."

-Confucius

"It is better, of course, to know useless things than to know nothing."

—Lucius Annaeus Seneca

"For every complex problem there is an answer that is clear, simple, and wrong."

-H. L. Mencken

The following tables represent a collection of high-yield associations between diseases and their clinical findings, treatments, and key associations. They can be quickly reviewed in the days before the exam.

► Classic Presentations	690
Classic Labs/ Findings	695
Classic/Relevant Treatments	699
▶ Key Associations	702
▶ Equation Review	707
▶ Easily Confused Medications	709

FAS1_2019_17_Rapid Rev.indd 689 11/7/19 6:09 PM

RAPID REVIEW ► CLASSIC PRESENTATIONS

► CLASSIC PRESENTATIONS CLINICAL PRESENTATION DIAGNOSIS/DISEASE PAGE Gout, intellectual disability, self-mutilating behavior in a Lesch-Nyhan syndrome (HGPRT deficiency, X-linked 37 boy recessive) 49 Situs inversus, chronic sinusitis, bronchiectasis, infertility Kartagener syndrome (dynein arm defect affecting cilia) Blue sclera Osteogenesis imperfecta (type I collagen defect) 51 Ehlers-Danlos syndrome (type V collagen defect, type III 51 Elastic skin, hypermobility of joints, † bleeding tendency collagen defect seen in vascular subtype of ED) Arachnodactyly, lens dislocation (upward and temporal), Marfan syndrome (fibrillin defect) 52 aortic dissection, hyperflexible joints Café-au-lait spots (unilateral), polyostotic fibrous McCune-Albright syndrome (G -protein activating 57 dysplasia, precocious puberty, multiple endocrine mutation) abnormalities Calf pseudohypertrophy Muscular dystrophy (most commonly Duchenne, due to 61 X-linked recessive frameshift mutation of dystrophin gene) Duchenne muscular dystrophy (Gowers sign) Child uses arms to stand up from squat 61 Becker muscular dystrophy (X-linked non-frameshift 61 Slow, progressive muscle weakness in boys deletions in dystrophin; less severe than Duchenne) Infant with cleft lip/palate, microcephaly or Patau syndrome (trisomy 13) 63 holoprosencephaly, polydactyly, cutis aplasia Infant with microcephaly, rocker-bottom feet, clenched 63 Edwards syndrome (trisomy 18) hands, and structural heart defect Single palmar crease Down syndrome 63 Dilated cardiomyopathy, edema, alcoholism or Wet beriberi (thiamine [vitamin B₁] deficiency) 66 malnutrition Dermatitis, dementia, diarrhea Pellagra (niacin [vitamin B₃] deficiency) 67 Swollen gums, mucosal bleeding, poor wound healing, Scurvy (vitamin C deficiency: can't hydroxylate proline/ 69 petechiae lysine for collagen synthesis) Chronic exercise intolerance with myalgia, fatigue, McArdle disease (skeletal muscle glycogen phosphorylase 87 painful cramps, myoglobinuria deficiency) Cori disease (debranching enzyme deficiency) or Von 87 Infant with hypoglycemia, hepatomegaly Gierke disease (glucose-6-phosphatase deficiency, more Myopathy (infantile hypertrophic cardiomyopathy), 87 Pompe disease (lysosomal α -1,4-glucosidase deficiency) exercise intolerance "Cherry-red spots" on macula Tay-Sachs (ganglioside accumulation) or Niemann-Pick 88 (sphingomyelin accumulation), central retinal artery occlusion Hepatosplenomegaly, pancytopenia, osteoporosis, Gaucher disease (glucocerebrosidase [β-glucosidase] 88 avascular necrosis of femoral head, bone crises deficiency) Achilles tendon xanthoma Familial hypercholesterolemia (LDL receptor signaling) 94 Anaphylaxis following blood transfusion IgA deficiency 116 Male child, recurrent infections, no mature B cells Bruton disease (X-linked agammaglobulinemia) 116

FAS1_2019_17_Rapid Rev.indd 690 11/7/19 6:09 PM

CLINICAL PRESENTATION	DIAGNOSIS/DISEASE	PAGE
Recurrent cold (noninflamed) abscesses, eczema, high serum IgE, † eosinophils	Hyper-IgE syndrome (Job syndrome: neutrophil chemotaxis abnormality)	116
"Strawberry tongue"	Scarlet fever Kawasaki disease	136, 314
Abdominal pain, diarrhea, leukocytosis, recent antibiotic use	Clostridium difficile infection	138
Back pain, fever, night sweats	Pott disease (vertebral TB)	140
Adrenal hemorrhage, hypotension, DIC	Waterhouse-Friderichsen syndrome (meningococcemia)	142, 349
Red "currant jelly" sputum in alcoholic or diabetic patients	Klebsiella pneumoniae pneumonia	145
Large rash with bull's-eye appearance	Erythema migrans from <i>Ixodes</i> tick bite (Lyme disease: Borrelia)	146
Ulcerated genital lesion	Nonpainful, indurated: chancre (1° syphilis, <i>Treponema pallidum</i>) Painful, with exudate: chancroid (<i>Haemophilus ducreyi</i>)	147, 184
Pupil accommodates but doesn't react	Neurosyphilis (Argyll Robertson pupil)	147
Smooth, moist, painless, wart-like white lesions on genitals	Condylomata lata (2° syphilis)	147
Fever, chills, headache, myalgia following antibiotic treatment for syphilis	Jarisch-Herxheimer reaction (rapid lysis of spirochetes results in endotoxin-like release)	148
Dog or cat bite resulting in infection	Pasteurella multocida (cellulitis at inoculation site)	149
Rash on palms and soles	Coxsackie A, 2° syphilis, Rocky Mountain spotted fever	150
Black eschar on face of patient with diabetic ketoacidosis	Mucor or Rhizopus fungal infection	153
Chorioretinitis, hydrocephalus, intracranial calcifications	Congenital toxoplasmosis	156
Child with fever later develops red rash on face that spreads to body	Erythema infectiosum/fifth disease ("slapped cheeks" appearance, caused by parvovirus B19)	164
Fever, cough, conjunctivitis, coryza, diffuse rash	Measles	170
Small, irregular red spots on buccal/lingual mucosa with blue-white centers	Koplik spots (measles [rubeola] virus)	170
Bounding pulses, wide pulse pressure, diastolic heart murmur, head bobbing	Aortic regurgitation	291
Systolic ejection murmur (crescendo-decrescendo)	Aortic stenosis	291
Continuous "machine-like" heart murmur	PDA (close with indomethacin; keep open with PGE analogs)	291
Chest pain on exertion	Angina (stable: with moderate exertion; unstable: with minimal exertion or at rest)	304
Chest pain with ST depressions on ECG	Angina (⊖ troponins) or NSTEMI (⊕ troponins)	304
Chest pain, pericardial effusion/friction rub, persistent fever following MI	Dressler syndrome (autoimmune-mediated post-MI fibrinous pericarditis, 2 weeks to several months after acute episode)	307
Painful, raised red lesions on pads of fingers/toes	Osler nodes (infective endocarditis, immune complex deposition)	311

692 SECTION III RAPID REVIEW ► CLASSIC PRESENTATIONS

CLINICAL PRESENTATION	DIAGNOSIS/DISEASE	PAGE
Painless erythematous lesions on palms and soles	Janeway lesions (infective endocarditis, septic emboli/microabscesses)	311
Splinter hemorrhages in fingernails	Bacterial endocarditis	311
Retinal hemorrhages with pale centers	Roth spots (bacterial endocarditis)	311
Distant heart sounds, distended neck veins, hypotension	Beck triad of cardiac tamponade	310
Cervical lymphadenopathy, desquamating rash, coronary aneurysms, red conjunctivae and tongue, hand-foot changes	Kawasaki disease (mucocutaneous lymph node syndrome, treat with IVIG and aspirin)	314
Palpable purpura on buttocks/legs, joint pain, abdominal pain (child), hematuria	Immunoglobulin A vasculitis (Henoch-Schönlein purpura, affects skin and kidneys)	315
Telangiectasias, recurrent epistaxis, skin discoloration, arteriovenous malformations, GI bleeding, hematuria	Hereditary hemorrhagic telangiectasia (Osler-Weber-Rendu syndrome)	316
Skin hyperpigmentation, hypotension, fatigue	1° adrenocortical insufficiency → ↑ ACTH, ↑ α-MSH (eg, Addison disease)	349
Cutaneous flushing, diarrhea, bronchospasm	Carcinoid syndrome (right-sided cardiac valvular lesions, † 5-HIAA)	352
Cold intolerance, weight gain, brittle hair	Hypothyroidism	341
Cutaneous/dermal edema due to deposition of mucopolysaccharides in connective tissue	Myxedema (caused by hypothyroidism, Graves disease [pretibial])	340
Facial muscle spasm upon tapping	Chvostek sign (hypocalcemia)	344
No lactation postpartum, absent menstruation, cold intolerance	Sheehan syndrome (postpartum hemorrhage leading to pituitary infarction)	339
Deep, labored breathing/hyperventilation	Diabetic ketoacidosis (Kussmaul respirations)	347
Pancreatic, pituitary, parathyroid tumors	MEN 1 (autosomal dominant)	351
Thyroid tumors, pheochromocytoma, ganglioneuromatosis, Marfanoid habitus	MEN 2B (autosomal dominant RET mutation)	351
Thyroid and parathyroid tumors, pheochromocytoma	MEN 2A (autosomal dominant RET mutation)	351
Jaundice, palpable distended non-tender gallbladder	Courvoisier sign (distal malignant obstruction of biliary tree)	398
Vomiting blood following gastroesophageal lacerations	Mallory-Weiss syndrome (alcoholic and bulimic patients)	377
Dysphagia (esophageal webs), glossitis, iron deficiency anemia	Plummer-Vinson syndrome (may progress to esophageal squamous cell carcinoma)	377
Enlarged, hard left supraclavicular node	Virchow node (abdominal metastasis)	379
Arthralgias, adenopathy, cardiac and neurological symptoms, diarrhea	Whipple disease (Tropheryma whipplei)	381
Severe RLQ pain with palpation of LLQ	Rovsing sign (acute appendicitis)	383
Severe RLQ pain with deep tenderness	McBurney sign (acute appendicitis)	383
Hamartomatous GI polyps, hyperpigmented macules on mouth, feet, hands, genitalia	Peutz-Jeghers syndrome (inherited, benign polyposis can cause bowel obstruction; † cancer risk, mainly GI)	387
Multiple colon polyps, osteomas/soft tissue tumors, impacted/supernumerary teeth	Gardner syndrome (subtype of FAP)	387
Abdominal pain, ascites, hepatomegaly	Budd-Chiari syndrome (posthepatic venous thrombosis)	392

CLINICAL PRESENTATION	DIAGNOSIS/DISEASE	PAGE
Severe jaundice in neonate	Crigler-Najjar syndrome (congenital unconjugated hyperbilirubinemia)	394
Golden brown rings around peripheral cornea	Wilson disease (Kayser-Fleischer rings due to copper accumulation)	395
Fat, female, forty, fertile	Cholelithiasis (gallstones)	396
Painless jaundice	Cancer of the pancreatic head obstructing bile duct	398
Bluish line on gingiva	Burton line (lead poisoning)	419
Short stature, café-au-lait spots, thumb/radial defects, † incidence of tumors/leukemia, aplastic anemia	Fanconi anemia (genetic loss of DNA crosslink repair; often progresses to AML)	421
Red/pink urine, fragile RBCs	Paroxysmal nocturnal hemoglobinuria	422
Painful blue fingers/toes, hemolytic anemia	Cold agglutinin disease (autoimmune hemolytic anemia caused by <i>Mycoplasma pneumoniae</i> , infectious mononucleosis, CLL)	423
Petechiae, mucosal bleeding, prolonged bleeding time	Platelet disorders (eg, Glanzmann thrombasthenia, Bernard Soulier, HUS, TTP, ITP)	427
Fever, night sweats, weight loss	B symptoms of malignancy	429
Skin patches/plaques, Pautrier microabscesses, atypical T cells	Mycosis fungoides (cutaneous T-cell lymphoma) or Sézary syndrome (mycosis fungoides + malignant T cells in blood)	430
WBCs that look "smudged"	CLL	432
Neonate with arm paralysis following difficult birth, arm in "waiter's tip" position	Erb-Duchenne palsy (superior trunk [C5–C6] brachial plexus injury)	448
Anterior drawer sign ⊕	Anterior cruciate ligament injury	454
Bone pain, bone enlargement, arthritis	Osteitis deformans (Paget disease of bone, † osteoblastic and osteoclastic activity)	463
Swollen, hard, painful finger joints in an elderly individual, pain worse with activity	Osteoarthritis (osteophytes on PIP [Bouchard nodes], DIP [Heberden nodes])	466
Sudden swollen/painful big toe joint, tophi	Gout/podagra (hyperuricemia)	467
Dry eyes, dry mouth, arthritis	Sjögren syndrome (autoimmune destruction of exocrine glands)	468
Urethritis, conjunctivitis, arthritis in a male	Reactive arthritis associated with HLA-B27	469
"Butterfly" facial rash and Raynaud phenomenon in a young female	Systemic lupus erythematosus	470
Painful fingers/toes changing color from white to blue to red with cold or stress	Raynaud phenomenon (vasospasm in extremities)	472
Anticentromere antibodies	Scleroderma (CREST)	473
Dark purple skin/mouth nodules in a patient with AIDS	Kaposi sarcoma, associated with HHV-8	478
Anti-desmoglein (anti-desmosome) antibodies	Pemphigus vulgaris (blistering)	480
Pruritic, purple, polygonal planar papules and plaques (6 P's)	Lichen planus	482
↑ AFP in amniotic fluid/maternal serum	Dating error, anencephaly, spina bifida (open neural tube defects)	491
Ataxia, nystagmus, vertigo, dysarthria	Cerebellar lesion	499

FAS1_2019_17_Rapid Rev.indd 693 11/7/19 6:09 PM

694 SECTION III RAPID REVIEW > CLASSIC PRESENTATIONS

CLINICAL PRESENTATION	DIAGNOSIS/DISEASE	PAGE
Toe extension/fanning upon plantar scrape	Babinski sign (UMN lesion)	510
Hyperphagia, hypersexuality, hyperorality	Klüver-Bucy syndrome (bilateral amygdala lesion)	511
Resting tremor, athetosis, chorea	Basal ganglia lesion	511
Lucid interval after traumatic brain injury	Epidural hematoma (middle meningeal artery rupture)	513
"Worst headache of my life"	Subarachnoid hemorrhage	513
Resting tremor, rigidity, akinesia, postural instability, shuffling gait	Parkinson disease (loss of dopaminergic neurons in substantia nigra pars compacta)	520
Chorea, dementia, caudate degeneration	Huntington disease (autosomal dominant CAG repeat expansion)	520
Nystagmus, intention tremor, scanning speech, bilateral internuclear ophthalmoplegia	Multiple sclerosis	523
Rapidly progressive limb weakness that ascends following GI/upper respiratory infection	Guillain-Barré syndrome (acute inflammatory demyelinating polyradiculopathy subtype)	524
Café-au-lait spots, Lisch nodules (iris hamartoma), cutaneous neurofibromas, pheochromocytomas, optic gliomas	Neurofibromatosis type I	525
Vascular birthmark (port-wine stain) of the face	Nevus flammeus (benign, but associated with Sturge-Weber syndrome)	525
Renal cell carcinoma (bilateral), hemangioblastomas, angiomatosis, pheochromocytoma	von Hippel-Lindau disease (dominant tumor suppressor gene mutation)	525
Bilateral vestibular schwannomas	Neurofibromatosis type 2	525
Hyperreflexia, hypertonia, Babinski sign present	UMN damage	529
Hyporeflexia, hypotonia, atrophy, fasciculations	LMN damage	529
Spastic weakness, sensory loss, bowel/bladder dysfunction	Spinal cord lesion	530
Unilateral facial drooping involving forehead	LMN facial nerve (CN VII) palsy; UMN lesions spare the forehead	532
Episodic vertigo, tinnitus, hearing loss	Ménière disease	534
Ptosis, miosis, anhidrosis	Horner syndrome (sympathetic chain lesion)	540
Conjugate horizontal gaze palsy, horizontal diplopia	Internuclear ophthalmoplegia (damage to MLF; may be unilateral or bilateral)	543
Polyuria, renal tubular acidosis type II, growth failure, electrolyte imbalances, hypophosphatemic rickets	Fanconi syndrome (multiple combined dysfunction of the proximal convoluted tubule)	586
Athlete with polycythemia	2° to erythropoietin injection	589
Periorbital and/or peripheral edema, proteinuria (> 3.5g/day), hypoalbuminemia, hypercholesterolemia	Nephrotic syndrome	597
Hereditary nephritis, sensorineural hearing loss, retinopathy, lens dislocation	Alport syndrome (mutation in collagen IV)	596
Streak ovaries, congenital heart disease, horseshoe kidney, cystic hygroma at birth, short stature, webbed neck, lymphedema	Turner syndrome (45,XO)	638
Red, itchy, swollen rash of nipple/areola	Paget disease of the breast (sign of underlying neoplasm)	650

CLINICAL PRESENTATION	DIAGNOSIS/DISEASE	PAGE
Fibrous plaques in tunica albuginea of penis with abnormal curvature	Peyronie disease (connective tissue disorder)	651
Hypoxemia, polycythemia, hypercapnia	Chronic bronchitis (hyperplasia of mucous cells, "blue bloater")	674
Pink complexion, dyspnea, hyperventilation	Emphysema ("pink puffer," centriacinar [smoking] or panacinar [α_1 -antitrypsin deficiency])	674
Bilateral hilar adenopathy, uveitis	Sarcoidosis (noncaseating granulomas)	676

► CLASSIC LABS/FINDINGS LAB/DIAGNOSTIC FINDING DIAGNOSIS/DISEASE PAGE ↓ AFP in amniotic fluid/maternal serum Down syndrome, Edwards syndrome 63 Large granules in phagocytes, immunodeficiency Chédiak-Higashi disease (congenital failure of 117 phagolysosome formation) Recurrent infections, eczema, thrombocytopenia Wiskott-Aldrich syndrome 117 Sensitive: S pneumoniae; resistant: viridans streptococci 134 Optochin sensitivity (S mutans, S sanguis) Sensitive: S epidermidis; resistant: S saprophyticus 134 Novobiocin response Sensitive: S pyogenes (group A); resistant: S agalactiae 134 Bacitracin response (group B) Streptococcus bovis bacteremia Colon cancer 137 Branching gram ⊕ rods with sulfur granules Actinomyces israelii 139 Hilar lymphadenopathy, peripheral granulomatous lesion Ghon complex (1° TB: Mycobacterium bacilli) 140 in middle or lower lung lobes (can calcify) "Thumb sign" on lateral neck x-ray Epiglottitis (Haemophilus influenzae) 142 "Clue cells" (Gardnerella vaginalis) 148 Bacteria-covered vaginal epithelial cells Cardiomegaly with apical atrophy Chagas disease (*Trypanosoma cruzi*) 158 **EBV** 165 Atypical lymphocytes Enlarged cells with intranuclear inclusion bodies "Owl eye" appearance of CMV 165 Heterophile antibodies Infectious mononucleosis (EBV) 165 Intranuclear eosinophilic droplet-like bodies Cowdry type A bodies (HSV or VZV) 166 Eosinophilic globule in liver Councilman body (viral hepatitis, yellow fever), represents 168 hepatocyte undergoing apoptosis 170 "Steeple" sign on frontal CXR Croup (parainfluenza virus) Eosinophilic inclusion bodies in cytoplasm of Negri bodies of rabies 171 hippocampal and cerebellar neurons Ring-enhancing brain lesion on CT/MRI in AIDS Toxoplasma gondii, CNS lymphoma 177 Psammoma bodies 211 Meningiomas, papillary thyroid carcinoma, mesothelioma, papillary serous carcinoma of the endometrium and ovary

FAS1_2019_17_Rapid Rev.indd 695 11/7/19 6:09 PM

696 SECTION III RAPID REVIEW > CLASSIC LABS/FINDINGS

"Delta wave" on ECC, short PR interval, supraventricular bypasses AV node) "Boots-haped" heart on x-ray Rib notching (inferior surface, on x-ray) Rear nodules (granulomatous) Antineutrophil cytoplasmic antibodies (ANCAs) Phypertension, hypokalemia, metabolic alkalosis Phypertension, hypokalemia, metabolic alkalosis Phypertension, hypokalemia, metabolic alkalosis Phyperaled thyroid cells with ground-glass nuclei with central clearing Mucin-filled cell with peripheral muclcus Signt inig "(gastric carcinoma) Anti-transglutaminase/anti-gliadin/anti-endomysial antibodies Narrowing of bowel lumen on barium x-ray "String sign" (Coolm disease) "Sal antibodies Narrowing of bowel lumen on barium x-ray "String sign" (Coolm disease) "Lead pipe" appearance of colon on abdominal imaging Thousands of polyps on colonoscopy "Applic core" lesion on barium enema x-ray "Autimil of APC gene) "Nulmeg" appearance of liver "Nulmeg" appearance of liver "Nulmeg" appearance of liver "Nulmeg" appearance of liver "Nulmeg" appearance of liver "Nulmeg "appearance of liver "Nulmeg "appeara	LAB/DIAGNOSTIC FINDING	DIAGNOSIS/DISEASE	PAGE
Rib notching (inferior surface, on x-ray) Heart nodules (granulomatous) Antineutrophil cytoplasmic antibodies (ANCAs) Hypertension, hypokalemia, metabolic alkalosis Finlarged thyroid cells with ground-glass nuclei with central clearing Mucin-filled cell with peripheral nucleus Mucin-filled cell with peripheral nucleus Signation rive eyes nuclei (papillary carcinoma of the thyroid) Teal gapta antibodies Narrowing of bowel lumen on barium x-ray Stiring sign" (Crohn disease) Thousands of polyps on colonoscopy Familial adenomatous polyposis (autosomal dominant, mutation of APC gene) "Apple core" lesion on barium enema x-ray Eosinophilic cytoplasmic inclusion in liver cell Allimitochondrial antibodies (AMAs) Antimitochondrial antibodies (AMAs) Low serum ceruloplasmin Migratory thrombophlebitis (leading to migrating DVTs) Rapophilic nuclear remnants in RBCs Basophilic nuclear remnants in RBCs Howell-folly bodies (due to splenectomy or nonfunctional splece) Basophilic nuclear remnants in RBCs Basophilic antipolitis (feron-control) Basophilic stippling of RBCs Howell-folly bodies (due to splenectomy or nonfunctional splece) Basophilic stippling of RBCs Howell-folly bodies (due to splenectomy or nonfunctional splece) Basophilic antipolitis (feron-control) Basophilic stippling of RBCs Howell-folly bodies (due to splenectomy or nonfunctional splece) Basophilic antibodies Megaloblastic anemia (B ₀ deficiency: neurologic symptoms) Antipatedet antibodies Megaloblastic anemia (B ₀ deficiency: neurologic symptoms) Autipatedet antibodies Hoperthemion (PTC-cw-cut") appearance on x-ray B-thulassemia, sickle cell disease (inarproceptus on periodogic symptoms) Autipatedet antibodies Hoperthemion (PTC-cw-cut") appearance on x-ray B-thulassemia, sickle cell disease (inarproceptus) Hoperthemion (PTC-cw-cut")	in the second of		294
Heart nodules (granulomatous) Aschoff bodies (rheumatic fever) 312	"Boot-shaped" heart on x-ray	Tetralogy of Fallot (due to RVH)	298
Electrical alternans (alternating amplitude on ECC) Antineutrophil cytoplasmic antibodics (ANCAs) Antineutrophil cytoplasmic antibodics (ANCAs) Antineutrophil cytoplasmic antibodics (ANCAs) Antineutrophil cytoplasmic antibodics (ANCAs) Wiscoscopic polyangiitis (MPO-ANCA/p-ANCA); granulomatosis with polyangiitis (Wegener; PR3-ANCA/p-ANCA) Enlarged thyroid cells with ground-glass nuclei with central clearing Mucin-filled cell with peripheral nucleus "Signet ring" (gastric carcinoma) Anti-transglutaminase/anti-gladin/anti-endomysial antibodics Narrowing of bowel lumen on barium x-ray "String sign" (Crohn discase) "String sign" (Crohn discase) "Apple core" lesion on barium nema x-ray Colorectal cancer (usually left-sided) Eosinophilic cytoplasmic inclusion in liver cell Mallory body (alcoholic liver disease) "Nutmeg" appearance of liver Chronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome Antimitochondrial antibodies (AMAs) Pibliary cholangitis (female, cholestasis, portal hypertension) Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) Basophilic nuclear remnants in RBCs Basophilic nuclear remnants in RBCs Howell-Joly bodies (due to splenectomy or nonfunctional spleen) "Hair on end" ("Crew-cut") appearance on x-ray Heal possoning, foldse deficiency; no neurologic symptoms) Antiplatelet antibodies High level of of-dimers DVT, PE, DIC Gant B cells with bilobed nuclei with prominent	Rib notching (inferior surface, on x-ray)	Coarctation of the aorta	299
Antineutrophil cytoplasmic antibodies (ANCAs) Microscopic polyangiitis and cosinophilic granulomatosis with polyangiitis (McPO-ANCA/p-ANCA); granulomatosis with polyangiitis (Wegence PR3-ANCA/α-ANCA); primary selerosing cholangitis (MPO-ANCA/p-ANCA). 315 Hypertension, hypokalemia, metabolic alkalosis 1° hyperaldosteronism (Conn syndrome) 349 Enlarged thyroid cells with ground-glass nuclei with central clearing "Orphan Annie" eyes nuclei (papillary carcinoma of the thyroid) 337 Mucin-filled cell with peripheral nucleus "Signet ring" (gastric carcinoma) 379 Anti-transglutaminase/anti-gliadin/anti-endomysial antibodies Celiae disease (diarrhea, weight loss) 381 Narrowing of bowel lumen on barium x-ray "String sign" (Crohn disease) 582 "Lead pipe" appearance of colon on abdominal imaging Ulcerative colitis (loss of haustra) 382 Thousands of polyps on colonoscopy Familial adenomatous polyposis (autosomal dominant, mutation of APC gene) 388 "Apple core" lesion on barium enema x-ray Colorectal cancer (usually left-sided) 388 Eoinophilic cytoplasmic inclusion in liver cell Mallory body (alcoholic liver disease) 391 "Nutmeg" appearance of liver Chronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome 392 Antimit	Heart nodules (granulomatous)	Aschoff bodies (rheumatic fever)	312
with polyangitis (MPO-ANCA)p-ANCA); granulomatosis with polyangitis (Wegener, PR3-ANCA/c-ANCA); primary sclerosing cholangitis (MPO-ANCA/p-ANCA) Hypertension, hypokalemia, metabolic alkalosis 1° hyperaldosteronism (Conn syndrome) 349 Enlarged thyroid cells with ground-glass nuclei with central clearing "Orphan Annie" eyes nuclei (papillary carcinoma of the children of thyroid) 343 Mucin-filled cell with peripheral nucleus "Signet ring" (gastric carcinoma) 379 Anti-transglutaminase/anti-gliadin/anti-endomysial antibodies String sign" (Crohn disease) 381 antibodies "String sign" (Crohn disease) 382 "Lead pipe" appearance of colon on abdominal imaging Ulcerative colitis (loss of haustra) 382 "Lead pipe" appearance of colon on abdominal imaging Ulcerative colitis (loss of haustra) 382 Thousands of polyps on colonoscopy Familial adenomatous polyposis (autosomal dominant, mutation of APC genc) 388 Eosinophilic cytoplasmic inclusion in liver cell Mallory body (alcoholic liver disease) 391 Triglyceride accumulation in liver cell vacuoles Fatty liver disease (alcoholic or metabolic syndrome) 391 "Nutmeg" appearance of liver Chronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome 392 Antimitochondrial antibodics (AMAs) 1° biliary cholangitis (female, cholestasis, portal hypertension) 395 Low serum ceruloplasmin Vilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation) 395 Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) 1 Trousscau syndrome (adenocarcinoma of pancreas or lung) 398 Basophilic nuclear remnants in RBCs Lead poisoning or sideroblastic anemia 416 Hypochromic, microcytic anemia 10 deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) 419 "Hair on end" ("Crew-cut") appearance on x-ray β-thalassemia, isolke cell disease (marrow expansion) 422 Hypersegmented neutrophils Megaloblastic anemia 427 High leve	Electrical alternans (alternating amplitude on ECG)	Cardiac tamponade	310
Enlarged thyroid cells with ground-glass nuclei with central clearing"Opphan Annie" eyes nuclei (papillary carcinoma of the thyroid)343Mucin-filled cell with peripheral nucleus"Signet ring" (gastric carcinoma)379Anti-transglutaminase/anti-gliadin/anti-endomysial antibodiesCeliac disease (diarrhea, weight loss)381Narrowing of bowel lumen on barium x-ray"String sign" (Crohn disease)382"Lead pipe" appearance of colon on abdominal imagingUlcerative colitis (loss of haustra)382Thousands of polyps on colonoscopyFamilial adenomatous polyposis (autosomal dominant, mutation of APC gene)388"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1' biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser- Fleischer rings due to copper accumulation)398Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaLead poisoning or sideroblastic anemia4	Antineutrophil cytoplasmic antibodies (ANCAs)	with polyangiitis (MPO-ANCA/p-ANCA); granulomatosis with polyangiitis (Wegener; PR3-ANCA/c-ANCA); primary sclerosing cholangitis (MPO-	315
central clearingthyroid)Mucin-filled cell with peripheral nucleus"Signet ring" (gastric carcinoma)379Anti-ransglutaminasc/anti-gliadin/anti-endomysial antibodiesCeliac disease (diarrhea, weight loss)381Narrowing of bowel lumen on barium x-ray"String sign" (Crohn disease)382"Lead pipe" appearance of colon on abdominal imagingUlcerative colitis (loss of haustra)382Thousands of polyps on colonoscopyFamilial adenomatous polyposis (autosomal dominant, mutation of APC gene)387"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasmin1° biliary cholangitis (female, cholestasis, portal hypertension)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaInon deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)	Hypertension, hypokalemia, metabolic alkalosis	l° hyperaldosteronism (Conn syndrome)	349
Anti-transglutaminase/anti-gliadin/anti-endomysial antibodiesCeliac disease (diarrhea, weight loss)381Narrowing of bowel lumen on barium x-ray"String sign" (Crohn disease)382"Lead pipe" appearance of colon on abdominal imagingUlcerative colitis (loss of haustra)382Thousands of polyps on colonoscopyFamilial adenomatous polyposis (autosomal dominant, mutation of APC gene)388"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Buddt-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)398Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B ₁₂ deficiency: neurologic symptoms)<			343
antibodiesString sign" (Crohn disease)382"Lead pipe" appearance of colon on abdominal imagingUlcerative colitis (loss of haustra)382Thousands of polyps on colonoscopyFamilial adenomatous polyposis (autosomal dominant, mutation of APC gene)387"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)398Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B ₁₂ deficiency: neurologic symptoms)420Antiplatelet antibod	Mucin-filled cell with peripheral nucleus	"Signet ring" (gastric carcinoma)	379
"Lead pipe" appearance of colon on abdominal imaging Ulcerative colitis (loss of haustra) 382 Thousands of polyps on colonoscopy Familial adenomatous polyposis (autosomal dominant, mutation of APC gene) 387 "Apple core" lesion on barium enema x-ray Colorectal cancer (usually left-sided) 388 Eosinophilic cytoplasmic inclusion in liver cell Mallory body (alcoholic liver disease) 391 Triglyceride accumulation in liver cell vacuoles Fatty liver disease (alcoholic or metabolic syndrome) 391 "Nutmeg" appearance of liver Chronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome 392 Antimitochondrial antibodies (AMAs) 1° biliary cholangitis (female, cholestasis, portal hypertension) 395 Low scrum ceruloplasmin Wilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation) 395 Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) Trousseau syndrome (adenocarcinoma of pancreas or lung) 398 Basophilic nuclear remnants in RBCs Howell-Jolly bodies (due to splenectomy or nonfunctional spleen) 416 Hypochromic, microcytic anemia Iron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) 419 "Hair on end" ("Crew-cut") appearance on x-ray <td></td> <td>Celiac disease (diarrhea, weight loss)</td> <td>381</td>		Celiac disease (diarrhea, weight loss)	381
Thousands of polyps on colonoscopyFamilial adenomatous polyposis (autosomal dominant, mutation of APC gene)387"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Pleischer rings due to copper accumulation)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B ₁₂ deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms; folate deficiency: no neurologic symptoms; folate deficiency: no neurologic symptoms; folate deficiency: no neurologic symptoms; folate deficiency: no neurologic symptoms427High leve	Narrowing of bowel lumen on barium x-ray	"String sign" (Crohn disease)	382
"Apple core" lesion on barium enema x-rayColorectal cancer (usually left-sided)388Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B ₁₂ deficiency: neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429	"Lead pipe" appearance of colon on abdominal imaging	Ulcerative colitis (loss of haustra)	382
Eosinophilic cytoplasmic inclusion in liver cellMallory body (alcoholic liver disease)391Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B12 deficiency: neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429	Thousands of polyps on colonoscopy		387
Triglyceride accumulation in liver cell vacuolesFatty liver disease (alcoholic or metabolic syndrome)391"Nutmeg" appearance of liverChronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome392Antimitochondrial antibodies (AMAs)1° biliary cholangitis (female, cholestasis, portal hypertension)395Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B ₁₂ deficiency: neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429	"Apple core" lesion on barium enema x-ray	Colorectal cancer (usually left-sided)	388
"Nutmeg" appearance of liver Chronic passive congestion of liver due to right heart failure or Budd-Chiari syndrome Antimitochondrial antibodies (AMAs) lobilitary cholangitis (female, cholestasis, portal hypertension) Low serum ceruloplasmin Wilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation) Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) Basophilic nuclear remnants in RBCs Howell-Jolly bodies (due to splenectomy or nonfunctional spleen) Basophilic stippling of RBCs Lead poisoning or sideroblastic anemia 416 Hypochromic, microcytic anemia Iron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) "Hair on end" ("Crew-cut") appearance on x-ray β-thalassemia, sickle cell disease (marrow expansion) 422 Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: no neurologic symptoms) 420 Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of D-dimers DVT, PE, DIC 428 Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	Eosinophilic cytoplasmic inclusion in liver cell	Mallory body (alcoholic liver disease)	391
failure or Budd-Chiari syndrome Antimitochondrial antibodies (AMAs) 1° biliary cholangitis (female, cholestasis, portal hypertension) Low serum ceruloplasmin Wilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation) Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) Basophilic nuclear remnants in RBCs Howell-Jolly bodies (due to splenectomy or nonfunctional spleen) Basophilic stippling of RBCs Lead poisoning or sideroblastic anemia Hopochromic, microcytic anemia Iron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) "Hair on end" ("Crew-cut") appearance on x-ray Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of D-dimers Reed-Sternberg cells (Hodgkin lymphoma) 429	Triglyceride accumulation in liver cell vacuoles	Fatty liver disease (alcoholic or metabolic syndrome)	391
Low serum ceruloplasminHypertension)Low serum ceruloplasminWilson disease (hepatolenticular degeneration; Kayser-Fleischer rings due to copper accumulation)395Migratory thrombophlebitis (leading to migrating DVTs and vasculitis)Trousseau syndrome (adenocarcinoma of pancreas or lung)398Basophilic nuclear remnants in RBCsHowell-Jolly bodies (due to splenectomy or nonfunctional spleen)416Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B12 deficiency: neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429	"Nutmeg" appearance of liver		392
Fleischer rings due to copper accumulation) Migratory thrombophlebitis (leading to migrating DVTs and vasculitis) Basophilic nuclear remnants in RBCs Howell-Jolly bodies (due to splenectomy or nonfunctional spleen) Basophilic stippling of RBCs Lead poisoning or sideroblastic anemia 416 Hypochromic, microcytic anemia Iron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) "Hair on end" ("Crew-cut") appearance on x-ray β-thalassemia, sickle cell disease (marrow expansion) 422 Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of D-dimers DVT, PE, DIC 428 Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma)	Antimitochondrial antibodies (AMAs)		395
and vasculitis) Basophilic nuclear remnants in RBCs Howell-Jolly bodies (due to splenectomy or nonfunctional spleen) Basophilic stippling of RBCs Lead poisoning or sideroblastic anemia Hypochromic, microcytic anemia Iron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present) Hair on end" ("Crew-cut") appearance on x-ray B-thalassemia, sickle cell disease (marrow expansion) Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura High level of p-dimers DVT, PE, DIC Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 426	Low serum ceruloplasmin	\ 1	395
spleen)Basophilic stippling of RBCsLead poisoning or sideroblastic anemia416Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418, hemoglobin sometimes present)"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B₁₂ deficiency: neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429		· · · · · · · · · · · · · · · · · · ·	398
Hypochromic, microcytic anemiaIron deficiency anemia, lead poisoning, thalassemia (fetal hemoglobin sometimes present)418, 419"Hair on end" ("Crew-cut") appearance on x-rayβ-thalassemia, sickle cell disease (marrow expansion)422Hypersegmented neutrophilsMegaloblastic anemia (B12 deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms)420Antiplatelet antibodiesIdiopathic thrombocytopenic purpura427High level of p-dimersDVT, PE, DIC428Giant B cells with bilobed nuclei with prominentReed-Sternberg cells (Hodgkin lymphoma)429	Basophilic nuclear remnants in RBCs		416
hemoglobin sometimes present) "Hair on end" ("Crew-cut") appearance on x-ray β-thalassemia, sickle cell disease (marrow expansion) 422 Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of p-dimers DVT, PE, DIC 428 Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	Basophilic stippling of RBCs	Lead poisoning or sideroblastic anemia	416
Hypersegmented neutrophils Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of p-dimers DVT, PE, DIC 428 Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	Hypochromic, microcytic anemia		
symptoms; folate deficiency: no neurologic symptoms) Antiplatelet antibodies Idiopathic thrombocytopenic purpura 427 High level of D-dimers DVT, PE, DIC 428 Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	"Hair on end" ("Crew-cut") appearance on x-ray	β-thalassemia, sickle cell disease (marrow expansion)	422
High level of p-dimers DVT, PE, DIC Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	Hypersegmented neutrophils	Megaloblastic anemia (B ₁₂ deficiency: neurologic symptoms; folate deficiency: no neurologic symptoms)	420
Giant B cells with bilobed nuclei with prominent Reed-Sternberg cells (Hodgkin lymphoma) 429	Antiplatelet antibodies	Idiopathic thrombocytopenic purpura	427
	High level of p-dimers	DVT, PE, DIC	428
	•	Reed-Sternberg cells (Hodgkin lymphoma)	429

LAB/DIAGNOSTIC FINDING	DIAGNOSIS/DISEASE	PAGE
Sheets of medium-sized lymphoid cells with scattered pale, tingible body–laden macrophages ("starry sky" histology)	Burkitt lymphoma (t[8:14] c-myc activation, associated with EBV; "starry sky" made up of malignant cells)	430
Lytic ("punched-out") bone lesions on x-ray	Multiple myeloma	431
Monoclonal antibody spike	 Multiple myeloma (usually IgG or IgA) Monoclonal gammopathy of undetermined significance (MGUS consequence of aging) Waldenström (M protein = IgM) macroglobulinemia Primary amyloidosis 	431
Stacks of RBCs	Rouleaux formation (high ESR, multiple myeloma)	423
Azurophilic peroxidase ⊕ granular inclusions in granulocytes and myeloblasts	Auer rods (AML, especially the promyelocytic [M3] type)	432
WBCs that look "smudged"	CLL (almost always B cell)	432
"Tennis racket"-shaped cytoplasmic organelles (EM) in Langerhans cells	Birbeck granules (Langerhans cell histiocytosis)	434
"Brown" tumor of bone	Hyperparathyroidism or osteitis fibrosa cystica (deposited hemosiderin from hemorrhage gives brown color)	464
"Soap bubble" in femur or tibia on x-ray	Giant cell tumor of bone (generally benign)	464
Raised periosteum (creating a "Codman triangle")	Aggressive bone lesion (eg, osteosarcoma, Ewing sarcoma, osteomyelitis)	465
"Onion skin" periosteal reaction	Ewing sarcoma (malignant small blue cell tumor)	465
Anti-IgG antibodies	Rheumatoid arthritis (systemic inflammation, joint pannus, boutonniere and swan neck deformities)	466
Rhomboid crystals, ⊕ birefringent	Pseudogout (calcium pyrophosphate dihydrate crystals)	467
Needle-shaped, ⊖ birefringent crystals	Gout (monosodium urate crystals)	467
↑ uric acid levels	Gout, Lesch-Nyhan syndrome, tumor lysis syndrome, loop and thiazide diuretics	467
"Bamboo spine" on x-ray	Ankylosing spondylitis (chronic inflammatory arthritis: HLA-B27)	469
Antinuclear antibodies (ANAs: anti-Smith and anti-dsDNA)	SLE (type III hypersensitivity)	470
Anti-histone antibodies	Drug-induced SLE (eg, hydralazine, isoniazid, phenytoin, procainamide)	250
Anti-topoisomerase antibodies	Diffuse scleroderma	473
Keratin pearls on a skin biopsy	Squamous cell carcinoma	484
Bloody or yellow tap on lumbar puncture	Xanthochromia (due to subarachnoid hemorrhage)	513
Eosinophilic cytoplasmic inclusion in neuron	Lewy body (Parkinson disease and Lewy body dementia)	520
Extracellular amyloid deposition in gray matter of brain	Senile plaques (Alzheimer disease)	520
Depigmentation of neurons in substantia nigra	Parkinson disease (basal ganglia disorder: rigidity, resting tremor, bradykinesia)	520
Protein aggregates in neurons from hyperphosphorylation of tau protein	Neurofibrillary tangles (Alzheimer disease) and Pick bodies (Pick disease)	520
Silver-staining spherical aggregation of tau proteins in neurons	Pick bodies (Pick disease: progressive dementia, changes in personality)	520

FAS1_2019_17_Rapid Rev.indd 697 11/7/19 6:09 PM

SECTION III RAPID REVIEW ► CLASSIC LABS/FINDINGS

LAB/DIAGNOSTIC FINDING	DIAGNOSIS/DISEASE	PAGE
Pseudopalisading tumor cells on brain biopsy	Glioblastoma multiforme	526
Circular grouping of dark tumor cells surrounding pale neurofibrils	Homer-Wright rosettes (neuroblastoma, medulloblastoma)	528
"Waxy" casts with very low urine flow	Chronic end-stage renal disease	594
Nodular hyaline deposits in glomeruli	Kimmelstiel-Wilson nodules (diabetic nephropathy)	597
Podocyte fusion or "effacement" on electron microscopy	Minimal change disease (child with nephrotic syndrome)	597
"Spikes" on basement membrane, "dome-like" subepithelial deposits	Membranous nephropathy (nephrotic syndrome)	597
RBC casts in urine	Glomerulonephritis	594
"Tram-track" appearance of capillary loops of glomerular basement membranes on light microscopy	Membranoproliferative glomerulonephritis	596
Anti-glomerular basement membrane antibodies	Goodpasture syndrome (glomerulonephritis and hemoptysis)	596
Cellular crescents in Bowman capsule	Rapidly progressive (crescentic) glomerulonephritis	596
"Wire loop" glomerular capillary appearance on light microscopy	Diffuse proliferative glomerulonephritis (usually seen with lupus)	596
Linear appearance of IgG deposition on glomerular and alveolar basement membranes	Goodpasture syndrome	596
"Lumpy bumpy" appearance of glomeruli on immunofluorescence	Poststreptococcal glomerulonephritis (due to deposition of IgG, IgM, and C3)	596
Necrotizing vasculitis (lungs) and necrotizing glomerulonephritis	Granulomatosis with polyangiitis (Wegener; PR3-ANCA/ c-ANCA) and Goodpasture syndrome (anti–basement membrane antibodies)	596
Thyroid-like appearance of kidney	Chronic pyelonephritis (usually due to recurrent infections)	600
WBC casts in urine	Acute pyelonephritis	600
Renal epithelial casts in urine	Intrinsic renal failure (eg, ischemia or toxic injury)	601
hCG elevated	Choriocarcinoma, hydatidiform mole (occurs with and without embryo, and multiple pregnancy)	633
Dysplastic squamous cervical cells with "raisinoid" nuclei and hyperchromasia	Koilocytes (HPV: predisposes to cervical cancer)	645
Disarrayed granulosa cells arranged around collections of eosinophilic fluid	Call-Exner bodies (granulosa cell tumor of the ovary)	647
"Chocolate cyst" of ovary	Endometriosis (frequently involves both ovaries)	648
Mammary gland ("blue domed") cyst	Fibrocystic change of the breast	649
Glomerulus-like structure surrounding vessel in germ cells	Schiller-Duval bodies (yolk sac tumor)	647
Rectangular, crystal-like, cytoplasmic inclusions in Leydig cells	Reinke crystals (Leydig cell tumor)	653
Thrombi made of white/red layers	Lines of Zahn (arterial thrombus, layers of platelets/RBCs)	672
Hexagonal, double-pointed, needle-like crystals in bronchial secretions	Bronchial asthma (Charcot-Leyden crystals: eosinophilic granules)	674

DIAGNOSIS/DISEASE	PAGE
Curschmann spirals (bronchial asthma; can result in whorled mucous plugs)	674
Idiopathic pulmonary fibrosis	675
Cystic fibrosis (autosomal recessive mutation in <i>CFTR</i> gene → fat-soluble vitamin deficiency and mucous plugs)	675
Ferruginous bodies (asbestosis: † chance of lung cancer)	677
Pancoast tumor (can compress cervical sympathetic chain and cause Horner syndrome)	685
	Curschmann spirals (bronchial asthma; can result in whorled mucous plugs) Idiopathic pulmonary fibrosis Cystic fibrosis (autosomal recessive mutation in <i>CFTR</i> gene → fat-soluble vitamin deficiency and mucous plugs) Ferruginous bodies (asbestosis: † chance of lung cancer) Pancoast tumor (can compress cervical sympathetic chain

► CLASSIC/RELEVANT TREATMENTS CONDITION COMMON TREATMENT(S) PAGE 72 Ethylene glycol/methanol intoxication Fomepizole (alcohol dehydrogenase inhibitor) IFN- α (HBV and HCV); ribavirin, simeprevir, sofosbuvir 121 Chronic hepatitis B or C (HCV) Penicillin prophylaxis; evaluation for colon cancer if 137 Streptococcus bovis linked to endocarditis 138 Clostridium botulinum Antitoxin 138 Clostridium tetani Antitoxin Haemophilus influenzae (B) Amoxicillin ± clavulanate (mucosal infections), 142 ceftriaxone (meningitis), rifampin (prophylaxis) Ceftriaxone (add doxycycline to cover likely concurrent 142 Neisseria gonorrhoeae C trachomatis) 142 Neisseria meningitidis Penicillin/ceftriaxone, rifampin (prophylaxis) Legionella pneumophila Macrolides (eg, azithromycin) 143 143 Pseudomonas aeruginosa Piperacillin/tazobactam, aminoglycosides, carbapenems Penicillin G 147 Treponema pallidum Doxycycline (+ ceftriaxone for gonorrhea coinfection), 148 Chlamydia trachomatis oral erythromycin to treat chlamydial conjunctivitis in infants 153 Candida albicans Topical azoles (vaginitis); nystatin, fluconazole, caspofungin (oral/esophageal); fluconazole, caspofungin, amphotericin B (systemic) Cryptococcus neoformans Induction with amphotericin B and flucytosine, 153 maintenance with fluconazole (in AIDS patients) 154 Sporothrix schenckii Itraconazole, oral potassium iodide Pneumocystis jirovecii TMP-SMX (prophylaxis and treatment in 154 immunosuppressed patients, CD4 < 200/mm³) 156 Toxoplasma gondii Sulfadiazine + pyrimethamine Malaria Chloroquine, mefloquine, atovaquone/proguanil (for 157 blood schizont), primaquine (for liver hypnozoite)

FAS1_2019_17_Rapid Rev.indd 699 11/7/19 6:09 PM

SECTION III RAPID REVIEW ► CLASSIC/RELEVANT TREATMENTS

CONDITION	COMMON TREATMENT(S)	PAGE
Trichomonas vaginalis	Metronidazole (patient and partner)	158
Streptococcus pyogenes	Penicillin prophylaxis	187
Streptococcus pneumoniae	Penicillin/cephalosporin (systemic infection, pneumonia), vancomycin (meningitis)	187, 190
Staphylococcus aureus	MSSA: nafcillin, oxacillin, dicloxacillin (antistaphylococcal penicillins); MRSA: vancomycin, daptomycin, linezolid, ceftaroline	188, 190, 195
Enterococci	Vancomycin, aminopenicillins/cephalosporins	189, 190
Rickettsia rickettsii	Doxycycline, chloramphenicol	192
Clostridium difficile	Oral metronidazole; if refractory, oral vancomycin	190, 195
Mycobacterium tuberculosis	RIPE (rifampin, isoniazid, pyrazinamide, ethambutol)	196
UTI prophylaxis	TMP-SMX	198
Influenza	Oseltamivir, zanamivir	201
CMV	Ganciclovir, foscarnet, cidofovir	202
Patent ductus arteriosus	Close with indomethacin; keep open with PGE analogs	282
Stable angina	Sublingual nitroglycerin	304
Buerger disease	Smoking cessation	314
Kawasaki disease	IVIG, aspirin	314
Temporal arteritis	High-dose steroids	314
Granulomatosis with polyangiitis (Wegener)	Cyclophosphamide, corticosteroids	315
Hypercholesterolemia	Statin (first-line)	320
Hypertriglyceridemia	Fibrate	320
Arrhythmia in damaged cardiac tissue	Class IB antiarrhythmic (lidocaine, mexiletine)	322
Prolactinoma	Cabergoline/bromocriptine (dopamine agonists)	330
Diabetes insipidus	Desmopressin (central); hydrochlorothiazide, indomethacin, amiloride (nephrogenic)	338
SIADH	Fluid restriction, IV hypertonic saline, conivaptan/ tolvaptan, demeclocycline	338
Diabetic ketoacidosis	Fluids, insulin, K ⁺	347
Diabetes mellitus type 1	Dietary intervention (low carbohydrate) + insulin replacement	347
Diabetes mellitus type 2	Dietary intervention, oral hypoglycemics, and insulin (if refractory)	347
Pheochromocytoma	α-antagonists (eg, phenoxybenzamine)	350
Carcinoid syndrome	Octreotide	352
Crohn disease	Corticosteroids, infliximab, azathioprine	382
Ulcerative colitis	5-ASA preparations (eg, mesalamine), 6-mercaptopurine, infliximab, colectomy	382
Sickle cell disease	Hydroxyurea († fetal hemoglobin)	422

FAS1_2019_17_Rapid Rev.indd 700 11/7/19 6:09 PM

CONDITION	COMMON TREATMENT(S)	PAGE
Chronic myelogenous leukemia	Imatinib	433
Acute promyelocytic leukemia (M3)	All-trans retinoic acid, arsenic trioxide	432
Drug of choice for anticoagulation in pregnancy or renal failure	Low-molecular-weight heparin	436
Heparin reversal	Protamine sulfate	436
Immediate anticoagulation	Heparin	436
Long-term anticoagulation	Warfarin, dabigatran, rivaroxaban and apixaban	436, 437
Warfarin reversal	Fresh frozen plasma (acute), vitamin K (non-acute)	436
Cyclophosphamide-induced hemorrhagic cystitis	Mesna	441
HER2/neu ⊕ breast cancer	Trastuzumab	443
Osteoporosis	Calcium/vitamin D supplementation (prophylaxis); bisphosphonates, PTH analogs, SERMs, calcitonin, denosumab (treatment)	462
Osteomalacia/rickets	Vitamin D supplementation	463
Chronic gout	Xanthine oxidase inhibitors (eg, allopurinol, febuxostat); pegloticase; probenecid	467
Acute gout attack	NSAIDs, colchicine, glucocorticoids	467
Neural tube defect prevention	Prenatal folic acid	491
Migraine	Abortive therapies (eg, sumatriptan, NSAIDs); prophylaxis (eg, propranolol, topiramate, CCBs, amitriptyline)	518
Multiple sclerosis	Disease-modifying therapies (eg, β-interferon, natalizumab); for acute flares, use IV steroids	523
Tonic-clonic seizures	Levetiracetam, phenytoin, valproate, carbamazepine	544
Absence seizures	Ethosuximide	544
Trigeminal neuralgia (tic douloureux)	Carbamazepine	544
Malignant hyperthermia	Dantrolene	551
Anorexia	Nutrition, psychotherapy, SSRIs	567
Bulimia nervosa	SSRIs	567
Alcoholism	Disulfiram, acamprosate, naltrexone, supportive care	571
ADHD	Methylphenidate, amphetamines, CBT, atomoxetine, guanfacine, clonidine	572
Alcohol withdrawal	Long-acting benzodiazepines	572
Bipolar disorder	Mood stabilizers (eg, lithium, valproic acid, carbamazepine), atypical antipsychotics	572
Depression	SSRIs (first-line)	572
Generalized anxiety disorder	SSRIs, SNRIs (first line); buspirone (second line)	572
Schizophrenia (positive symptoms)	Typical and atypical antipsychotics	573
Schizophrenia (negative symptoms)	Atypical antipsychotics	573

702 SECTION III RAPID REVIEW > KEY ASSOCIATIONS

CONDITION	COMMON TREATMENT(S)	PAGE
Hyperaldosteronism	Spironolactone	609
Benign prostatic hyperplasia	$\alpha_{_{\! 1}}$ -antagonists, 5α -reductase inhibitors, PDE-5 inhibitors	654
Infertility	Leuprolide, GnRH (pulsatile), clomiphene	656
Breast cancer in postmenopausal woman	Aromatase inhibitor (anastrozole)	656
$ER \oplus breast cancer$	Tamoxifen	656
Prostate adenocarcinoma/uterine fibroids	Leuprolide, GnRH (continuous)	656
Medical abortion	Mifepristone	657
Prostate adenocarcinoma	Flutamide	658
Erectile dysfunction	Sildenafil, tadalafil, vardenafil	686
Pulmonary arterial hypertension (idiopathic)	Sildenafil, bosentan, epoprostenol	686

► KEY ASSOCIATIONS

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE
Mitochondrial inheritance	Disease occurs in both males and females, inherited through females only	59
Intellectual disability	Down syndrome, fragile X syndrome	62, 63
Vitamin deficiency (USA)	Folate (pregnant women are at high risk; body stores only 3- to 4-month supply; prevents neural tube defects)	68
Lysosomal storage disease	Gaucher disease	88
Bacterial meningitis (adults and elderly)	S pneumoniae	180
Bacterial meningitis (newborns and kids)	Group B streptococcus/E coli/Listeria monocytogenes (newborns), S pneumoniae/N meningitidis (kids/teens)	180
HLA-DR3	Diabetes mellitus type 1, SLE, Graves disease, Hashimoto thyroiditis (also associated with HLA-DR5), Addison disease	100
HLA-DR4	Diabetes mellitus type 1, rheumatoid arthritis, Addison disease	100
Bacteria associated with gastritis, peptic ulcer disease, and gastric malignancies (eg, adenocarcinoma, MALToma)	H pylori	146
Opportunistic infection in AIDS	Pneumocystis jirovecii pneumonia	154
Helminth infection (US)	Enterobius vermicularis	159
Viral encephalitis affecting temporal lobe	HSV-1	164
Infection 2° to blood transfusion	Hepatitis C	172
Food poisoning (exotoxin mediated)	S aureus, B cereus	178
Osteomyelitis	S aureus (most common overall)	180
Osteomyelitis in sickle cell disease	Salmonella	180
Osteomyelitis with IV drug use	Pseudomonas, Candida, S aureus	180

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE	
UTI	E coli, Staphylococcus saprophyticus (young women)	181	
cually transmitted disease C trachomatis (usually coinfected with N gonorrhoeae)		184	
No so comial pneumonia S aureus, Pseudomonas, other enteric gram \ominus rods		185	
elvic inflammatory disease C trachomatis, N gonorrhoeae		185	
nfections in chronic granulomatous disease S aureus, E coli, Aspergillus (catalase ⊕)		186	
Metastases to bone			
Metastases to brain	Lung > breast > melanoma, colon, kidney	223	
Metastases to liver	Colon >> stomach > pancreas	223	
S3 heart sound	† ventricular filling pressure (eg, mitral regurgitation, HF), common in dilated ventricles	287	
S4 heart sound	Stiff/hypertrophic ventricle (aortic stenosis, restrictive cardiomyopathy)	287	
Constrictive pericarditis	TB (developing world); idiopathic, viral illness (developed world)	287	
Holosystolic murmur	VSD, tricuspid regurgitation, mitral regurgitation	291	
Ejection click	Aortic stenosis	291	
Mitral valve stenosis	Rheumatic heart disease	291	
Opening snap	Mitral stenosis	291	
Heart murmur, congenital	t murmur, congenital Mitral valve prolapse		
Chronic arrhythmia	rhythmia Atrial fibrillation (associated with high risk of emboli)		
Cyanosis (early; less common)	Tetralogy of Fallot, transposition of great vessels, truncus arteriosus, total anomalous pulmonary venous return, tricuspid atresia	298	
Late cyanotic shunt (uncorrected left to right becomes right to left)	Eisenmenger syndrome (caused by ASD, VSD, PDA; results in pulmonary hypertension/polycythemia)	299	
Congenital cardiac anomaly	VSD	299	
Hypertension, 2°	Renal artery stenosis, chronic kidney disease (eg, polycystic kidney disease, diabetic nephropathy), hyperaldosteronism	300	
Aortic aneurysm, thoracic	Marfan syndrome (idiopathic cystic medial degeneration)	302	
Aortic aneurysm, abdominal	Atherosclerosis, smoking is major risk factor	302	
Aortic aneurysm, ascending or arch	3° syphilis (syphilitic aortitis), vasa vasorum destruction	303	
Sites of atherosclerosis	Abdominal aorta > coronary artery > popliteal artery > carotid artery	302	
Aortic dissection	Hypertension	303	
Right heart failure due to a pulmonary cause	Cor pulmonale	309	
Heart valve in bacterial endocarditis	Mitral > aortic (rheumatic fever), tricuspid (IV drug abuse)	310	
Endocarditis presentation associated with bacterium S aureus (acute, IVDA, tricuspid valve), viridans streptococci (subacute, dental procedure), S be cancer), culture negative (Coxiella, Bartonella		310	
Temporal arteritis	Risk of ipsilateral blindness due to occlusion of ophthalmic artery; polymyalgia rheumatica	314	

704 SECTION III RAPID REVIEW > KEY ASSOCIATIONS

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE
Recurrent inflammation/thrombosis of small/medium vessels in extremities		
Cardiac 1° tumor (kids) Rhabdomyoma, often seen in tuberous sclerosis		316
dardiac tumor (adults) Metastasis, myxoma (90% in left atrium; "ball valve")		316
Congenital adrenal hyperplasia, hypotension	21-hydroxylase deficiency	
Hypopituitarism	Pituitary adenoma (usually benign tumor)	339
Cretinism	Iodine deficit/congenital hypothyroidism	341
Thyroid cancer	Papillary carcinoma (childhood irradiation)	343
Hypoparathyroidism	Accidental excision during thyroidectomy	344
1° hyperparathyroidism	Adenomas, hyperplasia, carcinoma	345
2° hyperparathyroidism	Hypocalcemia of chronic kidney disease	345
Cushing syndrome	 Iatrogenic (from corticosteroid therapy) Adrenocortical adenoma (secretes excess cortisol) ACTH-secreting pituitary adenoma (Cushing disease) Paraneoplastic (due to ACTH secretion by tumors) 	348
1° hyperaldosteronism	Adrenal hyperplasia or adenoma	349
Tumor of the adrenal medulla (kids)	Neuroblastoma (malignant)	350
Tumor of the adrenal medulla (adults)	Pheochromocytoma (usually benign)	350
Refractory peptic ulcers and high gastrin levels	Zollinger-Ellison syndrome (gastrinoma of duodenum or pancreas), associated with MEN1	351, 352
Esophageal cancer	Squamous cell carcinoma (worldwide); adenocarcinoma (US)	378
Acute gastric ulcer associated with CNS injury	Cushing ulcer († intracranial pressure stimulates vagal gastric H+ secretion)	379
Acute gastric ulcer associated with severe burns	Curling ulcer (greatly reduced plasma volume results in sloughing of gastric mucosa)	379
Bilateral ovarian metastases from gastric carcinoma	Krukenberg tumor (mucin-secreting signet ring cells)	379
Chronic atrophic gastritis (autoimmune)	Predisposition to gastric carcinoma (can also cause pernicious anemia)	379
Gastric cancer	Adenocarcinoma	379
Alternating areas of transmural inflammation and normal colon	Skip lesions (Crohn disease)	382
Site of diverticula	Sigmoid colon	383
Diverticulum in pharynx	Zenker diverticulum (diagnosed by barium swallow)	384
Hepatocellular carcinoma	Cirrhotic liver (associated with hepatitis B and C, alcoholism, and hemochromatosis)	392
Liver disease	Alcoholic cirrhosis	391
1° liver cancer	Hepatocellular carcinoma (chronic hepatitis, cirrhosis, hemochromatosis, α_{l} -antitrypsin deficiency, Wilson disease)	392
Congenital conjugated hyperbilirubinemia (black liver)	Dubin-Johnson syndrome (inability of hepatocytes to secrete conjugated bilirubin into bile)	394

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE
Hereditary harmless jaundice	Gilbert syndrome (benign congenital unconjugated hyperbilirubinemia)	394
Hemochromatosis	Multiple blood transfusions or hereditary <i>HFE</i> mutation (can result in heart failure, "bronze diabetes," and † risk of hepatocellular carcinoma)	395
Pancreatitis (acute)	Gallstones, alcohol	397
Pancreatitis (chronic)	Alcohol (adults), cystic fibrosis (kids)	397
Microcytic anemia	Iron deficiency	418
Autosplenectomy (fibrosis and shrinkage)	Sickle cell disease (hemoglobin S)	422
Bleeding disorder with GpIb deficiency	Bernard-Soulier syndrome (defect in platelet adhesion to von Willebrand factor)	427
Hereditary bleeding disorder	von Willebrand disease	428
DIC	Severe sepsis, obstetric complications, cancer, burns, trauma, major surgery, acute pancreatitis, APL	428
Malignancy associated with noninfectious fever	Hodgkin lymphoma	429
Type of Hodgkin lymphoma	Nodular sclerosis (vs mixed cellularity, lymphocytic predominance, lymphocytic depletion)	429
t(14;18)	Follicular lymphomas (BCL-2 activation, anti-apoptotic oncogene)	430
t(8;14)	Burkitt lymphoma (c- <i>myc</i> fusion, transcription factor oncogene)	430
Type of non-Hodgkin lymphoma	Diffuse large B-cell lymphoma	430
l° bone tumor (adults)	Multiple myeloma	431
Age ranges for patient with ALL/CLL/AML/CML	ALL: child, CLL: adult > 60, AML: adult ~ 65, CML: adult 45–85	432, 433
Malignancy (kids)	Leukemia, brain tumors	432, 526
Death in CML	Blast crisis	433
t(9;22)	Philadelphia chromosome, CML (BCR-ABL oncogene, tyrosine kinase activation), more rarely associated with ALL	434
Vertebral compression fracture	Osteoporosis (type I: postmenopausal woman; type II: elderly man or woman)	462
HLA-B27	Psoriatic arthritis, ankylosing spondylitis, IBD-associated arthritis, reactive arthritis (formerly Reiter syndrome)	469
Death in SLE	Lupus nephropathy	470
Tumor of infancy	Strawberry hemangioma (grows rapidly and regresses spontaneously by childhood)	478
Actinic (solar) keratosis	Precursor to squamous cell carcinoma	482
Cerebellar tonsillar herniation	Chiari I malformation	492
Atrophy of the mammillary bodies	Wernicke encephalopathy (thiamine deficiency causing ataxia, ophthalmoplegia, and confusion)	511

SECTION III RAPID REVIEW ► KEY ASSOCIATIONS

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE
Epidural hematoma	Rupture of middle meningeal artery (trauma; lentiform shaped)	513
Subdural hematoma	Rupture of bridging veins (crescent shaped)	513
Dementia	Alzheimer disease, multiple infarcts (vascular dementia)	520, 521
Demyelinating disease in young women	Multiple sclerosis	523
Brain tumor (adults)	Supratentorial: metastasis, astrocytoma (including glioblastoma multiforme), meningioma, schwannoma	526
Pituitary tumor	Prolactinoma, somatotropic adenoma	527
Brain tumor (kids)	Infratentorial: medulloblastoma (cerebellum) or supratentorial: craniopharyngioma	528
Mixed (UMN and LMN) motor neuron disease	Amyotrophic lateral sclerosis	530
Degeneration of dorsal column fibers	Tabes dorsalis (3° syphilis), subacute combined degeneration (dorsal columns, lateral corticospinal, spinocerebellar tracts affected)	530
Nephrotic syndrome (adults)	Membranous nephropathy	597
Nephrotic syndrome (kids)	Minimal change disease	597
Glomerulonephritis (adults)	Berger disease (IgA nephropathy)	596
Kidney stones	 Calcium = radiopaque Struvite (ammonium) = radiopaque (formed by urease ⊕ organisms such as <i>Klebsiella</i>, <i>Proteus</i> species, and S <i>saprophyticus</i>) Uric acid = radiolucent Cystine = faintly radiopaque 	598
Renal tumor	Renal cell carcinoma: associated with von Hippel-Lindau and cigarette smoking; paraneoplastic syndromes (EPO, renin, PTHrP, ACTH)	605
Obstruction of male urinary tract	ВРН	654
l° amenorrhea	Turner syndrome (45,XO or 45,XO/46,XX mosaic)	638
Neuron migration failure	Kallmann syndrome (hypogonadotropic hypogonadism and anosmia)	639
Clear cell adenocarcinoma of the vagina	DES exposure in utero	644
Ovarian tumor (benign, bilateral)	Serous cystadenoma	646
Ovarian tumor (malignant)	Serous cystadenocarcinoma	646
Tumor in women	Leiomyoma (estrogen dependent, not precancerous)	648
Gynecologic malignancy	Endometrial carcinoma (most common in US); cervical carcinoma (most common worldwide)	648
Breast mass	Fibrocystic change, carcinoma (in postmenopausal women)	649
Breast tumor (benign, young woman)	Fibroadenoma	649
Breast cancer	Invasive ductal carcinoma	650
Testicular tumor	Seminoma (malignant, radiosensitive), † placental ALP	652, 653

FAS1_2019_17_Rapid Rev.indd 706 11/7/19 6:09 PM

SECTION III

DISEASE/FINDING	MOST COMMON/IMPORTANT ASSOCIATIONS	PAGE
Pulmonary hypertension	Idiopathic, heritable, left heart disease (eg, HF), lung	679
	disease (eg, COPD), hypoxemic vasoconstriction (eg, OSA), thromboembolic (eg, PE)	
Hypercoagulability, endothelial damage, blood stasis	Virchow triad († risk of thrombosis)	671
SIADH	Small cell carcinoma of the lung	684

► EQUATION REVIEW TOPIC PAGE $V_d = \frac{\text{amount of drug in the body}}{\text{plasma drug concentration}}$ Volume of distribution 231 $t_{1\!/\!_2} = \frac{0.7 \times V_d}{CL}$ Half-life 231 $CL = \frac{\text{rate of elimination of drug}}{\text{plasma drug concentration}} = V_{\text{d}} \times K_{\text{e}} \text{ (elimination constant)}$ Drug clearance 231 $LD = \frac{C_p \times V_d}{F}$ Loading dose 231 $D = \frac{C_p \times CL \times \tau}{F}$ Maintenance dose 231 Sensitivity = TP / (TP + FN)Sensitivity 257 Specificity Specificity = TN / (TN + FP)257 PPV = TP / (TP + FP)Positive predictive value 257 NPV = TN / (FN + TN)Negative predictive value 257 $OR = \frac{a/c}{b/d} = \frac{ad}{bc}$ Odds ratio (for case-control studies) 258 Relative risk $RR = \frac{a/(a+b)}{c/(c+d)}$ 258 Attributable risk 258 RRR = 1 - RRRelative risk reduction 258 Absolute risk reduction 258 Number needed to treat NNT = 1/ARR258 Number needed to harm NNH = 1/AR258 $CO = \frac{\text{rate of O}_2 \text{ consumption}}{(\text{arterial O}_2 \text{ content} - \text{venous O}_2 \text{ content})}$ Cardiac output 285 285 $CO = stroke volume \times heart rate$

FAS1_2019_17_Rapid Rev.indd 707 11/7/19 6:09 PM

SECTION III RAPID REVIEW ► EQUATION REVIEW

TOPIC	EQUATION	PAGE
Mean arterial pressure	MAP = cardiac output × total peripheral resistance	285
	$MAP = \frac{2}{3}$ diastolic + $\frac{1}{3}$ systolic	285
Stroke volume	SV = EDV - ESV	285
Ejection fraction	$EF = \frac{SV}{EDV} = \frac{EDV - ESV}{EDV}$	285
Resistance	$Resistance = \frac{driving \ pressure \ (\Delta P)}{flow \ (Q)} = \frac{8 \eta \ (viscosity) \times length}{\pi r^4}$	286
Capillary fluid exchange	$J_{v} = net \; fluid \; flow = K_{f}[(P_{c} - P_{i}) - \sigma(\pi_{c} - \pi_{i})]$	297
Renal clearance	$C_{x} = (U_{x}V)/P_{x}$	582
Glomerular filtration rate	$C_{inulin} = GFR = U_{inulin} \times V/P_{inulin}$	582
	$= K_{f} [(P_{GC} - P_{BS}) - (\pi_{GC} - \pi_{BS})]$	
Effective renal plasma flow	$eRPF = U_{PAH} \times \frac{V}{P_{PAH}} = C_{PAH}$	582
Renal blood flow	$RBF = \frac{RPF}{1 - Hct}$	582
Filtration fraction	$FF = \frac{GFR}{RPF}$	583
Henderson-Hasselbalch equation (for extracellular pH)	$pH = 6.1 + log \frac{[HCO_3^-]}{0.03 Pco_2}$	592
Winters formula	$Pco_2 = 1.5 [HCO_3^-] + 8 \pm 2$	592
Anion gap	$Na^{+} - (Cl^{-} + HCO_{3}^{-})$	592
Physiologic dead space	$V_D = V_T \times \frac{Paco_2 - Peco_2}{Paco_2}$	664
Pulmonary vascular resistance	$PVR = \frac{P_{\text{pulm artery}} - P_{\text{L atrium}}}{\text{cardiac output}}$	668
Alveolar gas equation	$PAO_2 = PIO_2 - \frac{Paco_2}{R}$	668

FAS1_2019_17_Rapid Rev.indd 708 11/7/19 6:09 PM

► EASILY CONFUSED ME	DICATIONS
DRUG	CLINICAL USE/MECHANISM OF ACTION
Amiloride	K+-sparing diuretic
Amiodarone	Class III antiarrhythmic
Amlodipine	Dihydropyridine Ca ²⁺ channel blocker
Benztropine	Cholinergic antagonist
Bromocriptine	Dopamine agonist
Buspirone	Generalized anxiety disorder (5-HT _{1A} -receptor agonist)
Bupropion	Depression, smoking cessation (NE-DA reuptake inhibitor)
Cimetidine	H ₂ -receptor antagonist
Cetirizine	2nd-generation antihistamine
Chloramphenicol	Antibiotic (blocks 50S subunit)
Chlordiazepoxide	Long-acting benzodiazepine
Chlorpromazine	Typical antipsychotic
Chlorpropamide	1st-generation sulfonylurea
Chlorpheniramine	1st-generation antihistamine
Chlorthalidone	Thiazide diuretic
Clozapine	5-HT _{2A} -agonist
Clomipramine	Tricyclic antidepressant
Clomiphene	Selective estrogen receptor modulator
Clonidine	$lpha_2$ -agonist
Doxepin	Tricyclic antidepressant
Doxazosin	α_1 -antagonist
Eplerenone	K ⁺ -sparing diuretic
Propafenone	Class IC antiarrhythmic
Fluoxetine	Selective serotonin reuptake inhibitor
Fluphenazine	Typical antipsychotic
Duloxetine	Serotonin-norepinephrine reuptake inhibitor
Guaifenesin	Expectorant (thins respiratory secretions)
Guanfacine	α_{γ} -agonist
Mifepristone	Progesterone receptor antagonist
Misoprostol	PGE, synthetic analog
Naloxone	Opioid receptor antagonist (treats toxicity)
Naltrexone	Opioid receptor antagonist (prevents relapse)
Nitroprusside	Hypertensive emergency († cGMP/NO)
Nitroglycerin	Antianginal († cGMP/NO)
Omeprazole	Proton pump inhibitor
Ketoconazole	Antifungal (inhibits fungal sterol synthesis)
TOTOCOHAZOIC	1 mendingar (miniono temper steror synthesis)

710

SECTION III RAPID REVIEW ► EASILY CONFUSED MEDICATIONS

DRUG	CLINICAL USE/MECHANISM OF ACTION
Aripiprazole	Atypical antipsychotic
Anastrozole	Aromatase inhibitor
Rifaximin	Hepatic encephalopathy (↓ ammoniagenic bacteria)
Rifampin	Antimicrobial (inhibits DNA-dependent RNA polymerase)
Sertraline	Selective serotonin reuptake inhibitor
Selegiline	MAO-B inhibitor
Trazodone	Insomnia (blocks 5-HT $_2$, α_1 -adrenergic, and H $_1$ receptors)
Tramadol	Chronic pain (weak opioid agonist)
Varenicline	Smoking cessation (nicotinic ACh receptor partial agonist)
Venlafaxine	Serotonin-norepinephrine reuptake inhibitor

FAS1_2019_17_Rapid Rev.indd 710 11/7/19 6:09 PM

SECTION IV

Top-Rated Review Resources

"Some books are to be tasted, others to be swallowed, and some few to be chewed and digested."

-Sir Francis Bacon

"Always read something that will make you look good if you die in the middle of it."

-P.J. O'Rourke

"So many books, so little time."

—Frank Zappa

"If one cannot enjoy reading a book over and over again, there is no use in reading it at all."

-Oscar Wilde

▶ How to Use the Database 712 ▶ Question Banks and 714 ▶ Web and Mobile Apps 714 **▶** Comprehensive 715 ▶ Anatomy, Embryology, and Neuroscience ▶ Behavioral Science 716 **▶** Biochemistry 716 ▶ Cell Biology and 716 Histology ▶ Microbiology and **Immunology** 717 **▶** Pathology 717 **▶** Pharmacology 718 **▶** Physiology 718

711

► HOW TO USE THE DATABASE

This section is a database of top-rated basic science review books, sample examination books, software, websites, and apps that have been marketed to medical students studying for the USMLE Step 1. For each recommended resource, we list (where applicable) the Title, the First Author (or editor), the Current Publisher, the Copyright Year, the Number of Pages, the Approximate List Price, the Format of the resource, and the Number of Test Questions. Finally, each recommended resource receives a Rating. Within each section, resources are arranged first by Rating and then alphabetically by the first author within each Rating group.

For a complete list of resources, including summaries that describe their overall style and utility, go to www.firstaidteam.com/bonus.

A letter rating scale with six different grades reflects the detailed student evaluations for **Rated Resources**. Each rated resource receives a rating as follows:

A+	Excellent for boards review.
A A–	Very good for boards review; choose among the group.
B+ B	Good, but use only after exhausting better resources.
В-	Fair, but there are many better resources in the discipline; or low-yield subject material.

The Rating is meant to reflect the overall usefulness of the resource in helping medical students prepare for the USMLE Step 1. This is based on a number of factors, including:

- The cost
- The readability of the text or usability of the app
- The appropriateness and accuracy of the material
- The quality and number of sample questions
- The quality of written answers to sample questions
- The quality and appropriateness of the illustrations (eg, graphs, diagrams, photographs)
- The length of the text (longer is not necessarily better)
- The quality and number of other resources available in the same discipline
- The importance of the discipline for the USMLE Step 1

Please note that ratings do not reflect the quality of the resources for purposes other than reviewing for the USMLE Step 1. Many books with lower ratings are well written and informative but are not ideal for boards

SECTION IV

preparation. We have not listed or commented on general textbooks available in the basic sciences.

Evaluations are based on the cumulative results of formal and informal surveys of thousands of medical students at many medical schools across the country. The ratings represent a consensus opinion, but there may have been a broad range of opinion or limited student feedback on any particular resource.

Please note that the data listed are subject to change in that:

- Publishers' prices change frequently.
- Bookstores often charge an additional markup.
- New editions come out frequently, and the quality of updating varies.
- The same book may be reissued through another publisher.

We actively encourage medical students and faculty to submit their opinions and ratings of these basic science review materials so that we may update our database. (See p. xvii, How to Contribute.) In addition, we ask that publishers and authors submit for evaluation review copies of basic science review books, including new editions and books not included in our database. We also solicit reviews of new books or suggestions for alternate modes of study that may be useful in preparing for the examination, such as flash cards, computer software, commercial review courses, apps, and websites.

Disclaimer/Conflict of Interest Statement

No material in this book, including the ratings, reflects the opinion or influence of the publisher. All errors and omissions will gladly be corrected if brought to the attention of the authors through our blog at www.firstaidteam.com. Please note that USMLE-Rx and the entire First Aid for the USMLE series are publications by certain authors of this book; the following ratings are based solely on recommendations from the student authors of this book as well as data from the student survey and feedback forms.

► TOP-RATED REVIEW RESOURCES

Question Banks and Books

		AUTHOR	PUBLISHER	TYPE	PRICE
A +	UWorld Qbank	UWorld	www.uworld.com	Test/2400 q	\$249-\$749
A	NBME Practice Exams	National Board of Medical Examiners	www.nbme.org/students/sas/ Comprehensive.html	Test/200 q	\$60
A -	AMBOSS	Amboss	www.amboss.com	Test/3500 q	\$9-\$365
A -	USMLE-Rx Qmax	USMLE-Rx	www.usmle-rx.com	Test/2300 q	\$89-\$339
B ⁺	Kaplan Qbank	Kaplan	www.kaptest.com	Test/2100 q	\$99–\$349
В	BoardVitals		www.boardvitals.com	Test/1750 q	\$59-\$179
В	Kaplan USMLE Step 1 Qbook	Kaplan	Kaplan, 2017, 468 pages	Test/850 q	\$50
В	Pastest		www.pastest.com	Test/2100 q	\$79-\$249
В	TrueLearn Review		www.truelearn.com	Test/2200 q	\$159-\$399

Web and Mobile Apps

		AUTHOR	PUBLISHER	ТҮРЕ	PRICE
A	Anki		www.ankisrs.net	Flash cards	Free
A	Boards and Beyond		www.boardsbeyond.com	Review/ Test/1300 q	\$19–\$249
A	Physeo		www.physeo.com	Review	\$30-\$150
A	SketchyMedical		www.sketchymedical.com	Review	\$99-\$369
A -	Cram Fighter		www.cramfighter.com	Study plan	\$29-\$159
A -	First Aid Step 1 Express		www.usmle-rx.com	Review/Test	\$69-\$299
B ⁺	First Aid Step 1 Flash Facts		www.usmle-rx.com	Flash cards	\$29-\$149
B ⁺	Medbullets		www.medbullets.com	Review/ Test/1000 q	Free
B ⁺	Medical School Pathology		www.medicalschoolpathology.com	Review	Free
B ⁺	OnlineMedEd		www.onlinemeded.org	Review	Free
B ⁺	Osmosis		www.osmosis.org	Test	\$179-\$279
B ⁺	USMLE Step 1 Mastery		builtbyhlt.com/medical/usmle-step- 1-mastery	Test/1400 q	\$2–\$10
B ⁺	WebPath: The Internet Pathology Laboratory		webpath.med.utah.edu	Review/ Test/1300 q	Free
В	Blue Histology		www.lab.anhb.uwa.edu.au/mb140	Review/Test	Free
В	Digital Anatomist Project: Interactive Atlases	University of Washington	da.si.washington.edu/da.html	Review	Free
В	Dr. Najeeb Lectures		www.drnajeeblectures.com	Review	\$99

В	Firecracker	Firecracker Inc.	firecracker.lww.com	Review/ Test/2800 q	\$39-\$660	
В	KISSPrep		www.kissprep.com	Review	\$99-\$135	
В	Lecturio		www.lecturio.com	Review/ Test/2150 q	\$50-\$300	
В	Memorang	Memorang Inc.	www.memorangapp.com	Flash cards	\$19-\$239	
В	Picmonic		www.picmonic.com	Review	\$25-\$480	
B-	Radiopaedia.org		www.radiopaedia.org	Cases/Test	Free	
B-	The Pathology Guy	Friedlander	www.pathguy.com	Review	Free	
Comprehensive						
		AUTHOR	PUBLISHER	TYPE	PRICE	
A	First Aid for the Basic Sciences: General	Le	McGraw-Hill, 2017, 528 pages	Review	\$55	

		AUTHOR	PUBLISHER	TYPE	PRICE
A	First Aid for the Basic Sciences: General Principles	Le	McGraw-Hill, 2017, 528 pages	Review	\$55
A	First Aid Cases for the USMLE Step 1	Le	McGraw-Hill, 2018, 496 pages	Cases	\$50
A -	First Aid for the Basic Sciences: Organ Systems	Le	McGraw-Hill, 2017, 912 pages	Review	\$72
A -	Crush Step 1: The Ultimate USMLE Step 1 Review	O'Connell	Elsevier, 2017, 704 pages	Review	\$45
A -	Cracking the USMLE Step 1	Princeton Review	Princeton Review, 2013, 832 pages	Review	\$45
B ⁺	USMLE Step 1 Secrets in Color	Brown	Elsevier, 2016, 800 pages, ISBN 9780323396790	Review	\$43
B +	Step-Up to USMLE Step 1 2015	Jenkins	Lippincott Williams & Wilkins, 2014, 528 pages	Review	\$50
B ⁺	USMLE Step 1 Lecture Notes 2018	Kaplan	Kaplan Medical, 2018, ~2700 pages	Review	\$330
B +	USMLE Images for the Boards: A Comprehensive Image-Based Review	Tully	Elsevier, 2012, 296 pages	Review	\$42
В	USMLE Step 1 Made Ridiculously Simple	Carl	MedMaster, 2017, 416 pages,	Review/Test 1000 q	\$30
В	medEssentials for the USMLE Step 1	Manley	Kaplan, 2012, 588 pages	Review	\$55

Anatomy, Embryology, and Neuroscience

		AUTHOR	PUBLISHER	TYPE	PRICE
A -	High-Yield Gross Anatomy	Dudek	Lippincott Williams & Wilkins, 2014, 320 pages	Review	\$43
A -	Clinical Anatomy Made Ridiculously Simple	Goldberg	MedMaster, 2016, 175 pages	Review	\$30
B ⁺	High-Yield Embryology	Dudek	Lippincott Williams & Wilkins, 2013, 176 pages	Review	\$56
B ⁺	High-Yield Neuroanatomy	Fix	Lippincott Williams & Wilkins, 2015, 208 pages	Review/ Test/50 q	\$40

Anatomy, Embryology, and Neuroscience (continued)

		AUTHOR	PUBLISHER	TYPE	PRICE
B ⁺	Anatomy—An Essential Textbook	Gilroy	Thieme, 2017, 528 pages	Text/ Test/400 q	\$48
B ⁺	Netter's Anatomy Flash Cards	Hansen	Saunders, 2018, 688 flash cards	Flash cards	\$40
B ⁺	Crash Course: Anatomy	Stenhouse	Elsevier, 2015, 288 pages	Review	\$45
В	BRS Embryology	Dudek	Lippincott Williams & Wilkins, 2014, 336 pages	Review/ Test/220 q	\$56
В	Anatomy Flash Cards: Anatomy on the Go	Gilroy	Thieme, 2013, 752 flash cards	Flash cards	\$60
В	Clinical Neuroanatomy Made Ridiculously Simple	Goldberg	MedMaster, 2014, 90 pages + CD- ROM	Review/Test/ Few q	\$26
В	Netter's Anatomy Coloring Book	Hansen	Elsevier, 2018, 392 pages	Review	\$20
В	Case Files: Anatomy	Toy	McGraw-Hill, 2014, 416 pages	Cases	\$35
B-	Case Files: Neuroscience	Toy	McGraw-Hill, 2014, 432 pages	Cases	\$35

Behavioral Science

		AUTHOR	PUBLISHER	TYPE	PRICE
A-	BRS Behavioral Science	Fadem	Lippincott Williams & Wilkins, 2016, 384 pages	Review/ Test/700 q	\$52
B⁺	High-Yield Biostatistics, Epidemiology, and Public Health	Glaser	Lippincott Williams & Wilkins, 2013, 168 pages	Review	\$43

Biochemistry

		AUTHOR	PUBLISHER	TYPE	PRICE
A -	Pixorize		www.pixorize.com	Review	\$100-\$130
B ⁺	Medical Biochemistry—An Illustrated Review	Panini	Thieme, 2013, 441 pages	Review/ Test/400 q	\$40
В	Lange Flash Cards Biochemistry and Genetics	Baron	McGraw-Hill, 2017, 196 flash cards	Flash cards	\$40
В	Lippincott Illustrated Reviews: Biochemistry	Ferrier	Lippincott Williams & Wilkins, 2017, 560 pages	Review/ Test/200 q	\$78
В	BRS Biochemistry, Molecular Biology, and Genetics	Lieberman	Lippincott Williams & Wilkins, 2013, 432 pages	Review/Test	\$54
В	Case Files: Biochemistry	Toy	McGraw-Hill, 2014, 480 pages	Cases	\$35
В	PreTest Biochemistry and Genetics	Wilson	McGraw-Hill, 2017, 592 pages	Test/500 q	\$38

Cell Biology and Histology

		AUTHOR	PUBLISHER	TYPE	PRICE
B ⁺	BRS Cell Biology and Histology	Gartner	Lippincott Williams & Wilkins, 2018, 448 pages	Review/ Test/320 q	\$54
B ⁺	Crash Course: Cell Biology and Genetics	Stubbs	Elsevier, 2015, 216 pages	Review/Print + online	\$47
В	Wheater's Functional Histology	Young	Elsevier, 2013, 464 pages	Text	\$83

717

Microbiology and Immunology

		AUTHOR	PUBLISHER	TYPE	PRICE
A -	Basic Immunology	Abbas	Elsevier, 2019, 336 pages	Review	\$70
A -	Clinical Microbiology Made Ridiculously Simple	Gladwin	MedMaster, 2019, 418 pages	Review	\$38
A -	Medical Microbiology and Immunology Flash Cards	Rosenthal	Elsevier, 2016, 192 flash cards	Flash cards	\$40
B ⁺	Lippincott Illustrated Reviews: Immunology	Doan	Lippincott Williams & Wilkins, 2012, 384 pages	Reference/ Test/Few q	\$75
B ⁺	Microcards: Microbiology Flash Cards	Harpavat	Lippincott Williams & Wilkins, 2015, 312 flash cards	Flash cards	\$53
B ⁺	Review of Medical Microbiology and Immunology	Levinson	McGraw-Hill, 2018, 832 pages	Review/ Test/654 q	\$63
B ⁺	How the Immune System Works	Sompayrac	Wiley-Blackwell, 2019, 168 pages	Review	\$50
В	Case Studies in Immunology: Clinical Companion	Geha	W. W. Norton & Company, 2016, 384 pages	Cases	\$62
В	Pretest: Microbiology	Kettering	McGraw-Hill, 2013, 480 pages	Test/500 q	\$38
В	Case Files: Microbiology	Toy	McGraw-Hill, 2014, 416 pages	Cases	\$36
В	Lange Microbiology and Infectious Diseases Flash Cards, 3e	Somers	McGraw-Hill Education, 2017, 358 pages	Flash cards	\$46
B -	Lippincott Illustrated Reviews: Microbiology	Cornelissen	Lippincott Williams & Wilkins, 2019, 448 pages	Review/Test/ Few q	\$73

Pathology

ratii	lology				
		AUTHOR	PUBLISHER	TYPE	PRICE
A +	Pathoma: Fundamentals of Pathology	Sattar	Pathoma, 2019, 218 pages	Review/ Lecture	\$85-\$120
A -	Rapid Review: Pathology	Goljan	Elsevier, 2018, 864 pages	Review/ Test/500 q	\$65
A -	Robbins and Cotran Review of Pathology	Klatt	Elsevier, 2014, 504 pages	Test/1100 q	\$55
A -	Crash Course: Pathology	Xiu	Elsevier, 2019, 438 pages	Review	\$40
В	High-Yield Histopathology	Dudek	Lippincott Williams & Wilkins, 2017, 320 pages	Review	\$36
В	Pathophysiology of Disease: Introduction to Clinical Medicine	Hammer	McGraw-Hill, 2018, 832 pages	Text	\$90
В	Haematology at a Glance	Mehta	Blackwell Science, 2014, 136 pages	Review	\$49
В	Pocket Companion to Robbins and Cotran Pathologic Basis of Disease	Mitchell	Elsevier, 2016, 896 pages	Review	\$40
В	BRS Pathology	Schneider	Lippincott Williams & Wilkins, 2013, 480 pages	Review/ Test/450 q	\$54

718 SECTION IV

TOP-RATED REVIEW RESOURCES >

Pharmacology

		AUTHOR	PUBLISHER	TYPE	PRICE
B ⁺	Crash Course: Pharmacology	Battista	Elsevier, 2019, 336 pages	Review	\$40
B ⁺	Master the Boards USMLE Step 1 Pharmacology Flashcards	Fischer	Kaplan, 2015, 200 flash cards	Flash cards	\$55
B ⁺	BRS Pharmacology	Rosenfeld	Lippincott Williams & Wilkins, 2019, 384 pages	Review/ Test/200 q	\$55
В	Lange Pharmacology Flash Cards	Baron	McGraw-Hill, 2017, 266 flash cards	Flash cards	\$39
В	Pharmacology Flash Cards	Brenner	Elsevier, 2017, 230 flash cards	Flash cards	\$45
В	Katzung & Trevor's Pharmacology: Examination and Board Review	Trevor	McGraw-Hill, 2018, 592 pages	Review/ Test/800 q	\$54
В	Lippincott Illustrated Reviews: Pharmacology	Whalen	Lippincott Williams & Wilkins, 2018, 576 pages	Review/ Test/380 q	\$75

Physiology

		AUTHOR	PUBLISHER	TYPE	PRICE
A -	BRS Physiology	Costanzo	Lippincott Williams & Wilkins, 2018, 304 pages	Review/ Test/350 q	\$54
A -	Pathophysiology of Heart Disease	Lilly	Lippincott Williams & Williams, 2015, 480 pages	Review	\$57
A -	PreTest Physiology	Metting	McGraw-Hill, 2013, 528 pages	Test/500 q	\$38
A -	Color Atlas of Physiology	Silbernagl	Thieme, 2015, 472 pages	Review	\$50
B ⁺	BRS Physiology Cases and Problems	Costanzo	Lippincott Williams & Wilkins, 2012, 368 pages	Cases	\$58
B ⁺	Physiology	Costanzo	Saunders, 2017, 528 pages	Text	\$60
B ⁺	Vander's Renal Physiology	Eaton	McGraw-Hill, 2018, 224 pages	Text	\$49
B +	Acid-Base, Fluids, and Electrolytes Made Ridiculously Simple	Preston	MedMaster, 2017, 166 pages	Review	\$24
B ⁺	Pulmonary Pathophysiology: The Essentials	West	Lippincott Williams & Wilkins, 2017, 264 pages	Review/ Test/75 q	\$57
В	Rapid Review: Physiology	Brown	Elsevier, 2011, 384 pages	Test/350 q	\$39
В	Endocrine Physiology	Molina	McGraw-Hill, 2018, 320 pages	Review	\$59
B-	Netter's Physiology Flash Cards	Mulroney	Saunders, 2015, 450 flash cards	Flash cards	\$40

SECTION IV

Abbreviations and Symbols

ABBREVIATION	MEANING
1st MC*	1st metacarpal
A-a	alveolar-arterial [gradient]
AA	Alcoholics Anonymous, amyloid A
AAMC	Association of American Medical Colleges
AAo*	ascending aorta
Ab	antibody
ABPA	allergic bronchopulmonary aspergillosis
AC	adenylyl cyclase
ACA	anterior cerebral artery
Acetyl-CoA	acetyl coenzyme A
ACD	anemia of chronic disease
ACE	angiotensin-converting enzyme
ACh	acetylcholine
AChE	acetylcholinesterase
ACL	anterior cruciate ligament
ACom	anterior communicating [artery]
ACTH	adrenocorticotropic hormone
AD	Alzheimer disease, autosomal dominant
ADA	adenosine deaminase, Americans with Disabilities Act
ADH	antidiuretic hormone
ADHD	attention-deficit hyperactivity disorder
ADP	adenosine diphosphate
ADPKD	autosomal-dominant polycystic kidney disease
AFP	α-fetoprotein
Ag	antigen, silver
AICA	anterior inferior cerebellar artery
AIDS	acquired immunodeficiency syndrome
AIHA	autoimmune hemolytic anemia
AKI	acute kidney injury
AKT	protein kinase B
AL	amyloid light [chain]
ALA	aminolevulinate
ALI	acute lung injury
ALL	acute lymphoblastic (lymphocytic) leukemia
ALP	alkaline phosphatase
ALS	amyotrophic lateral sclerosis
ALT	alanine transaminase
AMA	American Medical Association, antimitochondrial antibody
AML	acute myelogenous (myeloid) leukemia
AMP	adenosine monophosphate
ANA	antinuclear antibody
ANCA	antineutrophil cytoplasmic antibody
ANOVA	analysis of variance

ABBREVIATION	MEANING
ANP	atrial natriuretic peptide
ANS	autonomic nervous system
Ant*	anterior
anti-CCP	anti-cyclic citrullinated peptide
Ao*	aorta
AOA	American Osteopathic Association
AP	action potential, A & P [ribosomal binding sites]
APC	antigen-presenting cell, activated protein C
Apo	apolipoprotein
APP	amyloid precursor protein
APRT	adenine phosphoribosyltransferase
aPTT	activated partial thromboplastin time
APUD	amine precursor uptake decarboxylase
AR	attributable risk, autosomal recessive, aortic regurgitation
ARB	angiotensin receptor blocker
ARDS	acute respiratory distress syndrome
Arg	arginine
ARPKD	autosomal-recessive polycystic kidney disease
ART	antiretroviral therapy
AS	aortic stenosis
ASA	anterior spinal artery
ASD	atrial septal defect
ASO	anti-streptolysin O
AST	aspartate transaminase
AΤ	angiotensin, antithrombin
ATN	acute tubular necrosis
ATP	adenosine triphosphate
ATPase	adenosine triphosphatase
ATTR	transthyretin-mediated amyloidosis
AUB	abnormal uterine bleeding
AV	atrioventricular
AZT	azidothymidine
BAL	British anti-Lewisite [dimercaprol]
BBB	blood-brain barrier
BCG	bacille Calmette-Guérin
BH_4	tetrahydrobiopterin
BM	basement membrane
BOOP	bronchiolitis obliterans organizing pneumonia
BP	bisphosphate, blood pressure
BPG	bisphosphoglycerate
BPH	benign prostatic hyperplasia
ВТ	bleeding time
BUN	blood urea nitrogen
Ca*	capillary

^{*}Image abbreviation only

ABBREVIATION	MEANING
Ca ²⁺	calcium ion
CAD	coronary artery disease
CAF	common application form
cAMP	cyclic adenosine monophosphate
CBG	corticosteroid-binding globulin
Cbm*	cerebellum
CBSE	Comprehensive Basic Science Examination
CBSSA	Comprehensive Basic Science Self-Assessment
CBT	computer-based test, cognitive behavioral therapy
CC*	corpus callosum
CCA*	common carotid artery
CCK	cholecystokinin
CCS	computer-based case simulation
CD	cluster of differentiation
CDK	cyclin-dependent kinase
cDNA	complementary deoxyribonucleic acid
CEA	carcinoembryonic antigen
CETP	cholesteryl-ester transfer protein
CF	cystic fibrosis
CFTR	cystic fibrosis transmembrane conductance regulator
CGD	chronic granulomatous disease
cGMP	cyclic guanosine monophosphate
CGRP	calcitonin gene–related peptide
$C_H 1 - C_H 3$	constant regions, heavy chain [antibody]
ChAT	choline acetyltransferase
CHD*	common hepatic duct
χ^2	chi-squared
CI	confidence interval
CIN	candidate identification number, carcinoma in situ, cervical intraepithelial neoplasia
CIS	Communication and Interpersonal Skills
CK	clinical knowledge, creatine kinase
CKD	chronic kidney disease
CK-MB	creatine kinase, MB fraction
C_{r}	constant region, light chain [antibody]
CL	clearance
Cl-	chloride ion
CLL	chronic lymphocytic leukemia
CMC	carpometacarpal (joint)
CML	chronic myelogenous (myeloid) leukemia
CMV	cytomegalovirus
CN	cranial nerve
CN-	cyanide ion
CNS	central nervous system
CNV	copy number variation
CO	carbon monoxide, cardiac output
CO,	carbon dioxide
CoA	coenzyme A
COLIAI	collagen, type I, alpha 1
COL1A1	collagen, type I, alpha 2
COLIAZ	catechol-O-methyltransferase
COP	coat protein
COPD	chronic obstructive pulmonary disease
CoQ	coenzyme Q
202	cocaz, inc g

400051//47101/	WEATHER.
ABBREVIATION	MEANING
COX	cyclooxygenase
C _p	plasma concentration
CPAP	continuous positive airway pressure
CPR	cardiopulmonary resuscitation
Cr	creatinine
CRC	colorectal cancer
CREST	calcinosis, Raynaud phenomenon, esophageal dysfunction, sclerosis, and telangiectasias [syndrome]
CRH	corticotropin-releasing hormone
CRP	C-reactive protein
CS	clinical skills
C-section	cesarean section
CSF	cerebrospinal fluid
CT	computed tomography
CTP	cytidine triphosphate
CXR	chest x-ray
DA	dopamine
DAF	decay-accelerating factor
DAG	diacylglycerol
dATP	deoxyadenosine triphosphate
DCIS	ductal carcinoma in situ
DCT	distal convoluted tubule
ddI	didanosine
DES	diethylstilbestrol
DH	dehydrogenase
DHAP	dihydroxyacetone phosphate
DHEA	dehydroepiandrosterone
DHF	dihydrofolic acid
DHT	dihydrotestosterone
DI	diabetes insipidus
DIC	disseminated intravascular coagulation
DIP	distal interphalangeal [joint]
DKA	diabetic ketoacidosis
DLCO	diffusing capacity for carbon monoxide
DM	diabetes mellitus
DNA	deoxyribonucleic acid
DNR	do not resuscitate
dNTP	deoxynucleotide triphosphate
DO	doctor of osteopathy
DPGN	diffuse proliferative glomerulonephritis
DPM	doctor of podiatric medicine
DPP-4	dipeptidyl peptidase-4
DPPC	dipalmitoylphosphatidylcholine
DS	double stranded
dsDNA	double-stranded deoxyribonucleic acid
dsRNA	double-stranded ribonucleic acid
DRG	dorsal root ganglion
d4T	didehydrodeoxythymidine [stavudine]
dTMP	deoxythymidine monophosphate
DTR	deep tendon reflex
DTs	delirium tremens
dUDP	deoxyuridine diphosphate
dUMP	deoxyuridine monophosphate
DVT	deep venous thrombosis
E*	euthromatin, esophagus
	Cataromatin, Coopiiagus

^{*}Image abbreviation only

ADDDEVIATION	MEANING
ABBREVIATION	MEANING English Brown in the second
EBV ECA*	Epstein-Barr virus
	external carotid artery
ECF	
ECFMG	Educational Commission for Foreign Medical Graduates
ECG	electrocardiogram
ECL	enterochromaffin-like [cell]
ECM	extracellular matrix
ECT	electroconvulsive therapy
ED_{50}	median effective dose
EDRF	endothelium-derived relaxing factor
EDTA	ethylenediamine tetra-acetic acid
EDV	end-diastolic volume
EEG	electroencephalogram
EF	ejection fraction
EGF	epidermal growth factor
EHEC	enterohemorrhagic E coli
EIEC	enteroinvasive E coli
ELISA	enzyme-linked immunosorbent assay
EM	electron micrograph/microscopy
EMB	eosin-methylene blue
EPEC	eneteropathogenic E coli
Ері	epinephrine
EPO	erythropoietin
EPS	extrapyramidal system
ER	endoplasmic reticulum, estrogen receptor
ERAS	Electronic Residency Application Service
ERCP	endoscopic retrograde cholangiopancreatography
ERP	effective refractory period
eRPF	effective renal plasma flow
ERT	estrogen replacement therapy
ERV	expiratory reserve volume
ESR	erythrocyte sedimentation rate
ESRD	
ESV	end-stage renal disease
	end-systolic volume
ETEC	enterotoxigenic E coli
EtOH	ethyl alcohol
EV	esophageal vein
F	bioavailability
FA	fatty acid
Fab	fragment, antigen-binding
FAD	flavin adenine dinucleotide
FADH ₂	reduced flavin adenine dinucleotide
FAP	familial adenomatous polyposis
F1,6BP	fructose-1,6-bisphosphate
F2,6BP	fructose-2,6-bisphosphate
FBPase	fructose bisphosphatase
FBPase-2	fructose bisphosphatase-2
Fc	fragment, crystallizable
FcR	Fc receptor
5f-dUMP	5-fluorodeoxyuridine monophosphate
Fe ²⁺	ferrous ion
Fe ³⁺	ferric ion
Fem*	femur
FENa	excreted fraction of filtered sodium

ABBREVIATION	MEANING
FEV,	forced expiratory volume in 1 second
FF	filtration fraction
FFA	free fatty acid
FGF	fibroblast growth factor
FGFR	fibroblast growth factor receptor
FISH	fluorescence in situ hybridization
FIT	fecal immunochemical testing
FKBP	FK506 binding protein
fMet	formylmethionine
FMG	foreign medical graduate
FMN	flavin mononucleotide
FN	false negative
FP, FP*	false positive, foot process
FRC	functional residual capacity
FSH	follicle-stimulating hormone
FSMB	Federation of State Medical Boards
FTA-ABS	fluorescent treponemal antibody—absorbed
FTD*	frontotemporal dementia
5-FU	5-fluorouracil
FVC	forced vital capacity
GABA	γ-aminobutyric acid
GAG	glycosaminoglycan
Gal	galactose
GBM	glomerular basement membrane
GC	glomerular capillary
G-CSF	granulocyte colony-stimulating factor
GERD	gastroesophageal reflux disease
GFAP	glial fibrillary acid protein
GFR	glomerular filtration rate
GGT	γ-glutamyl transpeptidase
GH	growth hormone
GHB	γ-hydroxybutyrate
GHRH	growth hormone–releasing hormone
G,	G protein, I polypeptide
GI	gastrointestinal
GIP	gastric inhibitory peptide
GIST	gastrointestinal stromal tumor
GLUT	glucose transporter
GM	granulocyte macrophage
GM-CSF	granulocyte-macrophage colony stimulating factor
GMP	guanosine monophosphate
GnRH	gonadotropin-releasing hormone
GP	glycoprotein
G6P	glucose-6-phosphate
G6PD	glucose-6-phosphate dehydrogenase
GPe	globus pallidus externa
GPi	globus pallidus interna
GPI	glycosyl phosphatidylinositol
GRP	gastrin-releasing peptide
G_s	G protein, S polypeptide
GSH	reduced glutathione
GSSG	oxidized glutathione
GTP	guanosine triphosphate
GTPase	guanosine triphosphatase
O I I asc	Saurovine arphosphiatase

^{*}Image abbreviation only

ABBREVIATIONS AND SYMBOLS

ADDDEVIATION	MEANING
ABBREVIATION	MEANING genitourinary
H*	heterochromatin
H+	
	hydrogen ion
H_1, H_2	histamine receptors
H ₂ S	hydrogen sulfide
HAV	hepatitis A virus
HAVAb	hepatitis A antibody
Hb	hemoglobin
HBcAb/HBcAg	hepatitis B core antibody/antigen
HBeAb/HBeAg	hepatitis B early antibody/antigen
HBsAb/HBsAg	hepatitis B surface antibody/antigen
HbCO ₂	carbaminohemoglobin
HBV	hepatitis B virus
HCC	hepatocellular carcinoma
hCG	human chorionic gonadotropin
HCO ₃ -	bicarbonate
Het	hematocrit
HCTZ	hydrochlorothiazide
HCV	hepatitis C virus
HDL	high-density lipoprotein
HDN	hemolytic disease of the newborn
HDV	hepatitis D virus
H&E	hematoxylin and eosin
HEV	hepatitis E virus
HF	heart failure
Hfr	high-frequency recombination [cell]
HFpEF	heart failure with preserved ejection fraction
HFrEF	heart failure with reduced ejection fraction
HGPRT	hypoxanthine-guanine phosphoribosyltransferase
ННЬ	deoxygenated hemoglobin
HHS	hyperosmolar hyperglycemic state
HHV	human herpesvirus
5-HIAA	5-hydroxyindoleacetic acid
HIT	heparin-induced thrombocytopenia
HIV	human immunodeficiency virus
HL	hepatic lipase
HLA	human leukocyte antigen
HMG-CoA	hydroxymethylglutaryl-coenzyme A
HMP	hexose monophosphate
HMWK	high-molecular-weight kininogen
HNPCC	hereditary nonpolyposis colorectal cancer
hnRNA	heterogeneous nuclear ribonucleic acid
H_2O_2	hydrogen peroxide
HOCM	hypertrophic obstructive cardiomyopathy
HPA	hypothalamic-pituitary-adrenal [axis]
HPL	human placental lactogen
HPO	hypothalamic-pituitary-ovarian [axis]
HPV	human papillomavirus
HR	heart rate
HSP	Henoch-Schönlein purpura
HSV	herpes simplex virus
5-HT	5-hydroxytryptamine (serotonin)
HTLV	human T-cell leukemia virus
HTN	hypertension

ABBREVIATION	MEANING
HUS	hemolytic-uremic syndrome
HVA	homovanillic acid
IBD	inflammatory bowel disease
IBS	irritable bowel syndrome
IC	inspiratory capacity, immune complex
	calcium current [heart]
I _{Ca}	
I _f ICA	funny current [heart]
	internal carotid artery
ICAM	intercellular adhesion molecule
ICD	implantable cardioverter defibrillator
ICE	Integrated Clinical Encounter
ICF	intracellular fluid
ICP	intracranial pressure
ID	identification
ID_{50}	median infective dose
IDL	intermediate-density lipoprotein
IF	immunofluorescence, initiation factor
IFN	interferon
Ig	immunoglobulin
IGF	insulin-like growth factor
I_K	potassium current [heart]
IL	interleukin
IM	intramuscular
IMA	inferior mesenteric artery
IMG	international medical graduate
IMP	inosine monophosphate
IMV	inferior mesenteric vein
I_{Na}	sodium current [heart]
INH	isoniazid
INO	internuclear ophthalmoplegia
INR	International Normalized Ratio
IO	inferior oblique [muscle]
IOP	intraocular pressure
IP ₃	inositol triphosphate
IPV	inactivated polio vaccine
IR	current × resistance [Ohm's law], inferior rectus [muscle]
IRV	inspiratory reserve volume
ITP	
	idiopathic thrombocytopenic purpura
IUD	intrauterine device
IUGR	intrauterine growth restriction
IV.	intravenous
IVC	inferior vena cava
IVDU	intravenous drug use
IVIG	intravenous immunoglobulin
JAK/STAT	Janus kinase/signal transducer and activator of transcription [pathway]
JGA	juxtaglomerular apparatus
JVD	jugular venous distention
JVP	jugular venous pulse
K ⁺	potassium ion
KatG	catalase-peroxidase produced by M tuberculosis
K_{e}	elimination constant
K_{f}	filtration constant
KG	ketoglutarate

^{*}Image abbreviation only

ABBREVIATION	MEANING
K _m	Michaelis-Menten constant
KOH	potassium hydroxide
L	left, liver
LA	left atrial, left atrium
LAD	left anterior descending coronary artery
LAP	leukocyte alkaline phosphatase
Lat cond*	lateral condyle
Lb*	lamellar body
LCA	·
LCAT	left coronary artery lecithin-cholesterol acyltransferase
LCC*	left common carotid artery
LCFA	·
LCL	long-chain fatty acid
LCL	lateral collateral ligament Liaison Committee on Medical Education
LCW	lymphocytic choriomeningitis virus
LCX LD	left circumflex coronary artery
	loading dose median lethal dose
LD ₅₀	
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
LES	lower esophageal sphincter
LFA	leukocyte function–associated antigen
LFT	liver function test
LH	luteinizing hormone
LLL*	left lower lobe (of lung)
LLQ	left lower quadrant
LM	lateral meniscus, left main coronary artery, light microscopy
LMN	lower motor neuron
LOS	lipooligosaccharide
LPA*	left pulmonary artery
LPL	lipoprotein lipase
LPS	lipopolysaccharide
LR	lateral rectus [muscle]
LT	labile toxin, leukotriene
LUL*	left upper lobe (of lung)
LV	left ventricle, left ventricular
M_1 - M_5	muscarinic (parasympathetic) ACh receptors
MAC	membrane attack complex, minimum alveolar concentration
MALT	mucosa-associated lymphoid tissue
MAO	monoamine oxidase
MAOI	monoamine oxidase inhibitor
MAP	mean arterial pressure, mitogen-activated protein
Max*	maxillary sinus
MC	midsystolic click
MCA	middle cerebral artery
MCAT	Medical College Admissions Test
MCHC	mean corpuscular hemoglobin concentration
MCL	medial collateral ligament
MCP	metacarpophalangeal [joint]
MCV	mean corpuscular volume
MD	maintenance dose
MDD	major depressive disorder

ABBREVIATION	MEANING
MELAS	mitochondrial encephalopathy, lactic acidosis, and stroke-
syndrome	like episodes
MEN M - 2+	multiple endocrine neoplasia
Mg ²⁺	magnesium ion
MgSO ₄	magnesium sulfate
MGUS	monoclonal gammopathy of undetermined significance
MHC	major histocompatibility complex
MI	myocardial infarction
MIF	müllerian inhibiting factor
MIRL	membrane inhibitor of reactive lysis
MLCK	myosin light-chain kinase
MLF	medial longitudinal fasciculus
MMC	migrating motor complex
MMR	measles, mumps, rubella [vaccine]
6-MP	6-mercaptopurine
MPGN	membranoproliferative glomerulonephritis
MPO	myeloperoxidase
MPO-ANCA/ p-ANCA	myeloperoxidase/perinuclear antineutrophil cytoplasmic antibody
MR	medial rectus [muscle], mitral regurgitation
MRI	magnetic resonance imaging
miRNA	microribonucleic acid
mRNA	messenger ribonucleic acid
MRSA	methicillin-resistant S aureus
MS	mitral stenosis, multiple sclerosis
MSH	melanocyte-stimulating hormone
mtDNA	mitochondrial DNA
mTOR	mammalian target of rapamycin
MTP	metatarsophalangeal [joint]
MTX	methotrexate
MVO,	myocardial oxygen consumption
MVP	mitral valve prolapse
N*	nucleus
Na ⁺	sodium ion
NAT	nucleic acid testing
NAD	nicotinamide adenine dinucleotide
NAD+	oxidized nicotinamide adenine dinucleotide
NADH	reduced nicotinamide adenine dinucleotide
NADP+	oxidized nicotinamide adenine dinucleotide phosphate
NADPH	reduced nicotinamide adenine dinucleotide phosphate
NBME	National Board of Medical Examiners
NBOME	National Board of Osteopathic Medical Examiners
NBPME	National Board of Podiatric Medical Examiners
NE NE	norepinephrine
NF	neurofibromatosis
NFAT	nuclear factor of activated T-cell
	ammonia
NH ₃	ammonium
NH ₄ ⁺	
NK	natural killer [cells]
N _M	muscarinic ACh receptor in neuromuscular junction
NMDA	N-methyl-d-aspartate
NMJ	neuromuscular junction
NMS	neuroleptic malignant syndrome
N_{N}	nicotinic ACh receptor in autonomic ganglia

^{*}Image abbreviation only

ABBREVIATION	MEANING
NRMP	National Residency Matching Program
NNRTI	non-nucleoside reverse transcriptase inhibitor
NO	nitric oxide
N_2O	nitrous oxide
NPH	neutral protamine Hagedorn, normal pressure hydrocephalus
NPV	negative predictive value
NRTI	nucleoside reverse transcriptase inhibitor
NSAID	nonsteroidal anti-inflammatory drug
NSE	neuron-specific enolase
NSTEMI	non-ST-segment elevation myocardial infarction
Nu*	nucleolus
OAA	oxaloacetic acid
OCD	obsessive-compulsive disorder
OCP	oral contraceptive pill
ODC	oxygen-hemoglobin dissociation curve
ОН	hydroxy
1,25-OH D ₃	calcitriol (active form of vitamin D)
25-OH D,	storage form of vitamin D
OPV	oral polio vaccine
OR	odds ratio
OS	opening snap
OSA	obstructive sleep apnea
OVLT	organum vasculosum of the lamina terminalis
P-body	processing body (cytoplasmic)
P-450	cytochrome P-450 family of enzymes
PA	posteroanterior, pulmonary artery
PABA	para-aminobenzoic acid
Paco,	arterial Pco,
PACO ₂	alveolar PCO ₂
PAH	para-aminohippuric acid
PAN	polyarteritis nodosa
Pao,	partial pressure of oxygen in arterial blood
PAO ₂	partial pressure of oxygen in alveolar blood
PAP	Papanicolaou [smear], prostatic acid phosphatase
PAPPA	pregnancy-associated plasma protein A
PAS	periodic acid–Schiff
Pat*	patella
PBP	penicillin-binding protein
PC	platelet count, pyruvate carboxylase
PCA	posterior cerebral artery
PCC	prothrombin complex concentrate
PCL	posterior cruciate ligament
Pco,	partial pressure of carbon dioxide
PCom	posterior communicating [artery]
PCOS	polycystic ovarian syndrome
PCP	phencyclidine hydrochloride, <i>Pneumocystis jirovecii</i> pneumonia
PCR	polymerase chain reaction
PCT	proximal convoluted tubule
PCV13	pneumococcal conjugate vaccine
PCWP	pulmonary capillary wedge pressure
PDA	patent ductus arteriosus, posterior descending artery
PDE	phosphodiesterase
IDE	Priospriodiesterase

ABBREVIATION	MEANING
PDGF	platelet-derived growth factor
PDH	pyruvate dehydrogenase
PECAM	pulmonary embolism
PECAM	platelet–endothelial cell adhesion molecule
PECO ₂	expired air PCO ₂
PEP	phosphoenolpyruvate
PF	platelet factor
PFK	phosphofructokinase
PFK-2	phosphofructokinase-2
PFT	pulmonary function test
PG	phosphoglycerate
P _i	plasma interstitial osmotic pressure, inorganic phosphate
PICA	posterior inferior cerebellar artery
PID	pelvic inflammatory disease
Pio ₂	Po ₂ in inspired air
PIP	proximal interphalangeal [joint]
PIP ₂	phosphatidylinositol 4,5-bisphosphate
PIP ₃	phosphatidylinositol 3,4,5-bisphosphate
PKD	polycystic kidney disease
PKR	interferon-α-induced protein kinase
PKU	phenylketonuria
PLP	pyridoxal phosphate
PML	progressive multifocal leukoencephalopathy
PMN	polymorphonuclear [leukocyte]
P _{net}	net filtration pressure
PNET	primitive neuroectodermal tumor
PNS	peripheral nervous system
Po ₂	partial pressure of oxygen
PO ₄ ³⁻	phosphate
Pop*	popliteal artery
Pop a*	popliteal artery
Post*	posterior
PPAR	peroxisome proliferator-activated receptor
PPD	purified protein derivative
PPI	proton pump inhibitor
PPM	parts per million
PPSV23	pneumococcal polysaccharide vaccine
PPV	positive predictive value
PR3-ANCA/	cytoplasmic antineutrophil cytoplasmic antibody
c-ANCA	
PrP	prion protein
PRPP	phosphoribosylpyrophosphate
PSA	prostate-specific antigen
PSS	progressive systemic sclerosis
РТ	prothrombin time
PTEN	phosphatase and tensin homolog
РТН	parathyroid hormone
PTHrP	parathyroid hormone-related protein
PTSD	post-traumatic stress disorder
PTT	partial thromboplastin time
PV	plasma volume, venous pressure
Pv*	pulmonary vein
PVC	polyvinyl chloride
PVR	pulmonary vascular resistance

^{*}Image abbreviation only

ABBREVIATION	MEANING
R	correlation coefficient, right, R variable [group]
R_3	Registration, Ranking, & Results [system]
RA	right atrium
RAAS	renin-angiotensin-aldosterone system
RANK-L	receptor activator of nuclear factor-κ B ligand
RAS	reticular activating system
RBF	renal blood flow
RCA	right coronary artery
REM	rapid eye movement
RER	rough endoplasmic reticulum
Rh	rhesus antigen
RLL*	right lower lobe (of lungs)
RLQ	right lower quadrant
RML*	right middle lobe (of lung)
RNA	ribonucleic acid
RNP	ribonucleoprotein
ROS	reactive oxygen species
RPF	renal plasma flow
RPGN	rapidly progressive glomerulonephritis
RPR	rapid plasma reagin
RR	relative risk, respiratory rate
rRNA	ribosomal ribonucleic acid
RS	Reed-Sternberg [cells]
RSC*	right subclavian artery
RSV	respiratory syncytial virus
RTA	renal tubular acidosis
RUL*	right upper lobe (of lung)
RUQ	right upper quadrant
RV	residual volume, right ventricle, right ventricular
RVH	right ventricular hypertrophy
[S]	substrate concentration
SA	sinoatrial
SAA	serum amyloid-associated [protein]
SAM	S-adenosylmethionine
SARS	severe acute respiratory syndrome
SCC	squamous cell carcinoma
SCD	sudden cardiac death
SCID	severe combined immunodeficiency disease
SCJ	squamocolumnar junction
SCM	sternocleidomastoid muscle
SCN	suprachiasmatic nucleus
SD	standard deviation
SE	standard deviation standard error [of the mean]
SEP	Spoken English Proficiency
SER	smooth endoplasmic reticulum
SERM	selective estrogen receptor modulator
SGLT	sodium-glucose transporter
SHBG	sex hormone–binding globulin
SIADH	syndrome of inappropriate [secretion of] antidiuretic
	hormone
SIDS	sudden infant death syndrome
SJS	Stevens-Johnson syndrome
SLE	systemic lupus erythematosus
SLL	small lymphocytic lymphoma

ABBREVIATION	MEANING
SLT	Shiga-like toxin
SMA	superior mesenteric artery
SMX	sulfamethoxazole
SNARE	soluble NSF attachment protein receptor
SNc	substantia nigra pars compacta
SNP	single nucleotide polymorphism
SNr	substantia nigra pars reticulata
SNRI	serotonin and norepinephrine receptor inhibitor
snRNA	small nuclear RNA
snRNP	small nuclear ribonucleoprotein
SO	superior oblique [muscle]
SOAP	Supplemental Offer and Acceptance Program
Sp*	spleen
spp	species
SR	superior rectus [muscle]
SS	single stranded
ssDNA	single-stranded deoxyribonucleic acid
SSPE	subacute sclerosing panencephalitis
SSRI	selective serotonin reuptake inhibitor
ssRNA	single-stranded ribonucleic acid
St*	stomach
ST	Shiga toxin
StAR	steroidogenic acute regulatory protein
STEMI	ST-segment elevation myocardial infarction
STEMI	sexually transmitted infection
	<u> </u>
STN	subthalamic nucleus
SV	splenic vein, stroke volume
SVC	superior vena cava
SVR	systemic vascular resistance
SVT	supraventricular tachycardia
T*	trachea
t _{1/2}	half-life
T,	triiodothyronine
T ₄	thyroxine
TAPVR	total anomalous pulmonary venous return
ТВ	tuberculosis
TBG	thyroxine-binding globulin
TBV	total blood volume
3TC	dideoxythiacytidine [lamivudine]
TCA	tricarboxylic acid [cycle], tricyclic antidepressant
Tc cell	cytotoxic T cell
TCR	T-cell receptor
TDF	tenofovir disoproxil fumarate
TdT	terminal deoxynucleotidyl transferase
TE	tracheoesophageal
TFT	thyroid function test
TG	triglyceride
TGF	transforming growth factor
Th cell	helper T cell
THF	tetrahydrofolic acid
TI	therapeutic index
TIA	transient ischemic attack
Tib*	tibia
TIBC	total iron-binding capacity
TIPS	transjugular intrahepatic portosystemic shunt

^{*}Image abbreviation only

726 SECTION IV ABBREVIATIONS AND SYMBOLS

MEANING
total lung capacity
maximum rate of transport
trimethoprim
true negative
tumor necrosis factor
tumor, node, metastases [staging]
topoisomerase
Toxoplasma gondii, rubella, CMV, HIV, HSV-2, syphilis
true positive
tissue plasminogen activator
thyroid peroxidase, thrombopoietin
thiamine pyrophosphate
Treponema pallidum particle agglutination assay
total peripheral resistance
tricuspid regurgitation
tartrate-resistant acid phosphatase
T-cell receptor excision circles
thyrotropin-releasing hormone
transfer ribonucleic acid
thyroid-stimulating hormone
triple sugar iron
toxic shock syndrome
toxic shock syndrome toxin
thrombotic thrombocytopenic purpura
transthyretin
tidal volume
thromboxane A ₂
uridine diphosphate
upper motor neuron
uridine monophosphate
uniparental disomy
upper respiratory infection
United States Medical Licensing Examination
urinary tract infection
uridine triphosphate

άT	1.1	1
image	abbreviation	OHIV

ABBREVIATION	MEANING
UV	ultraviolet
V_1, V_2	vasopressin receptors
VC	vital capacity
V_d	volume of distribution
VD	physiologic dead space
V(D)J	variable, (diversity), joining gene segments rearranged to form Ig genes
VDRL	Venereal Disease Research Laboratory
VEGF	vascular endothelial growth factor
$V_{_{ m H}}$	variable region, heavy chain [antibody]
VHL	von Hippel-Lindau [disease]
VIP	vasoactive intestinal peptide
VIPoma	vasoactive intestinal polypeptide-secreting tumor
VJ	light-chain hypervariable region [antibody]
V_{L}	variable region, light chain [antibody]
VLCFA	very-long-chain fatty acids
VLDL	very low density lipoprotein
VMA	vanillylmandelic acid
VMAT	vesicular monoamine transporter
V_{max}	maximum velocity
VPL	ventral posterior nucleus, lateral
VPM	ventral posterior nucleus, medial
VPN	vancomycin, polymyxin, nystatin [media]
Ϋ́/Q̈́	ventilation/perfusion [ratio]
VRE	vancomycin-resistant enterococcus
VSD	ventricular septal defect
V_{T}	tidal volume
VTE	venous thromboembolism
vWF	von Willebrand factor
VZV	varicella-zoster virus
VMAT	vesicular monoamine transporter
XR	X-linked recessive
XX/XY	normal complement of sex chromosomes for female/male
ZDV	zidovudine [formerly AZT]

SECTION IV

Image Acknowledgments

In this edition, in collaboration with MedIQ Learning, LLC, and a variety of other partners, we are pleased to include the following clinical images and diagrams for the benefit of integrative student learning.

Portions of this book identified with the symbol 🛭 are copyright © USMLE-Rx.com (MedIQ Learning, LLC).

Portions of this book identified with the symbol 🗓 are copyright © Dr. Richard Usatine and are provided under license through MedIQ Learning, LLC.

Portions of this book identified with the symbol ₹ are listed below by page number.

This symbol refers to material that is available in the public domain.

This symbol This s

This symbol refers to the Creative Commons Attribution-Share Alike license, full text at: http://creativecommons.org/licenses/by-sa/4.0/legalcode.

Biochemistry

- **Chromatin structure.** Electron micrograph showing heterochromatin, euchromatin, and nucleolus. This image is a derivative work, adapted from the following source, available under Ra, Rickett JD, Stickle WB. The hypobranchial gland of the estuarine snail *Stramonita haemastoma canaliculata* (Gray) (Prosobranchia: Muricidae): a light and electron microscopical study. *Am Malac Bull.* 1995;11(2):177-190. Available at https://archive.org/details/americanm101119931994amer.
- 49 Cilia structure: Image A. Nine doublet + 2 singlet arrangement of microtubule. Courtesy of Louisa Howard and Michael Binder. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Cilia structure: Image B.** Cilia structure of basal body. This image is a derivative work, adapted from the following source, available under :: Riparbelli MG, Cabrera OA, Callaini G, et al. Unique properties of *Drosophila* spermatocyte primary cilia. *Biol Open.* 2013 Nov 15; 2(11): 1137–1147. DOI: 10.1242/bio.20135355.
- 49 Cilia structure: Image C. Dextrocardia. This image is a derivative work, adapted from the following source, available under O, Ayoka AO, Akomolafe RO, et al. The role of electrocardiogram in the diagnosis of dextrocardia with mirror image atrial arrangement and ventricular position in a young adult Nigerian in Ile-Ife: a case report. J Med Case Rep. 2015;9:222. DOI: 10.1186/s13256-015-0695-4.
- 51 Osteogenesis imperfecta: Image A. Skeletal deformities in upper extremity of child. This image is a derivative work, adapted from the following source, available under Vanakker OM, Hemelsoet D, De Paepe. Hereditary connective tissue diseases in young adult stroke: a comprehensive synthesis. Stroke Res Treat. 2011;712903. DOI: 10.4061/2011/712903. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 51 Osteogenesis imperfecta: Image B. Blue sclera. This image is a derivative work, adapted from the following source, available under . Wheatley K, Heng EL, Sheppard M, et al. A case of spontaneous intestinal perforation in osteogenesis imperfects. *J Clin Med Res.* 2010;2(4):198–200. DOI: 10.4021/jocmr369w.
- **51 Ehlers-Danlos syndrome: Images A and B.** Hyperextensibility of skin and DIP joint. This image is a derivative work, adapted from the following source, available under Whitaker JK, Alexander, P,

- Chau DYS, et al. Severe conjunctivochalasis in association with classic type Ehlers-Danlos syndrome. *BMC Ophthalmol*. 2012;2:47. DOI: 10.1186/1471-2415-12-47.
- **Elastin: Image A.** Pes escavatum. This image is a derivative work, adapted from the following source, available under De Maio F, Fichera A, De Luna V, et al. Orthopaedic aspects of Marfan syndrome: the experience of a referral center for diagnosis of rare diseases. *Adv Orthop.* 2016; 2016: 8275391. DOI 10.1155/2016/8275391.
- **Fluorescence in situ hybridization.** This image is a derivative work, adapted from the following source, available under Paar C, Herber G, Voskova, et al. A case of acute myeloid leukemia (AML) with an unreported combination of chromosomal abnormalities: gain of isochromosome 5p, tetrasomy 8 and unbalanced translocation der(19)t(17;19)(q23;p13). *Mol Cytogenet*. 2013;6:40. DOI: 10.1186/1755-8166-6-40.
- 57 Genetic terms. Café-au-lait spots. This image is a derivative work, adapted from the following source, available under Dimittescu CE and Collins MT. Orphanet J Rare Dis. 2008;3:12. DOI: 10.1186/1750-1172-3-12.
- 61 Muscular dystrophies: Image A. Fibrofatty replacement of muscle.
 Courtesy of the Department of Health and Human Services and Dr. Edwin P. Ewing, Jr. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Williams syndrome.** This image is a derivative work, adapted from the following source, available under . Mazumdar J, Sarkar R, Badveli A, et al. Double chamber right ventricle in Williams syndrome: a rare cardiac anomaly reported. *Springerplus*. 2016; 5: 275. DOI: 10.1186/s40064-016-1897-v.
- **Vitamin A.** Bitot sponts on conjunctiva. This image is a derivative work, adapted from the following source, available under Baiyeroju A, Bowman R, Gilbert C, et al. Managing eye health in young children. *Comm Eye Health*. 2010;23(72):4-11. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873666.

FAS1 2019 20 ImageAck.indd 727 11/8/19 4:49 PM

- Vitamin B₃. Pellagra. This image is a derivative work, adapted from the following source, available under with a Dijk HA, Fred H. Images of memorable cases: case 2. Connexions Web site. Dec 4, 2008. Available at: http://cnx.org/contents/3d3dcb2e-8e98-496f-91c2-fe94e93428a1@3@3/.
- 70 Vitamin D. X-ray of lower extremity in child with rickets. This image is a derivative work, adapted from the following source, available under . Dr. Michael L. Richardson. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- 71 Protein-energy malnutrition: Image A. Child with kwashiorkor.
 © Courtesy of the Department of Health and Human Services and Dr. Lyle Conrad.
- 71 Protein-energy malnutrition: Image B. Child with marasmus.

 Courtesy of the Department of Health and Human Services.
- 84 Alkaptonuria. Pigment granules on dorsum of hand. This image is a derivative work, adapted from the following source, available under vasues. Vasudevan B, Sawhney MPS, Radhakrishnan S. Alkaptonuria associated with degenerative collagenous palmar plaques. *Indian J Dermatol.* 2009;54:299-301. DOI: 10.4103/0019-5154.55650.
- 85 Cystinuria. Hexagonal cystine stones in urine. This image is a derivative work, adapted from the following source, available under Courtesy of Cayla Devine.
- **Lysosomal storage diseases: Image A.** "Cherry-red" spot on macula in Tay-Sachs disease. This image is a derivative work, adapted from the following source, available under . Courtesy of Dr. Jonathan Trobe.
- 88 Lysosomal storage diseases: Image B. Angiokeratomas. This image is a derivative work, adapted from the following source, available under : Burlina AP, Sims KB, Politei JM, et al. Early diagnosis of peripheral nervous system involvement in Fabry disease and treatment of neuropathic pain: the report of an expert panel. BMC Neurol. 2011;11:61. DOI: 10.1186/1471-2377-11-61. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 88 Lysosomal storage diseases: Image C. Gaucher cells in Gaucher disease. This image is a derivative work, adapted from the following source, available under Sokołowska B, Skomra D, Czartoryska B. et al. Gaucher disease diagnosed after bone marrow trephine biopsy—a report of two cases. Folia Histochem Cytobiol. 2011;49:352-356. DOI: 10.5603/FHC.2011.0048. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 88 Lysosomal storage diseases: Image D. Foam cells in Niemann-Pick disease. This image is a derivative work, adapted from the following source, available under Prieto-Potin I, Roman-Blas JA, Martinez-Calatrava MJ, et al. Hypercholesterolemia boosts joint destruction in chronic arthritis. An experimental model aggravated by foam macrophage infiltration. Arthritis Res Ther. 2013;15:R81. DOI: 10.1186/ar4261.

Immunology

- 96 Lymph node: Images A and B. Lymph node histology. This image is a derivative work, adapted from the following source, available under P. Navid Golpur.
- 98 Spleen. Red and white pulp. This image is a derivative work, adapted from the following source, available under : Heinrichs S, Conover LF, Bueso-Ramos CE, et al. MYBL2 is a sub-haploinsufficient tumor suppressor gene in myeloid malignancy. eLife. 2013;2:e00825. DOI: 10.7554/eLife.00825. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.

- 78 Thymus: Image A. Hassall corpuscles. This image is a derivative work, adapted from the following source, available under :: Minato H, Kinoshita E, Nakada S, et al. Thymic lymphoid hyperplasia with multilocular thymic cysts diagnosed before the Sjögren syndrome diagnosis. Diagn Pathol. 2015;10:103. DOI: 10.1186/s13000-015-0332-v.
- Thymus: Image B. "Sail sign" on x-ray of normal thymus in neonate. This image is a derivative work, adapted from the following source, available under Discretion M, Esposito F, Severino R, et al. Think thymus, think well: the chest x-ray thymic signs. *J Pediatr Moth Care*. 2016;1(2):108-109. DOI: 10.19104/japm.2016.108.
- 107 Complement disorders. Paroxysmal nocturnal hemoglobinuria. This image is a derivative work, adapted from the following source, available under . Nakamura N, Sugawara T, Shirato K, et al. J Med Case Reports. 2011;5:550. doi: 10.1186/1752-1947-5-550
- 117 Immunodeficiencies: Image A. Spider angioma (telangiectasia). This image is a derivative work, adapted from the following source, available under Liapakis IE, Englander M, Sinani R, et al. Management of facial telangiectasias with hand cautery. World J Plast Surg. 2015 Jul;4(2):127-133.
- 117 Immunodeficiencies: Image B. Giant granules in granulocytes in Chédiak-Higashi syndrome. This image is a derivative work, adapted from the following source, available under □□□: Bharti S, Bhatia P, Bansal D, et al. The accelerated phase of Chediak-Higashi syndrome: the importance of hematological evaluation. Turk J Haematol. 2013;30:85-87. DOI: 10.4274/tjh.2012.0027. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.

Microbiology

- 125 Stains: Image A. Trypanosoma lewisi on Giemsa stain. Courtesy of the Department of Health and Human Services and Dr. Mae Melvin.
- 125 Stains: Image B. Periodic acid—Schiff stain reveals Tropheryma whipplei infection. This image is a derivative work, adapted from the following source, available under Courtesy of Dr. Ed Uthman.
- 125 Stains: Image C. Mycobacterium tuberculosis on Ziehl-Neelsen stain.
 Courtesy of the Department of Health and Human Services and Dr. George P. Kubica.
- 125 Stains: Image D. Cryptococcus neoformans on India ink stain.
 Courtesy of the Department of Health and Human Services.
- 125 Stains: Image E. Coccidioides immitis on silver stain. Courtesy of the Department of Health and Human Services and Dr. Edwin P. Ewing, Jr.
- 127 Encapsulated bacteria. Capsular swelling of Streptococcus pneumoniae using the Neufeld-Quellung test. Courtesy of the Department of Health and Human Services.
- Catalase-positive organisms. Oxygen bubbles released during catalase reaction. This image is a derivative work, adapted from the following source, available under sets: Stefano Nase. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under sets.
- 129 Spore-forming bacteria. This image is a derivative work, adapted from the following source, available under [1]. Jones SW, Paredes CJ, Tracy B. The transcriptional program underlying the physiology of clostridial sporulation. Genome Biol. 2008;9:R114. DOI: 10.1186/gb-2008-9-7-r114.
- 7. α-hemolytic bacteria. α-hemolysis. This image is a derivative work, adapted from the following source, available under (2002): Y. Tambe. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under (2002).

FAS1_2019_20_ImageAck.indd 728 11/8/19 4:49 PM

- **β-hemolytic bacteria.** β-hemolysis. This image is a derivative work, adapted from the following source, available under : Wikimedia
- Staphylococcus aureus. Courtesy of the Department of Health and Human Services and Dr. Richard Facklam.
- Streptococcus pneumoniae. Courtesy of the Department of Health and Human Services and Dr. Mike Miller.
- 136 Streptococcus pyogenes: (group A streptococci). This image is a derivative work, adapted from the following source, available under See: Y. Tambe. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Bacillus anthracis.** Ulcer with black eschar. Courtesy of the Department of Health and Human Services and James H. Steele.
- **Clostridia: Image A.** Gas gangrene due to *Clostridium perfringens*. This image is a derivative work, adapted from the following source, available under Schröpfer E, Rauthe S, Meyer T. Diagnosis and misdiagnosis of necrotizing soft tissue infections: three case reports. Cases J. 2008;1:252. DOI: 10.1186/1757-1626-1-252.
- Clostridia: Image B. Pseudomembranous enterocolitis on colonoscopy. This image is a derivative work, adapted from the following source, available under see: Klinikum Dritter Orden für die Überlassung des Bildes zur Veröffentlichu. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Corynebacterium diphtheriae. Pseudomembranous pharyngitis. This image is a derivative work, adapted from the following source, available under 2000: Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- 139 Listeria monocytogenes. Actin rockets. This image is a derivative work, adapted from the following source, available under Schuppler M, Loessner MJ. The opportunistic pathogen Listeria monocytogenes: pathogenicity and interaction with the mucosal immune system. Int J Inflamm. 2010;2010:704321. DOI: 10.4061/2010/704321. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Nocardia vs Actinomyces: Image A. Nocardia on acid-fast stain. This image is a derivative work, adapted from the following source, available under Esse: Venkataramana K. Human Nocardia infections: a review of pulmonary nocardiosis. Cereus. 2015;7(8):e304. DOI: 10.7759/cureus.304.
- Nocardia vs Actinomyces: Image B. Actinomyces israelii on Gram stain. See Courtesy of the Department of Health and Human
- Mycobacteria. Acid-fast stain. Courtesy of the Department of Health and Human Services and Dr. George P. Kubica
- **Tuberculosis.** Langhans giant cell in caseating granuloma. Courtesy of J. Hayman.
- **Leprosy: Image A.** "Glove and stocking" distribution. This image is a derivative work, adapted from the following source, available under Courtesy of Bruno Jehle.
- **Neisseria:** Image A. Intracellular N gonorrhoeae. Department of Health and Human Services and Dr. Mike Miller.
- **142** *Haemophilus influenzae*: Image A. Epiglottitis. This image is a derivative work, adapted from the following source, available under : Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Legionella pneumophila. Lung findings of unilateral and lobar infiltrate. This image is a derivative work, adapted from the following

- source, available under : Robbins NM, Kumar A, Blair BM. Legionella pneumophila infection presenting as headache, confusion and dysarthria in a human immunodeficiency virus-1 (HIV-1) positive patient: case report. BMC Infect Dis. 2012;12:225. DOI: 10.1186/1471-2334-12-225.
- *Pseudomonas aeruginosa*: Image A. Blue-green pigment on centrimide agar. This image is a derivative work, adapted from the following source, available under : Hansen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Pseudomonas aeruginosa: Image B. Ecthyma gangrenosum. This image is a derivative work, adapted from the following source, available under : Uludokumaci S, Balkan II, Mete B, et al. Ecthyma gangrenosum-like lesions in a febrile neutropenic patient with simultaneous Pseudomonas sepsis and disseminated fusariosis. Turk J Haematol. 2013 Sep;30(3):321-4. DOI: 10.4274/Tjh.2012.0030.
- 145 *Klebsiella*. © Courtesy of the Department of Health and Human
- Courtesy of the Department of Health and Human Services.
- Vibrio cholerae. This image is a derivative work, adapted from the following source, available under Phetsouvanh R, Nakatsu M, Arakawa E, et al. Fatal bacteremia due to immotile Vibrio cholerae serogroup O21 in Vientiane, Laos-a case report. Ann Clin Microbiol Antimicrob. 2008;7:10. DOI: 10.1186/1476-0711-7-10.
- Helicobacter pylori. Courtesy of the Department of Health and Human Services, Dr. Patricia Fields, and Dr. Collette Fitzgerald.
- **Spirochetes.** Appearance on darkfield microscopy. Courtesy of the Department of Health and Human Services.
- Lyme disease: Image A. Ixodes tick. Courtesy of the Department of Health and Human Services and Dr. Michael L. Levin.
- **Lyme disease: Image B.** Erythema migrans. Courtesy of the Department of Health and Human Services and James Gathany.
- **Syphilis: Image A.** Painless chancre in primary syphilis. Courtesy of the Department of Health and Human Services and M. Rein.
- **Syphilis: Image B.** Treponeme on darkfield microscopy. Courtesy of the Department of Health and Human Services and Renelle
- **Syphilis: Image D.** Rash on palms. This image is a derivative work, adapted from the following source, available under : Drahansky M, Dolezel M, Urbanek J, et al. Influence of skin diseases on fingerprint recognition. J Biomed Biotechnol. 2012;626148. DOI: 10.1155/2012/626148.
- Syphilis: Image E. Condyloma lata. Courtesy of the Department of Health and Human Services and Susan Lindsley.
- **Syphilis: Image F.** Gumma. This image is a derivative work, adapted from the following source, available under : Chakir K, Benchikhi H. Granulome centro-facial révélant une syphilis tertiaire. Pan Afr Med J. 2013;15:82. DOI: 10.11604/pamj.2013.15.82.3011.
- **Syphilis: Image G.** Congenital syphilis. Courtesy of the Department of Health and Human Services and Dr. Norman Cole.
- Syphilis: Image H. Hutchinson teeth. Courtesy of the Department of Health and Human Services and Susan Lindsley.
- Gardnerella vaginalis. Courtesy of the Department of Health and Human Services and M. Rein.
- Rickettsial diseases and vector-borne illnesses: Image A. Rash of Rocky Mountain spotted fever. Courtesy of the Department of Health and Human Services.

FAS1_2019_20_ImageAck.indd 729 11/8/19 4:49 PM

- Rickettsial diseases and vector-borne illnesses: Image B. Ehrlichia morulae. This image is a derivative work, adapted from the following source, available under Dantas-Torres F. Canine vector-borne diseases in Brazil. Parasit Vectors. 2008;1:25. DOI: 10.1186/1756-3305-1-25. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 150 Rickettsial diseases and vector-borne illnesses: Image C. Anaplasma phagocytophilium in neutrophil. Courtesy of the Department of Health and Human Services and Dumler JS, Choi K, Garcia-Garcia JC, et al. Human granulocytic anaplasmosis. Emerg Infect Dis. 2005. DOI 10.3201/eid1112.050898.
- 150 Mycoplasma pneumoniae. This image is a derivative work, adapted from the following source, available under Rottem S, Kosower ND, Kornspan JD. Contamination of tissue cultures by Mycoplasma. In: Ceccherini-Nelli L, ed: Biomedical tissue culture. 2016. DOI: 10.5772/51518.
- 151 Systemic mycoses: Image A. Histoplasma. Courtesy of the Department of Health and Human Services and Dr. D.T. McClenan.
- 151 Systemic mycoses: Image B. Blastomyces dermatitidis undergoing broad-base budding. Courtesy of the Department of Health and Human Services and Dr. Libero Ajello.
- 151 Systemic mycoses: Image C. Coccidiomycosis with endospheres.
 Courtesy of the Department of Health and Human Services.
- **151 Systemic mycoses: Image D.** "Captain's wheel" shape of *Paracoccidioides.*. Courtesy of the Department of Health and Human Services and Dr. Lucille K. Georg.
- 152 Cutaneous mycoses: Image G. Tinea versicolor. This image is a derivative work, adapted from the following source, available under : Sarah (Rosenau) Korf. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- **Opportunistic fungal infections: Image A.** Budding yeast of *Candida albicans*. This image is a derivative work, adapted from the following source, available under : T. Tambe. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- **Opportunistic fungal infections: Image B.** Germ tubes of *Candida albicans.*. This image is a derivative work, adapted from the following source, available under . Trambe. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 153 Opportunistic fungal infections: Image C. Oral thrush.
 Courtesy of the Department of Health and Human Services and Dr. Sol Silverman, Jr.
- 153 Opportunistic fungal infections: Image E. Conidiophores of Aspergillus fumigatus. Courtesy of the Department of Health and Human Services.
- **Opportunistic fungal infections: Image F.** Aspergilloma in left lung. This image is a derivative work, adapted from the following source, available under . Souilamas R, Souilamas JI, Alkhamees K, et al. Extra corporal membrane oxygenation in general thoracic surgery: a new single veno-venous cannulation. *J Cardiothorac Surg.* 2011;6:52. DOI: 10.1186/1749-8090-6-52.
- **Opportunistic fungal infections: Image G.** *Cryptococcus neoformans.*Courtesy of the Department of Health and Human Services and Dr. Leanor Haley.
- **Opportunistic fungal infections: Image H.** *Cryptococcus neoformans* on mucicarmine stain. Courtesy of the Department of Health and Human Services and Dr. Leanor Haley.

- 153 Opportunistic fungal infections: Image I. Mucor. See Courtesy of the Department of Health and Human Services and Dr. Lucille K. Georg.
- 153 Opportunistic fungal infections: Image J. Mucormycosis. This image is a derivative work, adapted from the following source, available under : Jiang N, Zhao G, Yang S, et al. A retrospective analysis of eleven cases of invasive rhino-orbito-cerebral mucormycosis presented with orbital apex syndrome initially. BMC Ophthalmol. 2016; 16: 10. DOI: 10.1186/s12886-016-0189-1.
- 154 Pneumocystis jirovecii: Image A. Interstitial opacities in lung. This image is a derivative work, adapted from the following source, available under : Chuang C, Zhanhong X, Yinyin G, et al. Unsuspected Pneumocystis pneumonia in an HIV-seronegative patient with untreated lung cancer: circa case report. J Med Case Rep. 2007;1:15. DOI: 10.1186/1752-1947-1-115.
- Pneumocystis jirovecii: Image B. CT of lung. This image is a derivative work, adapted from the following source, available under all elements: Allen CM, Al-Jahdali HH, Irion KL, et al. Imaging lung manifestations of HIV/AIDS. Ann Thorac Med. 2010 Oct-Dec; 5(4): 201–216. DOI: 10.4103/1817-1737.69106.
- Pneumocystis jiroveci: Image C. Disc-shaped yeast. This image is a derivative work, adapted from the following source, available under : Kirby S, Satoskar A, Brodsky S, et al. Histological spectrum of pulmonary manifestations in kidney transplant recipients on sirolimus inclusive immunosuppressive regimens. Diagn Pathol. 2012;7:25. DOI: 10.1186/1746-1596-7-25.
- 154 Sporothrix schenckii. Subcutaneous mycosis. This image is a derivative work, adapted from the following source, available under Govender NP, Maphanga TG, Zulu TG, et al. An outbreak of lymphocutaneous sporotrichosis among mine-workers in South Africa. PLoS Negl Trop Dis. 2015 Sep; 9(9): e0004096. DOI: 10.1371/journal. pntd.0004096.
- 155 Protozoa—Gl infections: Image A. Giardia lamblia trophozoite. This image is a derivative work, adapted from the following source, available under : Lipoldová M. Giardia and Vilém Dušan Lambl. PLoS Negl Trop Dis. 2014;8:e2686. DOI: 10.1371/journal. pntd.0002686.
- 155 Protozoa—Gl infections: Image B. Giardia lamblia cyst.
 Courtesy of the Department of Health and Human Services.
- 155 Protozoa—Gl infections: Image C. Entamoeba histolytica trophozoites. Courtesy of the Department of Health and Human Services.
- 155 Protozoa—Gl infections: Image D. Entamoeba histolytica cyst.
 Courtesy of the Department of Health and Human Services.
- **Protozoa—Gl infections: Image E.** *Cryptosporidium* oocysts. Courtesy of the Department of Health and Human Services.
- 156 Protozoa—CNS infections: Image A. Toxoplasma gondii. This image is a derivative work, adapted from the following source, available under :: Agrawal A, Bhake A, Sangole VM, et al. Multiple-ring enhancing lesions in an immunocompetent adult. J Glob Infect Dis. 2010 Sep-Dec;2(3):313-4. DOI: 10.4103/0974-777X.68545.
- Protozoa—CNS infections: Image B. Toxoplasma gondii tachyzoite.
 Courtesy of the Department of Health and Human Services and Dr. L.L. Moore, Jr.
- Protozoa—CNS infections: Image C. Naegleria fowleri amoebas.
 Courtesy of the Department of Health and Human Services.
- Protozoa—CNS infections: Image D. Trypanosoma brucei gambiense.
 Courtesy of the Department of Health and Human Services and Dr. Mae Melvin.

FAS1_2019_20_ImageAck.indd 730 11/8/19 4:49 PM

- Protozoa—hematologic infections: Image A. Plasmodium trophozoite ring form. Courtesy of the Department of Health and Human Services.
- Protozoa—hematologic infections: Image B. Plasmodium schizont containing merozoites. Courtesy of the Department of Health and Human Services and Steven Glenn.
- **Protozoa**—hematologic infections: Image C. *Babesia* with ring form and with "Maltese cross" form. Courtesy of the Department of Health and Human Services.
- 158 **Protozoa**—others: Image A. *Trypanosoma cruzi*. © Courtesy of the Department of Health and Human Services and Dr. Mae Melvin.
- Protozoa—others: Image B. Cutaneous leishmaniasis. This image is a derivative work, adapted from the following source, available under Sharara SL, Kanj SS. War and infectious diseases: challenges of the Syrian civil war. PLoS Pathog. 2014 Nov;10(11):e1004438. DOI: 10.1371/journal.ppat.1004438.
- **Protozoa**—others: Image C. *Leishmania* spp. Courtesy of the Department of Health and Human Services and Dr. Francis W. Chandler. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Protozoa**—others: Image D. *Trichomonas vaginalis*. Courtesy of the Department of Health and Human Services.
- Nematodes (roundworms): Image A. Enterobius vermicularis eggs. © Courtesy of the Department of Health and Human Services, BG Partin, and Dr. Moore.
- Nematodes (roundworms): Image B. Ascaris lumbricoides egg. Courtesy of the Department of Health and Human Services.
- **Nematodes (roundworms): Image C.** Ancylostoma spp rash This image is a derivative work, adapted from the following source, available under Es: Archer M. Late presentation of cutaneous larva migrans: a case report. Cases J. 2009; 2: 7553. doi:10.4076/1757-1626-
- Nematodes (roundworms): Image D. Trichinella spiralis cysts in muscle. This image is a derivative work, adapted from the following source, available under Franssen FFJ, Fonville M, Takumi K, et al. Vet Res. 2011; 42(1): 113. DOI: 10.1186/1297-9716-42-113.
- Nematodes (roundworms): Image E. Wuchereria bancrofti Elephantiasis. Courtesy of the Department of Health and Human Services.
- Cestodes (tapeworms): Image A. Taenia solium. Courtesy of the Department of Health and Human Services Robert J. Galindo. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Cestodes (tapeworms): Image B. Neurocysticercosis. This image is a derivative work, adapted from the following source, available under ____: Coyle CM, Tanowitz HB. Diagnosis and treatment of neurocysticercosis. Interdiscip Perspect Infect Dis. 2009;2009:180742. DOI: 10.1155/2009/180742. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Cestodes (tapeworms): Image C. Echinococcus granulosus. Courtesy of the Department of Health and Human Services.
- Cestodes (tapeworms): Image D. Hyatid cyst of Echinococcus granulosus. See Courtesy of the Department of Health and Human Services and Dr. I. Kagan
- Cestodes (tapeworms): Image E. Echinococcus granulosus cyst in liver. This image is a derivative work, adapted from the following source, available under . Ma Z, Yang W, Yao Y, et al. The adventitia resection in treatment of liver hydatid cyst: a case report

- of a 15-year-old boy. Case Rep Surg. 2014;2014:123149. DOI: 10.1155/2014/123149.
- **Trematodes (flukes): Image A.** Schistosoma mansoni egg with lateral spine. Courtesy of the Department of Health and Human Services.
- Trematodes (flukes): Image B. Schistosoma haematobium egg with terminal spine. Courtesy of the Department of Health and Human Services.
- 161 **Ectoparasites: Image A.** Scabies. This image is a derivative work, adapted from the following source, available under see: Siegfried EC, Hebert AA. Diagnosis of atopic dermatitis: mimics, overlaps, and complications. Clin Med. 2015 May; 4(5): 884-917. DOI: 10.3390/ jcm4050884.
- **Ectoparasites: Image B.** Nit of a louse. Courtesy of the Department of Health and Human Services and Joe Miller.
- 164 **DNA viruses: Image A.** Febrile pharyngitis. Balfour HH Jr, Dunmire SK, Hogquist KA. Clin Transl Immunology. 2015 Feb 27. DOI: 10.1038/cti.2015.1.
- **Herpesviruses: Image A.** Keratoconjunctivitis in HSV-1 infection. This image is a derivative work, adapted from the following source, available under Sang HK, Han YK, Wee WR, et al. Bilateral herpetic keratitis presenting with unilateral neurotrophic keratitis in pemphigus foliaceus: a case report. J Med Case Rep. 2011;5:328. DOI: 10.1186/1752-1947-5-328.
- **Herpesviruses: Image B.** Herpes labialis. Courtesy of the Department of Health and Human Services and Dr. Herrmann.
- **Herpesviruses: Image E.** Shingles (varicella-zoster virus infection). This image is a derivative work, adapted from the following source, available under .: Fisle. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Herpesviruses: Image F. Hepatosplenomegaly due to EBV infection. This image is a derivative work, adapted from the following source, available under Gow NJ, Davidson RN, Ticehurst R, et al. Case report: no response to liposomal daunorubicin in a patient with drugresistant HIV-associated visceral leishmaniasis. PLoS Negl Trop Dis. 2015 Aug; 9(8):e0003983. DOI: 10.1371/journal.pntd.0003983.
- **Herpesviruses: Image G.** Atypical lymphocytes in Epstein-Barr virus infection. This image is a derivative work, adapted from the following source, available under _____ Coutesy of Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Herpesviruses: Image I. Roseola. Courtesy of Emiliano Burzagli.
- Herpesviruses: Image J. Kaposi sarcoma. Courtesy of the Department of Health and Human Services.
- **HSV identification.** Positive Tzanck smear in HSV-2 infection. This image is a derivative work, adapted from the following source, available under 222: Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @....
- Services and Erskine Palmer.
- Rubella virus. Rubella rash. Courtesy of the Department of Health and Human Services.
- $\begin{tabular}{ll} \textbf{Acute laryngotracheobronchitis.} & \textbf{Steeple sign.} & \textbf{Reproduced, with} \\ \end{tabular}$ 170 permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- Measles (rubeola) virus: Image A. Koplik spots. © Courtesy of the Department of Health and Human Services. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.

FAS1_2019_20_ImageAck.indd 731 11/8/19 4:49 PM

- 170 Measles (rubeola) virus: Image B. Rash of measles. Courtesy of the Department of Health and Human Services.
- 170 Mumps virus. Swollen neck and parotid glands. Courtesy of the Department of Health and Human Services.
- Rabies virus: Image A. Transmission electron micrograph.
 Courtesy of the Department of Health and Human Services Dr. Fred Murphy, and Sylvia Whitfield.
- 171 Rabies virus: Image B. Negri bodies. Courtesy of the Department of Health and Human Services and Dr. Daniel P. Perl.
- 171 Ebola virus. Courtesy of the Department of Health and Human Services and Cynthia Goldsmith.
- **180 Osteomyelitis.** X-ray (left) and MRI (right) views. This image is a derivative work, adapted from the following source, available under ⊞ Huang P-Y, Wu P-K, Chen C-F, et al. Osteomyelitis of the femur mimicking bone tumors: a review of 10 cases. World J Surg Oncol. 2013;11:283. DOI: 10.1186/1477-7819-11-283.
- 181 Common vaginal infections: Image B. Motile trichomonads.
 © Courtesy of Joe Miller.
- **Common vaginal infections: Image C.** Candida vulvovaginitis. Courtesy of Mikael Häggström.
- **TORCH infections: Image A.** "Blueberry muffin" rash. This image is a derivative work, adapted from the following source, available under Benmiloud S, Elhaddou G, Belghiti ZA, et al. Blueberry muffin syndrome. *Pan Afr Med J.* 2012;13:23.
- **TORCH infections: Image B.** Cataract in infant with contenital rubella. Courtesy of the Department of Health and Human Services .
- **TORCH infections: Image C.** Periventricular calcifications in congenital cytomegalovirus infection. This image is a derivative work, adapted from the following source, available under Bonthius D, Perlman S. Congenital viral infections of the brain: lessons learned from lymphocytic choriomeningitis virus in the neonatal rat. *PLoS Pathog.* 2007;3:e149. DOI: 10.1371/journal.ppat.0030149. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Red rashes of childhood: Image C.** Child with scarlet fever. This image is a derivative work, adapted from the following source, available under ** www.badobadop.co.uk.
- **Red rashes of childhood: Image D.** Chicken pox. See Courtesy of the Department of Health and Human Services.
- 184 Sexually transmitted infections: Image A. Chancroid. Courtesy of the Department of Health and Human Services and Susan Lindsley.
- 184 Sexually transmitted infections: Image B. Donovanosis. Courtesy of the Department of Health and Human Services and Dr. Pinozzi.
- 185 Pelvic inflammatory disease: Image A. Purulent cervical discharge. This image is a derivative work, adapted from the following source, available under : SOS-AIDS Amsterdam The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **Pelvic inflammatory disease: Image B.** Adhesions in Fitz-Hugh–Curtis syndrome. Courtesy of Hic et nunc.
- 190 Vancomycin. Red man syndrome. This image is a derivative work, adapted from the following source, available under O'Meara P, Borici-Mazi R, Morton R, et al. DRESS with delayed onset acute interstitial nephritis and profound refractory eosinophilia secondary to vancomycin. Allergy Asthma Clin Immunol. 2011;7:16. DOI: 10.1186/1710-1492-7-16.

Pathology

- 209 Necrosis: Image A. Coagulative necrosis. Courtesy of the Department of Health and Human Services and Dr. Steven Rosenberg.
- 209 Necrosis: Image B. Liquefactive necrosis. See Courtesy of Daftblogger.
- **209 Necrosis: Image C.** Caseous necrosis. This image is a derivative work, adapted from the following source, available under Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- 209 Necrosis: Image E. Fibrinoid necrosis. This image is a derivative work, adapted from the following source, available under . Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- 209 Necrosis: Image F. Acral gangrene. Courtesy of the Department of Health and Human Services and William Archibald.
- **210 Ischemia.** This image is a derivative work, adapted from the following source, available under Section Van Assche LM, Kim HW, Jensen CJ, et al. A new CMR protocol for non-destructive, high resolution, ex-vivo assessment of the area at risk simultaneous with infarction: validation with histopathology. *J Cardiovasc Magn Reson.* 2012; 14(Suppl 1): O7. DOI: 10.1186/1532-429X-14-S1-O7.
- **210 Types of infarcts: Image B.** Pale infarct. See Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- **211 Types of calcification: Image A.** Dystrophic calcification. This image is a derivative work, adapted from the following source, available under .: Chun J-S, Hong R, Kim J-A. Osseous metaplasia with mature bone formation of the thyroid gland: three case reports. *Oncol Lett.* 2013;6:977-979. DOI: 10.3892/ol.2013.1475. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 211 Lipofuscin. This image is a derivative work, adapted from the following source, available under . The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **212 Amyloidosis: Image A.** Amyloid deposits on Congo red stain. This image is a derivative work, adapted from the following source, available under . Dr. Ed Uthman.
- **Acute inflammation: Image A.** Pericardium with severe inflammation, neutrophilic infiltration and fibrin with entrapped clusters of bacteria. This image is a derivative work, adapted from the following source, available under . Faida Ajili, et al. Coexistence of pyoderma gangrenosum and sweet's syndrome in a patient with ulcerative colitis. *Pan Afr Med J.* 2015 Jun 24. DOI: 10.11604/pamj.2015.21.151.6364.
- 217 Granulomatous diseases. Granuloma. Courtesy of Sanjay Mukhopadhyay.
- **Scar formation: Image A.** Hypertrophic scar. This image is a derivative work, adapted from the following source, available under Baker R, Urso-Baiarda F, Linge C, et al. Cutaneous scarring: a clinical review. *Dermatol Res Pract.* 2009;2009:625376. DOI: 10.1155/2009/625376.

FAS1_2019_20_ImageAck.indd 732 11/8/19 4:49 PM

- **Scar formation: Image B.** Keloid scar. This image is a derivative work, adapted from the following source, available under . Dr. Andreas Settje. The image may have been modified by cropping, labeling, and/ or captions. MedIQ Learning, LLC makes this available under
- Neoplasia and neoplastic progression: Image A. Cervical tissue. This image is a derivative work, adapted from the following source, available under see: Courtesy of Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **223 Common metastases: Image A.** Brain metastases from breast cancer. This image is a derivative work, adapted from the following source, available under .: Imarchn. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Common metastases: Image B.** Brain metastasis. Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- 223 **Common metastases: Image C.** Liver metastasis. This image is a derivative work, adapted from the following source, available under .: Dr. James Heilman The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Common metastases: Image D.** Liver metastasis. Courtesy of Havman.
- **Common metastases: Image E.** Bone metastasis. This image is a derivative work, adapted from the following source, available under 🖭: Dr. Paul Hellerhoff.
- **Common metastases: Image F.** Bone metastasis. This image is a derivative work, adapted from the following source, available under : Courtesy of M Emmanuel.
- Psammoma bodies. Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.

Cardiovascular

- **Anatomy of the heart: Image A.** MRI showing normal cardiac anatomy. This image is a derivative work, adapted from the following source, available under : Zhang J, Chen L, Wang X, et al. Compounding local invariant features and global deformable geometry for medical image registration. PLoS One. 2014;9(8):e105815. DOI: 10.1371/journal.pone.0105815.
- Congenital heart diseases: Image A. Tetralogy of Fallot. This image is a derivative work, adapted from the following source, available under Rashid AKM: Heart diseases in Down syndrome. In: Dey S, ed: Down syndrome. DOI: 10.5772/46009. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Congenital heart diseases: Image B. Ventricular septal defect. This image is a derivative work, adapted from the following source, available under Est Bardo DME, Brown P. Cardiac multidetector computed tomography: basic physics of image acquisition and clinical applications. Curr Cardiol Rev. 2008 Aug;4(3):231–243. DOI: 10.2174/157340308785160615.
- **Congenital heart diseases: Image C.** Atrial septal defect. This image is a derivative work, adapted from the following source, available under E: Teo KSL, Dundon BK, Molaee P, et al. Percutaneous closure of atrial septal defects leads to normalisation of atrial and ventricular volumes. J Cardiovasc Magn Reson. 2008;10(1):55. DOI: 10.1186/1532-429X-10-55.
- Congenital heart diseases: Image D. Patent ductus arteriosus. This image is a derivative work, adapted from the following source, available under Es: Henjes CR, Nolte I, Wesfaedt P. Multidetectorrow computed tomography of thoracic aortic anomalies in dogs

- and cats: patent ductus arteriosus and vascular rings. BMC Vet Res. 2011;7:57. DOI: 10.1186/1746-6148-7-57.
- **Congenital heart diseases: Image E.** Clubbing of fingers. Courtesy of Ann McGrath.
- **Congenital heart diseases: Image F.** MRI showing coarctation of the aorta. This image is a derivative work, adapted from the following source, available under Es: Vergales JE, Gangemi JJ, Rhueban KS, Lim DS. Coarctation of the aorta — the current state of surgical and transcatheter therapies. Curr Cardiol Rev. 2013 Aug; 9(3): 211–219. DOI: 10.2174/1573403X113099990032
- **Hypertension: Image A.** "String of beads" appearance in fibromuscular dysplasia. This image is a derivative work, adapted from the following source, available under : Plouin PF, Perdu J, LaBatide-Alanore A, et al. Fibromuscular dysplasia. Orphanet J Rare Dis. 2007;7:28. DOI: 10.1186/1750-1172-2-28. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Hyperlipidemia signs: Image C. Tendinous xanthoma. This image is a derivative work, adapted from the following source, available under Raffa W, Hassam B. Xanthomes tendineux et tubéreux révélant une hypercholestérolémie familiale. Pan Afr Med J. 2013; 15: 49. DOI: 10.11604/pamj.2013.15.49.2636.
- **Arteriosclerosis: Image A.** Hyaline type. This image is a derivative work, adapted from the following source, available under Dr. Michael Bonert. The image may have been modified by cropping labeling, and/or captions. MedIQ Learning, LLC makes this available under 🛛 😳 .
- **Arteriosclerosis: Image B.** Hyperplastic type. This image is a derivative work, adapted from the following source, available under see: Paco Larosa. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Arteriosclerosis: Image C.** Monckeberg sclerosis (medial calcific sclerosis). This image is a derivative work, adapted from the following source, available under Es: Couri CE, da Silva GA, Martinez JA, et al. The image may have been modified by cropping, labeling, and/ or captions. All rights to this adaptation by MedIQ Learning, LLC are
- **Aortic dissection.** This image is a derivative work, adapted from the following source, available under Qi Y, Ma X, Li G, et al. Three-dimensional visualization and imaging of the entry tear and intimal flap of aortic dissection using CT virtual intravascular endoscopy. PLoS One. 2016; 11(10): e0164750. DOI: 10.1371/journal. pone.0164750.
- Myocardial infarction complications: Image A. Papillary muscle rupture. This image is a derivative work, adapted from the following source, available under Es: Routy B, Huynh T, Fraser R, et al. Vascular endothelial cell function in catastrophic antiphospholipid syndrome: a case report and review of the literature. Case Rep Hematol. 2013;2013:710365. DOI: 10.1155/2013/710365.
- Myocardial infarction complications: Image B. Drawing of pseudoaneurysm. This image is a derivative work, adapted from the following source, available under **EXE**: Patrick J. Lynch and Dr. C. Carl Jaffe.
- Myocardial infarction complications: Image C. Free wall rupture of left ventricle. This image is a derivative work, adapted from the following source, available under Zacarias ML, da Trindade H, Tsutsu J, et al. Left ventricular free wall impeding rupture in post-myocardial infarction period diagnosed by myocardial contrast echocardiography: case report. Cardiovasc Ultrasound. 2006;4:7. DOI: 10.1186/1476-7120-4-7.
- **Cardiomyopathies: Image A.** Dilated cardiomyopathy. This image is a derivative work, adapted from the following source, available under

FAS1 2019 20 ImageAck.indd 733 11/8/19 4:49 PM

- Scho JMIH, van Es R, Stathonikos N, et al. High resolution systematic digital histological quantification of cardiac fibrosis and adipose tissue in phospholamban p.Arg14del mutation associated cardiomyopathy. *PLoS One.* 2014;9:e94820. DOI: 10.1371/journal. pone.0094820.
- 308 Cardiomyopathies: Image B. Hypertrophic obstructive cardiomyopathy. This image is a derivative work, adapted from the following source, available under Benetti MA, Belo Nunes RA, Benvenuti LA. Case 2/2016 76-year-old male with hypertensive heart disease, renal tumor and shock. Arq Bras Cardiol. 2016 May; 106(5): 439–446. DOI: 10.5935/abc.20160067.
- **Heart failure.** Pedal edema. This image is a derivative work, adapted from the following source, available under Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under Dr.
- **310 Cardiac tamponade: Image B.** This image is a derivative work, adapted from the following source, available under :: Maharaj SS, Chang SM. Cardiac tamponade as the initial presentation of systemic lupus erythematosus: a case report and review of the literature. *Pediatr Rheumatol Online J.* 2015; 13: 9. DOI: 10.1186/s12969-015-0005-0.
- **311 Bacterial endocarditis: Image A.** Courtesy of the Department of Health and Human Services and Dr. Edwin P. Ewing, Jr.
- 311 Bacterial endocarditis: Image C. Osler nodes. This image is a derivative work, adapted from the following source, available under and the endocarditis caused by Brevundimonas vesicularis. BMC Infect Dis. 2006;6:179. DOI: 10.1186/1471-2334-6-179.
- 311 Bacterial endocarditis: Image D. Janeway lesions on sole. This image is a derivative work, adapted from the following source, available under .: Courtesy of DeNanneke.
- 312 Rheumatic fever. Aschoff body and Anitschkow cells. This image is a derivative work, adapted from the following source, available under : Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 313 Acute pericarditis. This image is a derivative work, adapted from the following source, available under Bogaert J, Francone M. Cardiovascular magnetic resonance in pericardial diseases. J Cardiovasc Magn Reson. 2009;11:14. DOI: 10.1186/1532-429X-11-14. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 315 Vasculitides: Image A. Temporal arteritis histology. This image is a derivative work, adapted from the following source, available under ... Marvin. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- **Vasculitides: Image B.** Angiogram in patient with Takayasu arteritis.

 Courtesy of the Department of Health and Human Services and Justin Ly.
- 315 Vasculitides: Image C. Gangrene as a consequence of Buerger disease. This image is a derivative work, adapted from the following source, available under . Afsjarfard A, Mozaffar M, Malekpour F, et al. The wound healing effects of iloprost in patients with Buerger's disease: claudication and prevention of major amputations. Iran Red Crescent Med J. 2011;13:420-423.

- **Vasculitides: Image D.** Strawberry tongue in patient with Kawasaki disease. This image is a derivative work, adapted from the following source, available under Section Courtesy of Natr.
- 315 Vasculitides: Image E. Coronary artery aneurysm in Kawasaki disease. This image is a derivative work, adapted from the following source, available under Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 315 Vasculitides. Polyarteritis nodosa. Reproduced, with permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- 315 Vasculitides: Image G. Churg-Strauss syndrome histology. This image is a derivative work, adapted from the following source, available under . Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 315 Vasculitides: Image H. Granulomatosis with polyangiitis (formerly Wegener) and PR3-ANCA/c-ANCA. Courtesy of M.A. Little.
- 315 Vasculitides: Image I. Henoch-Schönlein purpura. See Courtesy of Okwikikim.
- **Vasculitides: Image J.** MPO-ANCA/p-ANCA in microscopic polyangiitis. Courtesy of and M.A. Little.

Endocrine

- **Thyroid development.** Thyroglossal duct cyst. This image is a derivative work, adapted from the following source, available under Adelchi C, Mara P, Melissa L, et al. Ectopic thyroid tissue in the head and neck: a case series. *BMC Res Notes*. 2014;7:790. DOI: 10.1186/1756-0500-7-790.
- **340 Hypothyroidism vs hyperthyroidism.** Onycholysis. This image is a derivative work, adapted from the following source, available under Rajebi MR, Shahrokni A, Chaisson M. Uncommon osseous involvement in multisystemic sarcoidosis. *Ann Saudi Med.* 2009 Nov-Dec;29(6):485–486.
- **341 Hypothyroidism: Image B.** Before and after treatment of congenital hypothyroidism. Courtesy of the Department of Health and Human Services.
- **Thyroid adenoma: Image A.** This image is a derivative work, adapted from the following source, available under ☐☐☐☐ Terada T. Brain metastasis from thyroid adenomatous nodules or an encapsulated thyroid follicular tumor without capsular and vascular invasion: a case report. Cases J. 2009; 2: 7180. DOI: 10.4076/1757-1626-2-7180.
- 344 Hypoparathyroidism. Shortened 4th and 5th digits. This image is a derivative work, adapted from the following source, available under □□□: Ferrario C, Gastaldi G, Portmann L, et al. Bariatric surgery in an obese patient with Albright hereditary osteodystrophy: a case report. J Med Case Rep. 2013; 7: 111. DOI: 10.1186/1752-1947-7-111.
- 345 Hyperparathyroidism. Multiple lytic lesions. This image is a derivative work, adapted from the following source, available under : Khaoula BA, Kaouther BA, Ines C, et al. An unusual presentation of primary hyperparathyroidism: pathological fracture. Case Rep Orthop. 2011;2011:521578. DOI: 10.1155/2011/521578. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Adrenal insufficiency: Image A.** Mucosal hyperpigmentation in primary adrenal insufficiency. Courtesy of FlatOut. The image

FAS1_2019_20_ImageAck.indd 734 11/8/19 4:49 PM

- may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Pheochromocytoma.** This image is a derivative work, adapted from the following source, available under : Dr. Michael Feldman.
- Multiple endocrine neoplasias. Mucosal neuroma. This image is a derivative work, adapted from the following source, available under Martucciello G, Lerone M, Bricco L, et al. Multiple endocrine neoplasias type 2B and RET proto-oncogene. Ital J Pediatr. 2012;38:9. DOI: 10.1186/1824-7288-38-9.
- Carcinoid syndrome. Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.

Gastrointestinal

- **358** Ventral wall defects. Gastroschisis. This image is a derivative work, adapted from the following source, available under . Zvizdic Z. Gastroschisis with concomitant jejuno-ileal atresia complicated by jejunal perforation. J Neonatal Surg. 2016 Apr-Jun; 5(2): 25.
- **Ventral wall defects.** Omphalocele. This image is a derivative work, adapted from the following source, available under .: Khan YA, Qureshi MA, Akhtar J. Omphalomesenteric duct cyst in an omphalocele: a rare association. Pak J Med Sci. 2013 May-Jun; 29(3): 866-868
- Ventral wall defects. Drawings of gastroschisis (left) and omphalocele (right). Courtesy of the Department of Health and Human
- **Intestinal atresia.** This image is a derivative work, adapted from the following source, available under Saha M. Alimentary tract atresias associated with anorectal malformations: 10 years' experience. J Neonatal Surg. 2016 Oct-Dec; 5(4): 43. DOI: 10.21699/jns.v5i4.449.
- **Hypertrophic pyloric stenosis.** This image is a derivative work, adapted from the following source, available under Es: Hassan RAA, Choo YU, Noraida R, et al. Infantile hypertrophic pyloric stenosis in postoperative esophageal atresia with tracheoesophageal fistula. J Neonatal Surg. 2015 Jul-Sep;4(3):32.
- Pancreas and spleen embryology. Annular pancreas. This image is a derivative work, adapted from the following source, available under Mahdi B, Selim S, Hassen T, et al. A rare cause of proximal intestinal obstruction in adults—annular pancreas: a case report. Pan Afr Med J. 2011;10:56. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Retroperitoneal structures.** This image is a derivative work, adapted from the following source, available under :: Sammut J, Ahiaku E, Williams DT. Complete regression of renal tumour following ligation of an accessory renal artery during repair of an abdominal aortic aneurysm. Ann R Coll Surg Engl. 2012 Sep; 94(6): e198-e200. DOI: 10.1308/003588412X13373405384972.
- **Digestive tract anatomy.** Histology of stomach wall. This image is a derivative work, adapted from the following source, available under : Alexander Klepnev.
- **Digestive tract histology: Image A.** Courtesy of Dr. Michale
- **Digestive tract histology: Image B.** Courtesy of W. Ben Smith.
- 362 Digestive tract histology: Images C, D, E. This image is a derivative work, adapted from the following source, available under see: Wikimedia Commons.
- **Liver tissue architecture: Image A.** Portal triad. This image is a derivative work, adapted from the following source, available under Eiver development. In: Zorn AM. Stem book. Cambridge: Harvard Stem Cell Institute, 2008.

- **Liver tissue architecture: Image B.** Kupffer cells. This image is a derivative work, adapted from the following source, available under some Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes
- Biliary structures. Gallstones. This image is a derivative work, adapted from the following source, available under :: J. Guntau. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Hernias: Image A. Congenital diaphragmatic hernia. This image is a derivative work, adapted from the following source, available under Tovar J. Congenital diaphragmatic hernia. Orphanet J Rare Dis. 2012;7:1. DOI: 10.1186/1750-1172-7-1.
- Gastrointestinal secretory products. Histology of gastric pit. This image is a derivative work, adapted from the following source, available under sa: Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Peyer patches.** This image is a derivative work, adapted from the following source, available under see: Plainpaper. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Sialolithiasis. This image is a derivative work, adapted from the following source, available under Eastor-Ramos V, Cuervo-Diaz A, Aracil-Kessler L. Sialolithiasis. Proposal for a new minimally invasive procedure: piezoelectric surgery. J Clin Exp Dent. 2014 Jul;6(3):e295-e298. DOI: 10.4317/jced.51253.
- Salivary gland tumors. Pleomorphic adenoma histology. This image is a derivative work, adapted from the following source, available under :: Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Achalasia.** This image is a derivative work, adapted from the following source, available under Estrowsh Farrokhi and Michael F. Vaezi. The image may have been modified by cropping, labeling, and/ or captions. All rights to this adaptation by MedIQ Learning, LLC are
- **Esophageal pathologies: Image A.** Pneumomediastinum in Boerhaave syndrome. This image is a derivative work, adapted from the following source, available under : Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Esophageal pathologies: Image B.** Esophageal varices on endoscopy. This image is a derivative work, adapted from the following source, available under .: Costaguta A, Alvarez F. Etiology and management of hemorrhagic complications of portal hypertension in children. Int J Hepatol. 2012;2012:879163. DOI: 10.1155/2012/879163.
- **Esophageal pathologies: Image C.** Esophageal varices on CT. This image is a derivative work, adapted from the following source, available under : Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under 200
- **Esophageal pathologies: Image D.** Esophagitis. This image is a derivative work, adapted from the following source, available under Takahashi Y, Nagata N, Shimbo T. Long-term trends in esophageal candidiasis prevalence and associated risk factors with or without HIV infection: lessons from an endoscopic study of 80,219 patients. PLoS One. 2015; 10(7): e0133589. DOI: 10.1371/journal. pone.0133589.
- **Barrett esophagus: Image A.** Endoscopy. This image is a derivative work, adapted from the following source, available under Coda S, Thillainayagam AV. State of the art in advanced endoscopic

FAS1_2019_20_ImageAck.indd 735 11/8/19 4:49 PM

- imaging for the detection and evaluation of dysplasia and early cancer of the gastrointestinal tract. *Clin Exp Gastroenterol.* 2014;7:133-150. DOI: 10.2147/CEG.S58157. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 378 Barrett esophagus: Image B. Goblet cells. This image is a derivative work, adapted from the following source, available under community. Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under community.
- 379 Ménétriere disease. This image is a derivative work, adapted from the following source, available under Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedlQ Learning, LLC makes this available under Dr.
- **379 Gastric cancer Tan Y, Fu J, Li X.** This image is a derivative work, adapted from the following source, available under (<50%) signet-ring cell component associated with poor prognosis in colorectal cancer patients: a 26-year retrospective study in China. *PLoS One.* 2015; 10(3): e0121944. DOI: 10.1371/journal. pone.0121944.
- **380 Ulcer complications.** Free air under diaphragm in perforated ulcer. Reproduced, with permission, from Dr. Frank Gaillard and www. radiopaedia.org.
- 381 Malabsorption syndromes: Image A. This image is a derivative work, adapted from the following source, available under :: Celiac disease. Sedda S, Caruso R, Marafini I, et al. Pyoderma gangrenosum in refractory celiac disease: a case report. BMC Gastroenterol. 2013; 13: 162. DOI: 10.1186/1471-230X-13-162.
- 381 Malabsorption syndromes: Image B. *Tropheryma whippeli* on PAS stain. This image is a derivative work, adapted from the following source, available under 3. Tran HA. Reversible hypothyroidism and Whipple's disease. *BMC Endocr Disord*. 2006;6:3. DOI: 10.1186/1472-6823-6-3.
- 382 Inflammatory bowel diseases: Image A. "String sign" on barium swallow in Crohn disease. This image is a derivative work, adapted from the following source, available under : Al-Mofarreh MA, Al Mofleh IA, Al-Teimi IN, et al. Crohn's disease in a Saudi outpatient population: is it still rare? Saudi J Gastroenterol. 2009;15:111-116. DOI: 10.4103/1319-3767.45357. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 382 Inflammatory bowel diseases: Images B (normal mucosa) and C (punched-out ulcers) in ulcerative colitis. This image is a derivative work, adapted from the following source, available under ☑ □:

 Ishikawa D, Ando T, Watanabe O, et al. Images of colonic real-time tissue sonoelastography correlate with those of colonoscopy and may predict response to therapy in patients with ulcerative colitis. BMC Gastroenterol. 2011;11:29. DOI: 10.1186/1471-230X-11-29.
- **Appendicitis.** Fecalith. This image is a derivative work, adapted from the following source, available under Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under Dr.
- 383 Diverticula of the GI tract: Image B. Diverticulosis. This image is a derivative work, adapted from the following source, available under same: Sartelli M, Moore FA, Ansaloni L, et al. A proposal for a CT driven classification of left colon acute diverticulitis. World J Emerg Surg. 2015;10:3. DOI: 10.1186/1749-7922-10-3.
- **383 Diverticula of the GI tract: Image C.** This image is a derivative work, adapted from the following source, available under Hupfeld L, Burcharth J, Pommergaard HC, Rosenberg J. The best choice of treatment for acute colonic diverticulitis with purulent peritonitis is uncertain. *Biomed Res Int.* 2014; 2014: 380607. DOI: 10.1155/2014/380607.

- **Zenker diverticulum.** This image is a derivative work, adapted from the following source, available under : Courtesy of Bernd Brägelmann.
- Maltotation. This image is a derivative work, adapted from the following source, available under Mathews R, Thenabadu S, Jaiganesh T. Abdominal pain with a twist. *Int J Emerg Med.* 2011;4:21. DOI: 10.1186/1865-1380-4-21.
- **385** Intussusception: Image A. Interoperative image of intussusception. This image is a derivative work, adapted from the following source, available under (Vasiliadis K, Kogopoulos E, Katsamakas M, et al. Ileoileal intussusception induced by a gastrointestinal stromal tumor. World J Surg Oncol. 2008;6:133. DOI: 10.1186/1477-7819-6-133.
- **385** Intussusception: Image B. Ultrasound showing target sign. This image is a derivative work, adapted from the following source, available under Abbo O, Pinnagoda K, Micol LA. Osteosarcoma metastasis causing ileo-ileal intussusception. World J Surg Oncol. 2013 Aug 12;11(1):188. DOI: 10.1186/1477-7819-11-188.
- **Volvulus.** Coffee bean sign. This image is a derivative work, adapted from the following source, available under [2022]: Yigit M, Turkdogan KA. Coffee bean sign, whirl sign and bird's beak sign in the diagnosis of sigmoid volvulus. *Pan Afr Med J.* 1014;19:56. DOI: 10.11604/pamj.2014.19.56.5142.
- **Other intestinal disorders: Image A.** Necrosis due to occlusion of SMA. This image is a derivative work, adapted from the following source, available under See: Van De Winkel N, Cheragwandi A, Nieboer K, et al. Superior mesenteric arterial branch occlusion causing partial jejunal ischemia: a case report. *J Med Case Rep.* 2012;6:48. DOI: 10.1186/1752-1947-6-48.
- **Other intestinal disorders: Image B.** Loops of dilated bowel suggestive of small bowel obstruction. This image is a derivative work, adapted from the following source, available under Welte FJ, Crosso M. Left-sided appendicitis in a patient with congenital gastrointestinal malrotation: a case report. *J Med Case Rep.* 2007;1:92. DOI: 10.1186/1752-1947-1-92.
- **Other intestinal disorders: Image C.** Endoscopy showing dilated vessels. This image is a derivative work, adapted from the following source, available under Gunjan D, Sharma V, Rana SS, et al. Small bowel bleeding: a comprehensive review. *Gastroenterol Rep.* 2014 Nov;2(4):262-75. DOI: 10.1093/gastro/gou025.
- 386 Other intestinal disorders: Image D. Pneumatosis intestinalis.

 This image is a derivative work, adapted from the following source, available under □□□: Pelizzo G, Nakib G, Goruppi I, et al. Isolated colon ischemia with norovirus infection in preterm babies: a case series. *J Med Case Rep.* 2013;7:108. DOI: 10.1186/1752-1947-7-108.
- **387** Colonic polyps: Image A. This image is a derivative work, adapted from the following source, available under : M. Emannuel.
- 387 Colonic polyps: Image B. Adenomatous polyps. This image is a derivative work, adapted from the following source, available under Schussman N, Wexner SD. Colorectal polyps and polyposis syndromes. Gastroenterol Rep (Oxf). 2014 Feb;2(1):1-15. DOI: 10.1093/gastro/got041.
- **Colonic polyps: Image C.** This image is a derivative work, adapted from the following source, available under :: Rehani B, Chasen RM, Dowdy Y, et al. Advanced adenoma diagnosis with FDG PET in a visibly normal mucosa: a case report. *J Med Case Reports*. 2007; 1: 99. DOI: 10.1186/1752-1947-1-99.
- **Colorectal cancer: Image A.** Polyp. This image is a derivative work, adapted from the following source, available under Takiyama A, Nozawa H, Ishihara S, et al. Secondary metastasis in the lymph node of the bowel invaded by colon cancer: a report of three cases. World J Surg Oncol. 2016; 14: 273. DOI: 10.1186/s12957-016-1026-y.
- 389 Cirrhosis and portal hypertension: Image A. Splenomegaly and liver nodularity in cirrhosis. This image is a derivative work, adapted from

FAS1_2019_20_ImageAck.indd 736 11/8/19 4:50 PM

- the following source, available under . Inversitus. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- 389 Cirrhosis and portal hypertension: Image B. This image is a derivative work, adapted from the following source, available under Blackburn PR, Hickey RD, Nace RA, et al. Silent tyrosinemia type I without elevated tyrosine or succinylacetone associated with liver cirrhosis and hepatocellular carcinoma. *Hum Mutat.* 2016 Oct; 37(10): 1097–1105.DOI: 10.1002/humu.23047.
- **391 Alcoholic liver disease: Image B.** Mallory bodies. This image is a derivative work, adapted from the following source, available under . Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 391 Alcoholic liver disease: Image C. Sclerosis in alcoholic cirrhosis. This image is a derivative work, adapted from the following source, available under . Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 391 Non-alcoholic fatty liver disease. This image is a derivative work, adapted from the following source, available under El-Karaksy HM, El-Koofy NM, Anwar GM, et al. Predictors of non-alcoholic fatty liver disease in obese and overweight Egyptian children: single center study. Saudi J Gastroenterol. 2011;17:40-46. DOI: 10.4103/1319-3767 74476
- **392 Hepatocellular carcinoma/hepatoma: Image A.** Gross specimen. Reproduced, with permission, from Jean-Christophe Fournet and Humpath.
- 392 α₁-antitrypsin deficiency. Liver histology. This image is a derivative work, adapted from the following source, available under . Dr. Jerad M. Gardner. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **Jaundice.** Yellow sclera. Courtesy of the Department of Health and Human Services and Dr. Thomas F. Sellers.
- **Wilson disease.** This image is a derivative work, adapted from the following source, available under Kodama H, Fujisawa C, Bhadhprasit W. Inherited copper transport disorders: biochemical mechanisms, diagnosis, and treatment. *Curr Drug Metab.* 2012 Mar; 13(3): 237–250. DOI: 10.2174/138920012799320455.
- 395 Hemochromatosis. Hemosiderin deposits. This image is a derivative work, adapted from the following source, available under work, adapted from the following source, available under following source, avail
- **396** Cholelithiasis and related pathologies: Image A. Gross specimen of gallstones. This image is a derivative work, adapted from the following source, available under Courtesy of M. Emmanuel.
- 396 Cholelithiasis and related pathologies: Image B. Large gallstone. This image is a derivative work, adapted from the following source, available under Spangler R, Van Pham T, Khoujah D, et al. Abdominal emergencies in the geriatric patient. *Int J Emerg Med*. 2014; 7: 43. DOI: 10.1186/s12245-014-0043-2.
- 397 Cholelithiasis and related pathologies: Image C. Porcelain gallbladder. This image is a derivative work, adapted from the following source, available under Fred H, van Dijk H. Images of memorable cases: case 19. Connexions Web site. December 4, 2008. Available at: http://cnx.org/content/m14939/1.3/. The image may have

- been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 397 Acute pancreatitis: Image A. Acute exudative pancreatitis. This image is a derivative work, adapted from the following source, available under . Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 397 Acute pancreatitis: Image B. Pancreatic pseudocyst. This image is a derivative work, adapted from the following source, available under .: Thomas Zimmerman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- **397 Chronic pancreatitis.** This image is a derivative work, adapted from the following source, available under : Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- **Pancreatic adenocarcinoma: Image A.** Histology. This image is a derivative work, adapted from the following source, available under : KGH. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- 398 Pancreatic adenocarcinoma: Image B. CT scan. Courtesy of MBq. The image may have been modified by cropping, labeling, and/ or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.

Hematology and Oncology

- **406** Neutrophils. Courtesy of B. Lennert.
- 407 Erythrocytes. Courtesy of the Department of Health and Human Services and Drs. Noguchi, Rodgers, and Schechter.
- 407 Thrombocytes (platelets). This image is a derivative work, adapted from the following source, available under . Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 407 Monocytes. This image is a derivative work, adapted from the following source, available under . Dr. Graham Beards. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 407 Macrophages. This image is a derivative work, adapted from the following source, available under De Tommasi AS, Otranto D, Furlanello T, et al. Evaluation of blood and bone marrow in selected canine vector-borne diseases. *Parasit Vectors*. 2014;7:534. DOI: 10.1186/s13071-014-0534-2.
- **408 Eosinophils.** This image is a derivative work, adapted from the following source, available under **Dr.** Ed Uthman.
- 408 Basophils. This image is a derivative work, adapted from the following source, available under : Dr. Erhabor Osaro. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 408 Mast cells. Courtesy of Wikimedia Commons.
- **408 Dendritic cells.** This image is a derivative work, adapted from the following source, available under : Cheng J-H, Lee S-Y, Lien Y-Y, et al. Immunomodulating activity of *Nymphaea rubra* roxb. extracts: activation of rat dendritic cells and improvement of the TH1 immune response. *Int J Mol Sci.* 2012;13:10722-10735. DOI: 10.3390/ijms130910722.
- 409 Lymphocytes. This image is a derivative work, adapted from the following source, available under Fickleandfreckled.
- 409 Plasma cells. Courtesy of the Department of Health and Human Services and Dr. Francis W. Chandler. The image may have been

FAS1_2019_20_ImageAck.indd 737 11/8/19 4:50 PM

- modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 415 RBC morphology: Image J. Sickle cell. Courtesy of the Department of Health and Human Services and the Sickle Cell Foundation of Georgia, Jackie George, and Beverly Sinclair.
- 416 RBC inclusions: Image A. Ringed sideroblast. This image is a derivative work, adapted from the following source, available under : Paulo Henrique Orlandi Mourao. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- 416 RBC inclusions: Image B. Howell-Jolly bodies. This image is a derivative work, adapted from the following source, available under .: Serio B, Pezzullo L, Giudice V, et al. OPSI threat in hematological patients. *Transl Med UniSa*. 2013 May-Aug;6:2-10.
- **RBC inclusions: Image C.** Bsaophilic stippling. This image is a derivative work, adapted from the following source, available under . Erhabor Osaro.
- 416 RBC inclusions: Image D. Pappenheimer bodies. This image is a derivative work, adapted from the following source, available under . Paulo Henrique Orlandi Mourao. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 419 Microcytic, hypochromic anemias: Image A. This image is a derivative work, adapted from the following source, available under Bock F, Borucki K, Vorwerk P, et al. A two-and-a-half-year-old breastfed toddler presenting with anemia: a case report. BMC Res Notes. 2014; 7: 917. DOI: 10.1186/1756-0500-7-917.
- 419 Microcytic, hypochromic anemia: Image D. Lead lines in lead poisoning. Reproduced, with permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- 419 Microcytic, hypochromic anemia: Image E. Sideroblastic anemia. This image is a derivative work, adapted from the following source, available under 22: Paulo Henrique Orlandi Moura. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under 22.
- **420 Macrocytic anemias.** Megaloblastic anemia. This image is a derivative work, adapted from the following source, available under Courtesy of Dr. Ed Uthman.
- **422** Intrinsic hemolytic anemias. This image is a derivative work, adapted from the following source, available under .: El Ariss AB, Younes M, Matar J. Prevalence of sickle cell trait in the southern suburb of Beirut, Lebanon. Mediterr J Hematol Infect Dis. 2016; 8(1): e2016015. DOI: 10.4084/MJHID.2016.015.
- 425 Heme synthesis, porphyrias, and lead poisoning: Image A.
 Basophilic stippling in lead poisoning. This image is a derivative work, adapted from the following source, available under wan Dijk HA, Fred HL. Images of memorable cases: case 81. Connexions Web site. December 3, 2008. Available at http://cnx.org/contents/3196bf3e-lele-4c4d-alac-d4fc9ab65443@4@4.
- **425 Heme synthesis, porphyrias, and lead poisoning: Image B.** Porphyria cutanea tarda. This image is a derivative work, adapted from the following source, available under Bovenschen HJ, Vissers WHPM. Primary hemochromatosis presented by porphyria cutanea tarda: a case report. Cases J. 2009;2:7246. DOI: 10.4076/1757-1626-2-7246.
- **426 Coagulation disorders.** This image is a derivative work, adapted from the following source, available under **2.2.** Lakjiri S, Mernissi FZ. Tabetic arthropathy revealing neurosyphilis: a new observation. *Pan Afr Med J.* 2014; 18: 198. DOI: 10.11604/pamj.2014.18.198.4893.
- **429 Hodgkin lymphoma.** This image is a derivative work, adapted from the following source, available under . Knecht H, Righolt C, Mai S. Genomic instability: the driving force behind refractory/relapsing

- Hodgkin's lymphoma. Cancers (Basel). 2013 Jun; 5(2): 714–725. DOI: 10.3390/cancers5020714.
- 430 Non-Hodgkin lymphoma: Image B. This image is a derivative work, adapted from the following source, available under Bi CF, Tang Y, Zhang WY, et al. Sporadic Burkitt lymphomas of children and adolescents in Chinese: a clinicopathological study of 43 cases. Diagn Pathol. 2012;7:72. DOI:10.1186/1746-1596-7-72.
- **430 Non-Hodgkin lymphoma: Image C.** This image is a derivative work, adapted from the following source, available under Mansour A, Qandeel M, Abdel-Razeq H, et al. MR imaging features of intracranial primary CNS lymphoma in immune competent patients. *Cancer Imaging*. 2014;14(1):22. DOI: 10.1186/1470-7330-14-22.
- 431 Plasma cell dyscrasias: Image C. This image is a derivative work, adapted from the following source, available under Mehrotra R, Singh M, Singh PA, et al. Should fine needle aspiration biopsy be the first pathological investigation in the diagnosis of a bone lesion? An algorithmic approach with review of literature. Cytojournal. 2007; 4: 9. DOI: 10.1186/1742-6413-4-9.
- 432 Myelodysplastic syndromes. This image is a derivative work, adapted from the following source, available under : Lukaszewska J, Allison RW, Stepkowska J. Congenital Pelger-Huët anomaly in a Danish/Swedish farmdog: case report. Acta Vet Scand. 2011; 53(1): 14. DOI: 10.1186/1751-0147-53-14.
- **Leukemias: Image A.** This image is a derivative work, adapted from the following source, available under . Chiaretti S, Zini G, Bassan R. Diagnosis and subclassification of acute lymphoblastic leukemia. *Mediterr J Hematol Infect Dis.* 2014; 6(1): e2014073. DOI: 10.4084/MJHID.2014.073.
- 433 Leukemias: Image C. Hairy cell leukemia. This image is a derivative work, adapted from the following source, available under ☑ ☑: Chan SM, George T, Cherry AM, et al. Complete remission of primary plasma cell leukemia with bortezomib, doxorubicin, and dexamethasone: a case report. Cases J. 2009;2:121. DOI: 10.1186/1757-1626-2-121.
- 433 Chronic myeloproliferative disorders: Image A. Erythromelalgia in polycythemia vera. This image is a derivative work, adapted from the following source, available under Experiment Fred H, van Dijk H. Images of memorable cases: case 151. Connexions Web site. December 4, 2008. Available at http://cnx.org/content/m14932/1.3/.
- **433 Chronic myeloproliferative disorders: Image C.** Myelofibrosis. This image is a derivative work, adapted from the following source, available under **Courtesy** of Dr. Ed Uthman.
- 434 Langerhans cell histiocytosis: Image A. Lytic bone lesion. This image is a derivative work, adapted from the following source, available under . Dehkordi NR, Rajabi P, Naimi A, et al. Langerhans cell histiocytosis following Hodgkin lymphoma: a case report from Iran. J Res Med Sci. 2010;15:58-61. PMCID PMC3082786.
- 434 Langerhans cell histiocytosis: Image B. Birbeck granules. This image is a derivative work, adapted from the following source, available under . The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 435 Hemophagocytic lymphohistiocytosis. This image is a derivative work, adapted from the following source, available under (a.g.): Kashif M, Tariq H, Ijaz M. Disseminated histoplasmosis and secondary hemophagocytic syndrome in a non-HIV patient. Case Rep Crit Care. 2015; 2015: 295735. DOI: 10.1155/2015/295735.

FAS1_2019_20_ImageAck.indd 738 11/8/19 4:50 PM

Warfarin. This image is a derivative work, adapted from the following source, available under see: Bakoyiannis C, Karaolanis G, Patelis N. Dabigatran in the treatment of warfarin-induced skin necrosis: A new hope. Case Rep Dermatol Med. 2016; 2016: 3121469. DOI: 10.1155/2016/3121469.

Musculoskeletal, Skin, and Connective Tissue

- Rotator cuff muscles. Glenohumeral instability. This image is a derivative work, adapted from the following source, available under Exercise Y, Sano H, Imamura I, et al. Changes with time in skin temperature of the shoulders in healthy controls and a patient with shoulder-hand syndrome. Ups J Med Sci 2010;115:260-265. DOI: 10.3109/03009734.2010.503354. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Brachial plexus lesions: Image A.** Cervical rib. This image is a derivative work, adapted from the following source, available under Dahlin LB, Backman C, Duppe H, et al. Compression of the lower trunk of the brachial plexus by a cervical rib in two adolescent girls: case reports and surgical treatment. J Brachial Plex Peripher Nerve Inj. 2009;4:14. DOI: 10.1186/1749-7221-4-14.
- Brachial plexus lesions: Image B. Winged scapula. This image is a derivative work, adapted from the following source, available under : Boukhris J, Boussouga M, Jaafar A, et al. Stabilisation dynamique d'un winging scapula (à propos d'un cas avec revue de la littérature). Pan Afr Med J. 2014; 19: 331. DOI: 10.11604/ pamj.2014.19.331.3429.
- **449** Wrist region: Image B. Anatomic snuff box. This image is a derivative work, adapted from the following source, available under Rhemrev SJ, Ootes D, Beeres FJP, et al. Current methods ofdiagnosis and treatment of scaphoid fractures. Int J Emerg Med. 2011;4:4. DOI: 10.1186/1865-1380-4-4.
- Motoneuron action potential to muscle contraction: Image A. This image is a derivative work, adapted from the following source, available under : Ottenheijm CAC, Heunks LMA, Dekhuijzen RPN. Diaphragm adaptations in patients with COPD. Respir Res. 2008; 9(1): 12. DOI: 10.1186/1465-9921-9-12.
- Wrist and hand injuries: Image A. Metacarpal neck fracture. This image is a derivative work, adapted from the following source, available under see: Bohr S, Pallua N. Early functional treatment and modern cast making for indications in hand surgery. Adv Orthop. 2016; 2016: 5726979. DOI: 10.1155/2016/5726979.
- Wrist and hand injuries: Image B. Thenar eminence atrophy in carpal tunnel syndrome. Courtesy of Dr. Harry Gouvas.
- Common hip and knee conditions: Image A. ACL tear. This image is a derivative work, adapted from the following source, available under Es: Chang MJ, Chang CB, Choi J-Y, et al. Can magnetic resonance imaging findings predict the degree of knee joint laxity in patients undergoing anterior cruciate ligament reconstruction? BMC Musculoskelet Disord. 2014;15:214. DOI: 10.1186/1471-2474-15-214. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Common hip and knee conditions: Images B (prepatellar bursitis) and C (Baker cyst). This image is a derivative work, adapted from the following source, available under Euri Z, Hunhun JS, Choudur HN. Imaging of the bursae. J Clin Imaging Sci. 2011;1:22. DOI: 10.4103/2156-7514.80374. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **462 Common pediatric fractures: Image A.** Greenstick fracture. This image is a derivative work, adapted from the following source, available under Randsborg PH, Sivertsen EA. Classification of distal radius fractures in children: good inter- and intraobserver

- reliability, which improves with clinical experience. BMC Musculoskelet Disord. 2013;13:6. DOI: 10.1186/1471-2474-13-6.
- **Common pediatric fractures: Image B.** Torus (buckle) fracture. This image is a derivative work, adapted from the following source, available under Es: Aksel Seyahi, et al. Tibial torus and toddler's fractures misdiagnosed as transient synovitis: a case series. J Med Case Reports. 2011; 5: 305. DOI: 10.1186/1752-1947-5-305.
- **Osteoporosis.** Vertebral compression fractures of spine. This image is a derivative work, adapted from the following source, available under : Imani F, Gharaei H, Rahimzadeh P, et al. Management of painful vertebral compression fracture with kyphoplasty in a sever cardio-respiratory compromised patient. Anesth Pain Med. 2012 summer;2(1):42-45. DOI: 10.5812/aapm.5030.
- Osteopetrosis. This image is a derivative work, adapted from the following source, available under Est. Kant P, Sharda N, Bhowate RR. Clinical and radiological findings of autosomal dominant osteopetrosis type II: a case report. Case Rep Dent. 2013;2013:707343. DOI: 10.1155/2013/707343.
- Osteomalacia/rickets: Image A, left. Clinical photo. This image is a derivative work, adapted from the following source, available under : Linglart A, Biosse-Duplan M, Briot K, et al. Therapeutic management of hypophosphatemic rickets from infancy to adulthood. Endocr Connect. 2014;3:R13-R30. DOI: 10.1530/EC-13-0103.
- **Osteomalacia/rickets: Image B.** Rachitic rosary on chest X-ray. This image is a derivative work, adapted from the following source, available under Essabar L, Meskini T, Ettair S, et al. Malignant infantile osteopetrosis: case report with review of literature. Pan Afr Med J. 2014;17:63. DOI: 10.11604/pamj.2014.17.63.3759.
- Osteitis deformans. Thickened calvarium. This image is a derivative work, adapted from the following source, available under ____: Dawes L. Paget's disease. [Radiology Picture of the Day Website]. Published June 21, 2007. Available at http://www.radpod.org/2007/06/21/pagets-
- Avascular necrosis of bone. Bilateral necrosis of femoral head. This image is a derivative work, adapted from the following source, available under : Ding H, Chen S-B, Lin S, et al. The effect of postoperative corticosteroid administration on free vascularized fibular grafting for treating osteonecrosis of the femoral head. Sci World J. 2013;708014. DOI: 10.1155/2013/708014. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Primary bone tumors: Image A. Osteochondroma. This image is a derivative work, adapted from the following source, available under so: Lucien Monfils. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @
- **Primary bone tumors: Image B.** Osteoid osteoma. This image is a derivative work, adapted from the following source, available under Jankharia B, Burute N. Percutaneous radiofrequency ablation for osteoid osteoma: how we do it. Indian J Radiol Imaging. 2009 Feb; 19(1): 36-42. DOI: 10.4103/0971-3026.44523.
- **Primary bone tumors: Image C.** Giant cell tumor. Reproduced, with permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- **Primary bone tumors: Image D.** This image is a derivative work, adapted from the following source, available under : Xu SF, Yu XC, Zu M, et al. Limb function and quality of life after various reconstruction methods according to tumor location following resection of osteosarcoma in distal femur. BMC Musculoskelet Disord. 2014; 15: 453. DOI: 10.1186/1471-2474-15-453
- **Primary bone tumors: Image E.** Starburst pattern in osteosarcoma. This image is a derivative work, adapted from the following source, available under Ding H, Yu G, Tu Q, et al. Computeraided resection and endoprosthesis design for the management of

FAS1_2019_20_ImageAck.indd 739 11/8/19 4:50 PM

- malignant bone tumors around the knee: outcomes of 12 cases. BMC Musculoskelet Disord. 2013; 14: 331. DOI: 10.1186/1471-2474-14-331.
- 466 Osteoarthritis vs rheumatoid arthritis: Image A. Histology of rheumatoid nodule. This image is a derivative work, adapted from the following source, available under Gomez-Rivera F, El-Naggar AK, Guha-Thakurta N, et al. Rheumatoid arthritis mimicking metastatic squamous cell carcinoma. Head Neck Oncol. 2011;3:26. DOI: 10.1186/1758-3284-3-26.
- 467 Gout: Image B. Uric acid crystals under polarized light. This image is a derivative work, adapted from the following source, available under ... Robert J. Galindo. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- 467 Gout: Image C. Podagra. This image is a derivative work, adapted from the following source, available under Roddy E. Revisiting the pathogenesis of podagra: why does gout target the foot? J Foot Ankle Res. 2011;4:13. DOI: 10.1186/1757-1146-4-13.
- 467 Calcium pyrophosphate deposition disease. Calcium phosphate crystals. This image is a derivative work, adapted from the following source, available under Dispher P, Swan A. Identification of crystals in synovial fluid. Ann Rheum Dis. 1999 May;58(5):261–263.
- 468 Sjögren syndrome: Image A. Lymphocytic infiltration. Courtesy of the Department of Health and Human Services.
- 468 Sjögren syndrome: Image B. Dry tongue. This image is a derivative work, adapted from the following source, available under Negrato CA, Tarzia O. Buccal alterations in diabetes mellitus. Diabetol Metab Syndr. 2010;2:3. DOI: 10.1186/1758-5996-2-3.
- **Septic arthritis.** Joint effusion. This image is a derivative work, adapted from the following source, available under . Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- 469 Seronegative spondyloarthropathies: Image C, left. Bamboo spine. This image is a derivative work, adapted from the following source, available under : Stevenfruitsmaak. The image may have been modified by cropping, labeling, and/or captions. MedlQ Learning, LLC makes this available under :
- **Seronegative spondyloarthropathies: Image C, right.** Bamboo spine. Courtesy of Heather Hawker.
- **Polymyositis/dermatomyositis: Image A.** Groton papules of dermatomyositis. This image is a derivative work, adapted from the following source, available under Pan Afr Med J.2015; 21: 89. DOI: 10.11604/pamj.2015.21.89.6971.
- **472 Raynaud phenomenon.** This image is a derivative work, adapted from the following source, available under : Jamclaassen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- 474 Epithelial cell junctions: Image A. Intracellular membrane. This image is a derivative work, adapted from the following source, available under : Tang VW. Proteomic and bioinformatic analysis of epithelial tight junction reveals an unexpected cluster of synaptic molecules. Biol Direct. 2006; 1: 37. DOI: 10.1186/1745-6150-1-37.
- 474 Epithelial cell junctions: Image B. Large, electron-dense actin structures within adherens junction. This image is a derivative work, adapted from the following source, available under .: Taylor RR, Jagger DJ, Saeed SR, et al. Characterizing human vestibular sensory epithelia for experimental studies: new hair bundles on old tissue and implications for therapeutic interventions in ageing. Neurobiol Aging. 2015 Jun;36(6):2068–2084. DOI: 10.1016/j. neurobiolaging.2015.02.013.
- **474 Epithelial cell junctions: Image C.** Desmosome. This image is a derivative work, adapted from the following source, available under

- **Massa F, Devader C, Lacas-Gervais S, et al. Impairement of HT29 cancer cells cohesion by the soluble form of neurotensin receptor-3. *Genes Cancer*. 2014 Jul; 5(7-8):240–249. DOI: 10.18632/genesandcancer.22.
- **474 Epithelial cell junctions: Image D.** Gap junction. This image is a derivative work, adapted from the following source, available under See: Shu X, Lev-Ram V, Deerinck TJ. A Genetically encoded tag for correlated light and electron microscopy of intact cells, tissues, and organisms. *PLoS Biol.* 2011 Apr; 9(4): e1001041. DOI: 10.1371/journal.pbio.1001041.
- **474 Epithelial cell junctions: Image E.** Hemidesmosome. This image is a derivative work, adapted from the following source, available under : Nguyen NM, Pulkkinen L, Schlueter JA, et al. Lung development in laminin gamma2 deficiency: abnormal tracheal hemidesmosomes with normal branching morphogenesis and epithelial differentiation. *Respir Res.* 2006 Feb 16;7:28. DOI: 10.1186/1465-9921-7-28.
- **Seborrheic dermatitis.** This image is a derivative work, adapted from the following source, available under Roymishali.
- 477 Common skin disorders: Image O. Urticaria. This image is a derivative work, adapted from the following source, available under . Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 478 Vascular tumors of skin: Image C. Glomus tumor under fingernail.

 This image is a derivative work, adapted from the following source, available under . Hazani R, Houle JM, Kasdan ML, et al. Glomus tumors of the hand. Eplasty. 2008;8:e48. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Skin infections: Image C.** Erysipelas. This image is a derivative work, adapted from the following source, available under Courtesy of Klaus D. Peter.
- **480 Autoimmune blistering skin disorders: Image D.** Bullous pemphigoid on immunofluorescence. This image is a derivative work, adapted from the following source, available under **Courtesy** of M. Emmanuel.
- 484 Skin cancer: Image D. Basal cell palisading nuclei. This image is a derivative work, adapted from the following source, available under □□□: Yuri T. Jadotte, MD, et al. Superficial spreading basal cell carcinoma of the face: a surgical challenge. Eplasty. 2010; 10: e46. Published online 2010 Jun 21.

Neurology and Special Senses

- 491 Holoprosencephaly: Image A. This image is a derivative work, adapted from the following source, available under Alorainy IA, Barlas NB, Al-Boukai AA. Pictorial essay: infants of diabetic mothers. Indian J Radiol Imaging. 2010 Aug;20(3):174-81. DOI: 10.4103/0971-3026.69349.
- **Posterior fossa malformations: Image A.** Chiari I malformation. This image is a derivative work, adapted from the following source, available under Toldo I, De Carlo D, Mardari R, et al. Short lasting activity-related headaches with sudden onset in children: a case-based reasoning on classification and diagnosis. *J Headache Pain*. 2013;14(1):3. DOI: 10.1186/1129-2377-14-3.
- **492 Posterior fossa malformations: Image B.** Dandy-Walker malformation. This image is a derivative work, adapted from the following source, available under Exercise Krupa K, Bekiesinska-Figatowska M. Congenital and acquired abnormalities of the corpus callosum: a pictorial essay. Biomed Res Int. 2013;2013:265619. DOI: 10.1155/2013/265619.

FAS1_2019_20_ImageAck.indd 740 11/8/19 4:50 PM

- Syringomyelia. Reproduced, with permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- **Myelin.** Myelinated neuron. © Courtesy of the Electron Microscopy Facility at Trinity College.
- **Chromatolysis.** This image is a derivative work, adapted from the following source, available under 2001: Dr. Michael Bonnert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Limbic system: Image A.** This image is a derivative work, adapted from the following source, available under : Schopf V, Fischmeister FP, Windischberger C, et al. Effects of individual glucose levels on the neuronal correlates of emotions. Front Hum Neurosci. 2013 May 21;7:212. DOI: 10.3389/fnhum.2013.00212.
- **Cerebellum.** This image is a derivative work, adapted from the following source, available under see: Jarius S, Wandinger KP, Horn S, et al. A new Purkinje cell antibody (anti-Ca) associated with subacute cerebellar ataxia: immunological characterization. J Neuroinflammation. 2010;7: 21. DOI: 10.1186/1742-2094-7-21.
- **Basal ganglia.** This image is a derivative work, adapted from the following source, available under Rudger P, Jaunmuktane Z, Adlard P, et al. Iatrogenic CJD due to pituitary-derived growth hormone with genetically determined incubation times of up to 40 years. Brain. 2015 Nov; 138(11): 3386-3399. DOI: 10.1093/brain/ awv235.
- **502** Cerebral arteries—cortical distribution. Cortical watershed areas. This image is a derivative work, adapted from the following source, available under Esabel C, Lecler A, Turc G, et al. Relationship between watershed infarcts and recent intra plaque haemorrhage in carotid atherosclerotic plaque. PLoS One. 2014;9(10):e108712. DOI: 10.1371/journal.pone.0108712.
- **Dural venous sinuses.** This image is a derivative work, adapted from the following source, available under :: Cikla U, Âagaard-Kienitz B, Turski PA, et al. Familial perimesencephalic subarachnoid hemorrhage: two case reports. J Med Case Rep. 2014;8. DOI: 10.1186/1752-1947-8-380. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Spinal cord and associated tracts: Image A.** Spinal cord cross-section. This image is a derivative work, adapted from the following source, available under : Regents of University of Michigan Medical School.
- 512 Neonatal interventricular hemorrhage. This image is a derivative work, adapted from the following source, available under Shooman D, Portess H, Sparrow O. A review of the current treatment methods for posthaemorrhagic hydrocephalus of infants. Cerebrospinal Fluid Res. 2009;6:1. DOI: 10.1186/1743-8454-6-1.
- 513 Intracranial hemorrhage: Images A and B. Axial CT of brain showing epidural blood. This image is a derivative work, adapted from the following source, available under : Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Intracranial hemorrhage: Image C. Subdural hematoma. This image is a derivative work, adapted from the following source, available under . Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Intracranial hemorrhage: Image E. Subarachnoid hemorrhage. This image is a derivative work, adapted from the following source, available under : Hakan T, Turk CC, Celik H. Intra-operative real time intracranial subarachnoid haemorrhage during glial tumour resection: a case report. Cases J. 2008;1:306. DOI: 10.1186/1757-1626-1-306. The image may have been modified by cropping, labeling, and/

- or captions. All rights to this adaptation by MedIO Learning, LLC are reserved.
- 515 **Effects of strokes: Image A.** Large abnormality of the left MCA territory. This image is a derivative work, adapted from the following source, available under Es: Hakimelahi R, Yoo AJ, He J, et al. Rapid identification of a major diffusion/perfusion mismatch in distal internal carotid artery or middle cerebral artery ischemic stroke. BMC Neurol. 2012 Nov 5;12:132. DOI: 10.1186/1471-2377-12-132. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Effects of strokes: Image B.** MRI diffusion weighted image shows a hypersensitive lesion on posterior limb of internal capsular. This image is a derivative work, adapted from the following source, available under : Zhou L, Ni J, Yao M, et al. High-resolution MRI findings in patients with capsular warning syndrome. BMC Neurol. 2014;14:16. DOI: 10.1186/1471-2377-14-16.
- **Effects of strokes: Image C.** This image is a derivative work, adapted from the following source, available under : Nouh A, Remke J, Ruland S. Ischemic posterior circulation stroke: a review of anatomy, clinical presentations, diagnosis, and current management. Front Neurol. 2014 Apr 7;5:30. DOI: 10.3389/fneur.2014.00030.
- **Effects of strokes: Image D.** This image is a derivative work, adapted from the following source, available under : Mittal P, Kalia V, Dua S. Pictorial essay: Susceptibility-weighted imaging in cerebral ischemia. Indian J Radiol Imaging. 2010 Nov; 20(4): 250-253. DOI: 10.4103/0971-3026.73530.
- **Diffuse axonal injury.** Moenninghoff C, Kraff O, Maderwald S, et al. Diffuse axonal injury at ultra-high field MRI. PLoS One. 2015;10(3):e0122329. DOI: 10.1371/journal.pone.0122329.
- **Aneurysms.** This image is a derivative work, adapted from the following source, available under : Kayhan A, Koc O, Keskin S. The role of bone subtraction computed tomographic angiography in determining intracranial aneurysms in non-traumatic subarachnoid hemorrhage. Iran J Radiol. 2014 May; 11(2): e12670. DOI: 10.5812/ iranjradiol.12670.
- 521 Neurodegenerative disorders: Image A. Lewy body in substantia nigra. This image is a derivative work, adapted from the following source, available under :: Werner CJ, Heyny-von Haussen R, Mall G, et al. Parkinson's disease. Proteome Sci. 2008;6:8. DOI: 10.1186/1477-5956-6-8. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Neurodegenerative disorders: Image B. Gross specimen of normal brain. This image is a derivative work, adapted from the following source, available under . Niedowicz DM, Nelson PT, Murphy MP. Alzheimer's disease: pathological mechanisms and recent insights. Curr Neuropharmacol. 2011 Dec;9(4):674-84. DOI: 10.2174/157015911798376181.
- Neurodegenerative disorders: Images C (brain atrophy in Alzheimer 521 disease) and F (atrophy in frontotemporal dementia). This image is a derivative work, adapted from the following source, available under : Niedowicz DM, Nelson PT, Murphy MP. Alzheimer's disease: pathological mechanisms and recent insights. Curr Neuropharmacol. 2011 Dec;9(4):674-84. DOI: 10.2174/157015911798376181.
- **Neurodegenerative disorders: Image G.** Frontotemporal dementia: Pick bodies in frontotemporal demendia (Pick disease). This image is a derivative work, adapted from the following source, available under with Neumann M. Molecular neuropathology of TDP-43 proteinopathies. *Int J Mol Sci.* 2009 Jan; 10(1): 232–246. DOI: 10.3390/ijms10010232.
- Neurodegenerative disorders: Image H. Spongiform changes in brain 521 in Creutzfeld-Jacob disease. This image is a derivative work, adapted from the following source, available under . DRdoubleB. The

FAS1 2019 20 ImageAck.indd 741 11/8/19 4:50 PM

- image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **522 Hydrocephalus: Image B.** Communicating hydrocephalus. This image is a derivative work, adapted from the following source, available under ... Torres-Martin M, Pena-Granero C, Carceller F, et al. Homozygous deletion of *TNFRSF4*, *TP73*, *PPAP2B* and *DPYD* at 1p and *PDCD5* at 19q identified by multiplex ligation-dependent probe amplification (MLPA) analysis in pediatric anaplastic glioma with questionable oligodendroglial component. *Mol Cytogenet*. 2014;7:1. DOI: 10.1186/1755-8166-7-1.
- **522 Hydrocephalus: Image C.** Ex vacuo ventriculomegaly. This image is a derivative work, adapted from the following source, available under Ghetti B, Oblak AL, Boeve BF, et al. Frontotemporal dementia caused by microtubule-associated protein tau gene (*MAPT*) mutations: a chameleon for neuropathology and neuroimaging. Neurophathol Appl Neurobiol. 2015 Feb;41(1):24-46. DOI: 10.1111/nan.12213.
- **Multiple sclerosis.** Periventricular plaques. This image is a derivative work, adapted from the following source, available under open Dooley MC, Foroozan R. Optic neuritis. *J Ophthalmic Vis Res.* 2010 Jul;5(3):182–187.
- Other demyelinating and dysmyelinating diseases: Image B.

 Progressive multifocal leukoencephalopathy. This image is a derivative work, adapted from the following source, available under Garrote H, de la Fuente A, Ona R, et al. Long-term survival in a patient with progressive multifocal leukoencephalopathy after therapy with rituximab, fludarabine and cyclophosphamide for chronic lymphocytic leukemia. Exp Hematol Oncol. 2015;4:8. DOI: 10.1186/s40164-015-0003-4.
- **Other demyelinated and dysmyelinating disorders: Image A.**Central pontine myelinolysis. This image is a derivative work, adapted from the following source, available under wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Neurocutaneous disorders: Image A.** Sturge-Weber syndrome and port wine stain. This image is a derivative work, adapted from the following source, available under :: Babaji P, Bansal A, Krishna G, et al. Sturge-Weber syndrome with osteohypertrophy of maxilla. *Case Rep Pediatr.* 2013. DOI: 10.1155/2013/964596.
- 525 Neurocutaneous disorders: Image B. Leptomeningeal angioma in Sturge-Weber syndrome. Reproduced, with permission, from Dr. Frank Gaillard and www.radiopaedia.org.
- 525 Neurocutaneous disorders: Image C. Tuberous sclerosis. This image is a derivative work, adapted from the following source, available under . Fred H, van Dijk H. Images of memorable cases: case 143. Connexions Web site. December 4, 2008. Available at: http://cnx.org/content/m14923/1.3/.
- **Section 8.1 Neurocutaneous disorders: Image D.** Ash leaf spots in tuberous sclerosis. This image is a derivative work, adapted from the following source, available under Tonekaboni SH, Tousi P, Ebrahimi A, et al. Clinical and para clinical manifestations of tuberous sclerosis: a cross sectional study on 81 pediatric patients. *Iran J Child Neurol.* 2012;6:25-31. PMCID PMC3943027.
- 525 Neurocutaneous disorders: Image E. Angiomyolipoma in tuberous sclerosis. This image is a derivative work, adapted from the following source, available under KGH. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Neurocutaneous disorders: Image F.** Café-au-lait spots in neurofibromatosis. This image is a derivative work, adapted from the following source, available under : Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :

- 525 Neurocutaneous disorders: Image G. Lisch nodules in neurofibromatosis. Courtesy of the Department of Health and Human Services.
- **Neurocutaneous disorders: Image H.** Cutaneous neurofibromas. This image is a derivative work, adapted from the following source, available under Kim BK, Choi YS, Gwoo S, et al. Neurofibromatosis type 1 associated with papillary thyroid carcinoma incidentally detected by thyroid ultrasonography: a case report. *J Med Case Rep.* 2012;6:179. DOI: 10.1186/1752-1947-6-179.
- Neurocutaneous disorders: Image J. Brainstem and spinal cord hemangioblastomas in von Hippel-Lindau disease. This image is a derivative work, adapted from the following source, available under Park DM, Zhuang Z, Chen L, et al. von Hippel-Lindau disease-associated hemangioblastomas are derived from embryologic multipotent cells. PLoS Med. 2007 Feb;4(2):e60. DOI: 10.1371/journal.pmed.0040060.
- 526 Adult primary brain tumors: Image A. This image is a derivative work, adapted from the following source, available under see: Rossmeisl JH, Clapp K, Pancotto TE. Canine butterfly glioblastomas: A neuroradiological review. Front Vet Sci. 2016; 3: 40. DOI: 10.3389/fvets.2016.00040.
- 526 Adult primary brain tumors: Image B. Glioblastoma multiforme histology. This image is a derivative work, adapted from the following source, available under Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- 526 Adult primary brain tumors: Image C. Oligodendroglioma in frontal lobes. This image is a derivative work, adapted from the following source, available under Celzo FG, Venstermans C, De Belder F, et al. Brain stones revisited—between a rock and a hard place. *Insights Imaging*. 2013 Oct;4(5):625-35. DOI: 10.1007/s13244-013-0279-z.
- 526 Adult primary brain tumors: Image D. Oligodendroglioma, "fried egg" cells. This image is a derivative work, adapted from the following source, available under . Nephron. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 526 Adult primary brain tumors: Image E. Meningioma with dural tail. This image is a derivative work, adapted from the following source, available under . Smits A, Zetterling M, Lundin M, et al. Neurological impairment linked with cortico-subcortical infiltration of diffuse low-grade gliomas at initial diagnosis supports early brain plasticity. Front Neurol. 2015;6:137. DOI: 10.3389/fneur.2015.00137.
- 526 Adult primary brain tumors: Image F. Meningioma, psammoma bodies. This image is a derivative work, adapted from the following source, available under .: Nephron. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- **Adult primary brain tumors: Image G.** Cerebellar hemangioblastoma. This image is a derivative work, adapted from the following source, available under Park DM, Zhengping Z, Chen L, et al. von Hippel-Lindau disease-associated hemangioblastomas are derived from embryologic multipotent cells. *PLoS Med.* 2007 Feb;4(2):e60. DOI: 10.1371/journal.pmed.0040060.
- Adult primary brain tumors: Image H. Minimal parenchyma in hemangioblastoma. This image is a derivative work, adapted from the following source, available under Marvin 101. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...

FAS1_2019_20_ImageAck.indd 742 11/8/19 4:50 PM

- hemianopia. This image is a derivative work, adapted from the following source, available under . Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- 527 Adult primary brain tumors: Image J. Prolactinoma. This image is a derivative work, adapted from the following source, available under with supractional cases and artery cerebral aneurysm: a case report and review of the literature. Cases J. 2009;2:6459. DOI: 10.4076/1757-1626-2-6459.
- **527** Adult primary brain tumors: Image K. Schwannoma at cerebellopontine angle. Courtesy of MRT-Bild.
- 527 Adult primary brain tumors: Image L. Schwann cell origin of schwannoma. This image is a derivative work, adapted from the following source, available under see: Nephron. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under see:
- 528 Childhood primary brain tumors: Image A. MRI of pilocytic astrocytoma. This image is a derivative work, adapted from the following source, available under :: Hafez RFA. Stereotaxic gamma knife surgery in treatment of critically located pilocytic astrocytoma: preliminary result. World J Surg Oncol. 2007;5:39. doi 10.1186/1477-7819-5-39.
- 528 Childhood primary brain tumors: Image C. CT of medulloblastoma.
 Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- 528 Childhood primary brain tumors: Image D. Medulloblastoma histology. This image is a derivative work, adapted from the following source, available under See: KGH. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under See:
- 528 Childhood primary brain tumors: Image E. MRI of ependymoma. This image is a derivative work, adapted from the following source, available under : Dr. Paul Hellerhoff. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- Childhood primary brain tumors: Image F. Ependymoma histology. This image is a derivative work, adapted from the following source, available under : Nephron. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- Childhood primary brain tumors: Image G. CT of craniopharyngioma. This image is a derivative work, adapted from the following source, available under Garnet MR, Puget S, Grill J, et al. Craniopharyngioma. Orphanet J Rare Dis. 2007;2:18. DOI: 10.1186/1750-1172-2-18.
- 528 Childhood primary brain tumors: Image H. Craniopharyngioma histology. This image is a derivative work, adapted from the following source, available under . Nephron. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **531 Friedreich ataxia: Image A.** Clinical kyphoscoliosis. This image is a derivative work, adapted from the following source, available under . Axelrod FB, Gold-von Simson. Hereditary sensory and autonomic neuropathies: types II, III, and IV. *Orphanet J Rare Dis.* 2007;2:39. DOI: 10.1186/1750-1172-2-39.
- **Friedreich ataxia: Image B.** Radiograph showing kyphoscoliosis. This image is a derivative work, adapted from the following source, available under Deal: Bounakis N, Karampalis C, Tsirikos AI. Surgical treatment of scoliosis in Rubinstein-Taybi syndrome type 2: a case report. *J Med Case Rep.* 2015; 9: 10. doi 10.1186/1752-1947-9-10.

- 532 Facial nerve lesions. Facial nerve palsy. This image is a derivative work, adapted from the following source, available under Socolovsky M, Paez MD, Di Masi G, et al. Bell's palsy and partial hypoglossal to facial nerve transfer: Case presentation and literature review. Surg Neurol Int. 2012;3:46. DOI: 10.4103/2152-7806.95391.
- 533 Cholesteatoma. This image is a derivative work, adapted from the following source, available under :: Welleschik. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ::
- **Normal eye anatomy.** This image is a derivative work, adapted from the following source, available under : Jan Kaláb. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under :
- 534 Conjunctivitis. This image is a derivative work, adapted from the following source, available under Baiyeroju A, Bowman R, Gilbert C, et al. Managing eye health in young children. Community Eye Health. 2010;23:4-11.
- **Cataract.** Juvenile cataract. This image is a derivative work, adapted from the following source, available under Roshan M, Vijaya PH, Lavanya GR, et al. A novel human CRYGD mutation in a juvenile autosomal dominant cataract. *Mol Vis.* 2010;16:887-896. PMCID PMC2875257.
- 536 Glaucoma: Image C. Closed/narrow angle glaucoma. This image is a derivative work, adapted from the following source, available under Description: Low S, Davidson AE, Holder GE, et al. Autosomal dominant Best disease with an unusual electrooculographic light rise and risk of angle-closure glaucoma: a clinical and molecular genetic study. *Mol Vis.* 2011;17:2272-2282. PMCID PMC3171497. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Glaucoma: Image D.** Acute angle closure glaucoma. This image is a derivative work, adapted from the following source, available under ... Courtesy of Dr. Jonathan Trobe.
- **Uveitis: Image A.** This image is a derivative work, adapted from the following source, available under : Weber AC, Levison AL, Srivastava, et al. A case of *Listeria monocytogenes* endophthalmitis with recurrent inflammation and novel management. *J Ophthalmic Inflamm Infect*. 2015;5(1):28. DOI: 10.1186/s12348-015-0058-8.
- **Age-related macular degeneration.** Courtesy of the Department of Health and Human Services.
- 537 Diabetic retinopathy. This image is a derivative work, adapted from the following source, available under Sundling V, Gulbrandsen P, Straand J. Sensitivity and specificity of Norwegian optometrists' evaluation of diabetic retinopathy in single-field retinal images a cross-sectional experimental study. BMC Health Services Res. 2013;13:17. DOI: 10.1186/1472-6963-13-17.
- **537 Hypertensive retinopathy.** This image is a derivative work, adapted from the following source, available under Diallo JW, Méda N, Tougouma SJB, et al. Intérêts de l'examen du fond d'œil en pratique de ville: bilan de 438 cas. *Pan Afr Med J.* 2015;20:363. DOI: 10.11604/pamj.2015.20.363.6629.
- 7537 Retinal vein occlusion. This image is a derivative work, adapted from the following source, available under Alasil T, Rauser ME. Intravitreal bevacizumab in the treatment of neovascular glaucoma secondary to central retinal vein occlusion: a case report. Cases J. 2009;2:176. DOI: 10.1186/1757-1626-2-176. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 537 Retinal detachment. Courtesy of EyeRounds.
- **538 Retinitis pigmentosa.** Courtesy of EyeRounds.
- **538 Leukocoria.** This image is a derivative work, adapted from the following source, available under **Exercise**: Aerts I, Lumbroso-Le Rouic L,

FAS1_2019_20_ImageAck.indd 743 11/8/19 4:50 PM

- Gauthier-Villars M, et al. Retinoblastoma. *Orphanet J Rare Dis.* 2006 Aug 25;1:31. DOI: 10.1186/1750-1172-1-31.
- 541 CN III, IV, VI palsies: Image A. Cranial nerve III damage. This image is a derivative work, adapted from the following source, available under :: Hakim W, Sherman R, Rezk T, et al. An acute case of herpes zoster ophthalmicus with ophthalmoplegia. Case Rep Ophthalmol Med. 1012; 2012:953910. DOI: 10.1155/2012/953910.
- **CN III, IV, VI palsies: Image B.** Cranial nerve IV damage. This image is a derivative work, adapted from the following source, available under . Mendez JA, Arias CR, Sanchez D, et al. Painful ophthalmoplegia of the left eye in a 19-year-old female, with an emphasis in Tolosa-Hunt syndrome: a case report. *Cases J.* 2009; 2: 8271. DOI: 10.4076/1757-1626-2-8271.

Psychiatry

563 Trichotillomania. Courtesy of Robodoc.

Renal

- 578 Potter sequence (syndrome). Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- 580 Kidney anatomy and glomerular structure. This image is a derivative work, adapted from the following source, available under Ramidi GA, Kurukumbi MK, Sealy PL. Collapsing glomerulopathy in sickle cell disease: a case report. J Med Case Reports. 2011; 5: 71. DOI: 10.1186/1752-1947-5-71.
- **Course of ureters.** This image is a derivative work, adapted from the following source, available under :: Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ::
- **Glomerular filtration barrier.** This image is a derivative work, adapted from the following source, available under Feng J, Wei H, Sun Y, et al. Regulation of podocalyxin expression in the kidney of streptozotocin-induced diabetic rats with Chinese herbs (Yishen capsule). BMC Complement Altern Med. 2013;13:76. DOI: 10.1186/1472-6882-13-76.
- **Casts in urine: Image D.** Fatty casts. This image is a derivative work, adapted from the following source, available under **Source**: Li S, Wang ZJ, Chang TT. Temperature oscillation modulated self-assembly of periodic concentric layered magnesium carbonate microparticles. *PLoS One.* 2014;9(2):e88648. DOI:10.1371/journal.pone.0088648
- **Nephritic syndrome: Image A.** Histology of acute poststreptococcal glomerulonephritis. This image is a derivative work, adapted from the following source, available under Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under

- 596 Nephritic syndrome: Image B. This image is a derivative work, adapted from the following source, available under □□□: Immunofluorescence of acute poststreptococcal glomerulonephritis. Oda T, Yoshizawa N, Yamakami K, et al. The role of nephritis-associated plasmin receptor (naplr) in glomerulonephritis associated with streptococcal infection. Biomed Biotechnol. 2012;2012:417675. DOI 10.1155/2012/417675.
- 596 Nephritic syndrome: Image C. Histology of rapidly progressive glomerulonephritis. Courtesy of the Department of Health and Human Services and Uniformed Services University of the Health Sciences.
- 596 Nephritic syndrome: Image D. This image is a derivative work, adapted from the following source, available under Exercise Kiremitci S, Ensari A. Classifying lupus nephritis: an ongoing story. Scientific World Journal. 2014; 2014: 580620. DOI: 10.1155/2014/580620.
- 597 Nephrotic syndrome: Image A. This image is a derivative work, adapted from the following source, available under DE: Teoh DCY, El-Modir A. Managing a locally advanced malignant thymoma complicated by nephrotic syndrome: a case report. *J Med Case Reports.* 2008; 2: 89. DOI: 10.1186/1752-1947-2-89.
- 597 Nephrotic syndrome: Image B. Histology of focal segmental glomerulosclerosis. This image is a derivative work, adapted from the following source, available under . The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- Nephrotic syndrome: Image D. Diabetic glomerulosclerosis with Kimmelstiel-Wilson lesions. This image is a derivative work, adapted from the following source, available under . Doc Mari. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 598 Kidney stones: Image A. Nair S, George J, Kumar S, et al. Acute oxalate nephropathy following ingestion of Averrhoa bilimbi juice. Case Rep Nephrol. 2014; 2014: DOI: 10.1155/2014/240936.
- **598 Kidney stones: Image B.** This image is a derivative work, adapted from the following source, available under . Joel Mills. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 599 Hydronephrosis. Ultrasound. This image is a derivative work, adapted from the following source, available under Wikimedia Commons. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Pyelonephritis: Image A.** This image is a derivative work, adapted from the following source, available under . Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **600 Pyelonephritis: Image B.** CT scan. Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- **Acute tubular necrosis: Image A.** Muddy brown casts. This image is a derivative work, adapted from the following source, available under . Dr. Serban Nicolescu.
- 602 Renal papillary necrosis. Courtesy of the Department of Health and Human Services and William D. Craig, Dr. Brent J. Wagner, and Mark D. Travis.
- **Renal cyst disorders: Image C.** Ultrasound of simple cyst. This image is a derivative work, adapted from the following source, available under . Nevit Dilmen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **Renal cell carcinoma: Image A.** Histoilogy. This image is a derivative work, adapted from the following source, available under ...

FAS1_2019_20_ImageAck.indd 744 11/8/19 4:50 PM

- Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under 🙉 🕫
- Renal cell carcinoma: Image C. CT scan. This image is a derivative work, adapted from the following source, available under Behnes CL, Schlegel C, Shoukier M, et al. Hereditary papillary renal cell carcinoma primarily diagnosed in a cervical lymph node: a case report of a 30-year-old woman with multiple metastases. BMC Urol. 2013;13:3. DOI: 10.1186/1471-2490-13-3.
- Renal cell carcinoma: Image B. Gross specimen. Courtesy of Dr. Ed Uthman.
- **Renal oncocytoma: Image A.** Gross specimen. This image is a derivative work, adapted from the following source, available under Courtesy of M. Emmanuel.
- **Renal oncocytoma: Image B.** Histology. This image is a derivative work, adapted from the following source, available under see: Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under 💇 💇 .
- **Nephroblastoma.** This image is a derivative work, adapted from the following source, available under Es: Refaie H, Sarhan M, Hafez A. Role of CT in assessment of unresectable Wilms tumor response after preoperative chemotherapy in pediatrics. Sci World J. 2008;8:661-669. doi 10.1100/tsw.2008.96.
- **Urothelial carcinoma of the bladder: Image A.** This image is a derivative work, adapted from the following source, available under Geavlete B, Stanescu F, Moldoveanu C, et al. NBI cystoscopy and bipolar electrosurgery in NMIBC management—an overview of daily practice. J Med Life. 2013;6:140-145. PMCID PMC3725437.

Reproductive

- **615 Fetal alcohol syndrome.** This image is a derivative work, adapted from the following source, available under see: Courtesy of Teresa Kellerman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **618 Umbilical cord: Image A.** Cross-section of normal umbilical cord. This image is a derivative work, adapted from the following source, available under .: Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Meckel diverticulum: Image B.** This image is a derivative work, adapted from the following source, available under : Mathur P, Gupta R, Simlot A, et al. Congenital pouch colon with double Meckel's diverticulae. J Neonatal Surg. 2013 Oct-Dec; 2(4): 48.
- Uterine (Müllerian) duct anomalies: Images A-D. This image is a derivative work, adapted from the following source, available under Ahmadi F, Zafarani F, Haghighi H, et al. Application of 3D ultrasonography in detection of uterine abnormalities. Int J Fertil Steril. 2011; 4:144-147. PMCID PMC4023499.
- Female reproductive epithelial histology. Transformation zone. This image is a derivative work, adapted from the following source, available under :: Courtesy of Dr. Ed Uthman. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- **Seminiferous tubules.** This image is a derivative work, adapted from the following source, available under see: Dr. Anlt Rao. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Pregnancy complications.** This image is a derivative work, adapted from the following source, available under : Li W, Wang C, Lin

- T, et al. Misdiagnosis of bilateral tubal pregnancy: a case report. I Med Case Rep. 2014;8:342. DOI: 10.1186/1752-1947-8-342.
- **Hydatidiform mole: Image A.** Cluster of cluster of grapes appearance in complete hydatidiform mole. This image is a derivative work, adapted from the following source, available under . Dr. Ed
- 642 Choriocarcinoma: Image B. "Cannonball" metastases. This image is a derivative work, adapted from the following source, available under Ese Lekanidi K, Vlachou PA, Morgan B, et al. Spontaneous regression of metastatic renal cell carcinoma: case report. J Med Case Rep. 2007;1:89. DOI: 10.1186/1752-1947-1-89.
- Vulvar pathology: Image A. Bartholin cyst.
 Courtesy of the Department of Health and Human Services and Susan Lindsley.
- Vulvar pathology: Image B. Lichen sclerosis. This image is a derivative work, adapted from the following source, available under Lambert J. Pruritus in female patients. Biomed Res Int. 2014;2014:541867. DOI: 10.1155/2014/541867.
- **Vulvar pathology: Image C.** Vulvar carcinoma. This image is a derivative work, adapted from the following source, available under Ramli I, Hassam B. Carcinome épidermoïde vulvaire: pourquoi surveiller un lichen scléro-atrophique. Pan Afr Med J. 2015;21:48. DOI: 10.11604/pamj.2015.21.48.6018.
- Vulvar pathology: Image D. Extramallary Paget disease. This image is a derivative work, adapted from the following source, available under Wang X, Yang W, Yang J. Extramammary Paget's disease with the appearance of a nodule: a case report. BMC Cancer. 2010;10:405. DOI: 10.1186/1471-2407-10-405.
- Polycystic ovarian syndrome. This image is a derivative work, adapted from the following source, available under : Kopera D, Wehr E, Obermayer-Pietsch B. Endocrinology of hirsutism. Int J Trichology. 2010;2(1):30-35. doi:10.4103/0974-7753.66910
- **Dysgerminoma: Image B.** This image is a derivative work, adapted from the following source, available under : Montesinos L, Acien P, Martinez-Beltran M, et al. Ovarian dysgerminoma and synchronic contralateral tubal pregnancy followed by normal intra-uterine gestation: a case report. J Med Rep. 2012;6:399. DOI: 10.1186/1752-1947-6-399.
- Ovarian neoplasms: Image D. Mature cystic teratoma. This image is a derivative work, adapted from the following source, available under .: Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Ovarian neoplasms: Image E. Yolk sac tumor. This image is a derivative work, adapted from the following source, available under see: Jensflorian. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @ 👓
- **Ovarian neoplasms: Image F.** Call-Exner bodies. This image is a derivative work, adapted from the following source, available under Estrogen-producing Katoh T, Yasuda M, Hasegawa K, et al. Estrogen-producing endometrioid adenocarcinoma resembling sex cord-stromal tumor of the ovary: a review of four postmenopausal cases. Diagn Pathol. 2012;7:164. DOI: 10.1186/1746-1596-7-164.
- **Uterine conditions: Image A.** Endometrial tissue found outside the uterus. This image is a derivative work, adapted from the following source, available under Estings JM, Fazleabas AT. A baboon model for endometriosis: implications for fertility. Reprod Biol Endocrinol. 2006;4(suppl 1):S7. DOI: 10.1186/1477-7827-4-S1-S7.
- Uterine conditions: Image B. Endometritis with inflammation of the endometrium. This image is a derivative work, adapted from the following source, available under : Montesinos L, Acien P, Martinez-Beltran M, et al. Ovarian dysgerminoma and synchronic contralateral tubal pregnancy followed by normal intra-uterine

FAS1 2019 20 ImageAck.indd 745 11/8/19 4:50 PM

- gestation: a case report. J Med Rep. 2012;6:399. DOI: 10.1186/1752-1947-6-399.
- 648 Uterine conditions: Image C. Endometrial carcinoma. This image is a derivative work, adapted from the following source, available under 29: Izadi-Mood N, Yarmohammadi M, Ahmadi SA, et al. Reproducibility determination of WHO classification of endometrial hyperplasia/well differentiated adenocarcinoma and comparison with computerized morphometric data in curettage specimens in Iran. Diagn Pathol. 2009;4:10. DOI:10.1186/1746-1596-4-10.
- **Uterine conditions: Image D.** Leiomyoma (fibroid), gross specimen. This image is a derivative work, adapted from the following source, available under .: Courtesy of Hic et nunc.
- **Uterine conditions: Image E.** Leiomyoma (fibroid) histology. This image is a derivative work, adapted from the following source, available under : Londero AP, Perego P, Mangioni C, et al. Locally relapsed and metastatic uterine leiomyoma: a case report. *J Med Case Rep.* 2008;2:308. DOI: 10.1186/1752-1947-2-308. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- 649 Benign breast disease: Image A. Fibroadenomas. This image is a derivative work, adapted from the following source, available under Gokhale S. Ultrasound characterization of breast masses. Indian J Radiol Imaging. 2009 Aug;19(3):242-7. DOI: 10.4103/0971-3026.54878.
- 649 Benign breast disease: Images B (phyllodes tumor on ultrasound) and C (phyllodes cyst). This image is a derivative work, adapted from the following source, available under :: Muttarak MD, Lerttumnongtum P, Somwangjaroen A, et al. Phyllodes tumour of the breast. Biomed Imaging Interv J. 2006 Apr-Jun;2(2):e33. DOI: 10.2349/biij.2.2.e33.
- 650 Breast cancer: Image A. Mammography of breast cancer. This image is a derivative work, adapted from the following source, available under ... Molino C, Mocerino C, Braucci A, et al. Pancreatic solitary and synchronous metastasis from breast cancer: a case report and systematic review of controversies in diagnosis and treatment. World J Surg Oncol. 2014;12:2. DOI:10.1186/1477-7819-12-2
- Breast cancer: Image C. Comedocarcinoma. This image is a derivative work, adapted from the following source, available under Costarelli L, Campagna D, Mauri M, et al. Intraductal proliferative lesions of the breast—terminology and biology matter: premalignant lesions or preinvasive cancer? Int J Surg Oncol. 2012;501904. DOI: 10.1155/2012/501904. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- derivative work, adapted from the following source, available under Muttarak M, Siriya B, Kongmebhol P, et al. Paget's disease of the breast: clinical, imaging and pathologic findings: a review of 16 patients. Biomed Imaging Interv J. 2011;7:e16. DOI: 10.2349/biij.7.2.e16.
- 650 Breast cancer: Image E. Invasive lobular carcinoma. This image is a derivative work, adapted from the following source, available under Franceschini G, Manno A, Mule A, et al. Gastro-intestinal symptoms as clinical manifestation of peritoneal and retroperitoneal spread of an invasive lobular breast cancer: report of a case and review of the literature. BMC Cancer. 2006;6:193. DOI: 10.1186/1471-2407-6-193.
- **Breast cancer: Image E.** Peau d'orange of inflammatory breast cancer. This image is a derivative work, adapted from the following source, available under : Levine PH, Zolfaghari L, Young H, et al. What Is inflammatory breast cancer? Revisiting the case definition. *Cancers* (Basel). 2010 Mar;2(1):143–152. DOI: 10.3390/cancers2010143.
- **Penile pathology: Image A.** Peyronie disease. This image is a derivative work, adapted from the following source, available

- under Eran VQ, Kim DH, Lesser TF, et al. Review of the surgical approaches for Peyronie's disease: corporeal plication and plaque incision with grafting. Adv Urol. 2008; 2008: 263450. DOI: 10.1155/2008/263450.
- 651 Penile pathology: Image B. Squamous cell carcinoma. This image is a derivative work, adapted from the following source, available under
 □□□: Antônio JR, Antônio CR, Trídico LA. Erythroplasia of queyrat treated with topical 5-fluorouracil. An Bras Dermatol. 2016 Sep-Oct; 91(5 Suppl 1): 42–44. DOI: 10.1590/abd1806-4841.20164595.
- 651 Cryptorchidism. This image is a derivative work, adapted from the following source, available under Pandey A, Gangopadhyay AN, Kumar V. High anorectal malformation in a five-month-old boy: a case report. J Med Case Reports. 2010; 4: 296. DOI: 10.1186/1752-1947-4-296
- **Varicocele.** This image is a derivative work, adapted from the following source, available under Mak CW, Tzeng WS. Sonography of the scrotum. DOI: 10.5772/27586.
- 652 Scrotal masses: Image A. Congenital hydrocele. This image is a derivative work, adapted from the following source, available under Example: Leonardi S, Barone P, Gravina G, et al. Severe Kawasaki disease in a 3-month-old patient: a case report. BMC Res Notes. 2013;6:500. DOI: 10.1186/1756-0500-6-500.

Respiratory

- 661 Alveolar cell types: Image A. Electron micrograph of type II pneumocyte. This image is a derivative work, adapted from the following source, available under Experimental H, Tews S, Fehrenbach A, et al. Improved lung preservation relates to an increase in tubular myelin-associated surfactant protein A. Respir Res. 2005 Jun 21;6:60. The image may have been modified by cropping, labeling, and/or captions. All rights to this adaptation by MedIQ Learning, LLC are reserved.
- Alveolar cell types: Image B. Micrograph of type II pneumocyte. This image is a derivative work, adapted from the following source, available under .: Courtesy of Dr. Thomas Caceci.
- 661 Neonatal respiratory distress syndrome: Image A. This image is a derivative work, adapted from the following source, available under : Alorainy IA, Balas NB, Al-Boukai AA. Pictorial essay: infants of diabetic mothers. *Indian J Radiol Imaging*. 2010;20:174-181. DOI: 10.4103/0971-3026.69349.
- 663 Lung anatomy: Image A. X-ray of normal lung. This image is a derivative work, adapted from the following source, available under : Namkoong H, Fujiwara H, Ishii M, et al. Immune reconstitution inflammatory syndrome due to Mycobacterium avium complex successfully followed up using 18 F-fluorodeoxyglucose positron emission tomography-computed tomography in a patient with human immunodeficiency virus infection: A case report. BMC Med Imaging. 2015;15:24. DOI 10.1186/s12880-015-0063-2.
- 667 Cyanide vs carbon monoxide poisoning. This image is a derivative work, adapted from the following source, available under Subhaschandra S, Jatishwor W, Suraj Th. Isolated symmetrical bilateral basal ganglia T2 hyperintensity in carbon monoxide poisoning. Ann Indian Acad Neurol. 2008 Oct-Dec; 11(4): 251–253. DOI: 10.4103/0972-2327.44563.
- **Rhinosinusitis.** This image is a derivative work, adapted from the following source, available under Extremely P, Zagolski O, Sktadzien

FAS1_2019_20_ImageAck.indd 746 11/8/19 4:50 PM

- J. Fatty tissue within the maxillary sinus: a rare finding. Head Face Med. 2006;2:28. DOI: 10.1186/1746-160X-2-28.
- **Deep venous thrombosis.** This image is a derivative work, adapted from the following source, available under see: Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **672 Pulmonary emboli: Image B.** CT scan. This image is a derivative work, adapted from the following source, available under 22: Dr. Carl Chartrand-Lefebvre. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @ ? .
- **Mediastinal pathology.** This image is a derivative work, adapted from the following source, available under : Aga Z, Avelino J, Darling GE. An unusual case of spontaneous esophageal rupture after swallowing a boneless chicken nugget. Case Rep Emerg Med. 2016; 2016: 5971656. DOI: 10.1155/2016/5971656.
- Obstructive lung diseases: Image A. Lung tissue with enlarged alveoli in emphysema. This image is a derivative work, adapted from the following source, available under 200: Dr. Michael Bonnert.
- Obstructive lung diseases: Image B. CT of centriacinar emphysema. Courtesy of the Department of Health and Human Services and Dr. Edwin P. Ewing, Jr.
- **Obstructive lung diseases: Image C.** Emphysema histology. This image is a derivative work, adapted from the following source, available under see: Dr. Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @....
- **675 Obstructive lung diseases: Image D.** Barrel-shaped chest in emphysema. This image is a derivative work, adapted from the following source, available under . Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Obstructive lung diseases: Image E.** Mucus plugs in asthma. This image is a derivative work, adapted from the following source, available under see: Courtesy of Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Obstructive lung disease: Image F. Curschmann spirals. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @ ... Dr. James Heilman.
- **Obstructive lung diseases: Image G.** Charcot-Leyden crystals on bronchalverolar lavage. This image is a derivative work, adapted from the following source, available under : Gholamnejad M, Rezaie N. Unusual presentation of chronic eosinophilic pneumonia with "reversed halo sign": a case report. Iran J Radiol. 2014 May;11(2):e7891. DOI: 10.5812/iranjradiol.7891.
- **Obstructive lung disease: Image H.** Bronchiectasis in cystic fibrosis. This image is a derivative work, adapted from the following source, available under see: Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under @...
- **Restrictive lung diseases: Image A.** Pulmonary fibrosis. This image is a derivative work, adapted from the following source, available under Walsh SLF, Wells AU, Sverzellati N, et al. Relationship between fibroblastic foci profusion and high resolution CT morphology in fibrotic lung disease. BMC Med. 2015;13:241. DOI: 10.1186/s12916-015-0479-0.
- Sarcoidosis: Images A. Kajal B, Harvey J, Alowami S. Melkerrson-Rosenthal Syndrome, a rare case report of chronic evelid swelling. Diagn Pathol. 2013; 8: 188. DOI: 10.1186/1746-1596-8-188.

- Sarcoidosis: Images B (X-ray of the chest) and C (CT of the chest). X-ray of the chest) and C CT of the chest. This image is a derivative work, adapted from the following source, available under Euroborg J, Ward M, Gill A, et al. Utility of cardiac magnetic resonance in assessing right-sided heart failure in sarcoidosis. BMC Med Imaging. 2013;13:2. DOI: 10.1186/1471-2342-13-2.
- Inhalational injury and sequelae: Images A (18 hours after inhalation injury) and B (11 days after injury). This image is a derivative work, adapted from the following source, available under Bai C, Huang H, Yao X, et al. Application of flexible bronchoscopy in inhalation lung injury. Diagn Pathol. 2013;8:174. DOI: 10.1186/1746-1596-8-174.
- **Pneumoconioses: Image A.** Pleural plaques in asbestosis. This image is a derivative work, adapted from the following source, available under see: Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- **Pneumoconioses: Image B.** CT scan of asbestosis. This image is a derivative work, adapted from the following source, available under Miles SE, Sandrini A, Johnson AR, et al. Clinical consequences of asbestos-related diffuse pleural thickening: a review. *J Occup Med Toxicol*. 2008;3:20. DOI: 10.1186/1745-6673-3-20.
- **Pneumoconioses: Image C.** Ferruginous bodies in asbestosis. This image is a derivative work, adapted from the following source, available under see: Dr, Michael Bonert. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under
- Pneumoconioses: Image D. Berylliosis: non-caseous granuloma. Ann Saudi Med. 2009 Nov-Dec; 29(6): 485-486. DOI: 10.4103/0256-4947.57175.
- **Mesothelioma.** This image is a derivative work, adapted from the following source, available under :: Weiner SJ, Neragi-Miandoab S. Pathogenesis of malignant pleural mesothelioma and the role of environmental and genetic factors. J Carcinog. 2008;7:3. DOI: 10.1186/1477-3163-7-3.
- Acute respiratory distress syndrome: Image A. This image is a derivative work, adapted from the following source, available under Pires-Neto RC, Del Carlo Bernardi F, de Araujo PA. The expression of water and ion channels in diffuse alveolar damage is not dependent on DAD etiology. PLoS One. 2016; 11(11): e0166184. DOI: 10.1371/journal.pone.0166184.
- 678 Acute respiratory distress syndrome: Image B. Bilateral lung opacities. This image is a derivative work, adapted from the following source, available under Emanaka H, Takahara B, Yamaguchi H, et al. Chest computed tomography of a patient revealing severe hypoxia due to amniotic fluid embolism: a case report. J Med Case Reports. 2010;4:55. DOI: 10.1186/1752-1947-4-55.
- **Atelectasis.** This image is a derivative work, adapted from the following source, available under Es: Khan AN, Al-Jahdali H, Al-Ghanem S, et al. Reading chest radiographs in the critically ill (Part II): Radiography of lung pathologies common in the ICU patient. Ann Thorac Med. 2009;4(3):149–157. DOI:10.4103/1817-1737.53349
- Pleural effusions: Images A and B. This image is a derivative work, adapted from the following source, available under Toshikazu A, Takeoka H, Nishioka K, et al. Successful management of refractory pleural effusion due to systemic immunoglobulin light chain amyloidosis by vincristine adriamycin dexamethasone chemotherapy: a case report. Med Case Rep. 2010;4:322. DOI: 10.1186/1752-1947-4-
- Pneumothorax: Image A. This image is a derivative work, adapted 682 from the following source, available under ____: Miura K, Kondo R, Kurai M, et al. Birt-Hogg-Dubé syndrome detected incidentally by asymptomatic bilateral pneumothorax in health screening: a

FAS1_2019_20_ImageAck.indd 747 11/8/19 4:50 PM

748 SECTION IV

IMAGE ACKNOWLEDGMENTS

- case of a young Japanese woman. Surg Case Rep. 2015 Dec; 1: 17. DOI: 10.1186/s40792-015-0014-8.
- 682 Pneumothorax: Image B. This image is a derivative work, adapted from the following source, available under ☐☐☐ Rosat A, Díaz C. Reexpansion pulmonary edema after drainage of tension pneumothorax. Pan Afr Med J. 2015; 22: 143.DOI: 10.11604/pamj.2015.22.143.8097.
- **Pneumonia: Image A.** This image is a derivative work, adapted from the following source, available under Yoon BW, Song YG, Lee SH. Severe community-acquired adenovirus pneumonia treated with oral ribavirin: a case report. *BMC Res Notes*. 2017; 10: 47. DOI: 10.1186/s13104-016-2370-2.
- 683 Pneumonia: Image B. Lobar pneumonia, gross specimen. This image is a derivative work, adapted from the following source, available under . Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **Pneumonia: Image C.** Acute inflammatory infiltrates in bronchopneumonia. This image is a derivative work, adapted from the following source, available under : Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- **Pneumonia: Image D.** Bronchopneumonia, gross specimen. This image is a derivative work, adapted from the following source, available under . Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- **Pneumonia: Image E.** This image is a derivative work, adapted from the following source, available under Allen CM, AL-Jahdali HH, Irion KL, et al. Imaging lung manifestations of HIV/AIDS. *Ann Thorac Med.* 2010 Oct-Dec; 5(4): 201–216. DOI: 10.4103/1817-1737.69106.

- 684 Lung cancer: Image B. Adenocarcinoma histology. See Courtesy of the Department of Health and Human Services and the Armed Forces Institute of Pathology.
- **Lung cancer: Image C.** Squamous cell carcinoma. This image is a derivative work, adapted from the following source, available under . Dr. James Heilman. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under .
- 684 Lung cancer: Image E. Large cell lung cancer. This image is a derivative work, adapted from the following source, available under Jala VR, Radde BN, Haribabu B, et al. Enhanced expression of G-protein coupled estrogen receptor (GPER/GPR30) in lung cancer. BMC Cancer. 2012;12:624. doi 10.1186/1471-2407-12-624.
- 685 Lung abscess: Image A. Gross specimen. This image is a derivative work, adapted from the following source, available under Dr. Yale Rosen. The image may have been modified by cropping, labeling, and/or captions. MedIQ Learning, LLC makes this available under ...
- **685 Lung abscess: Image B.** X-ray. This image is a derivative work, adapted from the following source, available under **Courtesy** of Dr. Yale Rosen.
- 685 Pancoast tumor. This image is a derivative work, adapted from the following source, available under Manenti G, Raguso M, D'Onofrio S, et al. Pancoast tumor: the role of magnetic resonance imaging. Case Rep Radiol. 2013; 2013:479120. DOI: 10.1155/2013/479120.
- Superior vena cava syndrome: Images A (blanching of skin with pressure) and B (CT of chest). This image is a derivative work, adapted from the following source, available under Shaikh I, Berg K, Kman N. Thrombogenic catheter-associated superior vena cava syndrome. Case Rep Emerg Med. 2013; 2013: 793054. DOI 10.1155/2013/793054.

FAS1_2019_20_ImageAck.indd 748 11/8/19 4:50 PM

Index

A	Abruptio placentae, 640 cocaine use, 614	for osteoarthritis, 466	Acid phosphatase in neutrophils, 406 Acid reflux
A-a gradient	preeclampsia, 643	toxicity effects, 485 toxicity treatment for, 248	H ₂ blockers for, 399
by age, 668	Abscesses, 479	Acetazolamide, 252, 552, 608	proton pump inhibitors for, 399
with oxygen deprivation, 669	acute inflammation and, 214	pseudotumor cerebri, 521	Acid suppression therapy, 398
restrictive lung disease, 675	brain, 156, 177, 180	Acetoacetate metabolism, 90	Acinetobacter baumannii
Abacavir, 203	calcification with, 211	Acetone breath, 347	highly resistant bacteria, 198
Abeiximab	cold staphylococcal, 116	Acetylation	nosocomial infections, 142
Glycoprotein IIb/IIIa inhibitors, 438	frontal lobe, 153	chromatin, 34	Acinetobacter spp
therapeutic antibodies, 122	Klebsiella spp, 145	drug metabolism, 232	nosocomial infections, 185
thrombogenesis and, 411	liver, 155, 179	histones, 34	Acne, 475, 477
Abdominal aorta	lung, 685	posttranslation, 45	danazol, 658
atherosclerosis in, 302	necrosis with, 209	Acetylcholine (ACh)	tetracyclines for, 192
bifurcation of, 663	Staphylococcus aureus, 135	anticholinesterase effect on, 240	Acquired hydrocele (scrotal), 652
branches, 363	Toxoplasma gondii, 177	change with disease, 495	Acrodermatitis enteropathica, 71
Abdominal aortic aneurysm, 302	treatment of lung, 192	Clostridium botulinum inhibition	Acromegaly, 339
Abdominal pain	in unvaccinated children, 186	of release, 138	carpal tunnel syndrome, 459
bacterial peritonitis, 390	Absence seizures	opioid analgesics, 551	GH, 329
Budd-Chiari syndrome, 392	characteristics of, 517	pacemaker action potential and,	octreotide for, 400
diabetic ketoacidosis and, 347	drug therapy for, 544	292	somatostatin analogs for, 328
ectopic pregnancy, 641	Absolute risk reduction (ARR), 258	Acetylcholine (ACh) receptor	Actin
Henoch-Schönlein purpura, 315	AB toxin, 132	agonists, 551	cytoskeleton, 48
hypercalcemia, 591	Abuse	Acetylcholine receptors, 228, 236	muscular dystrophies, 61
hyperparathyroidism, 345	child, 269, 556	Acetylcholinesterase (AChE)	Acting out, 554
intussusception, 385	intimate partner violence, 269	in amniotic fluid, 491	Actinic keratosis, 482
irritable bowel syndrome, 383	Acalculia, 511	malathion and, 200	squamous cell carcinoma, 484
Meckel diverticulum, 618	Acalculous cholecystitis, 396	neural tube defects and, 491	Actinomyces israelii
pancreas divisum, 360	Acanthocytes, 414 Acantholysis, 475, 480	Acetylcholinesterase (AChE) inhibitors	culture requirements of, 127
pancreatic cancer, 398	Acanthosis, 475	naming convention for, 253	oral infections, 186
polyarteritis nodosa, 314	psoriasis, 477	for neuromuscular junction	pigment production, 128
porphyria, 425	Acanthosis nigricans, 228, 482	disease, 472	Actinomyces spp
postprandial, 363 RLQ pain, 384	stomach cancer, 379	toxicity treatment for, 248	effects and treatment of, 139
RUQ pain, 396	Acarbose, 353	Acetyl-CoA carboxylase	penicillin G/V for, 187
Abdominal wall	Accessory nerve (CN XI), 506	fatty acid synthesis, 73	Action/willpower stage, substance
anatomy, 369	arm abduction, 446	vitamin B ₇ and, 68	addiction, 568
inguinal hernias, 369	lesion of, 532	Achalasia, 376	Activated carrier molecules and
ventral defects, 358	Accessory pancreatic duct, 360, 368	esophageal cancer and, 378	form, 75
Abducens nerve (CN VI), 506	Accommodation, eye, 506, 535	LES tone in, 371	Active errors, 274
ocular motility, 540	Accuracy (validity), 259	Achilles reflex, 510	Active immunity, 110
palsy, 541	Acebutolol, 245, 319	Achilles tendon xanthomas, 301	Acute chest syndrome, 422
Abduction	ACE inhibitors, 610	Achlorhydria	Acute cholestatic hepatitis
arm, 446	acute coronary syndromes, 307	stomach cancer, 379	drug reactions and, 249
hand, 450	C1 esterase inhibitor deficiency,	VIPomas, 371	macrolides, 193 Acute coronary syndrome
hip, 451, 453	107	Achondroplasia, 462	ADP receptor inhibitors for, 437
passive, abnormal, 454	dilated cardiomyopathy, 308	chromosome disorder, 64	heparin for, 436
Abductor digiti minimi muscle, 450	dry cough, 251	endochondral ossification in, 458	nitrates for, 318
Abductor pollicis brevis muscle, 450	heart failure, 309	inheritance, 60	treatments for, 307
Abertalipoproteinemia, 94 , 414	hypertension, 316 naming convention for, 253	Acid-base physiology, 592 Acid-fast oocysts, 177	Acute cystitis, 594, 600
Abnormal uterine bleeding (AUB) non-structural causes (COEIN),	preload/afterload effects, 284	Acid-fast oocysis, 177 Acid-fast organisms, 125, 155	Acute disseminated (postinfectious)
633	teratogenicity, 614	Acidic amino acids, 81	encephalomyelitis, 524
structural causes (PALM), 633	Acetaldehyde, 72	Acid maltase, 86	Acute dystonia, 569
ABO blood classification, 405	Acetaldehyde dehydrogenase, 72	Acidosis, 592	treatment of, 241
hemolytic disease of the newborn,	Acetaminophen, 485	acidemia diuretic effect on, 609	Acute gastritis, 379
405	vs aspirin for pediatric patients,	cardiac contractility in, 284	Acute hemolytic transfusion
Abortion	485	hyperkalemia with, 590	reactions, 114
ethical situations, 268	free radical injury and, 210	metabolic, 85, 349	Acute hemorrhagic cystitis, 164
methotrexate for, 440	hepatic necrosis from, 249	renal tubular, 592	Acute inflammation, 214
	•		

FAS1_2019_21_Index_749-806.indd 749 11/21/19 12:27 PM

Acute inflammatory demyelinating Adenomas polyradiculopathy, 524 Acute intermittent porphyria, 425 Acute interstitial nephritis, 601 Acute kidney injury, 601 Acute laryngotracheobronchitis, 170 Acute lymphoblastic leukemia (ALL), 432 methotrexate for, 440 oncogenes and, 224 Acute mesenteric ischemia, 386 Adenosine Acute myelogenous leukemia (AML), 432 chromosomal translocations, 434 cytarabine for, 440 myelodysplastic syndromes, 432 Acute pancreatitis, **397** hyperparathyroidism, 345 necrosis and, 209 Acute pericarditis, 313 Acute-phase proteins, 108, 213 Acute-phase reactants, 213 IL-6, 108 Acute poststreptococcal glomerulonephritis, 596 Acute promyelocytic leukemia vitamin A for, 66 Acute pulmonary edema opioid analgesics, 551 Acute pyelonephritis, 600 WBC casts in, 594 Acute respiratory distress syndrome (ARDS), **678** eclampsia and, 643 Acute stress disorder, 564 Acute transplant rejection, 119 Acute tubular necrosis, 602 Acyclovir, 201 Adalimumab, 122, 487 for Crohn disease, 382 Adaptive immunity, 99 Addiction, stages of change in overcoming, 568 Addison disease, 349 HLA subtype association, 100 Additive effect of drugs, 235 Adduction arm (rotator cuff), 446 hand, 450 hip, 451 passive, abnormal, 454 thigh, 452 Adductor brevis, 452 Adductor longus, 451, 452 Adductor magnus, 452 Adenine Shiga/Shiga-like toxins and, 132 Adenocarcinomas carcinogens causing, 225 esophagus, 378 gastric, 216, 226 lung, 224, 684 nomenclature for, 220 nonbacterial thrombotic endocarditis and, 228 pancreas, 226, 368, 398 paraneoplastic syndromes, 228 pectinate line, 366 prostatic, 654 stomach, 379 Adenohypophysis, 327 Adrenocorticotropic hormone (ACTH) embryologic derivatives, 613 adrenal cortex regulation of, 327 hypothalamus and, 498 in Cushing syndrome, 228, 348

bone, 464 colorectal, 389 $nomenclature \ for, \ 220$ salivary gland, 376 thyroid, 342 Adenomatous colonic polyps, 387 Adenomyosis (endometrial), 648 uterine bleeding from, 633 Adenopathy Kawasaki disease, 314 as antiarrhythmic drug, 324 blood flow regulation, 297 pacemaker action potential and, 292 Adenosine deaminase deficiency, Adenosine triphosphate (ATP) electron transport chain, 78 production of, 74, 78 in TCA cycle, 77 in urea cycle, 82 Adenosine triphosphate (ATP) synthase inhibitors, 78 Adenoviruses characteristics of, 164 conjunctivitis, 534 pneumonia, 683 Adherens junctions, 474 Adhesions, 386 Adipose lipolysis, 320 Adipose tissue estrogen production, 630 in starvation, 91 Adjustment disorder, 564 Adnexal (ovarian) torsion, 625 Adoption studies, 256 ADPKD (Autosomal dominant polycystic kidney disease) saccular aneurysms and, 516 ADP receptor inhibitors, 437 ADP ribosyltransferases, 132 Adrenal adenomas Cushing syndrome, 348 hyperaldosteronism, 349 Adrenal carcinomas Li-Fraumeni syndrome, 224 P-glycoprotein in, 227 Adrenal cortex, 327 progesterone production, 630 Adrenal hemorrhage Waterhouse-Friderichsen syndrome, 349 Adrenal hyperplasia Cushing syndrome, 348 hyperaldosteronism and, 349 Adrenal insufficiency adrenoleukodystrophy, 47 anovulation with, 645 fludrocortisone for, 354 mechanism and types of, 349 vitamin B₅ deficiency, 67 Adrenal medulla, **327** neuroblastomas of, 350 pheochromocytomas in, 350 Adrenal steroids, 335 Adrenal zona fasciculata, 336 Adrenocortical atrophy Addison disease, 349 exogenous corticosteroids, 348 Adrenocortical insufficiency drug reaction and, 249

secretion of, 327 signaling pathways of, 337 Adrenoleukodystrophy, 47, 524 Adults common causes of death, 272 primary brain tumors, 526 Adult T-cell leukemia, 226 Adult T-cell lymphoma, 430 Advance directives, 266 Aedes mosquitoes yellow fever transmission, 168 Aerobes, 126 Aerobic metabolism ATP production, 74 fed state, 91 vitamin B₁ (thiamine), 66 Aerobic organisms culture requirements, 126 Afferent arteriole, 580 ANP/BNP effect on, 588 constriction of, 583 Afferent nerves, 296 Aflatoxins, 153 as carcinogen, 225 AFP, 117, 653 African sleeping sickness, 156 Afterload cardiac output, 284 hydralazine, 318 in shock, 310 Agammaglobulinemia chromosome affected, 64 Agars (bacterial culture), 126 Agenesis, 613 Müllerian, 622 uterovaginal, 639 Age-related amyloidosis, 212 Age-related macular degeneration (ARMD), **536** Aging changes, 270 Agnosia, 511 Agonists indirect cholinomimetic, 234 indirect general, 242 indirect sympathomimetics, 242 partial, 234 potency and efficacy, 234 Agoraphobia, 563 Agranulocytosis, 573 drug reaction and, 250 sulfa drug allergies, 252 thionamides, 354 Agraphia, 511 AIDS (acquired immunodeficiency syndrome) bacillary angiomatosis, 478 brain abscess, 180 Candida albicans, 153 cryptococcal meningitis, 199 Cryptosporidium, 155 Cytomegalovirus (CMV), 165 human herpesvirus 8, 165 marijuana for, 571 mycobacteria, 140 Pneumocystis jirovecii, 154 primary central nervous system lymphoma, 430 retinitis, 165 retroviruses, 167 time course (untreated), 176 Air emboli, 672 Airways (conducting zone), 662 Akathisia, 499, 519 antipsychotic drugs and, 573 Akinesia, 520

ALA dehydratase, 419, 425 Alanine ammonia transport, 82 gluconeogenesis in starvation, 91 pyruvate dehydrogenase complex deficiency, 77 Alanine aminotransferase (ALT), 77 hepatitis viruses, 172 in liver damage, 390 toxic shock syndrome, 135 Alar plate, 490 Albendazole cestodes, 160 Albinism, 476 locus heterogeneity, 57 ocular, 61 Albumin, 213 calcium and, 333 as liver marker, 390 Albuminocytologic dissociation (CSF), 524 Albuterol, 242 asthma, 687 Alcohol dehydrogenase, 72 Alcohol exposure in utero, 300 Alcoholic cirrhosis, 391 cholelithiasis and, 396 Alcoholic hepatitis, 391 Alcoholic liver disease, 391 Alcoholism, 145 anemia, 420 cataracts and, 535 cirrhosis and, 389 common organisms affecting, 179 esophageal cancer, 378 ethanol metabolism and, 72 folate deficiency, 420 gastritis in, 379 hepatitis, 367 hypertension and, 300 ketone bodies in, 90 Korsakoff syndrome, 558 liver serum markers in, 390 magnesium levels in, 332 Mallory-Weiss syndrome in, 377 osteonecrosis in, 463 pancreatitis, 249, 397 porphyria, 425 sideroblastic anemia, 419 vitamin B₁ deficiency, 66 vitamin B₉ deficiency, 68 Alcohol-related disorders readmissions with, 272 Alcohol use essential tremor, 519 gout and, 467 head and neck cancer, 671 intoxication and withdrawal, 570 sleep, 497 teratogenic effects, 614 Alcohol use disorder, 571 Alcohol withdrawal, 570 drug therapy, 546, 572 hallucinations in, 559, 570 Aldesleukin, 121 Aldolase B, 80 Aldose reductase, 81 Aldosterone, 588, 590 adrenal cortex secretion of, 327 SIADH, 338 signaling pathways for, 337 Aldosterone antagonists, 316 Aldosterone resistance, 593 Aldosterone synthase, 335

FAS1_2019_21_Index_749-806.indd 750 11/21/19 12:27 PM

Alemtuzumab, 122 Alendronate, 486 Alexia, 515 Alirocumab, 320 Aliskiren, 610 Alkaline phosphatase (ALP), 390, 463 bone disorder lab values, 464 hyperparathyroidism and, 345 Paget disease of bone, 463 in thyroid storm, 342 as tumor marker, 226 Alkalosis, 592 contraction, 60 diuretic effects, 609 hypokalemia with, 590 metabolic, 349 Alkaptonuria, 84 ALK gene, 224 lung cancer, 684 Alkylating agents, 441 as carcinogens, 225 targets of, 438 teratogenicity of, 614 Allantois, 618 Allelic heterogeneity, 57 Allergic bronchopulmonary aspergillosis (ABPA), 153 Allergic contact dermatitis, 477 Allergic reactions, 112 blood transfusion, 114 All-trans retinoic acid for promyelocytic leukemia, 66 Allopurinol for gout, 487 kidney stones, 598 Lesch-Nyhan syndrome, 37 rash with, 250 Alopecia doxorubicin, 439 etoposide/teniposide, 442 minoxidil for, 658 syphilis, 147 tinea capitis, 152 vitamin A toxicity, 66 vitamin B₅ deficiency, 67 vitamin B₇ deficiency, 68 α-1,4-glucosidase glycogen metabolism, 86 α_1 -antagonists BPH treatment, 654 α_1 -antitrypsin, 52 α_1 -antitrypsin deficiency, 51, 392 emphysema, 674 α_1 -blockers tamsulosin, example of, 237 α_1 selective blockers, 244 α_2 -agonists, 243 α_2 -antagonists, 576 α_2 selective blockers, 244 α-adrenergic agonists, 686 α-agonists glaucoma treatment, 552 muscle spasm treatment, 551 α-amanitin RNA polymerase inhibition, 42 α-amylase, 373 α-antagonists for pheochromocytomas, 350 α-blockers, 244 Beers criteria, 247 for cocaine overdose, 571 nonselective, 244 α cells, 328 glucagonomas in, 351 glucagon production by, 333

α-dystroglycan muscular dystrophy, 61 α-fetoprotein as tumor marker, 226 in hepatocellular carcinoma, 392 neural tube defects, 491 α-galactosidase A Fabry disease, 88 α-glucosidase inhibitors, 353 α-hemolytic cocci viridans group streptococci, 136 α-hemolytic bacteria Streptococcus pneumoniae, 136 α-intercalated cells, 593 α-ketoglutarate hyperammonemia and, 82 α-ketoglutarate dehydrogenase metabolic pathways, 74 TCA cycle, 7 vitamin B₁ and, 66 α-methyldopa, 243 anemia and, 423 α-oxidation, 47 Alpha rhythm (EEG), 497 α-synuclein, 520 α-thalassemia, 418 Alpha toxin, 133 α-toxin Clostridium botulinum, 138 α (type I) error, 263 Alport syndrome, 596 cataracts and, 535 collagen deficiency in, 50 Alprazolam, 546 Alteplase (tPA), 413, 437 Alternative hypothesis, 262 Alternative splicing, 43 Altitude sickness, 670 Altruism, 555 Aluminum hydroxide, 399 Alveolar cell types, 661 Alveolar dead space, 664 Alveolar gas equation, 668 Alveolar macrophages, 661, 662 Alveolar PO₂, 668 Alveolar sacs, 662 Alveolar stage (development), 660 Alveolar ventilation, 664 Alveoli, 660 pneumocytes, 661 Alzheimer disease, 520 amyloidosis in, 212 drug therapy for, 240, 549 neurotransmitters for, 495 Amanita phalloides necrosis caused by, 42, 249 RNA polymerase inhibition, 42 Amantadine, 548 Ambiguous genitalia 46,XY DSD, 639 ovotesticular disorder of sex development, 638 placental aromatase deficiency, 639 Amebiasis Entamoeba histolytica amebiasis, 155 antiandrogens, 658 cystic fibrosis, 60 ectopic pregnancy and, 641 functional hypothalamic, 645 menopause diagnosis, 636

Müllerian agenesis, 622

pituitary prolactinomas, 328

Amides (local anesthetics), 550

Amikacin, 191 Amiloride, 609 for diabetes insipidus, 338 Amines MAO inhibitors, 575 Amine whiff test, 148 Amino acids blood-brain barrier and, 496 branched, 84 classification of, $\bf 81$ codons for, 37 derivatives of, 83 genetic code for, 37 in histones, 34 metabolism, 90 purine synthesis, 35 tRNA, 44 urea cycle, 82 Aminoacyl-tRNA, 45 Aminoglycosides, 191 magnesium levels and, 332 pregnancy use, 204 Pseudomonas aeruginosa, 143 teratogenicity, 614 toxicity of, 251 Aminopenicillins mechanism and use, 188 Amiodarone, 323 hypothyroidism, 249 hypothyroidism with, 341 photosensitivity, 250 pulmonary fibrosis, 251 Amitriptyline, 575 migraine headaches, 518 Amlodipine, 318 Ammonia Ornithine transcarbamylase deficiency, 83 Ammonia transport, 82 Ammonium chloride overdose treatment, 233 Ammonium magnesium phosphate (kidney stones), 598 Amnesia brain lesions, 511 classification of, 558 Amnionitis Listeria monocytogenes, 139 Amniotic fluid abnormalities, 641 Amniotic fluid emboli, 672 Amniotic fluid tests AChE in, 491 with neural tube defects, 491 Amoxapine, 575 Amoxicillin clinical use, 188 Haemophilus influenzae, 142 Helicobacter pylori, 146 Lyme disease, 146 prophylaxis, 198 Amphetamines, 242 intoxication and withdrawal, 570 narcolepsy treatment, 568 norepinephrine and, 239 as weak bases, 233 Amphotericin B clinical use, 199 Cryptococcus neoformans, 153 Naegleria fowleri, 156 opportunistic fungal infections, systemic mycoses, 151 Ampicillin Ĉlostridium difficile, 138 Listeria monocytogenes, 139

mechanism and use, 188 meningitis, 180 prophylaxis, 198 Ampulla of Vater, 368 Amygdala lesions of, 511 limbic system, 499 Amylase in pancreatitis, 397 Amylin analogs, 353 Amyloid angiopathy intraparenchymal hemorrhage, 513 Amvloidosis cardiomyopathy with, 308 carpal tunnel syndrome, 459 classification, 212 kidney deposition in, 597 with rheumatoid arthritis, 466 Amyloid precursor protein (APP), 520 Amyotrophic lateral sclerosis (ALS) drug therapy for, 549, 551 spinal cord lesions, 530 Anabolic steroids hepatic adenomas and, 392 Anaerobic metabolism glycolysis, 74 pyruvate metabolism, 77 Anaerobic organisms aspiration and, 179 clindamycin, 192 Clostridia (with exotoxins), 138 culture requirements, 127 glycyclines, 192 metronidazole, 195 Nocardia vs Actinomyces, 139 overgrowth in vagina, 148 pneumonia caused by, 179 Anal atresia, 614 Anal cancer HIV and, 177 oncogenic microbes and, 226 Anal fissures, 366 Anal wink reflex, 510 Anaphase, 46 Anaphylaxis, 112 blood transfusion, 114 complement and, 106 epinephrine for, 242 IgA-containing products, 116 shock with, 310 Anaplasma spp Gram stain, 125 transmission, 146, 149 Anaplasmosis Anaplasma spp, 150 Anaplastic thyroid carcinomas, 343 Anastomoses, 503 Anastrozole, 656 Anatomic dead space, 664 Anatomic snuff box, 449 Anatomy endocrinal, 327-328 gastrointestinal, 360-369 of heart, 276, **283** hematologic/oncologic, 406–409 musculoskeletal, 446–454 nervous system, 493–510 renal, 580 reproductive, 624-627 respiratory, 662–663 "anchovy paste" exudate, 155 Ancylostoma, 159 diseases associated with, 161 infection routes, 158 microcytic anemia, 161 Androblastoma, 653

FAS1_2019_21_Index_749-806.indd 751 11/21/19 12:27 PM

Androgen-binding protein Sertoli cell secretion, 628	Angelman syndrome chromosome association, 64	H ₂ , 254 nonselective, 245	Anticoagulant drugs acute coronary syndromes, 307
Androgenetic alopecia, 658 Androgenic steroid abuse, 636	Angina aortic stenosis, 291	of drugs, 235 Anterior cerebral artery	antiphospholipid syndrome, 470 atrial fibrillation, 295
Androgen insensitivity syndrome, 639	atherosclerosis, 302	cingulate herniation, 529	coagulation cascade and, 412
Androgen receptor defect, 639	cocaine causing, 571	cortical distribution, 502	Anticoagulation
Androgens, source and functions,	contraindicated drugs, 323	stroke, 514	coagulation cascade and, 413
636	drug therapy for, 318, 324	Anterior circulation strokes, 514	Anticonvulsant drugs, 471
Androstenedione, 335, 636 Anemia, 417	glycoprotein IIb/IIIa inhibitors for, 438	Anterior communicating artery saccular aneurysm, 516	Antidepressant drugs, 574 –576 atypical, 576
amphotericin B, 199	ischemic disease and, 304	Anterior corticospinal tract, 508	for fibromyalgia, 471
Ancylostoma, 161	unstable/NSTEMI treatment, 307	Anterior cruciate ligament (ACL)	long QT interval with, 294
babesiosis, 157	Angina, "intestinal," 386	injury	torsades de pointes, 248
bacterial endocarditis, 311 blood oxygen content, 666	Angina pectoris β-blockers for, 245	anterior drawer sign in, 454 "unhappy triad," 460	Anti-desmoglein (anti-desmosome) autoantibody, 115
blood transfusion therapy, 429	Angiodysplasia, 386	Anterior drawer sign, 454	Anti-digoxin Fab fragments, 248
blood viscosity in, 286	Angioedema, 610	Anterior hypothalamus, 498	for cardiac glycoside toxicity, 321
cephalosporins, 189	C1 esterase inhibitor deficiency,	Anterior inferior cerebellar artery, 514	Antidiuretic hormone (ADH), 329 ,
chloramphenicol, 192 colorectal cancer, 388	107	Anterior inferior tibiofibular	588, 590
cytarabine and, 440	scombroid poisoning, 247 Angiogenesis	ligament, 455 Anterior pituitary gland, 327, 331	antagonist naming conventions, 254
dapsone, 194	bevacizumab and, 442	Anterior spinal artery	antagonists, 338, 354
Diphyllobothrium latum, 160	wound healing and, 216	complete occlusion, 530	in diabetes insipidus, 338
drug reaction and, 250 Escherichia coli, 145	Angiokeratomas, 88	stroke, 514 Anterior talofibular ligament, 455	function of, 328
ESR in, 214	Angiomas, 117 Angiosarcomas, 392, 478	Anterior talonbular figament, 433 Anterograde amnesia, 558	hypothalamus synthesis, 498 pituitary gland and, 327
extrinsic hemolytic, 423	carcinogens causing, 225	benzodiazepines, 550	SIADH and, 338
G6PD deficiency, 79	nomenclature for, 220	brain lesions, 511	signaling pathways of, 337
hookworms, 159	Angiotensin-converting enzyme	Anthracosis, 677	Anti-DNA topoisomerase I
in hypertensive emergency, 300 intrinsic hemolytic, 422	(ACE) inhibitors, 610 Angiotensin II, 588, 590	Anthracyclines, 439 cardiomyopathy from, 248	autoantibody, 115 Anti-dsDNA antibody, 115
isoniazid, 197	ACE inhibitor effects on, 610	Anthrax, 132, 137	Antiemetic drugs
kwashiorkor, 71	signaling pathways for, 337	Anthrax toxin	aprepitant, 401
lab values, 419	Angiotensin II receptor blockers, 610	Bacillus anthracis and, 137	long QT interval with, 294
macrocytic, 419 malaria, 157	heart failure, 309 hypertension, 316	Anti-ACh receptor antibody, 115 Antiandrogen drugs, 658	marijuana, 571 metoclopramide, 400
megaloblastic, 420	naming convention for, 253	Antianginal therapy, 307, 318, 319 ,	ondansetron, 400
microcytic, hypochromic, 418	preload/afterload effects, 284	324	torsades de pointes, 248
nonhemolytic, normocytic, 421	Anhedonia, 561	Antiapoptotic molecule	Antiepileptic drugs
normocytic, normochromic, 421 NRTIs, 203	Anhidrosis Horner syndrome, 540	oncogene product, 224	Cytochrome P-450 interactions, 252
oxygen deprivation and, 669	Anidulafungin, 200	Antiarrhythmic drugs mechanisms and clinical uses,	for fibromyalgia, 471
penicillin G, V, 189	Aniline dyes, 606	322–324	rash from, 250
pernicious anemia, 372, 379	transitional cell carcinoma and,	torsades de pointes, 248	teratogenicity, 614
pregnancy and, 633 pure red cell aplasia, 228	606 Anisocytosis, 407	Antibiotics, 153 acne treatment, 477	Antifungal drugs griseofulvin, 48
recombinant cytokines for, 121	Anitschkow cells, 312	Clostridium difficile with, 138	mechanism and use, 198 –200
renal failure, 603	Ankle sprains, 455	Jarisch-Herxheimer reaction with,	seborrheic dermatitis, 476
sideroblastic, 67, 419	Ankylosing spondylitis, 469	148	tinea versicolor, 152
spherocytes in, 415 in sulfa drug allergies, 252	HLA-B27 and, 100	long QT interval, 294	Antigenic shift/drift, 169
taxonomy, 417	therapeutic antibodies for, 122 TNF-α inhibitors for, 487	selective growth media, 126 torsades de pointes, 248	Antigen-presenting cells (APCs) B cells as, 409
thioamides causing, 354	Annular pancreas, 360	Antibodies	CD28, 110
trimethoprim, 194	Anopheles mosquito, 157	in adaptive immunity, 99	MHC I and II and, 100
tropical sprue, 381 vitamin B ₁₂ deficiency, 69	Anopia visual field defects, 542	antibody diversity generation, 104 antibody specificity generation, 104	naive T-cell activation, 103 in spleen, 98
vitamin B_{12} deficiency, 68	Anorectal varices	exo- and endotoxins, 131, 133	Antigens
Weil disease, 147	portal circulation, 365	hepatitis viruses, 174	active immunity, 110
Wilson disease, 395	Anorexia	hypersensitivity mediation, 112	antibody structure and function,
Anemia of chronic disease, 421 rheumatoid arthritis, 466	hypothalamus and, 498 liver cancer/tumors, 392	structure and function, 104 therapeutic, 122	104 chronic mucocutaneous
Anencephaly, 491	pancreatic adenocarcinoma, 398	Antibody-dependent cell-mediated	candidiasis, 116
polyhydramnios and, 641	renal failure, 603	cytotoxicity, 101	for self, 102
Anergy, 110	Anorexia nervosa	Anticardiolipin	HLA I and II, 100
Anesthetics general principles, 549	anovulation with, 645 characteristics of, 567	antiphospholipid syndrome, 470 Anticardiolipin antibody, 115	lymphocyte recognition of, 98 type and memory, 105
inhaled, 550	Anosmia	Anti-CCP antibody, 115	Anti-glomerular basement membrane
intravenous, 550	zinc deficiency, 71	Anti-centromere antibodies	autoantibody, 115
local, 550	ANOVA tests, 264	scleroderma, 473	Anti-glutamic acid decarboxylase
Aneuploidy, 638 Aneurysms, 516	Anovulation common causes, 645	Anticentromere autoantibody, 115 Anticholinergic drugs	autoantibody, 115
atherosclerosis, 302	Antacids, 399	delirium with, 558	Antigout drugs colchicine, 48
coarctation of aorta, 299	Antagonists	toxicity treatment for, 248	Anti-HBc, 174
Ehlers-Danlos syndrome, 51	ADH, 254	Anticholinesterase drugs, 240	Anti-HBe, 174
superior vena cava syndrome, 685 ventricular, 305, 307	endothelin receptor, 254 ethanol antidote, for, 235	Anticholinesterase poisoning, 240 Anticipation (genetics), 56	Anti-HBs, 174 Anti-helicase autoantibody, 115
	Caranor and doc, 101, 277	· maiorpation (Serieties), 70	. Inc. memease autoditioody, 117

FAS1_2019_21_Index_749-806.indd 752 11/21/19 12:27 PM

stimulants and, 570

Antihelminthic drugs, 200
mebendazole, 48
naming convention, 253 Anti-hemidesmosome autoantibody,
115
Antihistamines, 686 for scombroid poisoning, 247
Anti-histone antibody, 115
Antihypertensive drugs
hypertension in pregnancy, 643 Anti-IgE monoclonal therapy, 687
Anti-IL-5 monoclonal therapy, 687
Anti-inflammatory drugs, 485
Anti-intrinsic factor autoantibody, 115 Anti-La/SSB autoantibody, 115
Antileukotrienes
for asthma, 687 Antimetabolites, 440
Antimicrobial drugs
highly resistant bacterial treatment,
198 mechanisms of action summary,
187 –204
naming conventions for, 253 pregnancy contraindications, 204
prophylaxis, 198
Antimicrosomal autoantibody, 115
Anti-mite/louse therapy, 200 Antimitochondrial autoantibody, 115
Antimuscarinic drugs
Parkinson disease, 548 reactions to, 251
toxicity treatment for, 248
Antimycin A electron transport chain, 78
Antimycobacterial therapy, 196
Anti-NMDA receptor paraneoplastic
syndrome encephalitis, 228 Antinuclear (ANA) antibody, 115
Sjögren syndrome, 468
Antioxidants free radical elimination by, 210
Antiparasitic drugs
naming convention for, 253 Antiparietal cell autoantibody, 115
Anti-phospholipase A2 receptor
autoantibody, 115
Antiphospholipid syndrome, 470 autoantibody in, 115
Antiplatelet antibodies
abciximab as, 122 Antiplatelet drugs
for acute coronary syndromes, 307
Anti-presynaptic voltage-gated calcium channel
autoantibody, 115
Antiprogestin drugs, 657
Antiprotozoan drugs, 200 Antipseudomonal drugs
cephalosporins, 189
fluoroquinolones, 195 penicillins, 188
Antipsychotic drugs
adverse effects/events, 573 antimuscarinic reaction, 251
atypical, 573
dopaminergic pathways, 499
dystonia with, 569 long QT interval with, 294
Parkinson-like syndrome, 251
tardive dyskinesia, 251 torsades de pointes, 248
Tourette syndrome, 572
typical, 573
Antiribonucleoprotein antibodies Sjögren syndrome, 468

Anti-Ro/SSA autoantibody, 115
Anti-Scl-70 autoantibody, 115
Anti-Smith autoantibody, 115 Anti-smooth muscle autoantibody,
Antisocial personality disorder, 565
early-onset disorder, 557 Antispasmodics, 551
Anti-SRP autoantibody, 115
Anti-streptolysin O (ASO) titers, 312 Antisynthetase autoantibody, 115
Antithrombin coagulation cascade and, 413
deficiency of, 428
Antitoxins as passive immunity, 110
Anti-TSH receptor autoantibody, 115
Antitumor antibiotics, 439 Anti-U1 RNP antibodies, 115, 470
Antiviral therapy hepatitis C, 203, 204
mechanism and use, 201
Anti- β_2 glycoprotein antiphospholipid syndrome, 470
autoantibody, 115
Anxiety drug therapy, 546, 563, 575
neurotransmitters, 495 Aorta
branches, 363
coarctation of, 299, 300 congenital heart disease, 298
diaphragm, 663 ECG and, 293
retroperitoneal, 360
in syphilitic heart disease, 312 traumatic rupture of, 303
"tree bark" appearance, 312
Aortic aneurysm, 302 Ehlers-Danlos syndrome, 51
hypertension, 300 Marfan syndrome, 300
syphilitic heart disease, 312
Aortic arch derivatives, 619 Aortic arch receptors, 296
Aortic dissection, 303
hypertension, 300 Marfan syndrome, 300
Aortic insufficiency syphilitic heart disease, 312
Aorticopulmonary septum, 281
embryologic derivatives, 613 Aortic regurgitation, 288
heart murmurs with, 291 Marfan syndrome, 300
Aortic root dilation
heart murmur with, 291 Aortic stenosis, 288
heart murmurs, 291
macroangiopathic anemia, 423 Williams syndrome, 300
Aortic valve cardiac cycle, 287
embryological development of,
281 Aortitis
syphilis, 147, 184 Apalutamide, 658
APC gene, 224
adenomatous colonic polyps and, 387
colorectal cancer and, 389
familial adenomatous polyposis and, 387
"Ape hand," 447, 451 Apgar score, 634

Apgar score, 634

Aphasia
MCA stroke, 514
types of, 516
Aphthous stomatitis
Crohn disease, 382
Apixaban
factor Xa inhibitors, 437 Aplasia, 613
Aplasia cutis
methimazole, 354
Aplastic anemia, 421
chloramphenicol, 192
drug reaction and, 250
neutropenia with, 424
thionamides, 354
Aplastic crisis
hereditary spherocytosis, 422 sickle cell anemia, 422
Apolipoproteins
functions of, 93
Apoptosis, 208
corticosteroids, 424
Appendages (bacterial), 124
Appendicitis, 383
mittelschmerz vs, 631
Appetite regulation, 336 , 371
"Apple core" lesion (X-ray), 388
Apraclonidine, 552
Aprepitant, 401 Aqueous humor pathway, 535
Arabinofuranosyl cytidine, 440
Arabinogalactan synthesis, 196
Arabinosyltransferase, 197
Arachidonic acid pathway, 485
Arachnodaetyly, 52
Arachnoid granulations, 503, 504, 522
Arachnoid mater
meninges, 496
meningioma, 526 ventricular system, 504
Arcuate fasciculus
aphasia and, 516
diagram, 501
Area postrema, 498
Area under the curve, 231
Arenaviruses, characteristics of, 167
Argatroban, 435
Arginine classification, 81
cystinuria, 85
kidney stones and, 598
Argininosuccinate,, 82
Argyll Robertson pupils
in syphilis, 184
tabes dorsalis, 530
Aripiprazole, 573
Arm abduction, 446
Armadillos (disease vectors), 149 Aromatase, 636
in pathway, 335
Aromatase inhibitors, 656
Aromatic amines
carcinogenicity of, 225
Arrhythmias
amphotericin B, 199
diabetic ketoacidosis, 347
diphtheria, 139 drug reactions and, 248
hypokalemia and, 591
local anesthetics and, 550
macrolides, 193
McArdle disease, 87
muscular dystrophy, 61
myocardial infarction and, 305, 307
shock caused by, 310
sleep apnea and, 679

```
TCA toxicity, 569
   thyroid hormones and, 354
Arsenic
   angiosarcomas, 392, 478
   carcinogenicity of, 225
   glycolysis and, 74
   toxicity symptoms, 76
   toxicity treatment, 248
Artemether, 200
Arterial oxygen saturation, 666
Arterial PCO<sub>2</sub>, 668
Arteries, anatomy of, 283
Arteriolosclerosis, 301, 346
Arteriosclerosis, 301
Arteriovenous malformations (AVMs)
   hereditary hemorrhagic
          telangiectasia, 316
Arteriovenous shunts, 463
Arteritis
   giant cell (temporal), 314, 518
   headaches, 518
Artesunate
   malaria, 157, 200
Arthralgias
   alkaptonuria, 84
   coccidiomycosis, 151
   Henoch-Schönlein purpura, 315
   hepatitis viruses, 172
   in alkaptonuria, 84
   rubella, 169, 182
   serum sickness, 113
   vitamin A toxicity, 66
Arthritis, 457, 466
azathioprine for, 440
Campylobacter jejuni, 145
   carpal tunnel syndrome and, 459
   celecoxib for, 486
   chlamydiae, 148, 184
   Crohn disease, 382
   gonococcal, 468
gonorrhea, 142, 180, 184
   immunosuppressants, 120
   inflammatory bowel disease, 100
   lupus, 470
   Lyme disease, 146 psoriatic, 469
   reactive arthritis, 469
   septic, 468
Staphylococcus aureus, 135
   Takayasu arteritis, 314
therapeutic antibodies, 122
   ulcerative colitis, 382
Arthropathy
   hemochromatosis, 395
Arthus reaction, 113
Arylsulfatase A
   metachromatic leukodystrophy, 88
 Arytenoids, 620
Asbestos
carcinogenicity, 225
Asbestosis, 677, 678
Ascaris lumbricoides, 159
Ascaris spp, 158
Ascending cholangitis, 397
Ascending colon, 360
Aschoff bodies, 312
Ascites
   Budd-Chiari syndrome, 392
   hepatocellular carcinoma, 392
   spontaneous bacterial peritonitis, 390
Ascorbic acid, 69
Asenapine, 573
Aseptic meningitis
   mumps, 170
   picornaviruses, 167
```

FAS1_2019_21_Index_749-806.indd 753 11/21/19 12:27 PM

Asherman syndrome, 648 Ashkenazi Jews	opsoclonus-myoclonus syndrome, 228	ECG tracings, 295 Lyme disease, 146	Autonomic ganglia, 236 Autonomic insufficiency, 242
disease incidence, 88	prion disease, 178	Atrioventricular canals, 281	Autonomic nervous system (ANS)
ASO titer, 136	psychoactive drug intoxication, 570	Atrioventricular node	delirium tremens, 569
Aspart, 352	streptomycin, 197	AV node, 292	dysregulation in inflammatory
Aspartame, 84	sypĥilis, 147	conduction pathway, 293	demyelinating
Aspartate	tabes dorsalis, 530	ECG and, 293	polyradiculopathy, 524
urea cycle, 82	trinucleotide repeat expansion	Atrioventricular valves	limbic system in, 499
Aspartate aminotransferase (AST), 390	disease, 62	embryologic development of, 281	male sexual response, 627
hepatitis, 172	truncal, 511	Atrophic gastritis gastrin in, 371	receptors in, 236
toxic shock syndrome, 135	vitamin B ₁₂ deficiency, 530 vitamin E deficiency, 70	Atrophy, 206	in serotonin syndrome, 569 Autonomy (ethics), 265
Aspartic acid, 81 Aspergillosis	Wernicke-Korsakoff syndrome,	motor neuron signs, 529, 531	Autoregulation of blood flow, 297
Aspergillus fumigatus, 153	511, 571	neurodegenerative disorders, 520	Autosomal dominant diseases, 60
bronchiectasis, 674, 675	Ataxia-telangiectasia, 40, 117	optic disc/nerve, 536	ADPKD, 516
echinocandins, 200	Atazanavir, 203	ventriculomegaly, 522	Brugada syndrome, 294
Aspergillus fumigatus, 153	Atelectasis, 680	Atropine, 241	Charcot-Marie-Tooth disease, 524
HIV-positive adults, 177	Atenolol, 245, 323	antimuscarinic reaction, 251	elastin syndrome, 52
Aspergillus spp	Atherosclerosis, 302	for β-blocker overdose, 323	Huntington disease, 520
chronic granulomatous disease, 109	abdominal aortic aneurysms and,	effects of, 241	hyper-IgE syndrome, 116
Aspiration	302 diabetes mellitus and, 346	toxicity treatment, 248	hypertrophic cardiomyopathy, 308
ARDS and, 678	familial dyslipidemias, 94	Attention-deficit hyperactivity disorder (ADHD), 557	malignant hyperthermia susceptibility, 550
in utero "breathing," 660	homocystinuria, 84	drug therapy for, 557, 572	neurofibromatosis, 525
lung abscess, 685 reflux-related, 359, 377	renovascular disease, 604	Tourette syndrome, 557	porphyrias, 425
Zenker diverticulum, 384	stable angina with, 304	Attributable risk (AR), 258	Romano-Ward syndrome, 294
Aspiration pneumonia	transplant rejection, 119	Atypical antidepressants, 576	tuberous sclerosis, 525
alcoholics, 179	Athetosis, 511, 519	Atypical antipsychotic drugs, 573	von Hippel-Lindau disease, 525
clindamycin, 192	Atomoxetine, 557	postpartum psychosis, 562	Autosomal dominant polycystic kidne
nosocomial infections, 185	Atonic seizures, 517	Atypical depression, 575	disease (ADPKD), 604
Aspirin, 486	Atopic dermatitis (eczema), 477	Atypical pneumonias	chromosome association, 64
acute coronary syndromes, 307	Atopic reactions, 112	chlamydiae, 148	Autosomal dominant tubulointerstiti
cyclooxygenase, 411	Atovaquone babesiosis, 157	macrolides, 193 typical organisms, 683	kidney disease, 604 Autosomal recessive diseases, 60
hemolysis in G6PD deficiency, 250	malaria, 157	Auditory cortex	abetalipoproteinemia, 94
for ischemic stroke, 512	P. falciparum, 200	diagram, 501	adenosine deaminase deficiency,
Kawasaki disease, 314	for Pneumocystis jirovecii, 154	thalamic relay, 498	117
thrombogenesis and, 411	ATPase, 395	Auditory hallucinations, 559	alkaptonuria, 84
uncoupling agent, 78 as weak acid, 233	ATP production, 74	Auditory physiology, 533	Chédiak-Higashi syndrome, 117
zero-order elimination of, 232	Atresia	Auerbach plexus, 376, 384	cystic fibrosis, 60
Asplenia	anal, 614	Auer rods	5α-reductase deficiency, 639
Streptococcus pneumoniae, 136	duodenal, 359	in AML, 432	Friedreich ataxia, 531
target cells, 415	esophageal, 359 intestinal, 359	Auramine-rhodamine stain, 125	hemochromatosis, 395 hereditary hyperbilirubinemias,
Asterixis, 519	jejunal/ileal, 359	Auscultation of heart, 290 Auspitz sign, 477	394
hepatic encephalopathy, 391	Atria	Autism spectrum disorder, 557	IL-12 receptor deficiency, 116
renal failure, 603	cardiac tumors, 316	double Y males and, 638	Jervell and Lange-Nielsen
Asteroid bodies, 676	depolarization/repolarization of,	fragile X syndrome, 62	syndrome, 294
Asthma, 674	293	Autoantibodies, 115	Kartagener syndrome, 49
albuterol for, 242 β-blockers and, 245	embryologic development of, 281	Autoclaves	leukocyte adhesion deficiency, 11
breast milk and, 636	Atrial fibrillation	disinfection/sterilization, 204	maple syrup urine disease, 84
cromolyn sodium for, 408	β-blockers for, 323	Autodigestion, 397	severe combined
drug therapy, 687	calcium channel blockers for, 324	Autoimmune diseases	immunodeficiency, 117
epinephrine for, 242	cardiac glycosides for, 321 ECG tracing of, 295	acute pericarditis, 313 blistering skin, 480	spinal muscular atrophy, 530 Wilson disease, 395
gastroesophageal reflux disease, 377	hypertension, 300	collagen and, 50	Autosomal recessive polycystic kidne
hypertension treatment with, 316	jugular venous pulse in, 287	Dressler syndrome, 307	disease (ARPKD), 604
immunosuppressants, 120	potassium channel blockers for,	myocarditis with, 313	Potter sequence caused by, 578
muscarinic antagonists for, 241	323	rheumatoid arthritis, 466	Autosomal trisomies, 63
omalizumab for, 122	Atrial flutter	self-antigen in, 102	Down syndrome (trisomy 21), 63
pulsus paradoxus in, 310 salmeterol for, 242	β-blockers for, 323	Sjögren syndrome, 468	Edwards syndrome (trisomy 18), 6
type I hypersensitivity, 112	ECG tracing of, 295	SLE, 470	karyotyping for, 55
Astigmatism, 535	potassium channel blockers for, 323	Autoimmune gastritis, 379 Autoimmune hemolytic anemia, 423	Patau syndrome (trisomy 13), 63
Astrocytes, 493	"Atrial kick," 287	cephalosporins, 189	Avascular necrosis femoral head, 461
foot processes, 496	Atrial natriuretic peptide (ANP), 296 ,	Autoimmune hepatitis type 1	Avascular necrosis, 463
origin of, 490	588, 590	autoantibody, 115	scaphoid bone, 449
Ataxia	in SIADH, 338	Autoimmune hypothyroidism, 173	sickle cell anemia, 422
abetalipoproteinemia, 94	signaling pathways for, 337	Autoimmune lymphoproliferative	Aversive stimulus (positive
cerebellar hemisphere lesions, 511	Atrial septal defect (ASD), 299	syndrome, 208	punishment), 554
Friedreich, 62, 64, 531	congenital rubella, 300	Autoimmune regulator (AIRE), 102	Avoidant personality disorder, 566
hypnotics, 546 lithium toxicity, 569	Down syndrome, 300	Autoimmune thrombocytopenia, 121	Axilla/lateral thorax, 455
metachromatic leukodystrophy, 88	fetal alcohol syndrome, 300 Atrioventricular (AV) block	Autonomic drugs, 236–245 actions of, 239	Axillary nerve arm abduction, 446
normal pressure hydrocephalus,	β-blockers, 245, 323	bladder dysfunction, action on, 237	injury presentation, 447
522	calcium channel blockers, 318, 324	naming conventions for, 253	neurovascular pairing, 455
	· · · · · · · · · · · · · · · · · · ·	· /	1 0,

FAS1_2019_21_Index_749-806.indd 754 11/21/19 12:27 PM

Axonal injury, 495	Bacterial infections	B-cell lymphomas	Berkson bias, 260
Axonal trafficking, 48	with immunodeficiency, 118	HIV-positive adults, 177	Bernard-Soulier syndrome, 411, 427
Axonemal dynein, 49	myocarditis with, 313	B cells, 409	Berry aneurysm, 516
Azathioprine	skin, 479	activation, 103, 105	Berylliosis, 677
antimetabolites, 440	Bacterial peritonitis (spontaneous),	adaptive immunity, 99	β ₁ -blockade, 284
for Crohn disease, 382	389, 390	anergy, 110	β ₂ -agonists
immunosuppressant, 120	Bacterial toxin mechanisms	cell surface proteins, 110	naming convention for, 253
pancreatitis caused by, 249	inhibit release of neurotransmitter,	class switching, 103	β ₂ -agonists
Azithromycin	132	disorders of, 116, 117	asthma, 687
atypical pneumonia treatment,	lysogenic phage encoding of, 130	function of, 409	insulin and, 334
148	Bacterial vaginosis	functions of, 101	β-adrenergic agonist
babesiosis, 157	characteristics of, 158, 181	glucocorticoid effects, 120	potassium shifts, 590
chlamydiae, 148	Gardnerella vaginalis, 148	immunodeficiency infections, 118	β-blockers, 245, 323
in cystic fibrosis, 60	Bacteroides fragilis, 178	in lymph node, 96	acute coronary syndromes, 307
gonorrhea treatment, 142	Bacteroides spp	neoplasms, 430	angina, 319
macrolides, 193	alcoholism, 179	non-Hodgkin lymphoma, 429	aortic dissections, 303
Mycobacterium avium-	clindamycin, 192	sirolimus effect, 120	Cardiomyopathy (hypertrophic),
intracellulare, 140, 196	culture requirements of, 127	spleen, 98	245
prophylaxis in HIV, 198	metronidazole, 195	BCG vaccine	cocaine overdose, 571
Azoles, 153, 199	nosocomial infections, 185	false positives from, 140	diabetes and, 245
vaginal infections, 181	"Bag of worms," 651	IL-12 receptor deficiency and, 116	dilated cardiomyopathy, 308
Azotemia	Baker cyst, 460	BCL-2 gene, 224	essential tremor, 519
acute interstitial nephritis, 601	tibial nerve injury, 453	Bcl-2 protein, 208	for cocaine overdose, 242
Aztreonam, 190	BAK protein, 208	BCR-ABL gene, 224	for pheochromocytomas, 350
_	Balancing (quality measurement), 273	Bead-like costochondral junctions, 463	for thyroid storm, 342
В	Bamboo spine, 469	Becker muscular dystrophy, 61	glaucoma treatment, 552
Babesia spp, 146, 157	Band cells, 406	Beck triad (cardiac tamponade), 310	heart failure, 309
Babesiosis, 157	Barbiturates	Beckwith-Wiedemann syndrome,	hyperkalemia, 590
Babinski reflex, 635	intoxication and withdrawal, 570	358, 606	hypertension, 316
motor neuron signs, 529	intravenous anesthetics, 550	Beers criteria, 247	hypertrophic cardiomyopathy, 308
primitive reflexes, 510	mechanism and use, 546	Behavioral therapy, 572	juxtaglomerular apparatus effects,
Bachmann bundle, 293	naming convention for, 253	Behavior modulation	589
Bacillary angiomatosis, 478	sleep alterations, 497	frontal lobe lesions and, 511	migraine headaches, 518
animal transmission, 149	Barlow maneuver, 461	limbic system and, 499	naming convention for, 253
HIV-positive adults, 177	Baroreceptors, 296	Behçet syndrome, 314	overdose treatment, 323
Bacillus anthracis, 137	Barr bodies, 34	Bell palsy, 532, 676	phobias, 563
exotoxin production, 132	in x-inactivation, 61	Bell-shaped distribution, 262	selectivity, 245
Bacillus cereus, 138	Barrett esophagus, 378	Bendazoles, 159	toxicity treatment for, 248
food poisoning, 178	Bartholin cyst/abscess, 644	Bends, 463	β cells, 328
Bacitracin	Bartonella henselae	Beneficence (ethics), 265	diabetes mellitus type 1 and 2, 347
gram-positive antibiotic test, 134	bacillary angiomatosis, 478	Benign breast disease, 649	insulinomas of, 351
sensitivity to, 134, 136	Bartonella quintana, 161	Benign paroxysmal positional vertigo	insulin production by tumors, 351
Baclofen, 551	Bartonella spp	(BPPV), 534	insulin secretion by, 334
multiple sclerosis, 523	animal transmission, 149	Benign prostatic hyperplasia (BPH),	β-dystroglycan, 61
Bacteremia	Gram Stain, 125	237, 654	β-galactosidase, 144
brain abscesses, 180	Bartter syndrome, 586	α_1 -blockers for, 244	β-glucan, 200
cutaneous anthrax, 137	markers in, 591	epididymitis and orchitis with, 654	β-glucuronidase, 406
daptomycin, 195	Basal cell carcinomas, 484	tamsulosin for, 658	β-hCG, 653
Staphylococcus gallolyticus, 137	5-fluorouracil for, 440	treatment of, 237	as tumor marker, 226
Streptococcus bovis, 137	Basal ganglia, 500	Benign tumors, 220	β-hemolysis, 133
Bacteria	intraparenchymal hemorrhage, 513	bones, 464	β-hemolytic bacteria, 135
biofilm-producing, 128	lesions in, 511	breast, 649	common colonization sites, 135
culture requirements, 126	movement disorders, 519	Benralizumab, 687	Staphylococcus aureus, 135
encapsulated, 127	thalamic connections, 498	Benzathine penicillin G, 198	Staphylococcus epidermidis, 135
genetics, 130 , 131	Basal lamina, 50	Benzene	Staphylococcus saprophyticus, 136
hemolytic, 135	Basal nucleus of Meynert, 495	aplastic anemia, 250	Streptococcus agalactiae (Group B
highly resistant, 198	Basal plate, 490	Benzidine as carcinogen, 225	strep), 137
normal flora, 178	Base excision repair, 40	Benznidazole, 158	Streptococcus pyogenes (Group A
phage infection of, 130	Basement membrane, 98	Benzocaine, 550	strep), 136
pigment-producing, 128	blood-brain barrier, 496	Benzodiazepines	β-hydroxybutyrate, 90
spore-forming, 129	collagen in, 50	addictive risk, 546	β-interferon
stains for, 125	glomerular filtration barrier, 581	alcohol withdrawal, 572	multiple sclerosis, 523
structures and functions, 124	Basic amino acids, 81	Beers criteria, 247	β-lactam antibiotics, 187
virulence factors, 127, 129 , 135,	Basilar artery	clinical use and adverse effects, 546	β-lactamase inhibitors, 189
143, 144, 145	herniation syndromes, 529	cocaine overdose, 571	β_2 -microglobulin
zoonotic, 149	stroke effects, 515	epilepsy treatment, 544	MHC I and II and, 100
Bacterial capsules, 124	Basilar membrane (cochlea), 533	intoxication and withdrawal, 570	β-oxidation of very-long-chain fatty
Bacterial endocarditis, 311	Basiliximab	naming convention for, 253	acids (VLCFA), 47
daptomycin, 195	immunosuppressant, 120	phobias, 563	β-prophage
Staphylococcus aureus, 135	Basophilia, 408	sleep effects, 497	Corynebacterium exotoxin
Bacterial exotoxin mechanisms	Basophilic stippling, 416	toxicity treatment for, 248	encoding, 139
increase fluid secretion, 132	lead poisoning, 419	Benzoyl peroxide for acne, 477	Beta rhythm (EEG), 497
inhibit phagocytic ability, 132	sideroblastic anemia, 419	Benztropine, 241, 548	β-thalassemia, 418
inhibit protein synthesis, 132	Basophils, 408	Berger disease, 596	allelic heterogeneity, 57
lyse cell membranes, 133	IgE antibody, 105	Beriberi	Betaxolol, 245, 552
superantigens causing shock, 133	BAX protein, 208	vitamin B ₁ deficiency, 66	Bethanechol, 240

FAS1_2019_21_Index_749-806.indd 755 11/21/19 12:27 PM

INDEX

Bevacizumab, 122, 442	metabolism, 72–94	Blastomycosis, 151	Blotting procedures, 53
Bezafibrate, 320	molecular, 34	Bleeding, 642	Blown pupil, 541
Bias and study errors, 260 –262	nutrition, 65	adenomatous polyps, 387	CN III damage, 541
Bicalutamide, 658	Biochemistry laboratory techniques	direct factor Xa inhibitors, 437	saccular aneurysms, 516
Bicarbonate	blotting procedures, 53	direct thrombin inhibitors, 435	"Blue babies," 298
carbon dioxide transport, 670	Cre-lox system, 56 CRISPR/Cas9, 53	diverticulosis, 383 essential thrombocythemia, 433	Blueberry muffin rash cytomegalovirus, 182
GI secretion, 372 overdose treatment, 233	enzyme-linked immunosorbent	glycoprotein IIb/IIIa inhibitors, 438	rubella, 169, 182
pancreatic insufficiency, 381	assay, 54	heparin, 436	Toxoplasma gondii, 182
salicylate toxicity, 248	flow cytometry, 54	inflammatory bowel disease, 382	"Blue bloater," 674
TCA toxicity, 233, 248	fluorescence in situ hybridization,	peptic ulcer disease, 380	"Blue kids," 299
Biceps brachii muscle	55	thrombolytics, 437	Blue sclerae, 51
Erb palsy, 448	free light chain (FLC) assay, 431	variceal, 371	Blumer shelf, 379
Biceps femoris, 452, 453	gene expression modifications, 56	warfarin, 436	BMPR2 gene, 679
Biceps reflex, 510	karyotyping, 55	Bleeding time, 427	Body compartments, 231
Biceps tendon, 446	microarrays, 54	Bleomycin	Body dysmorphic disorder, 563
Bicornuate uterus, 623	molecular cloning, 55	antitumor antibiotics, 439	Boerhaave syndrome, 377
Bicuspid aortic valve	polymerase chain reaction, 52	pulmonary fibrosis, 251	Bombesin, 350
aortic dissection and, 303	reverse transcriptase polymerase	targets of, 438	Bone cancer, 464
coarctation of aorta and, 299	chain reaction, 52	toxicity, 444	primary bone tumors, 464
heart murmur with, 291	RNA interference, 56	Blepharospasm, 519	Bone cell biology, 458, 459
thoracic aortic aneurysms and, 302	serum protein electrophoresis, 431	Blindness	Bone crises, 88
Turner syndrome, 300 Bifid ureter, 579	Biofilm-producing bacteria, 128	Chlamydia trachomatis, 149	Bone disorders adult T-cell lymphoma and, 430
Bifurcation external landmarks, 663	Staphylococcus epidermidis, 135 Biologic agents	giant cell arteritis, 314 neonatal, 142	lab values in, 464
Biguanide drugs, 353	naming conventions for, 254	Onchocerca volvulus, 159	Langerhans cell histiocytosis, 434
Bilaminar disc, 612	Biomarkers	Toxocara canis, 159	lytic ("punched out"), 431
Bilateral adenopathy, 676	α-fetoprotein, 491	Blistering skin disorders, 480	osteogenesis imperfecta, 51
Bilateral renal agenesis	astrocytes, 493	Blood	Bone formation, 458
oligohydramnios and, 641	neurons, 493	chocolate-colored, 666	Bone-in-bone (x-ray), 463
Potter sequence, 578	Biostatistics/epidemiology, 256–262	coagulation and kinin pathways,	Bone marrow
pulmonary hypoplasia and, 660	Biotin, 68	412	cytokine stimulation of, 121
Bile, 374	Bipolar disorder, 561	hCG detection in, 633	lymphoid functions of, 96
hereditary hyperbilirubinemias,	drug therapy for, 572	oxygen content, 666	suppression, 199
394	lithium for, 574	in placenta, 617	Bone mineral density scan, 462
secretin effect on, 371	Birbeck granules	umbilical cord, 618	Bone morphogenetic protein (BMP)
Bile acid resins, 320	Langerhans cell histiocytosis, 434	viscosity of, 668	490
lipid transport and, 92	"Bird's beak" sign (X-ray), 376	Blood-brain barrier	Bones
reabsorption of, 320	Birds (disease vectors), 148, 149	anesthetics, 549	collagen in, 50
synthesis of, 47	Bismuth, 399	astrocytes, 493	cortisol effect on, 336
Bile canaliculus, 367	Bisoprolol, 245	function and mechanism, 496	lytic/blastic metastases, 223
Bile ducts, 367, 368 Bile salts, 374	Bisphosphonates, 462, 486 esophagitis with, 249	at hypothalamus, 498 L-DOPA, 549	primary bone tumors, 464 PTH effect on, 332
in cholelithiasis, 396	naming convention for, 254	Blood flow	renal osteodystrophy, 603
Biliary atresia, 393	osteogenesis imperfecta treatment,	autoregulation, 297	Borderline personality disorder,
Biliary cholangitis, primary	51	exercise response, 670	565
autoantibody, 115	Bitemporal hemianopia, 542	Blood groups, 405	Bordetella pertussis, 143
Biliary cirrhosis, 389, 393	craniopharyngioma, 528	Blood-nerve permeability barrier, 495	culture requirements, 126
cystic fibrosis, 60	hypopituitarism, 339	Blood pH	exotoxin production, 132
Biliary colic, 396	optic chiasm compression, 516	diuretic effects on, 609	macrolides, 193
Biliary structures, 368	Bitot spots, 66	Blood pressure	vaccines, 143
Biliary tract disease, 395	Bivalirudin, 435	angiotensin II effects, 588	Bordet-Gengou agar, 126
Clonorchis sinensis, 161	BK virus, 164	antianginal therapy, 319	Borrelia burgdorferi
gallstones, 368	Black eschar, 137	cortisol effect on, 336	animal transmission, 149
hyperbilirubinemia with, 393	Black lung disease, 677	fenoldopam and, 318	coinfection with, 157
Biliary tract infections	Bladder, 160	renal disorders and, 591	facial nerve palsy, 186
Enterococci, 137	bethanechol effect on, 240	sympathomimetic effect on, 243	Lyme disease, 146
Bilirubin, 375	BPH and, 654	Blood-testis barrier, 628	tetracyclines, 192
bile, 374	development of, 618	Blood transfusions, 429	Borrelia recurrentis animal transmission, 149
cholelithiasis, 396 hereditary hyperbilirubinemias,	exstrophy, 624 outlet obstruction, 579	reactions, 114 therapy, 429	vectors, 161
394	placenta percreta invasion, 640	Blood vessels	Borrelia spp, 146
liver marker, 390	spasm treatment, 241	collagen in, 50	Bortezomib, 443
toxic shock syndrome, 135	urachus, 618	Ehlers-Danlos syndrome, 50	Bosentan, 686
Bimatoprost, 552	urgency in cystitis, 241	hereditary hemorrhagic	Botulinum toxin
Bimodal distribution, 262	Bladder cancer	telangiectasia, 316	lysogenic transduction, 130
Binge-eating disorder, 567, 575	cisplatin/carboplatin for, 442	Blood volume	passive antibodies for, 110
Binge-eating/purging, anorexia	hematuria with, 594	atrial natriuretic peptide release,	symptoms of, 138
nervosa, 567	hypercalcemia and, 228	296	toxin effects, 132
Bioavailability, 231	Schistosoma haematobium, 161	regulation, 588	Bovine spongiform encephalopathy
area under the curve from, 231	"Blast crisis," 433	Bloody diarrhea, 179	(BSE), 178
Biochemistry	Blastocyst implantation, 612	Campylobacter jejuni, 145, 149	Bowel stenosis, 383
cellular, 46–52	Blastomyces spp	Shigella, 144	Bowen disease, 651
genetics, 56	amphotericin B, 199	ulcerative colitis, 382	Bowenoid papulosis, 651
laboratory techniques, 52-94	itraconazole, 199	Bloody stool, 366	Bow legs (genu varum), 463

FAS1_2019_21_Index_749-806.indd 756 11/21/19 12:27 PM

Damman annual 502
Bowman capsule, 583
Boxer's fracture, 459
BPH (benign prostatic hyperplasia)
hydronephrosis in, 599
nydronepinosis in, 777
Brachial artery, 455
Brachial plexus
Danagast tumas 605
Pancoast tumor, 685
Brachial plexus lesions, 448
Brachiocephalic syndrome, 685
Brachiocephalic vein, 685
Brachioradialis reflex, 510
,
Bradycardia
amiodarone and, 323
atropine for, 241
β-blockers and, 245, 323
dopamine for, 242
on ECG, 293
hypermagnesemia, 591
reflex, 588
sympatholytic drugs and, 243
Bradykinesia
with antipsychotic drugs, 573
Bradykinin
AĆE inhibitors and, 610
C1 esterase inhibitor deficiency,
107
Bradykinin, 610
BRAF gene, 224 , 387
melanomas and, 484
· · · · · · · · · · · · · · · · · · ·
papillary thyroid carcinoma and,
343
vemurafenib and, 444
Brain
blood flow autoregulation, 297
embryologic derivatives, 613
embryology of, 490
infarcts, 209
ischemia in, 210
metastasis to, 223
Brain abscesses
bacteremia, 180
bacteremia, 180 HIV-positive adults, 180
bacteremia, 180 HIV-positive adults, 180
bacteremia, 180 HIV-positive adults, 180 otitis media, 180
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296,
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296,
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526–527 childhood primary, 528
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526–527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526–527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid dehydrogenase, 66
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526–527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosources for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen metabolism), 86
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen metabolism), 86 BRCA1/BRCA2 genes, 224
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosources for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen metabolism), 86
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen metabolism), 86 BRCA1/BRCA2 genes, 224 DNA repair in, 40
bacteremia, 180 HIV-positive adults, 180 otitis media, 180 Staphylococcus aureus, 180 Toxoplasma gondii, 177 Viridans streptococci, 180 Brain cysts, 161 Brain death, 269, 501, 502 Brain injury gastritis with, 379 hypopituitarism from, 339 Brain lesions (common), 511 Brain natriuretic peptide (BNP), 296, 588 in SIADH, 338 signaling pathways for, 337 Brain stem dorsal view, 504 ventral view, 504 Brain stem/cerebellar syndromes multiple sclerosis, 523 Brain tumors adult primary, 526-527 childhood primary, 528 hallucinations with, 559 incidence and mortality, 222 metastatic source, 223 nitrosoureas for, 441 Branched-chain ketoacid dehydrogenase, 66 Branching enzyme (glycogen metabolism), 86 BRCA1/BRCA2 genes, 224

Breastfeeding, 636
Breast milk
IgA antibodies in, 105
oxytocin's role in, 328 prolactin and, 330
Breast/ovarian cancer
BRCA1 mutation, 64
BRCA2 mutation, 64 incomplete penetrance, 56
Breast pathology, 649
benign disorders, 649
invasive carcinomas, 650 noninvasive carcinomas, 650
Breast cancer
aromatase inhibitors for, 656
breastfeeding and, 636 hormonal contraception
contraindication, 657
hypercalcemia and, 228
incidence/mortality of, 222 oncogenes and, 224
paclitaxel for, 441
paraneoplastic cerebellar
degeneration and, 228 tamoxifen for, 443
trastuzumab for, 443
tumor suppressor genes and, 224
Breathing
mechanics of, 675 with pneumothorax, 682
Breath sounds
bronchial, 680, 682
diminished, 682 physical findings, 680
Brenner tumor, 646
Brief psychotic disorder, 560
Brimonidine, 552 Brittle bone disease, gene defects
in, 51
Broad-base budding (blastomycosis), 151
Broad ligament, 625
Broca area, 501
aphasia, 516
MCA stroke, 514 Bromocriptine, 548
Bronchi, 662
Bronchial carcinoid tumor, 684
Bronchiectasis Aspergillus fumigatus, 153
cystic fibrosis, 60
Kartagener syndrome, 49
Bronchioles, 662 histamine receptors and, 238
Bronchiolitis obliterans, 119, 683
organizing pneumonia (BOOP),
683 Bronchitis
cystic fibrosis, 60
Haemophilus influenzae, 142
Bronchoconstriction, 687 Bronchodilation, 687
sympathetic receptors and, 238
Bronchogenic carcinomas
asbestosis and, 677
carcinogens causing, 225 Bronchogenic cysts, 660
Bronchopneumonia, 683
Bronchopulmonary dysplasia, 210 free radical injury, 210
neonatal respiratory distress
syndrome, 661
Brown Saguard condrome 521

syndrome, 661 Brown-Séquard syndrome, **531** Horner syndrome, 531 "Brown tumors," 464

Brucella spp, 127
transmission and treatment of, 143
zoonotic infections, 149
Brucellosis, 149
Brugada syndrome, 294 , 304
Danisias
Bruising
scurvy, 69
Brunner glands
bicarbonate product, 372
duodenum, 362
Bruton agammaglobulinemia, 61, 116
Bruxism, 497
BTK gene, 116
B-type natriuretic peptide, 296
Buckle (torus fracture), 462
Budd-Chiari syndrome, 392
Budesonide, 687
Buerger disease, 314
Bugs
affecting unvaccinated children, 186
causing diarrhea, 179
causing food-borne illness, 178
hints, 186
Bulbar (spongy) urethra injury, 627
Bulbus cordis, 281
Bulimia nervosa, 567
anovulation and, 645
drug therapy for, 572
laxative abuse by, 401
Mallory-Weiss syndrome and, 377
SSRIs for, 575
Bulk-forming laxatives, 401
Bullae, 475
impetigo, 479
necrotizing fasciitis, 479
skin lesions, 475
Bull neck lymphadenopathy, 132
Bullous impetigo, 479
Bullous pemphigoid, 475, 480
autoantibody, 115
Bulls-eye erythema, 146
Bumetanide, 608
BUN (blood urea nitrogen)
ornithine transcarbamylase
deficiency, 83
Bundled payment, 271
Bundle of His, 293
Bundle of Kent, 294
Bunyaviruses, 167–168
Bupivacaine, 550
Buprenorphine, 551
heroin detoxification, 576
morphine and, 234
Bupropion 576
Bupropion, 576
seizures with, 251
seizures with, 251 Burkholderia cepacia
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and,
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and,
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone for, 658
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone for, 658 "Burr cells," 414
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone for, 658 "Burr cells," 414 Bursitis
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone for, 658 "Burr cells," 414 Bursitis prepatellar, 460
seizures with, 251 Burkholderia cepacia cystic fibrosis, 179 Burkitt lymphoma, 430 chromosomal translocations and, 434 EBV, 165 oncogenes and, 224 oncogenic microbes and, 226 Burnout (medical errors), 274 Burns classification, 483 shock with, 310 sunburn, 482 testosterone/methyltestosterone for, 658 "Burr cells," 414 Bursitis

Buspirone
mechanism and clinical use, 574 Busulfan, 441
pulmonary fibrosis and, 251
toxicity, 444 Butorphanol, 551, 552
*
C
C1 esterase inhibitor deficiency, 107 C3 deficiency, 107
C5a receptor, 406
C5-C9 deficiencies, 107
CA 15-3/CA27-29 (tumor markers), 226
CA 19-9 (tumor marker), 226, 398
CATT have 41
CAAT box, 41 Cachexia, 227
TNF- α and, 108
Café-au-lait spots
McCune-Albright syndrome, 57 Caffeine intoxication and withdrawal,
570
Cahill cycle, 82 Calcarine sulcus
thalamic relay to, 498
Calciferol (vitamin D), 589
Calcification, 211
dystrophic, 227 Calcineurin, 120
Calcinosis cutis, 473
Calcitonin, 333
medullary thyroid carcinoma production, 343
tumor marker, 226
Calcitriol, 589 Calcium
in bone disorders, 464
calcitonin and, 333
in cardiac muscle, 292 in osteomalacia/rickets, 463
in Paget disease of bone, 463
Vitamin D and, 337
Calcium carbonate, 399 Calcium channels
ethosuximide effect on, 544
glucose and, 334 Lambert-Eaton myasthenic
syndrome, 228
myocardial action potential, 292
opioid effect on, 551 pacemaker action potential, 292
Calcium channel blockers
angina, 318
antiarrhythmic drugs, 324 contractility in, 284
cutaneous flushing, 248
gingival hyperplasia, 250
hypertension, 316 hypertrophic cardiomyopathy, 308
mechanism and clinical use, 318
migraine headaches, 518
Raynaud phenomenon, 472 Calcium homeostasis, 333
Calcium (kidney stones), 598
calcium oxalate nephrolithiasis, 69
Calcium pyrophosphate deposition disease, 467
Calcium-sensing receptor (CaSR), 355
Calculation bioavailability of, 231
reabsorption and secretion rate, 584
Calculous cholecystitis, 396
Caliciviruses, 163 characteristics of, 167
characteristics of, 107

FAS1_2019_21_Index_749-806.indd 757 11/21/19 12:27 PM

INDEX

0.1% : 1.1% 167
California encephalitis, 167
Calluses (dermatology), 475
cAMP (cyclic adenosine
` ,
monophosphate)
endocrine hormone messenger,
337
fructose bisphosphatase-2 and, 76
heat-labile/heat-stable toxin effects,
132
hyperparathyroidism, 345
PTH effect on, 332
Vibrio cholerae, 146
CAMP factor, 137
Campylobacter spp
animal transmission, 149
bloody diarrhea, 179
jejuni, 145
reactive arthritis and, 469
C 1:0 : 252
Canagliflozin, 353
Canalicular stage (development), 660
Cancer
common metastases, 223
deaths from, 272
ESR in, 214
111
hallmarks of, 221
immune evasion in, 221
mortality of, 222
11101tanty 01, 222
pneumoconioses, 676, 677
Cancer drugs
cell cycle, 438
targets, 438
Cancer epidemiology, 222
Candesartan, 610
Candida albicans, 153
HIV-positive adults, 177
T cell dysfunction, 116
r cen dystanetion, rro
C 1: 1
Candida spp
amphotericin B, 199
amphotericin B, 199 azoles, 199
amphotericin B, 199 azoles, 199 echinocandins, 200
amphotericin B, 199 azoles, 199 echinocandins, 200
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and,
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capiltate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249 Carbamoyl phosphate, 82
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249 Carbamoyl phosphate, 82 Carbamoyl phosphate synthetase, 73
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249 Carbamoyl phosphate, 82
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249 Carbamoyl phosphate, 82 Carbamoyl phosphate synthetase, 73 Carbapenems
amphotericin B, 199 azoles, 199 echinocandins, 200 immunodeficiency infections, 118 osteomyelitis, 180 tricuspid valve endocarditis and, 311 vulvovaginitis, 181 Candidiasis Candida albicans, 153 chronic mucocutaneous, 116 cortisol and, 336 nystatin, 199 Cannibalism, 178 "Cannonball" metastases, 642 Capecitabine 5-F-dUMP, 36 "Cape-like" sensory loss, 492 Capillary fluid exchange, 297 Capitate bone, 449 Capitation, 271 Caplan syndrome, 466, 677 Capsules (bacterial), 124 Captain's wheel Paracoccidioidomycosis, 151 Captopril, 610 Caput medusae, 365 Carbachol, 240, 552 Carbamazepine agranulocytosis, 250 aplastic anemia, 250 cytochrome P-450 and, 252 epilepsy, 544 SIADH and, 249 Carbamoyl phosphate, 82 Carbamoyl phosphate synthetase, 73

DEV
Carbidopa, 549
Carbohydrate absorption, 373
Carbohydrate metabolism
inborn errors of, 80
Carbol fuchsin, 125
Carbon dioxide (CO ₂)
production in tissues, 127 retention, 679
transport, 670
Carbonic anhydrase, 670
Carbon monoxide (CO)
vs cyanide poisoning, 667
electron transport inhibition, 78
poisoning, 666 teratogenicity, 614
toxicity treatment, 248
Carbon tetrachloride
free radical injury and, 210
Carboplatin
mechanism and clinical use, 442
toxicities of, 444
Carboplatin toxicity, 444 Carboxylases, 73
Carboxypeptidase, 373
Carcinoembryonic antigen (CEA)
(tumor marker), 226
Carcinogens, 225
griseofulvin, 200
Carcinoid syndrome, 352
bronchial carcinoid tumors, 684 somatostatin in treatment, 371
Carcinoid tumors
biomarkers for, 226
immunohistochemical stains for,
227
octreotide for, 400
stomach, 379 Carcinoma in situ, 219
cervical dysplasia, 645
ductal, 650
neoplastic progression, 219
penis, 651
vulvar, 644 Carcinomas
bone, 464
colorectal, 388
invasive, 219
metastases of, 219, 223
nomenclature of, 220
thyroid, 343 Cardiac arrest
antacid adverse effects, 399
hypermagnesemia, 591
Cardiac cycle, 287
Cardiac depression, 318
Cardiac function curves, 286
Cardiac glycosides mechanism and clinical use, 321
sodium-potassium pump
inhibition, 49
Cardiac looping, 280
Cardiac output
exercise and, 670
in pregnancy, 633
variables in, 284 V/Q mismatch and, 669
Cardiac output equations, 285
Cardiac pressures (normal), 297
Cardiac tamponade, 310
aortic dissection and, 303
jugular venous pulse in, 287
MI, 305, 307 shock, 310
Cardiac therapy, 317
Cardiac tumors, 316
Cardinal veins, 281

Cardiogenic shock, 310
etiology, 310
Cardiomegaly
Pompe disease, 87
Cardiomyopathy, 308
β-blockers, 245 Chagas disease, 158
drug reaction and, 248
familial amyloid, 212
glycogen storage diseases, 87
heart failure with, 309
hemochromatosis and, 395
hypertrophic, 245 Kussmaul sign in, 316
Starling curves, 285
sudden cardiac death, 304
Cardiotoxicity
doxorubicin, 439
drugs causing, 444
methylxanthines, 687 TCA adverse effects, 575
trastuzumab, 443
Cardiovascular drugs
naming conventions for, 253
reactions to, 248
Cardiovascular system, 281–323
anatomy, 283 embryology, 281–283
pathology, 298–313
pharmacology, 316-322
physiology, 284–299
sclerosis of, 473
Carditis
Lyme disease, 146 rheumatic fever, 312
Carfilzomib, 443
Carina (trachea), 663
Carmustine, 441
pulmonary fibrosis, 251
Carnitine acyltransferase I, 73, 89 Carotid artery
atherosclerosis in, 302
cavernous sinus, 542
emboli from, 538
embryonic development, 619
giant cell arteritis and, 314 Carotid massage, 296
Carotid sinus, 296
Carpal bones, 449
Carpal tunnel syndrome, 459
lunate dislocation, 449
nerve injury, 447
rheumatoid arthritis, 466 Carteolol, 552
Cartilage
collagen in, 50
fluoroquinolone damage to, 250
Cartilage damage, 204
Carvedilol, 245, 323
Casal necklace, 67 Caseating granulomas
in tuberculosis, 140
Case-control studies, 256
Caseous necrosis, 209
Caspases, 208
Caspofungin
echinocandins, 200 Casts in urine, 594
Catabolism of amino acids, 82
Catalase, 210
Catalase-positive organisms, 128
Cataplara, 569
Cataplexy, 568
Cataracts, 535
Cataracts, 535 corticosteroid toxicity, 120 diabetes mellitus and, 346

muscular dystrophy, 61
rubella, 182
sorbitol, 81
Catecholamines
adrenal medulla secretion, 327
amphetamines and, 242 contractility effects of, 284
ephedrine and, 242
heart contractility, 284
pacemaker action potential, 292
pheochromocytoma and, 350 Catecholamine synthesis
tyrosine catabolism, 83
Cats (disease vectors)
Campylobacter jejuni, 145
Cat scratch disease, 149
Pasteurella multocida, 149, 186 Tinea corporis, 152
Toxoplasma gondii, 156, 182
Cauda equina, 507
Cauda equina syndrome, 530
Caudal fold closure defects, 358
Caudal regression syndrome, 614 Caudate
basal ganglia, 500
Huntington disease, 520
Cavernous hemangiomas
liver, 392
Cavernous hemangiomas (liver), 392 Cavernous sinus, 542
dural venous sinuses, 503
syndrome, 542
thrombosis with mucormycosis,
153 CCR5 protein
HIV and, 175
maraviroc, 203
viral receptor, 166
CD4+ cell count disease associations by levels, 177
CD4 protein, 101
viral receptor, 166
CD4+ T cells (HIV), 176
CD5 protein, 432
CD8 protein, 101 CD16 protein, 101
CD20 protein, 110
in CLL, 432
CD21 protein, 110
viral receptor, 166
CD25 protoin
CD25 protein
CD25 protein cell surface protein, 110 regulatory T cells and, 102
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan mechanism and use, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan mechanism and use, 189 Cefotettan mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefpodoxime mechanism and use, 189 Cefpodoxime mechanism and use, 189
CD25 protein cell surface protein, 110 regulatory T cells and, 102 CD28 protein, 110 CD34 protein, 110 leukocyte extravasation and, 215 CD40 protein, 110 CDKN2A gene, 224 CEA tumor marker, 388 Cefaclor, 189 Cefazolin mechanism and use, 189 prophylaxis, 198 Cefepime mechanism and use, 189 Pseudomonas aeruginosa, 143 Cefotaxime, 189 Cefotetan mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin mechanism and use, 189 Cefoxitin

FAS1_2019_21_Index_749-806.indd 758 11/21/19 12:27 PM

○ 6 · 11		0 1	
Ceftazidime	Central tendon (diaphragm), 663	Cestodes, 160	Childbirth
mechanism and use, 189	Central vertigo, 534	Cetirizine, 686	brachial plexus injury in, 448
Pseudomonas aeruginosa, 143	Centriacinar emphysema, 674	Cetuximab, 442	Budd-Chiari syndrome and, 392
Ceftriaxone	Cephalexin	CFTR gene	Graves disease and, 342
Chlamydia spp, 148	mechanism and use, 189	chronic pancreatitis and, 397	low birth weight, 635
for gonococci, 142	Cephalosporins	cGMP (cyclic guanosine	
			misoprostol induction, 399
for Haemophilus influenzae, 142	disulfiram-like reaction, 251	monophosphate)	neonatal flora, 178
mechanism and use, 189	mechanism and use, 189	atrial natriuretic peptide and, 296	oxytocin and uterine contractions,
meningitis, 180	pseudomembranous colitis, 249	endocrine hormone messenger,	328, 636
meningococci, 142	Pseudomonas aeruginosa, 143	337	postpartum mood disturbances,
typhoid fever, 144	Ceramide trihexoside	male sexual response, 627	562
Cefuroxime	in sphingolipidoses, 88	Chagas disease, 158	preterm, as common cause of
mechanism and use, 189	Cerebellar degeneration	achalasia in, 376	death, 272
Celecoxib, 252, 486	paraneoplastic, 228	Chalk-stick fractures, 463	progesterone levels after, 630
Celiac artery	Cerebellar lesions	Chancroids, 184	Sheehan syndrome after, 339
mesenteric ischemia, 386	hemisphere, 511	Changes in the elderly, 270	stress incontinence and, 599
structures supplied, 364	lateral, 499	Chaperone protein, 45	Childhood disorders, 557
Celiac disease, 381	medial, 499	Charcoal yeast extract culture	Childhood musculoskeletal
autoantibody, 115	tonsillar herniation, 492, 529	Legionella pneumophila, 126, 143	conditions, 461
HLA genes and, 100	vermis lesions, 511	Charcot-Bouchard microaneurysm,	Childhood primary brain tumors, 528
IgA deficiency, 116	Cerebellum	516	Child neglect, 556
Celiac sprue, 381	development of, 490	Charcot joints	Children
Celiac trunk, 364	input/output of, 499	syphilis, 147	causes of death, 272
Cell biology of bone, 459	tonsils, 492	tabes dorsalis and, 530	Chi-square tests, 264
Cell cycle phases, 46	Cerebral aqueduct of Sylvius, 504	Charcot-Leyden crystals, 674	Chlamydia spp, 148 , 184
Cell envelope (bacterial), 124	Cerebral artery distributions, 502	Charcot-Marie-Tooth disease, 524	atypical infections, 179
Cell injury, 207	Cerebral cortex	Charcot triad, 397	diagnostic tests for, 148
		,	
Cell lysis, 590	aphasia, 514	Charging, tRNA, 44	Giemsa stain, 125
Cell membrane in apoptosis, 208	arterial distribution, 502	Chédiak-Higashi syndrome, 117	Gram stain, 125
Cell surface proteins	dominant parietal lesions, 511	Cheilosis, 67	intracellular organism, 127
association and functions, 110	functional areas of, 501	Chelation	macrolides, 193
leukocyte adhesion deficiency, 117	hemineglect, 514	hemochromatosis, 395	pneumonia, 683
T cells and, 101	nondominant parietal lesions, 511	lead poisoning, 419	reactive arthritis, 469
Cell trafficking, 47	visual field defects, 514	Chemokines, 108	sulfonamides for, 194
Cell types	Cerebral edema	delayed hypersensitivity, 112	tetracyclines, 192
labile, 46	diabetic ketoacidosis and, 347	Chemoreceptors, 296	Chlamydia trachomatis
permanent, 46	therapeutic hyperventilation, 501	Chemoreceptor trigger zone (CTZ),	eosinophilia, 149
stable (quiescent), 46	Cerebral hemispheres, 490	496	pelvic inflammatory disease, 149
Cellular biochemistry, 46–52	Cerebral palsy, 551	Chemotherapy	pneumonia, 179
Cellular injury	Cerebral perfusion pressure (CPP),	AML and, 432	serotypes, 149
cellular adaptations, 206	501	MDR1 and responsiveness to,	UTIs, 600
irreversible, 207	"Cerebriform" nuclei, 430	227	Chlamydophila pneumoniae, 148
reversible, 207	Cerebrospinal fluid (CSF)	neutropenia with, 424	pneumonia, 179
Cellulitis, 136, 479	albuminocytologic dissociation,	ondansetron, 400	Chlamydophila psittaci
Pasteurella multocida, 149	524	paclitaxel, 48	atypical pneumonia, 148
Cell walls (bacterial), 124	blood-brain barrier and, 496	pancreatic cancer, 398	transmission, 149
Central clearing	circulation of, 496, 503	readmissions with, 272	Chloasma (melasma), 476
nuclei, 343	findings in meningitis, 180	treatments for vomiting, 401	Chloramphenicol
rash, 152	Guillain-Barré syndrome, 524	vincristine/vinblastine, 48	aplastic anemia and, 250
Central diabetes insipidus, 338	hydrocephalus, 522	Chemotoxicities, 444	
Central/downward transtentorial	Hydrocephalus, 722		
LEITOTOPATALLI LETTATORIA			gray baby syndrome, 250
	multiple sclerosis, 523	Cherry hemangiomas, 478	gray baby syndrome, 250 mechanism and use, 192
herniation, 529	multiple sclerosis, 523 neurodegenerative disorders, 521	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204
herniation, 529 Central nervous system (CNS)	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686 Chlorpromazine, 573
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroquine, 200 malaria, 157 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 573 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 573 Chlorpheniramine, 686 Chlopromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome,	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis sexually transmitted infections, 184	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 573 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome, 515 Central precocious puberty, 637	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis sexually transmitted infections, 184 Cervix	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165 Chief cells (parathyroid), 332	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 570 Chloropheniramine, 686 Chlorpheniramine, 686 Chlorpheniramine, 699 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226 sclerosing cholangitis, 395
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome, 515 Central precocious puberty, 637 Central retinal artery occlusion, 538	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis sexually transmitted infections, 184	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 573 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome, 515 Central precocious puberty, 637	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis sexually transmitted infections, 184 Cervix	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165 Chief cells (parathyroid), 332	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 570 Chloropheniramine, 686 Chlorpheniramine, 686 Chlorpheniramine, 699 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226 sclerosing cholangitis, 395
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome, 515 Central precocious puberty, 637 Central retinal artery occlusion, 538 Central sleep apnea, 679	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervicitis sexually transmitted infections, 184 Cervix anatomy of, 625 epithelial histology, 626	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165 Chief cells (parathyroid), 332 Chief cells (stomach), 372 Child abuse, 556	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 573 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226 sclerosing cholangitis, 395 Cholangitis, 368, 382, 393, 397 Cholecalciferol, 70
herniation, 529 Central nervous system (CNS) anesthetic principles for, 549 antiarrhythmic adverse effects, 322, 323 cancer epidemiology, 222 cell types in, 493–494 depression, 546 drug name conventions, 253 nitrosoureas effect on, 441 origins of, 490 posterior fossa malformations, 491, 492 regional specification of, 506 shock from injury, 310 Central nervous system stimulants, 572 Central pontine myelinolysis, 524 Central post-stroke pain syndrome, 515 Central precocious puberty, 637 Central retinal artery occlusion, 538	multiple sclerosis, 523 neurodegenerative disorders, 521 origins, 490 poliomyelitis, 531 production, 493 ventricular system, 504 Cerebrovascular disease diabetes mellitus, 346 Certolizumab, 487 Ceruloplasmin free radical elimination by, 210 Cervical cancer, 645 carcinogens causing, 225 epidemiology of, 643 HIV-positive adults, 177 hydronephrosis with, 599 oncogenic microbes and, 226 papillomaviruses, 164 Cervical rib, 448 Cervicitis sexually transmitted infections, 184 Cervix anatomy of, 625	Cherry hemangiomas, 478 "Cherry red" epiglottis, 142 Cherry-red spot (macula), 538 lysosomal storage disease, 88 Chest pain panic disorder, 563 pneumothorax, 682 Chest wall elastic properties, 665 Chest X-rays aortic dissections on, 303 balloon heart on, 308 eggshell calcification, 677 notched ribs on, 299 Wegener granulomatosis on, 315 widened mediastinum on, 137 Cheyne-Stokes respirations, 679 Chiari malformations, 492 Chickenpox rash, 183 VZV, 165 Chief cells (parathyroid), 332 Chief cells (stomach), 372	gray baby syndrome, 250 mechanism and use, 192 pregnancy contraindications, 204 protein synthesis inhibition, 191 Chlordiazepoxide, 546 alcohol withdrawal, 572 Chlorhexidine, 204 Chloride channels cystic fibrosis, 60 Chlorine, 204 Chloroprocaine, 550 Chloroprocaine, 550 Chloropromazine, 577 Chlorpheniramine, 686 Chlorpromazine, 573 Chlorthalidone, 609 Chocolate agar Haemophilus influenzae, 126, 142 Cholangiocarcinomas Clonorchis sinensis, 160, 161 hyperbilirubinemia, 393 oncogenic microbes and, 226 sclerosing cholangitis, 395 Cholangitis, 368, 382, 393, 397

FAS1_2019_21_Index_749-806.indd 759 11/21/19 12:27 PM

Cholecystokinin (CCK) secretory cell location, 373 Choledocholithiasis, 396 Cholelithiasis, 395, 396, 397 acute pancreatitis, 397 bile ducts and, 368 biliary cirrhosis and, 396 Crohn disease, 382 hyperbilirubinemia and, 393 octreotide and, 400 Cholera toxin lysogenic phage infection, 130 mechanism, 132 Cholestasis serum markers, 390 Cholesteatomas, 533 Cholesterol atherosclerosis, 302 in bile, 374 cholelithiasis and, 396 lipid-lowering agents, 320 synthesis of, 47, 73, 79 vitamin B3 effects, 67 Cholesteryl ester transfer protein, 93 Cholestyramine, 320 Cholinergic agonists, 253 Cholinergic effects, 321 cardiac glycosides, 321 Cholinesterase inhibitors diarrhea with, 249 neuromuscular blockade reversal, Cholinomimetic agents, 240 glaucoma treatment, 552 Chondrocalcinosis, 467 Chondrocytes, 458, 462 osteoarthritis, 466 Chondroma, 464 Chondrosarcoma, 465 Chordae rupture, 291 Chorea brain lesions, 511 Huntington disease, 520 movement disorders, 519 Choriocarcinoma, 642 hCG in, 633 methotrexate for, 440 testicular, 653 theca-lutein cysts and, 646 Chorionic plate, 617 Chorionic somatomammotropin, 634 Chorionic villi hydatidiform moles, 642 placenta, 617 Chorioretinitis congenital toxoplasmosis, 182 Choristomas, 220 Choroid layer (ophthalmology) inflammation, 536 neovascularization, 536 Choroid plexus (CNS), 504 Christmas tree distribution, 482 Chromaffin cells diagram, 327 pheochromocytomas, 350 Chromatin structure, 34 Chromatolysis, 495 Chromogranin, 226, 684 Chromosomal translocations, 434 Chromosome abnormalities congenital microdeletion, 64 gene associations with, 64 hemochromatosis, 395 karyotyping for, 55 nephroblastoma, 606 nondisjunction (meiosis), 63 omphaloceles, 358

polyposis syndrome, 387 renal cell carcinoma, 605 Robertsonian translocation, 64 von Hippel-Lindau disease, 525 Wilson disease, 395 Chronic bronchitis, 674 Chronic disease, anemia of, 421 Chronic gastritis, 379 Chronic granulomatous disease (CGD) catalase-positive microbes, 186 immunodeficiencies and, 117 recombinant cytokines for, 121 respiratory burst in, 109 Chronic inflammation, 216 Chronic ischemic heart disease, 304 Chronic kidney disease erythropoietin in, 589 hypertension and, 300 Chronic lymphocytic leukemia (CLL), 432 immunosuppressants, 120 rituximab for, 443 Chronic mesenteric ischemia, 386 Chronic mucocutaneous candidiasis, Chronic myelogenous leukemia (CML), 433 basophilia caused by, 408 busulfan for, 441 chromosomal translocations and, imatinib for, 443 oncogenes and, 224 Chronic myeloproliferative disorders, Chronic obstructive pulmonary disease (COPD) albuterol for, 242 B-blockers and, 245 muscarinic antagonists for, 241 salmeterol for, 242 Chronic pancreatitis, 397 pancreatic insufficiency from, 381 Chronic placental insufficiency, Chronic pyelonephritis, 600 Chronic renal failure, 603 hyperphosphatemia with, 345 Chronic respiratory diseases bronchitis, 674 with chronic inflammatory diseases, 683 death in children, 272 obstructive diseases, 674 pneumoconioses, 675 sinusitis, 674 thromboembolism, 679 Chronic thromboembolic pulmonary hypertension, 679 Chronic transplant rejection, 119 Churg-Strauss syndrome, 315 autoantibody, 115 Chvostek sign hypocalcemia, 591 hypoparathyroidism, 344 Chylomicrons, 92, 94 Chymotrypsin, 373 Cidofovir, **202** Cigarette smoke (carcinogen), 225 Ciguatoxin, 247

Cilastatin

imipenem and, 190

seizures with, 251

Ciliary ganglia, 539

Cilia structure, 49

Ciliated cells, 662 Cimetidine, 399 cytochrome P-450 and, 252 gynecomastia and, 649 Cinacalcet, 355 Cinchonism antiarrhythmic causing, 322 neurologic drug reaction, 251 Cingulate gyrus limbic system, 499 Cingulate (subfalcine) herniation, Ciprofloxacin for Crohn disease, 382 cytochrome P-450 and, 252 fluoroquinolones, 195 meningococci, 142 Mycobacterium aviumintracellulare, 196 prophylaxis, 198 Pseudomonas aeruginosa, 143 Circadian rhythm hypothalamic control, 498 sleep physiology, 497 Circle of Willis, **503** saccular aneurysms, 516 Circulatory system fetal, 282 kidneys and, 580 Circumflex femoral artery, 463 Circumoral pallor group A streptococcal pharyngitis, Cirrhosis α_1 -antitrypsin deficiency, 392 alcoholic, 71, 391 bacterial peritonitis (spontaneous), 390 cholelithiasis and, 396 cystic fibrosis, 60 encephalopathy with, 391 esophageal varices and, 377 fructose intolerance, 80 gynecomastia, 649 hemochromatosis, 395 with hepatitis, 389 hepatocellular carcinomas, 392 hyperbilirubinemia in, 393 non-alcoholic fatty liver disease, portal hypertension, 389 serum markers for, 390 Cisplatin mechanism and clinical use, 442 targets of, 438 toxicities of, 251, 444 Citalopram, 575 Citrate synthase, 74 Citrulline, 82 c-KIT gene, 224 CK-MB, 304, 306 Cladribine, 440 for hairy cell leukemia, 432 Clara cells, 661, 662 Clarithromycin Helicobacter pylori, 146 HIV prophylaxis, 198 macrolides, 193 Mycobacterium avium $intracellulare,\,196$ pregnancy use, 204 Clasp knife spasticity, 529 Class IA antiarrhythmics, 322 Class IB antiarrhythmics, 322

Class III antiarrhythmics, 323 Class IV antiarrhythmics, 324 Classical conditioning, 554 Class switching CD40, 103 thymus-dependent antigens, 105 Clathrin, 47 Claudication atherosclerosis, 302 Buerger disease, 314 giant cell arteritis, 314 Clavicle fractures, 460 Clavulanate Haemophilus influenzae, 142 Clavulanic acid, 189 Clawing (hand), 451 Klumpke palsy, 448 Clearance (CL) of drugs, 231 Clear cell adenocarcinoma, 644 DES and, 656 Cleavage in collagen synthesis, 50 Cleft lip and palate development, 621 Patau syndrome, 63 Pierre Robin sequence, 620 Clevidipine, 318 for hypertensive emergency, 318 Clindamycin bacterial vaginosis, 148 Clostridium difficile and, 138 mechanism and use, 192 metronidazole vs, 192 protein synthesis inhibition, 191 pseudomembranous colitis with, 249 Clinical reflexes, 510 Clinical trials, 256 Clinical vignette strategies, 23 "Clock-face" chromatin, 409, 431 Clofazimine Hansen disease, 141 Mycobacterium leprae, 196 Clomiphene estrogen receptor modulators, 656 hot flashes with, 249 Clonipramine, 575 Clonidine, 240, 243 Cloning methods (laboratory technique), 55 Clonorchis sinensis cholangiocarcinoma, 226 diseases association, 161 trematodes, 160 Clopidogrel, 437 acute coronary syndromes, 307 for ischemic stroke, 512 thrombogenesis and, 411 Closed-angle glaucoma, 536 pilocarpine for, 240 Clostridium botulinum exotoxin production, 132 food poisoning, 178 therapeutic uses, 138 Clostridium difficile antibiotic use, 185 metronidazole, 195 nosocomial infection, 185 PPI association, 138 proton pump inhibitor use, 399 toxins and effects of, 138 vancomycin, 190 watery diarrhea, 179 Clostridium perfringens

clindamycin, 192

exotoxin production, 133

FAS1_2019_21_Index_749-806.indd 760 11/21/19 12:27 PM

Class IC antiarrhythmics, 322

Class II antiarrhythmics, 323

food poisoning, 178
toxins produced, 138
traumatic open wound, 186
watery diarrhea, 179
Clostridium spp, 138
anaerobic organism, 127 exotoxins, 138
Clostridium tetani, 138
exotoxin production, 132
Clotrimazole, 199
Clotting factors, 71
Clozapine, 573
agranulocytosis with, 250
Clubbing (digital), 675
cystic fibrosis, 60
Eisenmenger syndrome, 299 Club cells, 661
Clue cells
bacterial vaginosis, 148, 181
Cluster A personality disorders
characteristics of, 565
schizoid, 565
schizotypal, 565
Cluster B personality disorders
antisocial, 565
borderline, 565 histrionic, 565
narcissistic, 565
Cluster C personality disorders
avoidant, 566
dependent, 566
obsessive-compulsive, 566
Cluster headaches, 518, 547
c-MYC gene, 224
CN III, IV, VI palsies, 541
CNS (central nervous system) cancer epidemiology, 222
CNS lymphomas
HIV-positive adults, 177
oncogenic microbes and, 226
CO_2
production in tissues, 127
Coagulation, 71
Coagulation disorders, 426
hemophilia, 426 hereditary thrombosis syndromes,
428
mixed platelet/coagulation, 428
vitamin K and, 426
Coagulation pathways, 412
Coagulative necrosis, 209
MI, 305
Coagulopathy
postpartum hemorrhage, 641 preeclampsia, 643
uterine bleeding with, 633
Coal workers' pneumoconiosis, 677
CoA production, 67, 72
Coarctation of aorta, 299, 300
Cobalamin, 69
Cobblestone mucosa, 382
Cocaine
β-blockers and, 245
coronary vasospasm, 248 intoxication and withdrawal, 571
liver processing of, 367
sympathomimetic action, 242
teratogenicity, 614
Coccidioides spp
silver stain, 125
treatment, 199
Coccidioidomycosis, 151
erythema nodosum and, 482 Coccobacilli, 141
Cocci bacteria
antibiotic tests, 134

Cochlea
CN VIII, 506
inner ear, 533
presbycusis, 533
Codeine, 551 Codman triangle (x-ray), 465
Codominance, 56
Codons
amino acid specification, 37
genetic code features, 37
start and stop, 44 Cofactors
apolipoproteins, 93
biotin, 68, 73
cobalamin, 69
copper, 51
Menkes disease, 51
pantothenic acid, 67 phenylketonuria, 84
pyridoxine, 67
pyruvate dehydrogenase complex,
76
riboflavin, 67
TCA cycle, 77
thiamine, 74 vitamin K, 71
"Coffee bean sign" (X-ray), 386
Cognitive behavioral therapy (CBT),
557, 572
ADHD, 557
anxiety disorders, 562
atypical depression, 561 bipolar disorder, 561
body dysmorphic disorder, 563
obsessive-compulsive disorder, 563
panic disorder, 563
phobias, 563
postpartum depression, 562 PTSD, 563
Cohort studies, 256
Coin lesion (X-ray), 684
x-ray signs, 684
Cola-colored urine, 596
Colchicine, 55
agranulocytosis, 250 calcium pyrophosphate deposition
disease, 467
diarrhea with, 249
gout, 467, 487
microtubules and, 48
myopathy with, 250 "Cold enrichment," 139
Colectomy
adenomatous polyposis, 387
inflammatory bowel disease, 382
Colesevelam, 320
Colestipol, 320 Colistin
polymyxin E, 193
Pseudomonas aeruginosa, 143
Colitis
Clostridium difficile, 138
oral vancomycin, 190
pseudomembranous, 179 , 188, 192 Collagen, 50
decreased/faulty production, 51
epithelial cell junctions and, 474
osteoblast secretion of, 459
polyostotic fibrous dysplasia and, 57
scar formation, 218
synthesis and structure, 50 in systemic sclerosis, 473
types of, 50
vitamin C in synthesis, 69

vitamin C in synthesis, 69

Collagenase in neutrophils, 406

wound healing, 216

Collapsing pressure (alveoli), 661
Collecting tubules
potassium-sparing diuretics and, 609
Colles fracture, 462
Colliculi, 504
Colon
histology of, 362
ischemia in, 210 Colon cancer, 388
adenomatous polyposis and, 387
bevacizumab for, 442
cetuximab for, 442
5-fluorouracil for, 440 incidence/mortality in, 222
irinotecan/topotecan for, 442
Lynch syndrome, 40
molecular pathogenesis of, 389
oncogenes and, 224
serrated polyps and, 387 Staphylococcus gallolyticus and,
137
tumor suppressor genes and, 224
Colonic ischemia, 363, 386
Colonic polyps, 387 Colony stimulating factor, 121
Colorado tick fever, 167
Color blindness, 197
Colovesical fistulas, 383
Coltivirus, 167
Coma hepatic encephalopathy, 391
herniation syndromes, 529
hyponatremia, 591
rabies, 171
thyroid storm, 342 Toxocara canis, 159
Trypanosoma brucei, 156
Comedones, 477
Commaless genetic code, 37
Comma-shaped rods, 141 Common bile duct, 361, 368
Common cold, 168
Common peroneal nerve, 452, 453
Common variable immunodeficiency
(CVID), 116 Communicating hydrocephalus, 522
Communicating hydrocepharus, 322 Communication with patient, 268
Compartment syndrome, 461
Competence (bacterial genetics), 130
Competitive agonists, 234 Competitive antagonist, 234
Competitive inhibitors, 230
Complement
activation pathways and functions,
106
binding of, 104 disorders of, 107 –122
eculizumab, 122
endotoxin activation, 133
immunodeficiency infections, 118
immunoglobulin isotypes, 105 innate immunity, 99
splenic dysfunction, 98
transplant rejection, 119
Complement activation inhibition
β-hemolytic bacteria, 135
Complementation (viral), 162 Complete (third-degree) AV block,
295
Complex partial seizures, 517
Complex renal cysts, 604
Compliance (lung), 665 Comprehensive Basic Science
Delicitories Datate Deferies

Examination (CBSE), 11

Comprehensive Basic Science Self-Assessment (CBSSA), 11 Computer-Based Test (CBT) environment of, 3-4 exam schedule for, 7-8 structure of, 3 COMT inhibitors, 548 Conditioning (psychological), 554 Conduct disorder, 557 Conducting zone (respiratory tree), 662 Conduction aphasia, 516 Conductive hearing loss, 533 Condylomata acuminata, 477 sexual transmission, 184 Condylomata lata syphilis, 147, 184 Confidence intervals, 263 Confidentiality, 267 in abuse, 269 behavioral science ethics, 265 exceptions to, 267 Confluence of the sinuses, 503 Confounding bias, 261 Congenital adrenal hyperplasias, **335** Congenital heart disease, 298–300 defect associations, 300 maternal phenylketonuria, 84 pulmonary arterial hypertension, 679 rubella, 182 Congenital hydrocele (scrotal), 652 Congenital hypothyroidism (cretinism), 341 Congenital long QT syndrome, 294 Congenital lung malformations, 660 Congenital malformation mortality, Congenital nevus, 475 Congenital rubella cardiac defect associations, 300 heart murmur, 291 Congenital solitary functioning kidney, **579** Congenital syphilis, 147 Congestion (respiratory) with lobar pneumonia, 683 Congo red stain, 212 Conivaptan, 354 SIADH, 354 Conjoined tendon, 369 Conjugated (direct) hyperbilirubinemia, 393 Conjugate vaccines, 127 Conjugation (bacterial genetics), 130 Conjunctival suffusion/injection eye disorders, 147 Kawasaki disease, 314 Conjunctivitis, 148, 534 adenovirus, 164 chlamydia, 184 gonococcal prophylaxis, 198 Haemophilus influenzae, 142 reactive arthritis, 469 rubeola, 170, 183, 186 Zika virus, 171 Connective tissue diseases aortic dissection and, 303 pulmonary arterial hypertension, 679 thoracic aortic aneurysms and, 302 Connective tissue drug reactions, 250 Conn syndrome, 349, 591 Consensual light reflex, 539 Consent healthcare proxy, 269 minors, 265, 268

FAS1_2019_21_Index_749-806.indd 761 11/21/19 12:27 PM

Consolidation (lung finding), 680	pulmonary hypertension, 679	C-peptide	Cryptococcus neoformans, 153
lobar pneumonia, 683	right ventricular failure, 668	insulin and, 334	HIV-positive adults, 177
Constipation anal fissures, 366	Corpus cavernosum	with insulinomas, 351	stains for, 125 Cryptococcus spp
calcium channel blockers, 318	lymphatic drainage of, 624 Corpus luteum	CpG island methylator phenotype (CIMP), 387	meningitis, 180
Hirschsprung disease, 384	hCG and, 633	Crackles (physical findings), 680	treatment, 199
irritable bowel syndrome, 383	progesterone production, 630	Cranial nerve palsies	urease-positive, 127
laxative treatments, 401	Correlation coefficient, 264	osteopetrosis, 463	Cryptogenic organizing pneumonia,
loperamide, 400	Cortical signs, 514	Cranial nerves, 506	683
ondansetron, 400	Corticopapillary osmotic gradient,	common lesions, 532	Cryptorchidism, 651
ranolazine, 319	588	functions of, 506	Sertoli cells and, 628
vincristine, 441	Corticosteroid-binding globulin, 336	locations of, 504	Cryptosporidium spp, 155
Constrictive pericarditis	Corticosteroids	nerve and vessel pathways, 505	fluorescent antibody stain, 125
jugular venous pulse in, 287	asthma, 687 cataracts, 535	nuclei of, 505	watery diarrhea, 179
Kussmaul sign, 316 Contact dermatitis, 113	Crohn disease, 382	pharyngeal arch derivation, 620 reflexes of, 507	Crypts of Lieberkühn, 362 C-section deliveries
Contemplation stage, substance	Cushing syndrome, 348	Craniopharyngioma, 528, 613	neonatal flora, 178
addiction, 568	giant cell arteritis, 314	hypopituitarism with, 339	neonatal flora with, 178
Continuous heart murmurs, 291	hyperglycemia with, 249	Craniotabes, 463	risk factors after, 640
Contraception	hypopituitarism, 339	C-reactive protein (CRP), 213	Culture requirements
isotretinoin teratogenicity, 614	lymphopenia with, 424	innate immunity and, 99	bacteria, 126
methods for, 657	microscopic polyangiitis, 315	Creatine kinase, 203	Cuneiform cartilage, 620
parental consent for minors and,	neutrophilia from, 424	Creatinine	Curling ulcers
265 progestins for, 657	osteonecrosis, 463	ACE inhibitor effects, 610	gastritis, 379 "Currant jelly" stools, 385, 386
Contractility in cardiac output, 284	osteoporosis with, 250 pancreatitis with, 249	glomerular filtration rate and, 582	"Currant jelly" sputum
Contraction alkalosis, 60, 587, 588,	for polymyalgia rheumatica, 470	proximal convoluted tubules,	Klebsiella spp, 186
609	Takayasu arteritis, 314	587	Curschmann spirals, 674
Coombs-positive hemolysis	thyroid storm, 342	Creatinine clearance, 582	Cushing disease, 348
α-methyldopa, 243	Wegener granulomatosis, 315	Cre-lox system, 56	Cushing-like symptoms, 203
anemia with, 423	Corticotropin-releasing hormone	Cremasteric muscle and fascia	Cushing reflex, 296
Coombs test, 423	(CRH)	inguinal canal and, 369	Cushing syndrome, 348
Cooperative kinetics, 230	adrenal cortex regulation of, 327	Cremasteric reflex, 452, 510	anovulation with, 645
COPI/COPII proteins, 47 Copper deficiency, 419	cortisol regulation, 336 function of, 328	Crepitus esophageal perforation, 377	corticosteroids, 120 eosinopenia, 424
Copper intrauterine device, 657	signaling pathways of, 337	in necrotizing fasciitis, 479	paraneoplastic syndrome, 228
Copper metabolism	Cortisol, 336	soft tissue, 138	small cell lung cancer, 684
Wilson disease, 395	congenital adrenal hyperplasias,	Crepitus in necrotizing fasciitis, 479	Cushing ulcers
Copper toxicity, 248	335	Crescentic glomerulonephritis, 596	gastritis, 379
Coprolalia, 557	in Cushing syndrome, 348	CREST syndrome, 473	Cutaneous anthrax, 137
Copy number variations (CNV), 54 Cord factor, 140	signaling pathways for, 337	autoantibody, 115	edema toxin, 132
Cori cycle, 82	Corynebacterium diphtheriae culture requirements for, 126	sclerodermal esophageal dysmotility, 377	Cutaneous flushing drugs causing, 248
Cori disease, 87	exotoxin effects, 139	Creutzfeldt-Jakob disease, 178, 521	Cutaneous larva migrans, 159
Corkscrew fibers, 528	exotoxin production, 132	"Crew cut" (skull X-ray), 422	Cutaneous leishmaniasis, 158
"Corkscrew" hair, 69	Costovertebral angle tenderness, 601	Cricoid cartilage, 620	Cutaneous mycoses, 152
Cornea	Co-transporter 2 (SGLT2) inhibitors,	Cricothyroid muscle, 620	Cutaneous paraneoplastic syndromes,
astigmatism, 535	353	Cri-du-chat syndrome, 64	228
collagen in, 50 Corneal arcus	Cough ACE inhibitors, 251, 610	Crigler-Najjar syndrome, 393, 394 Crimean-Congo hemorrhagic fever,	Cutaneous small-vessel vasculitis, 314
familial hypercholesterolemia, 94	chronic bronchitis, 674	167	Cutis aplasia
hyperlipidemia, 301	gastroesophageal reflux disease,	CRISPR/Cas9, 53	Patau syndrome, 63
Corneal reflex, 507	377	Crohn disease, 382	CXCR4
Corneal vascularization, 67	guaifenesin, 686	azathioprine, 120	viral receptor, 166
Corniculate cartilage, 620	hypersensitivity pneumonitis, 675	B ₁₂ deficiency, 420	CXCR4/CCR5 protein
Coronary arteries	lung cancer, 684	cholelithiasis and, 396 natalizumab, 122	presence on cells, 110
anatomy of, 283 atherosclerosis in, 302	nonproductive, 140 staccato, 149	spondyloarthritis and, 469	Cyanide electron transport chain, 78
Coronary artery disease	Wegener granulomatosis, 315	sulfasalazine for, 400	Cyanide poisoning
atrial fibrillation and, 295	whooping, 132, 143	vitamin B ₁₂ deficiency, 69	vs carbon monoxide poisoning, 667
diabetes mellitus and, 346	Councilman bodies	Cromolyn, 687	induced methemoglobinemia, 666
hormonal contraception with, 657	yellow fever, 168	Cross-linking in collagen synthesis, 50	nitroprusside, 318
hypertension and, 300	Countertransference, 554	Cross-over study, 256 , 261	treatment for, 248
sudden cardiac death, 304	Courvoisier sign	Cross-sectional studies, 256	Cyanosis "blue babies," 298
Coronary sinus anomalous pulmonary return, 298	pancreatic cancer, 398 Cowpox, 164	Croup, 170 paramyxoviruses, 167, 169	"blue kids," 299
development, 281	Coxiella burnetii	pulsus paradoxus in, 310	Eisenmenger syndrome, 299
Coronary steal syndrome, 304	animal transmission, 149	CRP and ESR, 214	esophageal atresia, 359
Coronary vasospasm, 248	Q fever, 150	Crust (skin), 475	methemoglobinemia, 666
triptans and, 547	Coxiella spp	basal cell carcinoma, 484	patent ductus arteriosus, 299
Coronaviruses	intracellular organisms, 127	impetigo, 479	pulmonary hypertension, 679
characteristics of, 167	Coxsackievirus	varicella zoster virus, 479	tetralogy of Fallot, 298
genomes of, 163 Cor pulmonale, 309, 668	acute pericarditis, 313 picornavirus, 168	Cryoprecipitate, 429 Crypt hyperplasia, 381	Cyclins, 46 Cyclobenzaprine, 551
from obstructive lung disease, 674	presentation, 167	Cryptococcal meningitis, 199	Cyclooxygenase
pneumoconioses, 677	rashes of childhood, 183	Cryptococcosis, 153	aspirin effect on, 411
*	•	**	* '

FAS1_2019_21_Index_749-806.indd 762 11/21/19 12:27 PM

Cyclooxygenase inhibition	Cytoplasmic membrane (bacterial),	Decussation	De novo synthesis
irreversible, 486	124	in spinal tracts, 509	pyrimidine and purine, 36 , 73
reversible, 485, 486	Cytoplasmic processing bodies	Deep brachial artery, 455	Dense deposit disease, 596
selective, 486	(P-bodies), 41	Deep inguinal lymph nodes, 624	Dental plaque
Cyclophosphamide, 441	Cytoskeletal elements, 48	Deep venous thrombosis (DVT), 671	normal flora, 178
hemorrhagic cystitis with, 249 microscopic polyangiitis, 315	Cytotoxic T cells, 102 cell surface proteins, 110	direct factor Xa inhibitors for, 437 glucagonomas and, 351	viridans streptococci, 128 Dentate line, 366
SIADH with, 249	MHC I and II, 100	heparin for, 436	Dentate nucleus, 499
toxicities of, 444	Cytotrophoblast, 617	tamoxifen/raloxifene and, 443	Dentin
transitional cell carcinoma and,	-)	Deer flies (disease vectors), 159	collagen in, 50
606	D	Defense mechanisms	osteogenesis imperfecta, 51
Wegener granulomatosis, 315	Dabigatran, 435	immature, 554–555	Dentinogenesis imperfecta, 51
Cycloplegia	Dabrafenib, 444	mature, 555	Denys-Drash syndrome, 606
atropine, 241	Daclizumab	Defensins, 99	Dependent personality disorder, 566
muscarinic antagonists for, 241 Cyclosporine	targets of, 121	Deferasirox, 248 Deferiprone, 248	Depersonalization/derealization disorder, 558
gingival hyperplasia, 250	Dacrocytes, 414 Dactinomycin, 439	Deferoxamine, 248	panic disorder, 563
gout, 250	RNA polymerase inhibition, 42	Deformation, 613	Depolarizing neuromuscular
immunosuppression, 120	targets of, 438	Degarelix, 656	blocking drugs, 551
Cyclothymic disorder, 561	Dactylitis	Degenerate/redundant genetic code, 37	Depressants, intoxication and
Cystathionine, 67	seronegative spondyloarthritis, 469	Degmacytes, 414	withdrawal, 570
Cystathionine synthase deficiency, 84	sickle cell anemia, 422	G6PD deficiency, 79	Depression
Cyst disorders (renal), 604	Dalfopristin	Dehydration	atypical features in, 561
Cysteine, 85 Cystic duct, 368	VRE, 198 Danazol, 658	diabetic ketoacidosis, 347 filtration changes and, 583	benzodiazepine withdrawal, 570 dissociative identity disorder, 558
Cystic fibrosis, 60	pseudotumor cerebri, 521	gout exacerbation, 467	drug therapy, 572
Aspergillus fumigatus, 153	"Dancing eyes, dancing feet," 228	loop diuretics and, 608	electroconvulsive therapy, 562
bronchiectasis, 675	Dandy-Walker syndrome, 492	mannitol and, 607	hyperparathyroidism, 345
chromosome association, 64	Dantrolene, 550, 551	osmotic laxatives, 401	metoclopramide, 400
common organisms, 179	Dapagliflozin, 353	salivary stones with, 376	mirtazapine for, 244
meconium ileus and, 386	Dapsone	shock, 310	neurotransmitters for, 495
N-acetylcysteine, 686	Hansen disease, 141	Dehydrogenases, 73	postpartum, 562
pancreatic insufficiency, 381	hemolysis in G6PD deficiency, 250	Delavirdine	seasonal pattern with, 561
vitamin deficiencies and, 65 Cystine, 598	mechanism and use, 194 <i>Mycobacterium leprae</i> , 196	HIV therapy, 203 Delirium, 558	serotonin-norepinephrine reuptake inhibitors (SNRIs) for, 575
Cystinuria, 85	Pneumocystis jirovecii, 154	barbiturate withdrawal, 570	SSRIs for, 575
Cystitis	Daptomycin	diabetic ketoacidosis, 347	Deprivation effects (infants), 556
acute bacterial, 594, 600	mechanism and use, 195	PCP, 571	De Quervain tenosynovitis, 461
squamous cell carcinoma risk, 606	MRSA, 198	thyroid storm, 342	De Quervain thyroiditis, 341
Cytarabine, 440	Darkfield microscopy	Delirium tremens (DTs), 569 , 570	Dermacentor tick (disease vector), 149
Cytochrome C, 208	for Treponema, 146	δ cells	Dermatitis
Cytochrome P-450 azoles, 199	Darunavir HIV therapy, 203	endocrine pancreas somatostatin production, 371	B-complex deficiency, 65 drug reactions and, 250
barbiturates and, 546	Dasabuvir, 204	somatostatin production, 371	glucagonomas, 351
cimetidine and, 399	Dasatinib, 443	Delta rhythm (EEG), 497	IPEX syndrome, 102
griseofulvin, 200	Datura, 241	Delta virus, 167	type IV hypersensitivity reaction, 113
interactions with, 252	Daunorubicin, 439	Deltoid muscle	vitamin B ₅ deficiency, 67
macrolides, 193	dilated cardiomyopathy, 248	axillary nerve injury, 447	vitamin B ₇ deficiency, 68
phenobarbital effect on, 544	DCC gene, 224	Erb palsy, 448	Dermatitis herpetiformis, 481
rifamycins, 196	Deacetylation	Delusional disorder, 560	celiac disease and, 381
ritonavir, 203 Cytokeratin, 227	histones, 34 Dead space (lung), 664	Delusions, 559 mesolimbic pathway, 499	Dermatologic lesion terms, 475 Dermatomes
Cytokines, 101, 108	Deafness	Demeclocycline	landmarks, 510
corticosteroids and, 120	Alport syndrome, 596	diabetes insipidus and, 249, 338	Dermatomyositis, 228
Graves disease and, 342	congenital long QT syndrome, 294	Dementia	autoantibody, 115
rejection reactions, 119	congenital syphilis, 147	HIV-positive adults, 177	Dermatomyositis/polymyositis, 471
type IV hypersensitivity, 113	rubella, 182	metachromatic leukodystrophy, 88	Dermatophytes, 152
Cytokinesis, 46	syphilis, 182	neurodegenerative disorders, 520–521	Dermis, 473
Cytomegalovirus (CMV) AIDS retinitis, 165	Deamination base excision repair, 40	prion disease, 178	Descending colon, 360 Desert bumps, 151
cholecystitis and, 396	Death	vitamin B ₃ deficiency, 67	Desert rheumatism
clinical significance, 165	aortic dissection in, 303	Demyelinating/dysmyelinating	Coccidioidomycosis, 151
esophagitis and, 377	children, explaining to, 269	disorders, 523	Desflurane, 550
HIV-positive adults, 177	common causes, 272	lead poisoning (adult), 425	Desipramine, 575
hyper-IgM syndrome and, 117	sudden cardiac death, 304	metachromatic leukodystrophy, 88	Desloratadine, 686
immunodeficient patients, 118	thyroid storm, 342	progressive multifocal	Desmin, 48, 227
pneumonia, 683 TORCH infection, 182	Death receptor pathway, 207, 208 Debranching enzyme	leukoencephalopathy, 524	Desmopressin central DI, 329
treatment, 202	Cori disease, 87	vitamin B ₁₂ deficiency, 530 Dendritic cells, 408	DI treatment, 338
viral receptor, 166	glycogen metabolism, 86	IL-10, 108	for hemophilia, 426
Cytoplasm	Decay-accelerating factor (DAF), 106	innate immunity, 99	Desmosome, 474
cell cycle phase, 46	Deceleration injury, 303	T- and B-cell activation, 102, 103	Desquamation
cytoskeletal elements, 48	Decerebrate (extensor) posturing, 511	Dengue, 167	staphylococcal toxic shock
glycolysis, 76	Decidua basalis, 617	Denial, 554	syndrome, 135
HMP shunt, 79	Decision-making capacity, 266	Denosumab, 122	Desvenlafaxine, 575
metabolism in, 72	Decorticate (flexor) posturing, 511	for osteoporosis, 462	Detached retina, 537

FAS1_2019_21_Index_749-806.indd 763 11/21/19 12:27 PM

INDEX

Developmental delay
fetal alcohol syndrome, 615
renal failure and, 603
Dexamethasone
Cushing syndrome diagnosis, 348
Dexlansoprazole, 399
Dexrazoxane, 439
Dextroamphetamine, 572
Dextrocardia, 280
x-ray, 49
Dextromethorphan, 551, 686
DHT (dihydrotestosterone), 622,
636, 639
Diabetes insipidus, 338
antidiuretic hormone in, 329
drug reaction and, 249
lithium, 574
lithium toxicity, 569
potassium-sparing diuretics for, 609
thiazides for, 609
Diabetes mellitus, 346 –347
atherosclerosis and, 302
β-blockers and, 245
carpal tunnel syndrome, 459
cataracts and, 535
chronic renal failure and, 603
CN III damage, 541
diabetic ketoacidosis, 347
diabetic retinopathy, 537
Friedreich ataxia, 531
fungal infections, 186
glucagonomas, 351
glucosuria in, 584
hemochromatosis, 395
hepatitis C, 173
hypertension and, 300, 316
management of, 352–353
naming conventions for, 253
nanhranathy with 507
nephropathy with, 597
opportunistic infections, 153
pancreatic cancer, 398
polyhydramnios and, 641
in pregnancy, 300
pyelonephritis and, 600
readmissions with, 272
tacrolimus and, 120
teratogenic potential of maternal,
614
therapy management, 352
type I vs type 2, 347
urinary tract infections, 181
urinary tract infections, 181 UTIs and, 600
urinary tract infections, 181
urinary tract infections, 181 UTIs and, 600
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 577 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61 Diagnostic test evaluation, 257
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61 Diagnostic test evaluation, 257 Diagnostic tests/maneuvers
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61 Diagnostic test evaluation, 257 Diagnostic test evaluation, 257 Diagnostic test symaneuvers laboratory tests in bone disorders, 464
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61 Diagnostic test evaluation, 257 Diagnostic test evaluation, 257 Diagnostic test symaneuvers laboratory tests in bone disorders, 464
urinary tract infections, 181 UTIs and, 600 Diabetes mellitus type 1, 347 autoantibody, 115 HLA subtypes with, 100 Diabetes mellitus type 2, 347 amyloidosis, 212 Diabetic ketoacidosis (DKA), 347 DM type 1 and, 346 ketone bodies, 90 Diabetic nephropathy ACE inhibitors for, 610 Diabetic neuropathy, 575 Diabetic retinopathy, 575 Diabetic retinopathy, 537 Diagnosis errors, 274 Diagnostic criteria, psychiatric grief, 562 panic disorder, 563 symptom duration and, 564 Diagnostic maneuvers/signs Gower sign, 61 Diagnostic test evaluation, 257 Diagnostic tests/maneuvers

Dialectical behavioral therapy, 565,
572
Dialysis-related amyloidosis, 212
Diamond-Blackfan anemia, 420
Diapedesis, 215
Diaper rash
Candida albicans, 153
nystatin, 199
Diaphoresis, 305
acromegaly, 339
Diaphragmatic hernia, 370
Diaphragm structures, 663
Diaphysis, 465
Diarrhea, 117
B-complex deficiency, 65
bismuth/sucralfate for, 399
Campylobacter jejuni, 145
cholera toxin, 132
clindamycin, 192
Clostridium difficile, 138
Cryptosporidium, 155
drug reaction and, 249
ezetimibe, 320
giardiasis, 155
graft-versus-host disease, 119
HIV-positive adults, 177
inflammatory bowel diseases, 382
irritable bowel syndrome, 383
lactase deficiency, 81
lactose intolerance, 381
as laxative adverse effect, 401
leflunomide, 486
loperamide for, 400
magnesium deficiency from, 332
magnesium hydroxide, 399
malabsorption syndromes, 381
metoclopramide, 400
misoprostol, 399
opioids for, 551
organisms causing, 179
pellagra, 67
rice-water, 132
rotavirus, 168
Salmonella, 144
Shigella, 144
thyroid storm and, 342
Vibrio cholerae, 146
VIPomas, 371
vitamin C toxicity, 69
watery, 132
Diastole
cardiac cycle, 287
heart failure and, 309
heart murmurs of, 291
heart sounds of, 287
Diazepam, 546
alcohol withdrawal, 572
Diclofenac, 486
Dicloxacillin
mechanism and use, 188
Dicrotic notch, 287
Dicyclomine, 241
Didanosine, 203
HIV therapy, 203
pancreatitis, 249
Diencephalon, 490
Diethylcarbamazine
antihelminthic, 200
nematode infections, 159
Diethylstilbestrol (DES), 656
teratogenicity, 614
vaginal tumors, 644
Differential media, 126
Diffuse axonal injury, 515
Diffuse cortical necrosis, 602
Diffuse esophageal spasm, 377
Zinase coopiiageai spasiii, 7//

Diffuse gastric cancer, 379
Diffuse glomerular disorders, 594
Diffuse large B-cell lymphoma (DLBCL), 430, 432
Diffuse partial seizures, 517
Diffuse proliferative glomerulonephritis (DPGN), 596
Diffuse scleroderma, 473
Diffuse stomach cancer, 379 Diffusion-limited gas exchange, 668
DiGeorge syndrome, 344
lymph node paracortex in, 96 thymic shadow in, 98
Digestion
malabsorption syndromes, 381 secretory products for, 372–374
ulcerative colitis and, 382
Digestive tract anatomy and histology, 362
Digitalis
arrhythmias induced by, 322 contractility effects, 284
hyperkalemia and, 590
toxicity treatment for, 248 Digoxin
contractility effects of, 285, 286
for dilated cardiomyopathy, 308 mechanism and clinical use, 321
sodium-potassium pump
inhibition, 49 therapeutic index of, 234
toxicity treatment, 324
Dihydroergotamine, 518 Dihydrofolic acid, 194
Dihydroorotate dehydrogenase
leflunomide effects, 36, 486 Dihydropyridine calcium channel
blockers, 253
Dihydropyridine receptor, 456 Dihydrorhodamine test, 117
Dihydrotestosterone (DHT)
5α-reductase deficiency, 639 function, 636
sexual determination, 622
Dihydroxyacetone-P, 80 Dilated cardiomyopathy, 308, 309
doxorubicin, 439
drug reaction and, 248 hemochromatosis, 395
muscular dystrophy, 61
wet beriberi, 66 with myocarditis, 313
Diltiazem, 318
Dimenhydrinate, 686 Dimercaprol
for arsenic toxicity, 248
for lead poisoning, 248, 419 for mercury poisoning, 248
Dinitrophenol, 78
Diphenhydramine, 686 Diphenoxylate, 551
Diphtheria
Corynebacterium diphtheriae, 139 exotoxins, 130, 131, 132
unvaccinated children, 186
vaccine for, 139 Diphyllobothrium latum
disease association, 161
presentation, 160 vitamin B ₁₂ deficiency, 69, 420
Diplococci, 142
Diplopia brain stem/cerebellar syndromes,
523
central vertigo, 534 drug toxicity, 544
O 17.

in botulism, 138
intracranial hypertension, 521
myasthenia gravis, 472
osmotic demyelination syndrome,
524
Dipyridamole
for coronary steal syndrome, 304 Direct bilirubin, 375
Direct cholinomimetic agonists, 240
Direct (conjugated)
hyperbilirubinemia, 393
Direct Coombs test
Type II hypersensitivity, 112
Direct factor Xa inhibitors, 437 Direct fluorescent antibody (DFA)
microscopy
for Treponema, 146
Direct inguinal hernia, 370
Direct light reflex, 539
Direct sympathomimetics, 242
Direct thrombin inhibitors, 435
Discharge planning, 272 Discolored teeth, 204
Discounted fee-for-service, 271
Disease associations, 161
Disease prevention, 270
Disease vectors
Aedes mosquitoes, 168
Anopheles mosquito, 157 armadillos, 149
birds, 148, 149
cats 149
dogs, 145, 149
fleas, 149, 150
flies, 144, 149
horse flies, 159 <i>Ixodes</i> ticks, 146
1xoues ticks, 1 to
rodents 167
rodents, 167
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods,
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociation, 554 Dissociative disorders, 558
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociative disorders, 558 amnesia, 558
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociation, 554 Dissociative disorders, 558
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints,
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints,
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints, 451 Distal renal tubular acidosis (type 1),
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints, 451 Distal renal tubular acidosis (type 1), 593
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociation, 554 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints, 451 Distal renal tubular acidosis (type 1), 593 Distributive shock, 310
rodents, 167 ticks, 146, 150 zoonotic bacteria, 149 Disinfection/sterilization methods, 204 Disinhibited behavior Klüver-Bucy syndrome, 511 Disinhibited social engagement, 556 Disopyramide, 322 Disorganized thought, 559 Dispersion measures, 262 Displacement, 554 Disruption (morphogenesis), 613 Disruptive mood dysregulation disorder, 557 Disseminated candidiasis, 153 Disseminated intravascular coagulation (DIC), 428 acute myelogenous leukemia, 432 Ebola, 171 endotoxins, 131, 133 meningococci, 142 microangiopathic anemia, 423 Waterhouse-Friderichsen syndrome, 349 Dissociative disorders, 558 amnesia, 558 identity disorder, 558 Distal humerus, 455 Distal interphalangeal (DIP) joints, 451 Distal renal tubular acidosis (type 1), 593

disulfiram-like reaction, 251

FAS1_2019_21_Index_749-806.indd 764 11/21/19 12:27 PM

-		_	
Diuresis	Dorsal columns (spinal cord), 508,	multiorgan, 251	Dyskinesia
atrial natriuretic peptide, 296	509	musculoskeletal, 250	tardive, 251
for shock, 310	thalamic relay for, 498	neurologic, 251	Dyslipidemia
Diuretics	Dorsal interossei muscle, 450	renal/genitourinary, 251	β-blocker adverse effects, 323
dilated cardiomyopathy, 308	Dorsal motor nucleus, 506	respiratory, 251	β-blockers, 245
electrolyte changes, 609	Dorsal optic radiation, 542	Drug reaction with eosinophilia	familial, 94
glaucoma treatment, 552	Dorsal pancreatic bud, 360	and systemic symptoms	renal failure and, 603
hypertension treatment, 316	Dorsiflexion	(DRESS), 250	vitamin B ₃ for, 67
magnesium levels and, 332	common peroneal nerve injury,	Drug-related disorders	Dysmenorrhea
mechanism and clinical use, 607	453	myocarditis, 313	copper IUD, 657
pancreatitis, 249	Dosage calculations, 231	Drug resistance	primary, 645
for SIADH, 338	Dosage interval, 231	plasmids in, 131	Dysmetria 524
Diverticula, 383	Double-blinded studies, 256 Double stranded viruses, 163	Drugs	central vertigo, 534
Diverticulitis, 383 Diverticulosis, 383		cholinomimetic agents, 240	with strokes, 514
	Double Y males, 638	efficacy vs potency, 233	Dyspareunia, 567
Diverticulum, 383	Down syndrome, 63	elimination of, 232, 233 errors in, 274	Dysphagia achalasia, 376
Dizygotic ("fraternal") twins, 616 Dizziness	ALL and AML in, 432 cardiac defect association, 300	patient difficulty with, 268	esophageal pathologies and,
AChE inhibitors, 549	cataracts and, 535	phase I metabolism, 232	377–378
calcium channel blockers, 318	chromosome association, 64	reactions to, 248–251	in botulism, 138
dihydropyridine, 318	hCG in, 633	therapeutic index, 234	osmotic demyelination syndrome,
nitrates, 318	Hirschsprung disease and, 384	toxicities, 248	524
ramelteon, 547	intestinal atresia and, 359	Drug safety	Plummer-Vinson syndrome, 418
ranolazine, 319	Doxazosin, 244	therapeutic index, measurement,	stroke effects, 514
sacubitril, 319	Doxepin, 575	234	Zenker diverticulum, 384
vertigo and, 534	Doxorubicin	Drug trials, 256	Dysplasia
DMPK gene, 61	dilated cardiomyopathy, 248	Drunken sailor gait, 511	bronchopulmonary, 210
DNA	targets, 438	Drusen, 536	cellular adaptive response, 206
cloning methods, 55	toxicities, 444	Dry beriberi, 66	cervical, 645
free radical effect on, 210	Doxycycline	Dry cough with ACE inhibitors, 251	neoplastic progression, 219
introns vs exons, 43	chlamydiae, 148	Dry mouth	Dysplastic kidney
laddering in apoptosis, 208	in gonorrhea treatment, 142	Lambert-Eaton myasthenic	multicystic, 578, 579
methylation in, 34	lymphogranuloma venereum, 149	syndrome, 472	Dyspnea
mutations in, 39	MRSA, 198	Dry skin, 66	α ₁ -antitrypsin deficiency, 392
plasmid transfer, 130	Mycoplasma pneumoniae, 150	Dubin-Johnson syndrome, 393, 394	aortic stenosis, 291
repair of, 40	rickettsial/vector-borne disease,	Duchenne muscular dystrophy, 61	heart failure, 309
DNÂ ligase	150	inheritance, 61	hypersensitivity pneumonitis, 675
action of, 38	tetracyclines, 192	Ductal adenocarcinomas, 368	hypertrophic cardiomyopathy, 308
DNA mutations	Doxylamine, 686	Ductal carcinoma in situ (DCIS),	in botulism, 138
types of, 39	DPP-4 inhibitors, 353	650	Wegener granulomatosis, 315
DNA polymerase inhibitors, 253	Dressler syndrome, 305, 307, 313	Ductal carcinomas (invasive), 650	Dystonia
DNA polymerases	DRESS syndrome, 250	Ductus arteriosus, 282, 619	acute, 241
action of, 38	Drooling treatment, 241	Ductus deferens	antipsychotics/antiepileptics, 569
DNA repair, 40	Drop metastases, 528	embryology, 622	benztropine for, 241
DNA replication, 38	Drop seizures, 517	Ductus venosus, 282	Lesch-Nyhan syndrome, 37
DNA topoisomerases, 38	Drug dosages, 234	Duloxetine, 575	movement disorders, 519
DNA transcription	calculations, 231	Duodenal atresia, 359	nigrostriatal pathway and, 499
deacetylation, 34	lethal median, 234	Duodenal ulcer, 380	treatment of, 241
DNA viruses, 164	liver disease, 231	Duodenum	Dystrophic calcification, 211, 227
characteristics, 163	loading, 231	basal electric rhythm, 362	Dystrophin gene, 61
genomes, 163 Dobutamine, 242	maintenance dose, 231	biliary structures and, 368	Dysuria, 654
	median effective, 234	histology of, 362	cystitis, 181 urinary catheterization, 185
Dogs (disease vectors) 145, 149	renal disease, 231 toxic dose, 234	location, 360	UTIs causing, 600
Dogs (disease vectors), 145, 149 Dolutegravir, 203	Drug elimination, 231	secretory cells, 373 Duplex collecting system, 579	C 1 13 Cattoring, 000
Dominant inheritance, 59	Drug-induced lupus, 250	Dural venous sinuses, 503	E
Dominant negative mutations, 57	Drug interactions	Dura mater, 496	– Ear
Donepezil, 240, 549	additive, type, 235	Dwarfism	pharyngeal pouch derivation, 621
Do not resuscitate (DNR) order, 266	antagonistic, type, 235	achondroplasia, 462	Eardrum, 533
Dopamine, 242	permissive, type 235	D-xylose test, 381	Early complement deficiencies (C1-
basal ganglia, 500	potentiation, type, 235	Dynein	C4), 107
bupropion effect, 576	synergistic, type, 235	movement of, 48	Eating disorders
changes with disease, 495	tachyphylactic, type, 235	Dynein motors, 171	anovulation and, 645
function of, 328	Drug metabolism, 232	Dysarthria, 516	binge-eating disorder, 567
Huntington disease, 520	cytochrome P-450 dependent,	Friedreich ataxia as, 531	bulimia nervosa, 567
kidney functions and, 589	232	in botulism, 138	characteristics of, 567
L-DOPA, 548, 549	geriatric patients in, 232	osmotic demyelination syndrome,	pica, 567
MAO inhibition, 549, 575	Drug name conventions, 253 –255	524	Eaton agar
Parkinson disease, 548	Drug overdoses	Dysbetalipoproteinemia, 94	culture requirements, 126
PCT secretion of, 589	of weak acids, 233	Dysentery	Ebola virus, 167, 171
pheochromocytoma secretion, 350	of weak bases, 233	Entamoeba histolytica, 179	Ebstein anomaly, 281, 298, 300
vitamin B ₆ and, 67	Drug reactions	Escherichia coli, 145	lithium side effect, 574
Dopamine agonists, 330, 339, 548	cardiovascular, 248	Shigella spp, 132, 144, 179	E-cadherin, 219, 474
Dopamine receptors, 238	endocrine/reproductive, 249	Dysfunctional uterine bleeding, 633	ECF
Dopaminergic pathways, 499	gastrointestinal, 249	Dysgerminoma, 647	body compartments of, 231
Dornase alfa (DNAse), 60	hematologic, 250	Dysgeusia, 71	Echinocandins, 200

FAS1_2019_21_Index_749-806.indd 765 11/21/19 12:27 PM

INDEX

Echinococcus granulosus
cestodes, 160
disease association, 161
Echinocytes, 414
Echothiophate, 552
Echovirus
picornavirus, 167, 168
Eclampsia, 300, 643
Eciampsia, 500, 075
Ecthyma gangrenosum, 143
Pseudomonas spp, 143
Ectocervix, 626
Ectoderm
branchial clefts, 619
derivatives of, 613
Ectoparasites, 161
Ectopic pregnancy, 641
appendicitis differential diagnosis,
383
Chlamydia trachomatis, 149
hCG in, 633
Kartagener syndrome, 49
methotrexate for, 440
salpingitis and, 185
Eculizumab, 122
Eczema
atopic dermatitis, 477
eczematous dermatitis, 475
phenylketonuria, 84
skin scales in, 475
type I hypersensitivity, 112
Wiskott-Aldrich syndrome, 117
Edema
acute poststreptococcal
glomerulonephritis, 596
Arthus reaction, 113
calcium channel blockers, 318
capillary fluid exchange and, 297
danazol, 658
diabetic ketoacidosis, 347
endotoxins, 133
fludrocortisone, 354
heart failure and, 309
with hyperaldosteronism, 349
immunosuppressants, 120
Kawasaki disease and, 314
kwashiorkor, 71
loop diuretics for, 608
periorbital, 159, 161
peripheral, 309, 610
pitting, 309
pseudoephedrine/phenylephrine,
686
pulmonary hypertension, 668
Trichinella spiralis, 159, 161
trichinosis, 159
vasogenic, 496
wet beriberi, 66
,
Edema factor
Bacillus anthracis, 132
Edinger-Westphal nuclei, 539
Edrophonium, 240
Edwards syndrome, 63
cataracts and, 535
chromosome association, 64
Efavirenz
HIV-positive adults, 203
Effective refractory period
Class IA antiarrhythmic effect, 322
Class IC antiarrhythmic effect, 322
myocardial action potential, 292
Effective renal plasma flow, 582
Efferent/afferent nerves, 296
Efferent arteriole, 580
ANP/BNP, 588
constriction of, 583
Efficacy vs potency of drugs. 233
Hitheact its noteness of drives 144

EGFR gene, 684
"Eggshell" calcification, 677
Ego defenses, 554 , 555 Ego-dystonic behavior, 563
Egophony, 680 Ego-syntonic behavior, 565, 566
Ehlers-Danlos syndrome
aneurysm association with, 516 collagen in, 50
collagen synthesis in, 51
heart murmur with, 291 Ehrlichia spp
animal transmission, 149 E <i>hrlichia chaffeensis</i> , 149
Gram stain, 125
rickettsial/vector-borne, 150 Eisenmenger syndrome, 299
Ejaculation
innervation of, 627 sperm pathway in, 626
Ejaculatory ducts, 626 embryology of, 622
Ejection fraction
equation for, 285 Elastase, 373
activity in emphysema, 674
Elastic recoil (lung and chest wall), 665
Elastin characteristics of, 52
Elbow injuries, 459, 461
Elderly changes in, 270
Electrocardiograms (ECGs), 293
acute pericarditis on, 313 cardiac tamponade on, 310
low-voltage, 308, 310 MI diagnosis with, 306
with pulmonary embolism, 672
tracings of, 295 Electroconvulsive therapy (ECT)
adverse effects, 562
postpartum psychosis, 562 Electroencephalogram (EEG)
Creutzfeldt-Jakob disease, 521 in delirium, 558
sleep stages, 497
Electrolytes disturbances in, 591
diuretic effects on, 609
Electron acceptors (universal), 75 Electron transport chain and
oxidative phosphorylation, 78
inhibitors of, 78
Electrophoresis hemoglobin, 410
Elek test, 139
Elementary bodies (chlamydiae), 148
Elephantiasis, 159 11β-hydroxylase, 335
11-deoxycortisol
and metyrapone, 335 11-deoxycorticosterone, 335
Elfin facies, 64
Elimination constant, 231 Elimination of drugs, 232
urine pH and, 233
ELISA (enzyme-linked immunosorbent assay), 54
Elongation Factor 2 Corynebacterium diphtheriae, 139
eltrombopag (TPO receptor agonist),
121 Elvitegravir, 203

Emancipated minors, 265
EMB agar Escherichia coli, 181
lactose-fermenting enterics, 144
Emboli atherosclerosis, 302
atrial fibrillation, 295
atrial septal defect, 299 pulmonary, 310
stroke, 512
Emboliform nucleus, 499 Embryogenesis
genes involved in, 612
intrinsic pathway and, 208 Embryology
cardiovascular, 281–283
derivatives, 613 erythropoiesis, 404
gastrointestinal, 358-359
gland derivations in, 621 hematologic/oncologic, 404
neurological, 490–492
pancreas and spleen, 359, 360 renal, 578–579
reproductive, 612–623
respiratory, 660 thyroid development, 326
USMLE Step 1 preparation, 276
Embryonal carcinoma, 653 Embryonic age calculation, 633
Embryonic development, 612
Embryonic morphogenic errors, 613 Embryonic stage (development), 660
Embryotoxic, 204
Emergent care proxy, 269 Emission
innervation of, 627
Emollients laxative, 401
Emotion neural structures and, 499
Emotionally distraught patients, 268
Emotional/social development neglect and deprivation effects, 55
Empagliflozin, 353
Emphysema, 674 diffusion in, 668
diffusion-limited gas exchange,
668 elastin in, 52
panacinar, 392
Empty/full can test, 446 Empty sella syndrome, 339
Emtricitabine, 203
HIV-positive adults, 203 Enalapril, 610
Encapsulated bacteria, 127
infections with immunodeficiency 118
Encephalitis
anti-NMDA receptor, 228 Cryptococcus neoformans, 153
guanosine analogs, 201
herpesviruses, 165, 180 HSV identification, 166
Lassa fever, 167
neonatal, 182 West Nile virus, 180
Encephalomyelitis
paraneoplastic, 228 paraneoplastic syndrome, 228
Encephalopathy hepatic, 365, 391
hypertensive emergency, 300
lead poisoning, 419 Lyme disease, 146

prion disease, 178 renal failure, 603 Wernicke, 66 Encephalotrigeminal angiomatosis, Endemic typhus, 149 Endocannabinoids, 336 Endocardial cushion, 281 Endocardial fibroelastosis, 308 Endocarditis bacterial, 311 Candida albicans, 153 coarctation of aorta, 299 Coxiella burnetii, 150daptomycin, 195 enterococci, 137 heart murmurs, 291 heroin addiction and, 576 nonbacterial thrombotic, 228 prophylaxis, 198 Staphylococcus aureus, 135 Streptococcus bovis, 137 viridans streptococci, 128 Endocervix, 626 Endochondral ossification, 458 Endocrine functions kidney, 589 Endocrine system anatomy, 327–328 embryology, 326 hormones acting on kidney, 589, hormone signaling pathways, 337 pathology, 338–354 pharmacology, 352–354 physiology, 328–336 Endocrine/reproductive drug reactions, 249 Endoderm branchial pouch derivation, 619 derivatives of, 613 Endodermal sinus tumor, 647, 653 Endodermal tubules, 660 Endometrial abnormal uterine bleeding, 633 Endometrial artery, 617 Endometrial carcinoma, 648 epidemiology of, 643 estrogens and, 656 Lynch syndrome and, 388 PCOS and, 645 tamoxifen and, 443 Endometrial hyperplasia follicular cysts, 646 Endometrial polyps uterine bleeding with, 633 Endometrial vein, 617 Endometriosis characteristics and treatment, 648 danazol for, 658 Endometritis, 648 Endometrium hyperplasia, 648-649 maintenance of, 632 Endoneurium, 495 Endoplasmic reticulum, 46, 47 rough, 46 smooth, 46 Endosomes, 47 Endothelial cells leukocyte extravasation and, 215 in wound healing, 216 Endothelin receptor antagonist, 686 naming conventions for, 254 Endothelium-derived relaxing factor (EDRF), 337

FAS1_2019_21_Index_749-806.indd 766 11/21/19 12:27 PM

P 1
Endotoxins
effects of, 133
features of, 131
Enflurane, 550
seizures with, 251
Enfuvirtide, 203
HIV-positive adults, 203
Enhancers (gene expression), 41
Enoxacin, 195
Entacapone, 548
Entamoeba histolytica
amebiasis, 155
bloody diarrhea, 179
metronidazole, 195
Enteric gram ⊝ bacteria
facultative anaerobic metabolism,
127
Enteric nerves, 362, 401
Enteritis
vitamin B ₁₂ deficiency, 69
vitamin B ₅ deficiency, 67
vitamin B ₇ deficiency, 68
Entered rates are garden 190
Enterobacter aerogenes, 189
Enterobacter spp
nosocomial infection, 185
Enterobius spp
diseases association, 161
infection routes, 158
Enterobius vermicularis, 159
Enterochromaffin-like (ECL) cells,
350, 373
Enterococci, 137
penicillins for, 188
vancomycin 100
vancomycin, 190
vancomycin-resistant (VRE), 137
Enterococcus spp
UTIs, 181
Enterococcus faecalis, 137
Enterococcus faecium, 137
Enterocolitis
vitamin E excess, 70
Enterocolitis (necrotizing), 386
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli
Enterocolitis (necrotizing), 386 Enterohemorrhagic <i>Escherichia coli</i> (EHEC), 132, 145, 178, 179
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar special culture, 126
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar special culture, 126 Eosinopenia, 424 Eosinophilia
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar special culture, 126 Eosinopenia, 424 Eosinophilia Aspergillus fumigatus, 153
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar special culture, 126 Eosinopenia, 424 Eosinophilia Aspergillus fumigatus, 153 Chlamydia trachomatis, 149
Enterocolitis (necrotizing), 386 Enterohemorrhagic Escherichia coli (EHEC), 132, 145, 178, 179 Enteroinvasive Escherichia coli (EIEC), 145, 179 Enterokinase/enteropeptidase, 373 Enteropathogenic Escherichia coli (EPEC), 145 Enterotoxigenic Escherichia coli (ETEC), 132, 179 Enterovirus meningitis, 179, 180 Entorhinal cortex, 499 Enuresis characteristics/treatment, 568 sleep stages and, 497 TCA use for, 575 Envelopes (viral), 163 env gene, 175 Enzalutamide, 658 Enzyme kinetics, 230 antagonists, 234 partial agonists, 234 Enzymes glycolysis regulation, 76 lipid transport and, 91, 92 rate-determining, 73 terminology for, 73 Eosin-methylene blue (EMB) agar special culture, 126 Eosinopenia, 424 Eosinophilia Aspergillus fumigatus, 153

Eosinophilic casts (urine), 600
Eosinophilic esophagitis, 377
Eosinophilic granuloma, 675
Eosinophilic granulomatosis
autoantibody, 115 Eosinophilic granulomatosis with
polyangiitis, 315
Eosinophils, 408
corticosteroid effects, 424
in esophagus, 377
Ependymal cells, 493 Ependymoma, 528
Ephedrine, 242
Epicanthal folds
cri-du-chat syndrome, 64
Down syndrome, 63
Epidemic typhus, 149 Epidemiology/biostatistics, 256–262
Epidermal growth factor (EGF)
signaling pathways for, 337
in wound healing, 216
Epidermis, 473
embryologic derivatives, 613 Epidermophyton, 152
Epididymis, 626
embryology of, 622
Epididymitis, 184, 654
Epidural hematomas, 513
Epidural space, 496
Epigastric pain chronic mesenteric ischemia, 386
Ménétrier disease, 379
pancreatitis, 397
Epigastric veins, 365
Epiglottitis
Haemophilus influenzae, 142 unvaccinated children, 186
Epilepsy
confidentiality exceptions for
patients with, 267
gustatory hallucinations in, 559
hallucinations in, 559 seizures, 517
Epinephrine, 242
adrenal medulla secretion, 327
glaucoma treatment, 552
glycogen regulation by, 85 pheochromocytoma secretion,
350
unopposed secretion of, 346
vitamin B ₆ and, 67
Epineurium, 495
Epiphysis estrogen effects on, 459
slipped capital femoral, 461, 463
tumors in, 464
widening of, 463
Episcleritis
inflammatory bowel disease, 382 Epispadias, 624
Epistaxis, 671
hereditary hemorrhagic
telangiectasia, 316
Epithelial cell junctions, 474
Epithelial cells tumor nomenclature of, 220
Epithelial histology (female), 626
Epithelial hyperplasia, 649
Eplerenone, 609
Epley maneuver, 534

Epoetin alfa (EPO analog), 121

Epstein-Barr virus (EBV)

aplastic anemia, 421

Burkitt lymphoma, 430

false-positive VDRL, 148

hairy leukoplakia and, 479

```
head and neck cancer, 671
  HIV-positive adults, 17
  Hodgkin lymphoma, 429
  in immunodeficient patients, 118
  nasopharyngeal carcinomas, 165
  oncogenesis of, 226
  paracortical hyperplasia in, 96
  receptors for, 166
Eptifibatide, 438
  thrombogenesis and, 411
Equations
  half-life of, 231
Erb palsy, 448
Erectile dysfunction, 567
β-blockers and, 245, 323
  cimetidine, 399
  Lambert-Eaton myasthenic
         syndrome, 472
  Peyronie disease, 651 sildenafil, 686
Erection
  autonomic innervation, 627
  ischemic priapism, 651
Ergocalciferol, 70
Ergosterol synthesis inhibitors, 253
Ergot alkaloids
  coronary vasospasm, 248
Erlotinib, 442
Erosions (gastrointestinal), 362, 379
Errors (medical), 274
Erysipelas, 479
  Streptococcus pyogenes, 136
Erythema
  complicated hernias, 370
  Kawasaki disease, 314
Erythema marginatum, 312
Erythema migrans
  in Lyme disease, 146
Erythema multiforme, 481
  Coccidioidomycosis, 151
Erythema nodosum, 151, 482
  inflammatory bowel disease, 382
Erythroblastosis fetalis, 405
Erythrocytes, 407
  blood types, 405
  casts in urine, 594
  Coombs test, 423
  DAF deficiency and, 107
  erythropoietin and, 589
  glucose usage by, 334
  hereditary spherocytosis, 422
  myeloproliferative disorders, 433
  transfusion of, 429
Erythrocyte sedimentation rate
         (ESR), 214
  subacute granulomatous thyroiditis,
Erythrocytosis, 407
  oxygen-hemoglobin dissociation
         curve, 666
Erythrogenic toxin, 136
Erythromelalgia, 433
Erythromycin
  macrolides, 193
  prophylaxis, 198
  protein synthesis inhibition, 191
  reactions to, 249
erythroplasia of Queyrat, 651
Erythropoiesis, 679
  fetal, 404
Erythropoietin (EPO), 121
  anemia of chronic disease, 421
  aplastic anemia, 421
  high altitude, 670
  with pheochromocytoma, 350
  polycythemia and, 228
```

release of, 589 in renal failure, 603 signaling pathways for, 337 Eschar, 132 in cutaneous anthrax, 137 with mucormycosis, 153 Escherichia coli, 145 cephalosporins, 189 culture requirements, 126 encapsulation, 127 galactosemia, 80 lac operon, 40 lactose fermentation, 144 meningitis, 180 neonatal illness, 182 nosocomial infection, 185 O157-H7, 132, 145, 178, 179 penicillins for, 188 pneumonia, 179 prostatitis, 654 urinary tract infections, 181, 600 Escitalopram, 575 E-selectin, 215 Esmolol, 245, 323 Esomeprazole, 399 Esophageal adenocarcinoma, 378 Esophageal atresia, 359 Esophageal cancer, **378** achalasia and, 376 Esophageal dysmotility CREST syndrome, 473 Esophageal perforation, 377 Esophageal strictures, 37 Esophageal varices, 365, 377 Esophageal webs, 418 Esophagitis, 377 bisphosphonates, 486 drug reaction and, 249 HIV-positive adults, 177 Esophagus blood supply and innervation, 364 diaphragm, 663 histology of, 362 pathologies of, 377 portosystemic anastomosis, 365 Essential amino acids, 81 Essential fructosuria, 80 Essential hypertension, 316 Essential mixed cryoglobulinemia, Essential thrombocythemia, 433 Essential tremor, 519 Esters (local anesthetics), 550 Estrogen, 656 androgen insensitivity syndrome, androgen conversion to, 636 benign breast tumors, 649 bone formation, 459 epiphyseal plate closure, 636 gynecomastia, 649 menopause, 636 menstrual cycle, 632 osteoporosis, 462 ovulation, 631 premature ovarian failure, 636, 645 prolactin suppression of, 330 signaling pathways for, 337 source and function of, 630 Turner syndrome, 638 Estrogen receptor modulators (selective), 656 Eszopiclone, 546 Etanercept, 487 Ethacrynic acid, 608

Ethambutol, 196, 197

FAS1_2019_21_Index_749-806.indd 767 11/21/19 12:27 PM

INDEX

Ethanol
as carcinogen, 225
gluconeogenesis and, 72
lactic acidosis and, 72
metabolism, 72 , 232
NADPH (nicotinamide adenine
dinucleotide phosphate), 72
zero-order elimination, 232
Ethics, 265–268
confidentiality, 267
consent, 265
core principles of, 265 –267
directives, 268
religious beliefs and, 269
situations in, 268-269, 269-270
Ethinyl estradiol, 656, 657
Ethosuximide
absence seizures, 544
Ethylenediaminetetraacetic (EDTA),
419
Ethylene glycol
toxicity treatment, 248
Ethylene oxide, 204
Etonogestrel, 657
Etollogestici, 077
Etoposide/teniposide, 442
targets of, 438
teniposide, 38
Euchromatin, 34
Eukaryotes
DNA replication, 38
functional gene organization, 41
mRNA start codons, 44
ribosomes in, 45
RNA polymerase in, 42
RNA processing, 41
Eukaryotic initiation factors, 45
Eukaryotic release factors, 45
Eustachian tubes
embryonic derivation, 621
Eversion, 453
Evolucumab, 320
Ewing sarcoma, 465
dactinomycin for, 439
dactinomycin for, 439 Exanthem subitum, 165
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan,
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocytosis, 50 Exogenous corticosteroids, 336
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies,
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies,
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory pathway, 500 Excitatory provider organization plan, 271 Executioner caspases, 208 Exementate, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686 Expiratory reserve volume (ERV), 664
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686 Expiratory reserve volume (ERV), 664 Extension
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686 Expiratory reserve volume (ERV), 664 Extension hip, 451, 453
dactinomycin for, 439 Exanthem subitum, 165 "Excision" event, 130 Excitatory pathway, 500 Exclusive provider organization plan, 271 Executioner caspases, 208 Exemestane, 656 Exenatide, 353 Exercise blood flow autoregulation, 297 peripheral resistance, 286 respiratory response, 670 syncope with, 308 Tetralogy of Fallot, 298 Exercise-induced amenorrhea, 645 Exocrine glands, 236 Exocytosis, 50 Exogenous corticosteroids, 336 Exons deletions in muscular dystrophies, 61 vs introns, 43 Exotoxins features of, 131 organisms with, 132–133 Pseudomonas aeruginosa, 132 Streptococcus pyogenes, 133 Expectorants, 686 Expiratory reserve volume (ERV), 664 Extension

External oblique muscle inguinal canal and, 369 External rotation arm (rotator cuff), 446 hip, 451 External spermatic fascia, 369 Extinction (conditioning), 554 Extracellular fluid (ECF) volume measurement, 581 volume regulation, 588 Extragonadal germ cell tumors, 652 Extramammary Paget disease, 644 Extraperitoneal tissue, 369 Extravascular hemolysis, 421
Extrinsic hemolytic anemia, 423 Extrinsic pathway, 208 warfarin and, 436, 437
Exudate "anchovy paste," 155 Ex vacuo ventriculomegaly, 522 Eye movements, 540 bilateral, 543 cranial nerve palsies, 541 with stroke, 515
Eyes anatomy of, 534 aqueous humor pathway, 535 Ezetimibe, 320 diarrhea, 249
Fab region of antibodies, 104 Fabry disease, 61 Facial nerve (Bell) palsy, 146, 186 Facial nerve (CN VII), 146, 186 functions of, 506 inflammatory demyelinating polyradiculopathy, 524 lesions of, 532 pharyngeal arch derivation, 620
tongue, 493 Facies congenital syphilis, 147 elfin, 64
epicanthal folds, 63, 64 "facial plethora," 685 in fetal alcohol syndrome, 615 flat, 63 leonine (lion-like), 141 long face with a large jaw, 62 risus sardonicus, 138 twisted face, 578 Factitious disorder
characteristics of, 566 on another, 566 on self, 566 Factor IX concentrate, 426 Factor VIII concentrate, 426 Factor V Leiden, 413, 428 venous sinus thrombosis and, 503 Factor Xa
direct inhibitors of, 437 heparin effect on, 436 inhibitors of, 413 Factor XI concentrate, 426 Facultative anaerobes culture requirements, 127 Facultative intracellular organisms, 127 FADH (flavin adenine dinucleotide), 77 Failure mode and effects analysis, 274 Failure to thrive, 556 galactosemia, 80 orotic aciduria, 420 SCID, 117 Falciform ligament, 361

Fallopian tubes
anatomy, 625
epithelial histology, 626 fertilization, 633
False-negative rate, 257
False-positive rate, 257
Famciclovir, 201 Familial adenomatous polyposis, 387
APC gene and, 389
chromosome association, 64
Familial amyloid cardiomyopathy, 212
Familial amyloid polyneuropathies,
212
Familial dyslipidemias, 94 Familial hypercholesterolemia, 60, 9 [,]
Familial hypocalciuric
hypercalcemia, 345
Family discussions, 268 Family therapy
separation anxiety, 557
Famotidine, 399
Fanconi anemia, 421
DNA repair in, 40 nonhomologous end joining and, 4
Fanconi syndrome, 586
drug reaction and, 251
renal tubular acidosis, 593 Fascia
collagen in, 50
Fascia of Buck, 627
Fasciculations, 529 Fastigial nucleus, 499
Fasting plasma glucose test, 346
Fasting state, 76, 91
Fat emboli, 672 Fatigue
adrenal insufficiency, 349
heart failure and, 309
MI signs, 305 Fatigue, medical errors and, 274
Fat necrosis, 209, 649
Fat redistribution, 250
Fat-soluble vitamins, 65
Fatty acids gluconeogenesis, 78
metabolism of, 72, 89 , 90
oxidation of, 72, 73
synthesis, 73 Fatty acid synthase, 67
Fatty casts, 594
Fatty liver disease
hepatocellular carcinoma and, 392 nonalcoholic, 391
Fc region of antibodies, 104
Fear
anxiety disorder and, 562 panic disorder and, 563
Febrile nonhemolytic transfusion
reaction, 114
Febrile pharyngitis, 164 Febrile seizures, 517
Febuxostat
gout, 487
Lesch-Nyhan syndrome, 37
Fecal elastase, 381 Fecal immunochemical testing (FIT)
388
Fecalith obstruction, 383
Fecal microbiota transplant, 138 Fecal occult blood testing (FOBT),
388
Fecal retention, 558
Feces explosive expulsion of, 384
I I I I I I I I I I I I I I I I I I I

I	Federation of State Medical Boards
	(FSMB), 2
I	Fed state, 76, 91 Fee for service, 271
1	Felty syndrome, 466
	Female genital embryology, 622 Female/male genital homologs, 623
	Female reproductive anatomy, 625
	Female reproductive epithelial
1	histology, 626 Femoral artery, 368
	Femoral head
ı	osteonecrosis, 463 Femoral hernia, 370
]	Femoral nerve, 452
	Femoral region, 368 Femoral sheath, 368
	Femoral triangle, 368
I	Femoral vein, 368
I	Fenestrated capillaries, 496, 581 Fenofibrate, 320
I	Fenoldopam, 242, 318
	Fentanyl, 551 Ferritin, 213
•	anemia of chronic disease, 421
	iron deficiency anemia, 418 lab values in anemia, 419
	sideroblastic anemia, 419
	Ferrochelatase, 425
1	Fertility double Y males, 638
	GnRH and, 328
I	menstrual cycle, 632 Fertilization, 631, 633
I	Fetal alcohol syndrome, 300, 614,
	615 holoprosencephaly in, 491
	Fetal circulation, 282
I	Fetal development early, 612
	placental component, 617
	Fetal erythropoiesis, 404 Fetal hypothyroidism, 341
	Fetal lung maturity, 661
	Fetal movement, 612
	Fetal-postnatal derivatives, 282 Fetal respiration, 660
	Fetal tissue
I	collagen in, 50 Fever
	amphotericin B, 199
	childhood rashes, 183 clindamycin, 192
	complicated hernias, 370
	endotoxins, 131 epiglottitis, 186
	exotoxins, 133
	genital herpes, 184 vs heat stroke, 517
	high fever, 165, 168, 171, 183
	with inflammation, 213 Jarisch-Herxheimer reaction, 148
	Legionnaires' disease, 143
	low-grade, 143, 171
	malaria, 157 with meningococci, 142
	mononucleosis, 165
	neuroleptic malignant syndrome 569
	pulmonary anthrax, 137
	recurring, 156 Rickettsia rickettsii, 150
	Salmonella spp, 149
	Salmonella typhi, 144 seizures with, 165
	spiking, 158

FAS1_2019_21_Index_749-806.indd 768 11/21/19 12:27 PM

Tetralogy of Fallot, 298
thyroid storm causing, 342
toxic shock syndrome, 135
Trichinella spiralis, 159
tuberculosis, 140
undulant, 143 vasculitides, 314
Waterhouse-Friderichsen
syndrome, 142
Weil disease, 147
Fexofenadine, 686
Fibrates, 320
hepatitis and, 249
myopathy and, 250
Fibrinogen, 213 in cryoprecipitate, 429
ESR and, 214
receptor for, 407
thrombocytes, 407
Fibrinoid necrosis, 209
Fibrinous pericarditis, 305
Fibroblest growth factor (ECF)
Fibroblast growth factor (FGF)
signaling pathways for, 337
in wound healing, 216
Fibroblast growth factor receptor
(FGFR3), 462
Fibroblasts
cortisol and, 336
in wound healing, 216
Fibrocystic breast disease, 649
Fibro fog, 471
Fibroid (leiomyoma)
leuprolide for, 656
Fibromas, 647
nomenclature for, 220
Fibromuscular dysplasia, 300, 604
Fibromyalgia, 470, 471 , 575
Fibronectin
in cryoprecipitate, 429
thrombocytes, 407
Fibrosarcomas, 220
Fibrosis
diffusion-limited gas exchange, 668
silicosis, 677
Fibrous plaque in atherosclerosis, 302
Fick principle, 285
Fidaxomicin
Clostridium difficile, 138
Fifth disease
rash, 183
50S inhibitors, 191
Filgrastim (G-CSF), 121
Filoviruses
characteristics of, 167
negative-stranded, 168
Filtration fraction
glomerular dynamics, 583
Fimbria, 124
Financial considerations in treatment,
269
Finasteride, 658
gynecomastia with, 649
reproductive hormones and, 636
Finger agnosia, 511
Finger drop, 447
Finger movements, 450
upper extremity nerve injury, 447
Fingernails, 478
Finkelstein test, 461
First-degree AV block, 295
First-order elimination, 231, 232
Fish oil, 320
Fishy smell, 148
Fitz-Hugh-Curtis syndrome, 142, 185
5-aminosalicylic drugs, 382, 400

5α-reductase
deficiency, 622, 639 inhibitors for BPH, 654
testosterone conversion, 636
5-fluorouracil (5-FU) antimetabolites, 440
photosensitivity, 250 pyrimidine synthesis and, 36
targets of, 438
thymidylate synthase, 36 5-HT _{1B/ID} agonists, 253 5-HT agonists, 547
5-HT agonists, 547 5-HT
opioid effects, 551
MAO inhibitor effect on, 575 trazodone effects, 576
vilazodone effects, 576 vortioxetine effects, 576
Fixation, 555
Fixed splitting, 289 Flaccid paralysis
botulinum toxin, 138 LMN lesion, 531
motor neuron signs, 529
Flagellin, 99 Flagellum, 124
Flask-shaped ulcers, 155 Flat affect, 499
Flavin nucleotides, 75
Flaviviruses, 163, 167 Fleas (disease vectors), 149, 150
Flecainide, 322 Flexion
foot, 453
hand, 450 hip, 451
Flexor digiti minimi muscle, 450 Flexor pollicis brevis muscle, 450
Flies (disease vectors), 144, 159
Floppy baby syndrome Clostridium botulinum, 138
spinal cord lesions, 530 Flow volume loops, 673
Fluconazole, 151
Cryptococcus neoformans, 153 mechanism and use, 199
opportunistic fungal infections, 153
Flucytosine, 199 <i>Cryptococcus neoformans</i> , 153
Fludrocortisone, 354
Fluid compartments, 581 Flumazenil
benzodiazepine overdose, 248, 546, 570
nonbenzodiazepine hypnotics, 546
Fluorescence in situ hybridization, 55 Fluorescent antibody stain
bacteria, 125 Fluoroquinolones, 38
mechanism and use, 195
Mycoplasma pneumoniae, 150 pregnancy contraindication, 204
Pseudomonas aeruginosa, 143 tendon/cartilage damage with, 250
TOP II (DNA gyrase) and TOP IV
inhibition in prokaryotes, 38
typhoid fever, 144 Fluoxetine, 575
Fluphenazine, 573
Tourette syndrome, 572 Flutamide, 658
Fluticasone, 687 Fluvoxamine, 575
FMR1 gene, 62

Foam cells
in atherosclerosis, 302
Niemann-Pick disease, 88
Focal glomerular disorders, 594
Focal hepatic necrosis, 249
Focal necrotizing vasculitis, 315
Focal neurological deficits
pituitary apoplexy, 339 Focal segmental glomerulosclerosis,
597
Focal seizures, 517
Folate antagonist
teratogenicity, 614
Folate synthesis
inhibition/block, 194
Folic acid antimicrobials and, 187
folate, 68
in pregnancy, 68
neural tube defects and, 491
Follicles (lymph), 96
Follicle-stimulating hormone (FSH)
clomiphene effect, 656
hCG and, 633
PCOS, 645
premature ovarian failure, 636 secretion of, 327
signaling pathways of, 337
Follicular conjunctivitis, 148
Follicular cysts, 646
Follicular lymphomas, 430 , 434
Follicular phase (menstrual cycle), 6
Follicular thyroid carcinomas, 343
Fomepizole
ethanol metabolism and, 72
toxicity treatment with, 248
Food-borne illness, 178 Food poisoning
Bacillus cereus, 138, 178
causes of, 178
Staphylococcus aureus, 135, 178
toxic shock syndrome toxin, 133
Food toxins, 247
Foot drop, 453 lead poisoning, 419
Foramen cecum, 326
Foramen of Magendie, 504
Foramen of Monro, 504
Foramen ovale
atrial septal defect, 299
embryology, 280
fetal circulation, 282
retained patency of, 298 Foramen primum, 280
Foramen secundum, 280
Foramina of Luschka, 504
Forced expiratory volume (FEV)
obstructive lung disease, 674
restrictive lung disease, 675
Forebrain, 490
Foregut
blood supply/innervation of, 364 development of, 358
Foreign body inhalation, 663
Formoterol, 687
Fornix (uterus), 625
45,XO, 638
47,XXY, 638
46,XX/46,XY DSD, 639
Fosamprenavir
HIV-positive adults, 203 Foscarnet, 202
Fosphenytoin, 544
Fossa ovalis, 282
Fovea
cherry-red spot, 538

	FOXP3 protein, 102
	Fractures
	bone diseases and, 51
	chalk-stick, 463
	common pediatric, 462
	compartment syndrome with, 461
	humerus, 447
	in child abuse, 556
	pathologic, 465
	scaphoid, 449
	vertebral compression, 462
	Fragile X syndrome, 62
	chromosome association, 64
	Frameshift mutations
	deletions, 61
	muscular dystrophy and, 61
	Francisella spp
	intracellular organism, 127
	Francisella tularensis
	animal transmission, 149
	Frataxin, 531
	Free fatty acids
	fast/starvation states, 91
	lipid transport and, 92
	Free light chain (FLC) assay
	plasma cell dyscrasias, 431
	Free nerve endings, 494
	Free radical injury, 210
	Fremitus (tactile), 680, 682
	Fresh frozen plasma, 429
	"Fried egg" cells, 494, 526
32	
0.4	Friedreich ataxia, 531
	chromosome association, 64
	hypertrophic cardiomyopathy, 308
	inheritance of, 60
	mechanism of, 62
	Frontal bossing, 339
	Frontal eye fields
	cortical functions, 501
	lesions in, 511
	Frontal lobe
	lesions in, 511
	stroke effects, 514
	Frontotemporal dementia, 520
	Fructokinase, 80
	Fructose-1,6-bisphosphatase, 73
	gluconeogenesis, 78
	in matabalia pathwaya 74
	in metabolic pathways, 74
	Fructose-2,6-bisphosphate, 76
	Fructose intolerance, 80
	Fructose metabolism
	disorders, 80
	pathways, 74
	Fructosuria, 80
	FTA-ABS, 125, 147
	Fumarate, 82
	Functional hypothalamic
	amenorrhea, 645
	Functional neurologic symptom
	disorder, 566
	Functional residual capacity (FRC),
	664
	Fungal infections
	II 12 recentor deficiency 116
	IL-12 receptor deficiency, 116
	infections with
	immunodeficiencies, 118
	Fungi
	culture requirements, 126
	immunocompromised patients,
	179
	necrosis and, 209
	opportunistic infections, 153
	silver stain, 125
	topical infections, 199
	Funny current, 292
	"funny" sodium channels, 324

FAS1_2019_21_Index_749-806.indd 769 11/21/19 12:27 PM

INDEX

Furosemide, 252, 608	Gangrenous necrosis, 209	Gastroschisis, 358	Germ cell tumors
gout with, 250	Gap junctions, 474	Gastrosplenic ligament, 361	cryptorchidism risk for, 651
pancreatitis, 249	Gardener's pupil, 241	Gastrulation, 612	hormone levels in, 653
Fusion inhibitors, 203	Gardnerella vaginalis, 148	Gaucher disease, 88	testicular, 652
Fusion protein EWS-FLI1, 465	Gardner syndrome, 387	osteonecrosis, 463	Germinal centers of lymph nodes, 96
Fusobacterium spp	Gargoylism, 88	osteonecrosis in, 463	Germinal center (spleen), 98
alcoholism, 179	Gas gangrene	Gaussian distribution, 262	Gerstmann syndrome, 511
anaerobic metabolism of, 127	alpha toxin, 133	G cells, 371	Gestational age calculation, 633
6	Clostridium perfringens, 138, 179	Gemfibrozil, 320	Gestational diabetes, 634
G	Gastrectomy, 420	Gemifloxacin, 195	Gestational hypertension, 643
G6PD	Gastric acid, 372	Gender dysphoria, 567	GFAP (glial fibrillary acid proteins),
deficiency, 61, 79	histamine receptors and, 238	Gender identity, 635	48, 227
HMP shunt and, 73	regulatory substances and, 371	Gene expression	astrocyte marker, 493
in respiratory burst, 109	Gastric arteries	modifications, 56	cytoskeletal elements, 48
GAPA	celiac trunk, 364	regulation, 41	stain, 227
GABA anesthesia effects, 550	intraligmental, 361 Gastric bypass surgery	Generalized anxiety disorder (GAD), 563	Ghrelin, 336, 371 Giant cells
barbiturate effects, 546	ghrelin and, 371	buspirone, 574	with Aschoff bodies, 312
basal ganglia and, 500	vitamin B ₁₂ deficiency, 69	drug therapy for, 572	astrocytomas, 525
benzodiazepine effects, 546	Gastric cancer, 379	Selective serotonin reuptake	Warthin-Finkeldey, 170
changes with disease, 495	carcinogens causing, 225	inhibitors (SSRIs) for, 575	Giant cell (temporal) arteritis, 314,
epilepsy drugs, 544	Helicobacter pylori, 146	serotonin-norepinephrine reuptake	518
Huntington disease, 520	oncogenes and, 224	inhibitors (SNRIs) for, 575	polymyalgia rheumatica, 470
vitamin B ₆ and, 67	oncogenic microbes and, 226	Generalized seizures, 517	Giant cell tumor, 464
Gabapentin, 544	sign of Leser-Trélat and, 228	Genes	Giardia spp
GABA _B receptor agonists, 523, 551	trastuzumab for, 443	introns vs exons, 42, 43	fluorescent antibody stain, 125
gag gene, 175	types of, 379	Genetics, 56–65	watery diarrhea, 179
Gag reflex, 507	Gastric inhibitory peptide (GIP),	anticipation, 62	Giardia lamblia, 155
Gait disorders	351	autosomal dominant diseases, 60	Giardiasis, 155
"steppage," 453	Gastric outlet obstruction, 359,	autosomal recessive diseases, 60	Giemsa stain, 125
Trendelenburg sign/gait, 453	380	autosomal trisomies, 63	Borrelia, 146
Gait disturbance	Gastric sclerosis, 473	bacterial, 130–204, 131	chlamydiae, 148
cerebellar lesions and, 499	Gastric ulcers, 380	chromosome disorders, 64	Gigantism, 329, 339
Friedreich ataxia, 531	NSAID toxicity, 486	code features, 37	Gilbert syndrome, 393, 394
Parkinson disease, 520	Gastric vessels, 361	inheritance modes, 59	Gingival hyperplasia
vitamin B ₁₂ deficiency, 530	Gastrin, 371, 373	muscular dystrophies, 61	calcium channel blockers, 318
waddling, 61	signaling pathways for, 337	terms, 56 –57	cyclosporine, 120
Galactocerebrosidase, 88	somatostatinomas and, 351	trinucleotide repeat expansion	drug reaction and, 250
Galactoleipass deficiency 80	Gastrin releasing pentide (CPP) 271	diseases, 62 viral, 162–163	Gingivostomatitis, 164 Gitelman syndrome, 586
Galactokinase deficiency, 80 cataracts and, 535	Gastrin-releasing peptide (GRP), 371 Gastritis, 146, 379	X-linked recessive disorders, 61	markers in, 591
Galactorrhea	gastrin in, 371	Geniculate nuclei (thalamus), 498	Glans penis
antipsychotic drugs and, 328	H ₂ blockers for, 399	Genital herpes, 184	lymphatic drainage of, 624
pituitary prolactinomas, 328	proton pump inhibitors for, 399	Genitalia	Glanzmann thrombasthenia, 427
tuberoinfundibular pathway,	stomach cancer and, 379	ambiguous, 622, 638, 639	Glaucoma, 242
499	Gastrocolic ligament, 361	embryology of, 612, 622	atropine, 241
Galactose-1-phosphate	Gastroenteritis	estrogen and, 630	β-blockers for, 245
uridyltransferase, 80	caliciviruses, 167	male/female homologs, 623	carbachol for, 240
Galactose metabolism	Listeria monocytogenes, 139	Genital tubercles, 624	closed-angle, 240
disorders of, 80	rotavirus, 168	Genital ulcers, 184	diabetes mellitus and, 346
Galactosemia, 80	Salmonella spp, 144	Genital warts, 184	diagnosis of, 240
cataracts and, 535	Gastroepiploic arteries, 361, 364	Genitofemoral nerve, 452	epinephrine for, 242
Galantamine, 240, 549	Gastroesophageal reflux disease	Genitourinary/renal drug reactions,	open-angle, 240, 242
Galant reflex, 510	(GERD)	251	pilocarpine for, 240
Gallbladder	Barrett esophagus, 378	Genome editing	types of, 536
biliary structures, 368	esophageal cancer and, 378	reverse transcriptase polymerase	Glioblastoma multiforme, 526
blood supply and innervation of,	presentation, 377	chain reaction, 52	nitrosoureas for, 441
364 regulatory substances, 371	Gastrohepatic ligament, 361 Gastrointestinal bleeding	Genotyping microarrays, 54 Gentamicin, 191	Glipizide, 353 Glitazones/thiazolidinediones, 353
Gallbladder cancer	hereditary hemorrhagic	Genu varum (bow legs), 463	Global aphasia, 516
porcelain gallbladder and, 397	telangiectasia, 316	Geriatric patients	Global payment, 271
sclerosing cholangitis and, 395	Gastrointestinal drug reactions, 249	atropine in, 241	Globoid cells
Gallstone ileus, 396	Gastrointestinal stromal tumors	Beers criteria in, 247	Krabbe disease, 88
γ-glutamyltransferase (GGT)	(GISTs), 224	changes in, 270	Globose nucleus, 499
alcohol use, 570	Gastrointestinal system	colonic ischemia and, 386	Globus pallidus externus, 500
γ-glutamyl transpeptidase (GGT),	anatomy, 360–369	colorectal cancer, 388	Glomerular disorders/disease
390	blood supply to, 363	common cause of death, 272	etiology and presentation, 594
γ-interferon, 407	embryology, 358–359	drug-related delirium in, 558, 575	nomenclature, 594
Ganciclovir, 202	innervation of, 364	lipofuscin in, 211	types of, 595
agranulocytosis, 250	ligaments, 361	Medicare for, 272	Glomerular filtration barrier, 581
Ganglion cyst, 461	pathology, 376–397	nosocomial infections, 185	Glomerular filtration parameters,
Ganglioneuromatosis	pharmacology, 398–400	osteoporosis, 462	583
oral/intestinal, 351	physiology, 371–375	PPI adverse effects, 399	Glomerular filtration rate (GFR), 582
Gangrene	regulatory substances, 371	respiratory system changes in, 665	ACE inhibitor effects, 610
Buerger disease, 314 diabetes mellitus, 346	secretory cells, 373 secretory products, 372	vascular skin tumors, 478	glomerular dynamics in, 583
diabetes memus, 210	secretory products, 3/2	Zenker diverticulum, 384	juxtaglomerular apparatus, 589

FAS1_2019_21_Index_749-806.indd 770 11/21/19 12:27 PM

Glomerulonephritis	Glucosuria	Gonorrhea	hyperthyroidism, 342
azathioprine for, 120	glucose clearance, 584	ceftriaxone, 189	ophthalmopathy, 340
		for the second s	
bacterial endocarditis, 311	threshold for, 584	gonococci, 142	thyroid cellular action in, 331
RBC casts in, 594	Glucuronidation	STI, 184	type II hypersensitivity, 112
Streptococcus pyogenes, 133, 136	drug metabolism, 232	Goodpasture syndrome, 50, 596	Gray baby syndrome, 192 , 204, 250
Wegener granulomatosis, 315	Glulisine, 352	autoantibody, 115	Gray hepatization, 683
Glomerulus	Glutamic acid	HLA-DR2, 100	Grazoprevir, 204
dynamics of, 583	ammonia transport, 82	restrictive lung disease, 675	Greater omental sac, 361
Glomus tumors, 478	classification of, 81	type II hypersensitivity reactions, 112	Great vein of Galen, 503
Glossitis	opioid analgesics and, 551	Good syndrome	Green twig (greenstick) fracture,
B-complex deficiency, 65	Glutathione	paraneoplastic syndrome, 228	462
megaloblastic anemia, 420	acetaminophen and, 485	thymoma and, 98	Grief, 562
vitamin B ₃ deficiency, 67	in G6PD deficiency, 422	Goserelin, 656	Griseofulvin, 200
vitamin B ₉ deficiency, 68	Glutathione peroxidase, 109	Gottron papules, 228, 471	cytochrome P-450 interaction,
Glossopharyngeal nerve (CN IX), 506	free radical elimination by, 210	Gout, 467	252
blood flow regulation, 296	Glutathione reductase, 109	drug reaction and, 250	microtubules and, 48
pharyngeal arch derivative, 620	NADPH and, 75	drug therapy for, 487	pregnancy contraindication, 204
tongue, 493	Gluten-sensitive enteropathy, 381	kidney stones and, 598	"Ground-glass" appearance (X-ray),
Glossoptosis, 620	Gluteus maximus muscle, 453		
Glossopiosis, 020		Lesch-Nyhan syndrome, 37	177, 661
Glove and stocking neuropathy, 346	Gluteus minimus muscle, 451	loop diuretics and, 608	Pneumocystis jirovecii, 154
GLP-1 analogs, 353	GLUT transporters, 334	Von Gierke disease, 87	Growth factors
Glucagon, 333	Glyburide, 353	Gower maneuver/sign, 61	tumor suppressor gene mutations
for β-blocker toxicity, 323	Glycerol	gp41, 203	and, 46
fructose bisphosphatase-2, 76	starvation days and, 91	G-protein-coupled receptors, 236	Growth hormone (GH), 354
glucagonomas and, 351	Glycogen	G-protein-linked 2nd messengers, 238	diabetes mellitus, 346
glycogen regulation, 85	metabolism and storage, 73, 86	Gracilis, 452	ghrelin and, 336
insulin and, 333, 334			for hypopituitarism, 339
	Glycogenesis, 73	Graft-versus-host disease, 119	ior hypopituitarism, 559
production of, 331	Glycogenolysis	type IV hypersensitivity, 113	insulin resistance and, 329
somatostatin and, 371	rate-determining enzyme for, 73	Gram-negative organisms	secretion of, 327
somatostatinomas and, 351	thyroid hormone and, 331	cell wall structure, 124	signaling pathways for, 337
Glucagonomas	Glycogen storage diseases, 87	cephalosporins, 189	somatostatin, 339
MEN 1 syndrome, 351	Glycogen synthase, 73, 86	lab algorithm, 141	Growth-hormone-releasing hormone
pancreatic cell tumor, 351	Glycolysis	Gram-positive organisms	(GHRH)
somatostatin for, 354	arsenic and, 74	antibiotic tests, 134	function of, 328
Glucocerebrosidase		cell wall structure, 124	Growth media properties, 126
	hexokinase/glucokinase in, 75		
Gaucher disease, 88	metabolic site, 72	cephalosporins, 189	Growth retardation
Glucocerebroside	pyruvate metabolism and, 77	lab algorithm, 134	with renal failure, 603
in sphingolipidoses, 88	rate-determining enzyme for, 73	vancomycin, 190	GTPase, 224
Glucocorticoids	regulation of, 76	Gram stain	GTP (guanosine triphosphate), 77
adrenal insufficiency, 349	Glycoprotein IIb/IIIa inhibitors,	peptidoglycan layer and, 125	Guaifenesin, 686
calcium pyrophosphate deposition	438	Granular casts	Guanfacine, 240, 243
disease, 467	Glycoproteins	acute tubular necrosis, 602	Guanosine analogs
diabetes mellitus, 346	bacterial pilus/fimbria, 124	"muddy brown" in urine, 594	mechanism and use, 201
		Cranulacita coloni stimulating factor	
fat redistribution with, 250	HIV, 175	Granulocyte-colony stimulating factor	Gubernaculum, 624, 625
gout, 467, 487	Glycopyrrolate, 241	(G-CSF), 337	Guessing during USMLE Step 1
immunosuppression, 120	Glycosylation	Granulocytes	exam, 23
myopathy, 250	collagen synthesis, 50	morulae, 150	Guillain-Barré syndrome
rheumatoid arthritis, 466	protein synthesis, 45	Granulocytopenia	acute inflammatory demyelinating
Glucokinase	GNAQ gene, 525	trimethoprim, 194	polyradiculopathy, 524
hexokinase vs, 75	Goblet cells, 362, 662	Granuloma inguinale, 184	Campylobacter jejuni, 145
metabolic pathways, 74	Goiter	Granulomas, 147	restrictive lung disease, 675
Gluconeogenesis	maternal hypothyroidism from,	macrophages and, 407	Schwann cell injury, 494
cortisol and, 336	341		Schwann cells, 524
ethanol metabolism and, 72	maternal iodine deficiency, 614	in systemic mycoses, 151 TNF-α and, 110	Gummas
	inatemai fodine deficiency, 017		
irreversible enzymes, 78	in Riedel thyroiditis, 341	in tuberculosis, 140	syphilis, 147, 184
metabolic site, 72	types and causes of, 342	Granulomatosis infantiseptica	Gustatory hallucinations, 559
pyruvate metabolism and, 77	Golfer's elbow, 459	Listeria monocytogenes, 139	Gustatory pathway
rate-determining enzyme for, 73	Golgi apparatus	Granulomatosis with polyangiitis	cranial nerves in, 532
thyroid hormone and, 331	in plasma cells, 409	(Wegener)	thalamic relay for, 498
Glucose	Golgi tendon organ, 458	restrictive lung disease and, 675	Guyon canal syndrome, 459
ATP production, 74	Golimumab, 487	Granulomatous disease	Gynecologic procedures
blood-brain barrier and, 496	Gonadal drainage, 624	catalase + organism infections	ureteric damage in, 581
clearance, 584	Gonadal mosaicism, 57	with, 128	Gynecologic tumor epidemiology,
		·	643
glycogen metabolism, 86	Gonadotropin, 646	excess vitamin D in, 70	
insulin and, 334	Gonadotropin-releasing hormone	hypervitaminosis D with, 464	Gynecomastia, 649
metabolism of, 40	(GnRH)	Granulomatous inflammation, 217	antiandrogens for, 658
for porphyria, 425	function of, 328	Granulosa cells	azoles, 199
transporters, 334	neurons producing, 498	tumors of, 647	cimetidine, 399
Glucose-6-phosphatase	ovulation, 631	Granzyme B	SHBG and, 337
dehydrogenase deficiency, 79	prolactin and, 330	cytotoxic T cells, 101, 102	spironolactone, 658
gluconeogenesis, 78	signaling pathways for, 337	extrinsic pathway and, 208	tuberoinfundibular pathway, 499
HMP shunt, 79			
	spermatogenesis, 628	Grapefruit juice and cytochrome	н
Von Gierke disease, 87	Gonads	P-450, 252	
Glucose-dependent insulinotropic	dysgenesis of, 606	Graves disease	H ₁ blockers, 251, 686
peptide (GIP), 351, 371 , 372	Gonococcal arthritis, 468	autoantibody, 115	H_2
			<u> </u>
polypeptide (GIP), 334	Gonococci, vs meningococci, 142	HLA subtype associations, 100	production in tissues, 127

FAS1_2019_21_Index_749-806.indd 771 11/21/19 12:27 PM

H ₂ blockers, 399	Hashimoto thyroiditis, 341	Heart failure, 309	Hemangioblastomas, 526
H ₂ O ₂ degradation	autoantibody, 115	ACE inhibitors for, 610	Hemangiomas, 220
catalase and, 128	HLA subtype association, 100	acromegaly, 339 amiodarone, 323	cavernous (liver), 392 pyogenic granuloma, 478
H ₂ -antagonist naming conventions for, 254	Hassall corpuscles, 98 Hay fever	angiotensin II receptor blockers, 610	strawberry, 478
Haemophilus ducreyi	association, 100	aortic regurgitation as precursor,	Hemarthroses
sexual transmission, 184	HbA _{1c} test, 346	291	hemophilias, 426
Haemophilus influenzae, 142	HBcAg (hepatitis B core antigen), 174	atrial septal defect, 299	Vitamin C deficiency, 69
biofilm production, 128	HbC disease, 422	β-blockers for, 245	Hematemesis, 377
cephalosporins, 189	target cells in, 415	B-type natriuretic peptide in, 296	Hematin, 126, 142
chloramphenicol, 192	HBsAg (hepatitis B surface antigen),	calcium channel blockers, 324	Hematochezia
culture requirements, 126	174	cardiac glycosides for, 321	diverticulosis, 383
encapsulation, 127	HDL (high-density lipoprotein), 94	chronic ischemic heart disease, 304	intestinal disorders, 386
IgA protease, 129	Headaches, 518	contractility in, 284	Meckel diverticulum, 384, 618
influenza, 169	adverse effects with drugs, 195,	diabetic ketoacidosis, 347	Hematocrit
meningitis, 179, 180	199, 200	disopyramide, 322	polycythemia vera, 433
penicillins for, 188 pneumonia, 179	α-blockers, 244 bupropion toxicity, 576	dobutamine for, 242 dopamine for, 242	Hematologic abnormalities laboratory techniques for, 54
postviral infection, 179	caffeine withdrawal, 570	Ebstein anomaly, 298	Hematologic disorders
rifamycins, 196	Chiari I malformation, 492	ESR in, 214	paraneoplastic syndromes, 228
transformation, 130	cimetidine, 399	fludrocortisone and, 354	Hematologic drug reactions, 250
type b conjugate vaccine, 127	drug adverse effects, 546	hypertension, 300 , 316	Hematology/oncology
unvaccinated children, 186	electroconvulsive therapy, 562	in sleep apnea, 679	anatomy, 406–409
vaccine, 142, 180	genital herpes, 184	jugular venous pulse in, 287	pathology, 414–434
Hair	giant cell (temporal) arteritis, 518	left heart, 309	pharmacology, 435-443
"kinky," 51	glaucoma, 536	Paget disease of bone, 463	physiology, 410–413
Menkes disease, 51	hydralazine, 318	potassium-sparing diuretics, 609	Hematopoiesis, 406 , 432
vitamin C deficiency, 69	increased intracranial pressure, 521	readmissions with, 272	Hematopoietic stem cells, 110
Hairy cell leukemia, 227, 432	Jarisch-Herxheimer reaction, 148	right heart, 309	Hematuria, 595
cladribine for, 440	lead poisoning, 425	shock caused by, 310	bladder cancer, 606
Hairy leukoplakia, 479 HIV-positive adults, 177	malaria, 157 <i>Mucor</i> spp and <i>Rhizopus</i> spp, 153	thiazides for, 609 ventricular septal defect, 299	hereditary hemorrhagic telangiectasia, 316
Half-life equation, 231	nitrates, 318	Heart murmurs, 291	interstitial nephritis, 601
Halitosis	ondansetron, 400	cardiomyopathies, 308	kidney stones, 598
fetor hepaticus, 389	pituitary apoplexy, 339	patent ductus arteriosus, 299	protease inhibitors, 203
Zenker diverticulum, 384	ranolazine, 319	Heart rate, 243	renal cyst disorders, 604
Hallucinations, 559	Rocky Mountain spotted fever, 150	Heart sounds, 287	renal oncocytoma and, 605
cocaine, 571	sodium-channel blockers, 322	cardiac cycle, 287	renal papillary necrosis, 602-610
delirium, 558	subarachnoid hemorrhage, 513,	cardiac tamponade, 310	Schistosoma haematobium, 161
mesolimbic pathway, 499	516	splitting in, 289	transitional cell carcinoma, 606
pellagra, 67	triptans for, 547	Heart transplant	UTIs, 181
postpartum psychosis, 562	vasculitides, 314	dilated cardiomyopathy, 308	Wegener granulomatosis, 315
tricyclic antidepressants, 575 Hallucinogen intoxication and	venous sinus thrombosis and, 503 Head and neck cancer, 671	Heart valve development, 281 Heat-labile toxin (LT)	Wilms tumor, 606 Heme
withdrawal, 571	cetuximab for, 442	Clostridium botulinum, 138	bilirubin and, 375
Haloperidol, 573	Head size	Clostridium perfringens, 138	chloroquine, 200
torsades de pointes, 294	Paget disease of bone, 463	Cl ⁻ secretion in gut, 132	porphyria and, 425
Halothane, 550	Healing, wound, 216	Heat shock proteins, 45	synthesis of, 425
hepatic necrosis, 249	Healthcare delivery, 270–273	Heat-stable toxin (ST)	vitamin B ₆ and, 67
Hamartin protein, 224, 525	Healthcare payment models, 271	resorption of NaCl and H ₂ 0 in	Hemianopia, 515, 542
Hamartomas, 220 , 525	Healthcare proxy, 269	gut, 132	Hemiballismus, 519
Hamartomatous colonic polyps, 387	Health maintenance organization	Heat stroke, 517	brain lesions and, 511
Hamate bone, 449	plan, 271	Heavy menstrual bleeding (AUB/	Hemidesmosome, 474, 480
fracture of hook, 447	Hearing loss, 533	HMB), 633	Hemineglect, 514
Hamman sign crepitus, 672	conductive, 49	Heel pain, 461	Hemiparesis
Hammer toes, 531 Hand	cytomegalovirus, 182 osteogenesis imperfecta, 51	Heinz bodies, 79, 414, 416 , 422 Helicase, 38	saccular aneurysms, 516 Hemochromatosis, 395
distortions of, 451	Paget disease of bone, 463	Helicobacter pylori, 146	calcium pyrophosphate deposition
injuries of, 459	sensorineural deafness, 596	as oncogenic microbe, 226	disease, 467
muscles of, 450	Heart	disease association, 379	cardiomyopathy with, 308
squamous cell carcinoma, 484	autoregulation of, 297	metronidazole, 195	chromosome association, 64
Hand-foot-mouth disease, 183	electrocardiograms, 293	penicillins for, 188	chronic, 426
Hansen disease, 141	embryology, 281	silver stain, 125	free radical injury, 210
animal transmission, 149	fetal development, 612	urease-positive, 127	hepatocellular carcinoma and, 392
dapsone, 194	ischemia in, 210	Heliotrope rash, 228	HLA-A3 and, 100
erythema nodosum, 482	morphogenesis of, 280 –281	HELLP syndrome, 643	Hemoglobin, 665
Hantavirus, 167	myocardial action potential, 292	"Helmet cells," 423 Helminthic infections	carbon dioxide transport, 670
Haptens acute interstitial nephritis, 601	normal pressures in, 297 sclerosis of, 473	eosinophils and, 408	development of, 404 kinetics of, 230
amiodarone as, 323	Heartburn, 377	Helper T cells	Hemoglobin electrophoresis, 410
Haptoglobin, 421	Heart disease	cell surface proteins, 110	Hemoglobinuria
Hardy-Weinberg population genetics,	congenital, 63, 298–299	cytokine secretion, 108	acute tubular necrosis and, 602
57	death, common causes by age, 272	Hemagglutinin	G6PD deficiency, 422
Hartnup disease, 67	Fabry disease, 88	influenza viruses, 169	intravascular hemolysis, 421
vitamin B ₃ deficiency, 67	ischemic, 304	parainfluenza viruses, 170	paroxysmal nocturnal, 122

FAS1_2019_21_Index_749-806.indd 772 11/21/19 12:27 PM

Hemolysis	osteoporosis, 250	leishmaniasis, 158	Hexokinase
alpha toxin, 133	thrombocytopenia, 250	lysosomal storage diseases, 88	glucokinase vs, 75
Clostridium perfringens, 138	toxicity treatment, 248	mononucleosis, 165	metabolic pathways, 74
G6PD deficiency, 250	warfarin vs, 436 , 437	TORCH infections, 182	"HF" cells (lungs), 309
HELLP syndrome, 643 sulfonamides, 194	Heparin-induced thrombocytopenia (HIT), 436	Hepatosteatosis, 72 Hepatotoxicity	HFE gene hemochromatosis and, 395
Hemolytic anemia, 421	Hepatic adenomas, 392	amiodarone, 323	HGPRT (hypoxanthine guanine
autoimmune, 189	Hepatic arteries, 364, 367	bosentan, 686	phosphoribosyltransferase),
babesiosis, 157	Hepatic ascites, 609	danazol, 658	37, 440
cephalosporins, 189	Hepatic ducts, 368 Hepatic encephalopathy, 391	inhaled anesthetics, 550	Hiatal hernias, 370 Hiccups, 519
direct Coombs-positive, 250 extrinsic, 421, 423	Hepatic fibrosis, 367	isoniazid, 197 leflunomide, 486	High altitude respiratory response, 670
folate deficiency and, 420	Hepatic lipase, 93	methotrexate, 440	High-frequency recombination (Hfr)
G6PD deficiency, 79	Hepatic necrosis, 249, 485	pyrazinamide, 197	cells, 130
intrinsic, 421, 422	Hepatic steatosis, 391	rifamycins, 196	Highly active antiretroviral therapy
penicillin G, V, 187 pyruvate kinase deficiency and, 422	Hepatitis alcoholic, 391, 571	terbinafine, 199 thionamides, 354	(HAART), 203 High-riding prostate, 627
spherocytes in, 415	drug reaction and, 249	valproic acid, 544	Hilar lymph nodes
sulfa drug allergies, 252	heroin addiction and, 576	zileuton, 687	calcification of, 677
Wilson disease, 395	hyperbilirubinemia, 393	Hepcidin, 213	Hilar mass, 684
Hemolytic disease of the newborn,	Hepatitis A (HAV)	in anemia of chronic disease, 421	Hilum (lung), 663 lymphadenopathy, 675
112, 405 Hemolytic reactions and blood types	characteristics of, 172 picornavirus, 167, 168	Hepeviruses characteristics, 167	Hindbrain, 490
newborns, 405	serologic markers, 174	genomes, 163	Hindgut
Hemolytic-uremic syndrome (HUS)	Hepatitis antigens, 174	naked viruses, 163	blood supply/innervation of, 364
Escherichia coli, 145 , 179	Hepatitis B (HBV)	HER2/neu (c-erbB2), 224	development of, 358
exotoxins, 132 platelet disorders, 427	characteristics of, 172 extrahepatic manifestations, 173	"Herald patch" (pityriasis rosea), 482 Herceptin (trastuzumab), 443	Hip dislocation nerve injury with, 453
Hemophagocytic lymphohistiocytosis,	hepatocellular carcinomas and, 392	Hereditary amyloidosis, 212	Hip injuries/conditions
435 , 544	medical importance, 164	Hereditary angioedema, 658	common, 460
Hemophilia, 426	nosocomial infection, 185	complement disorder and, 107	developmental dysplasia, 461
X-linked recessive disorder, 61	as oncogenic microbe, 226	Hereditary elliptocytosis, 414	Hip muscles, 451
Hemoptysis Aspergillus fumigatus, 177	passive antibodies for, 110 polyarteritis nodosa and, 314	Hereditary hemorrhagic telangiectasia, 316	Hippocampus lesions in, 511
bronchiectasis, 675	serologic markers, 174	autosomal dominance of, 60	limbic system, 499
choriocarcinomas, 642	sexually transmitted infection, 184	Hereditary hyperbilirubinemias, 394	pyramidal cells, 210
lung cancer, 684	Hepatitis C (HCV)	Hereditary motor and sensory	Hippurate test, for Streptococcus
tuberculosis, 140 Wegener granulomatosis, 315	characteristics of, 172 extrahepatic manifestations, 173	neuropathy, 524 Hereditary spherocytosis, 422	agalactiae, 137 Hirschsprung disease, 384
Hemorrhage	flaviviruses, 167	spherocytes in, 415	Hirsutism
acute pancreatitis, 397	hepatocellular carcinoma and, 392	Hereditary thrombosis syndromes,	cyclosporine, 120
AIDS retinitis, 165	lichen planus, 482	428	danazol, 658
baroreceptors and, 296	as oncogenic microbe, 226 therapy for, 204	Hermaphrodites, 639	menopause, 636
bevacizumab, 442 delirium caused by, 558	Hepatitis D (HDV), 172	Hernias, 370 Herniation syndromes, 529	SHBG and, 337 Histaminase, 408
Ebola virus, 171	Hepatitis E (HEV), 172	Heroin, 551	Histamine blockers, 398, 399
intracranial, 513	hepevirus, 167	detoxification medications, 576	Histamine receptors, 238
intraventricular, 512	Hepatitis viruses, 172	intoxication and withdrawal, 570	Histamines
pulmonary, 137 shock from, 310	aplastic anemia, 421 serologic markers for, 174	opioids for withdrawal, 551 Herpes genitalis, 164	in basophils, 408 cortisol effect on, 336
subarachnoid hemorrhage, 513 ,	Hepatocellular carcinomas, 392	Herpes labialis, 164	location of, 373
516	Åspergillus fumigatus, 153	Herpes simplex virus (HSV), 164–166	mast cells and, 408
ulcers, 380	Budd-Chiari syndrome and, 392	HSV-1/HSV-2, 164, 184	seafood toxins, 247
Weil disease, 147	carcinogens causing, 225 cirrhosis and, 389	cidofovir, 202 clinical significance, 164	signaling pathways for, 337
Hemorrhagic cystitis adenovirus, 164	hemochromatosis, 395	envelope, 163	vitamin B ₆ and, 67 Histidine, 81
drug reaction, 251	non-alcoholic fatty liver disease,	foscarnet for, 202	Histiocytosis (Langerhans cell), 434
Hemorrhagic fever	391	guanosine analogs, 201	Histocompatibility complex I and
bunyavirus, 167	oncogenic microbes, 226	identification, 166	II, 100
filovirus, 167 Hemorrhagic stroke, 513	Hepatocytes, 86 Hepatoduodenal ligament, 361	meningitis caused by, 180 skin infections, 479	Histones acetylation, 34
Hemorrhoids, 366	Hepatomas, 392	STI, 184	amino acids in, 81
Hemosiderinuria, 421	Hepatomegaly	TORCH infection, 182	deacetylation, 34
Hemostasis, 407	Budd-Chiari syndrome, 392	Herpes zoster	methylation, 34
platelet plug formation, 411 Henderson-Hasselbalch equation, 592	galactosemia, 80 hepatocellular carcinoma, 392	dorsal root latency, 165 famciclovir, 201	Histoplasma spp treatment, 199
Henoch-Schönlein purpura, 315	pulmonary hypertension, 668	reactivation, 443	Histoplasma capsulatum
Hepadnaviruses	right heart failure, 309	Herpetic whitlow, 164	HIV-positive adults, 177
characteristics of, 164	Von Gierke disease, 87	Heterochromatin, 34	necrosis and, 209
genome, 163 Heparin, 436	Zellweger syndrome, 47 Hepatosplenomegaly	Heterodimer, 48 Heterodisomy, 57	Histoplasmosis, 151
acute coronary syndromes, 307	β-thalassemia and, 418	Heterogeneous nuclear RNA	erythema nodosum, 482 Histrionic personality disorder, 565
in basophils, 408	biliary tract disease, 395	(hnRNA), 41	HIV (human immunodeficiency
in coagulation cascade, 413	graft-versus-host disease, 119	Heteroplasmy, 57	virus), 175
mast cells and, 408	hyperchylomicronemia, 94	Heterozygosity loss, 56	aplastic anemia in, 421

FAS1_2019_21_Index_749-806.indd 773 11/21/19 12:27 PM

INDEX

HIV (continued)	Hookworms, 159	Hydatid cysts, 161	Hypercholesterolemia, 94
common disease associations, 177	Hormone effects on kidney, 590	Hydatidiform mole, 642	familial, 60
diagnosis, 175	Hormone replacement therapy, 657	hCG in, 633	Hyperchylomicronemia, 94
flow cytometry diagnosis, 54	estrogens for, 656	theca-lutein cysts and, 646	Hypercoagulability, 671
hairy leukoplakia, 479	for hypopituitarism, 339	Hydralazine	hereditary syndromes, 428
heroin addiction and, 576	thrombotic complications, 250	gestational hypertension, 316	in pregnancy, 633
Kaposi sarcoma, 165, 478	Hormone-sensitive lipase, 93	heart failure, 309	marantic endocarditis in, 311
lymphopenia, 424	Hormones (reproductive), 655	mechanism and clinical use, 318	venous sinus thrombosis with, 503
meningitis, 180	Horn cysts, 477	Hydrocele (scrotal)	warfarin adverse effect, 436
non-Hodgkin lymphoma and, 429	Horner syndrome, 514, 518, 540	acquired, 652	Hyperemesis gravidarum, 642
		congenital, 652	Hyperemia
Pneumocystis jirovecii, 154	cavernous sinus, 542		
primary central nervous system	lung cancer, 684	Hydrocephalus, 522	pseudoephedrine/phenylephrine,
lymphoma and, 430	Pancoast tumor, 685	childhood tumors, 528	686
prophylaxis for HIV patients, 198	Horse flies (disease vector), 159	headaches with, 518	Hypereosinophilic syndrome, 308
pulmonary arterial hypertension,	Horseshoe kidney, 579	posterior fossa malformations, 492	Hyperestrogenism, 646
679	Hospice care, 272	risk for developing, 513	Hyperglycemia
retrovirus, 167	Hospital readmission causes, 272	Toxoplasma gondii, 182	Cushing syndrome, 348
rifamycins in, 196	Hot flashes	Hydrochlorothiazide (HCTZ), 609	diabetic ketoacidosis, 347
STI, 184	drug reaction and, 249	for diabetes insipidus, 338	diabetic retinopathy, 537
T cells and, 409	"Hourglass stomach," 370	hyperglycemia, 249	drug reaction and, 249
therapy for, 203	Howell-Jolly bodies	pancreatitis, 249	glucagon and, 333
TORCH infection, 182	postsplenectomy, 98	Hydrogen peroxide, 204	hyperkalemia, 590
untreated time course, 176	Hu antigens, 228	Hydronephrosis, 599	immunosuppressants, 120
viral receptor, 166	Human chorionic gonadotropin	BPH, 654	pancreatic cell tumors, 351
HLA-B8	(hCG)	horseshoe kidney, 579	protease inhibitors, 203
graves disease and, 342	as tumor marker, 226	kidney stones, 598	thiazides, 609
HLA-DR3	choriocarcinomas, 642	posterior urethral valves, 579	vitamin B ₃ toxicity, 67
graves disease and, 342	ectopic pregnancy, 641	Hydrophobia, 171	Hypergonadotropic hypogonadism,
HLA-DR4, 466	hydatidiform moles, 642	Hydrops fetalis	639
HLA genes	secretion of, 612, 633	parvovirus B19, 182, 183	Hypergranulosis, 475, 482
celiac disease and, 381	signaling pathways, 337	syphilis, 182	Hyper-IgM syndrome, 117
disease associations, 100, 341	source and functions of, 633	Hydroxychloroquine	Hyperinsulinemia, 645
DM type 1 association, 347	Human factors design, 273	myopathy, 250	Hyperkalemia
	Human herpesvirus 4 (HHV-4), 165	Hydroxylases, 73	aldosterone in, 588
seronegative spondyloarthritis, 469	Human herpesvirus + (HHV-+), 107		
HMG-CoA reductase	Human herpesvirus 6 (HHV-6), 165,	Hydroxylation	aliskiren, 610
cholesterol synthesis, 73	183	collagen synthesis, 50	angiotensin II receptor blockers, 610
metabolic pathways, 74	Human herpesvirus 7 (HHV-7), 165	in protein synthesis, 45	cardiac glycosides, 321
HMG-CoA synthase, 73	Human herpesvirus 8 (HHV-8), 165,	Vitamin C and, 50	causes of, 590
HMP shunt	177	Hydroxyurea, 442	depolarizing neuromuscular
metabolic site, 72	Kaposi sarcoma, 478	polycythemia vera, 433	blocking drugs, 551
NADPH production, 75, 79	as oncogenic microbe, 226	purine synthesis, 36	diabetic ketoacidosis, 347
rate-determining enzyme, 73	Humanized monoclonal antibodies,	sickle cell anemia, 422	potassium-sparing diuretics, 609
vitamin B ₁ deficiency, 66	110	targets of, 438	primary adrenal insufficiency, 349
Hoarseness	Human papillomavirus 6 (HPV-6),	Hyoid artery, 619	Hyperkalemic tubular acidosis (type
gastroesophageal reflux disease, 377	184	Hyoscyamine, 241	4, 593
lung cancer, 684	Human papillomavirus 11 (HPV-11),	Hyperacute transplant rejection, 119	Hyperkeratosis, 475, 477
Ortner syndrome, 283	184	Hyperaldosteronism, 349	Hyperlipidemia, 301
Pancoast tumor, 685	Human papillomavirus 16 (HPV-16),	hypertension with, 300	atherosclerosis and, 302
thyroid cancer, 343	671	potassium-sparing diuretics for, 609	immunosuppressants, 120
Hodgkin lymphoma, 429	Human papillomavirus (HPV)	Hyperammonemia, 82, 85	thiazides, 609
bleomycin for, 439	cervical pathology, 645	fatty acid metabolism and, 89	Hyperopia, 535
non-Hodgkin vs, 429	HIV-positive adults, 177	Hyperbilirubinemia	Hyperosmolar hyperglycemic state,
oncogenic microbes and, 226	as oncogenic microbe, 226	conjugated (direct), 393	347
paraneoplastic cerebellar	penile cancer, 651	hereditary, 394	DM type 2, 346
degeneration and, 228	tumor epidemiology, 643	jaundice with, 393	Hyperosmolarity, 590
vinca alkaloids for, 441	verrucae, 477	unconjugated (indirect), 393	Hyperparathyroidism, 345
Holistic medical therapy, 269	warts, 164	Hypercalcemia	calcium pyrophosphate deposition
Holoprosencephaly, 491	Human placental lactogen, 634	acute pancreatitis and, 397	disease, 467
Patau syndrome, 63	Humerus fracture	adult T-cell lymphoma, 430	cinacalcet for, 355
Homatropine, 241	axillary nerve and, 447	bisphosphonates for, 486	lab values in, 464
Homer-Wright rosettes, 528			
	radial nerve with, 447	calcium carbonate antacid effects,	renal osteodystrophy and, 603
Homicide, 272	Humoral immune response, 409	399	Hyperphagia
Homocysteine	Hunger/satiety regulation, 498	diabetes insipidus, 338	depression with, 561
folate deficiency, 420	Hunter syndrome, 60, 61, 88	hyperparathyroidism, 345	hypothalamus and, 498
vitamin B ₉ deficiency, 68	Huntington disease	loop diuretics for, 608	Hyperphosphatemia
vitamin B ₁₂ deficiency, 69, 420	drug therapy for, 549	lung cancer, 684	hyperparathyroidism (secondary),
Homocysteine methyltransferase	movement disorders, 519	paraneoplastic syndrome, 228	345
deficiency in, 84		parancopiastic syndrome, 440	
genciency in At		t. 1.11t FF1	
	neurodegenerative disorder, 520	succinylcholine, 551	hypoparathyroidism, 344
vitamin B ₁₂ and, 69	neurodegenerative disorder, 520 neurotransmitters for, 495	teriparatide, 487	renal osteodystrophy and, 603
	neurodegenerative disorder, 520	teriparatide, 487 thiazides, 609	renal osteodystrophy and, 603 Hyperpigmentation
vitamin B ₁₂ and, 69	neurodegenerative disorder, 520 neurotransmitters for, 495	teriparatide, 487 thiazides, 609	renal osteodystrophy and, 603
vitamin B 12 and, 69 Homocystinuria causes of, 84	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62	teriparatide, 487 thiazides, 609 Williams syndrome, 64	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439
vitamin B ₁₂ and, 69 Homocystinuria causes of, 84 Homologous recombination repair,	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62 Hurler syndrome, 88	teriparatide, 487 thiazides, 609 Williams syndrome, 64 Hypercalciuria	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439 busulfan, 441
vitamin B ₁₂ and, 69 Homocystinuria causes of, 84 Homologous recombination repair, 40	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62 Hurler syndrome, 88 Hürthle cells, 341	teriparatide, 487 thiazides, 609 Williams syndrome, 64 Hypercalciuria hyperparathyroidism, 345	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439 busulfan, 441 fludrocortisone, 354
vitamin B ₁₂ and, 69 Homocystinuria causes of, 84 Homologous recombination repair, 40 Homovanillic acid (HVA)	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62 Hurler syndrome, 88 Hürthle cells, 341 Hutchinson teeth, 147	teriparatide, 487 thiazides, 609 Williams syndrome, 64 Hypercalciuria hyperparathyroidism, 345 thiazides for, 609	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439 busulfan, 441 fludrocortisone, 354 hemochromatosis, 395
vitamin B ₁₂ and, 69 Homocystinuria causes of, 84 Homologous recombination repair, 40 Homovanillic acid (HVA) in neuroblastomas, 350	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62 Hurler syndrome, 88 Hürthle cells, 341 Hutchinson teeth, 147 Hyaline arteriolosclerosis, 301	teriparatide, 487 thiazides, 609 Williams syndrome, 64 Hypercalciuria hyperparathyroidism, 345 thiazides for, 609 Hypercapnia	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439 busulfan, 441 fludrocortisone, 354 hemochromatosis, 395 Peutz-Jeghers syndrome, 387
vitamin B ₁₂ and, 69 Homocystinuria causes of, 84 Homologous recombination repair, 40 Homovanillic acid (HVA)	neurodegenerative disorder, 520 neurotransmitters for, 495 trinucleotide repeat expansion diseases, 62 Hurler syndrome, 88 Hürthle cells, 341 Hutchinson teeth, 147	teriparatide, 487 thiazides, 609 Williams syndrome, 64 Hypercalciuria hyperparathyroidism, 345 thiazides for, 609	renal osteodystrophy and, 603 Hyperpigmentation bleomycin, 439 busulfan, 441 fludrocortisone, 354 hemochromatosis, 395

FAS1_2019_21_Index_749-806.indd 774 11/21/19 12:27 PM

Hyperplasia, 206	thoracic aortic aneurysm and, 302	Hypogonadism	Hypotonia
adrenal, 348, 349	treatment for, 316	diagnosis of, 639	poliomyelitis, 531
parathyroid, 345 , 351	tyramine, 244, 575	estrogens for, 656	Zellweger syndrome, 47
uterine bleeding with, 633	Hypertensive crisis, 569	gynecomastia, 649	Hypoventilation, 592
Hyperplastic arteriolosclerosis, 301 Hyperplastic polyps, 387	MAO inhibitors, 575 phenoxybenzamine for, 244	hemochromatosis, 395 Kallmann syndrome, 639	Hypovolemic shock, 310 Hypoxanthine guanine
Hyperprolactinemia, 249, 328, 527	pheochromocytoma, 350	pituitary prolactinomas, 328	phosphoribosyltransferase
anovulation, 645	Hypertensive emergency, 300, 318	testosterone/methyltestosterone, 658	(HGPRT), 37
calcium channel blockers and,	RBC casts in, 594	zinc deficiency, 71	Hypoxemia
318	Hypertensive nephropathy, 300	Hypokalemia	alveolar gas equation, 668
risperidone and, 573	Hypertensive retinopathy, 537	antacid use, 399	oxygen deprivation, 669
Hyperpyrexia with TCAs, 575	Hyperthermia atropine causing, 241	causes of, 590 cystic fibrosis, 60	vasoconstriction, 679 Hypoxia
Hyperresonance (chest percussion),	ecstasy intoxication, 571	on ECG, 293	apoptosis caused by, 208
682	MDMA, 571	loop diuretics, 608	contractility in, 284
pneumothorax, 680, 682	Hyperthyroidism, 340, 342	nephrogenic DI, 338	erythropoietin and, 589
Hypersensitivity reactions, 112–113	amiodarone and, 323	VIPomas and, 371	lung diseases, 679
acute interstitial nephritis, 601	β-blockers in, 245	Hypomanic episodes, 561	nocturnal, 679
C3 deficiency, 107 cephalosporins, 189	drug reactions, 249 hCG elevation and, 633	Hyponatremia MDMA, 571	oxygen deprivation, 669 regions susceptible to, 210
Graves disease, 342	hydatidiform moles, 642	as paraneoplastic syndrome, 228	renal, 666
IgE antibodies, 105	Hypertriglyceridemia, 94	thiazides, 609	vasoconstriction/vasodilation and,
mast cells and, 408	acute pancreatitis and, 397	Hypo-osmolarity, 590	297
organ transplants, 119	Hypertrophic cardiomyopathy, 308,	Hypoparathyroidism, 344	Hypoxia inducible factor 1a, 224
penicillins, 187–188	531 Damma diagna 97	Hypophosphatemia	Hypoxic stroke, 512
pneumonitis, 675 rheumatic fever, 312	Pompe disease, 87 Hypertrophic osteoarthropathy, 684	hyperparathyroidism, 345 Hypopituitarism, 339	Hypoxic vasoconstriction (pulmonary), 668
sulfonamides, 194	cancer association, 228	Hypoplasia, 613	high altitude, 670
Hypersensitivity reaction (type II)	Hypertrophic pyloric stenosis, 359	pulmonary, 660	Hysterectomy
rapidly progressive	Hypertrophic scars, 218	Hypopyon, 536	cardinal ligament in, 625
glomerulonephritis, 596	Hypertrophy, 206	Hyporeflexia	Hysteresis (lung and chest wall), 665
Hypersensitivity reaction (type III)	Hyperuricemia	LMN lesions, 531	T. Control of the Con
acute poststreptococcal glomerulonephritis, 596	drug reaction and, 250 gout and, 467	magnesium hydroxide and, 399 Hypospadias, 624	Iatrogenic abnormal uterine bleeding,
Hypersensitivity reaction type IV	kidney stones and, 598	Hypotension	633
contact dermatitis, 477	Lesch-Nyhan syndrome, 37	adrenal insufficiency, 349	Ibandronate, 486
Hypersomnia, 561	pyrazinamide, 197	aliskiren, 610	Ibuprofen, 486
Hypertension, 300 , 679	thiazides, 609	amphotericin B, 199	hemolysis in G6PD deficiency, 250
ACE inhibitors for, 610	vitamin B ₃ toxicity, 67	angiotensin II receptor blockers,	Ibutilide, 323
acromegaly and, 339 aliskiren for, 610	Hyperventilation metabolic acidosis and alkalosis,	610 baroreceptors in, 296	ICAM-1 protein in leukocyte extravasation, 215
α-blockers for, 244	592	cardiac tamponade, 310	viral receptor, 166
angiotensin II receptor blockers	in pregnancy, 633	endotoxins, 131	I cells, 371
for, 610	therapeutic, 501	ephedrine for, 242	disease, 47
aortic dissection and, 303	Hypervitaminosis D, 464	hypermagnesemia, 591	Icosahedral viruses, 163
atherosclerosis and, 302	Hypnagogic hallucinations, 559	local anesthetics, 550	Icterohemorrhagic leptospirosis, 147
atrial fibrillation and, 295 autosomal recessive polycystic	narcolepsy, 568 Hypnopompic hallucinations, 559	magnesium hydroxide and, 399 metronidazole, 195	Idarucizumab, 435 Idealization, 555
kidney disease, 604	narcolepsy, 568	midodrine for, 242	Identification, 555
β-blockers for, 245	Hypoaldosteronism, 593	norepinephrine for, 242	Idiopathic intracranial hypertension,
Charcot-Bouchard	Hypocalcemia, 333	orthostatic, 349	521
microaneurysms, 516	acute pancreatitis and, 397	phenylephrine for, 242	Idiopathic pulmonary fibrosis, 675
episodic, 350	cinacalcet causing, 355	scombroid poisoning, 247	Idiopathic thrombocytopenic purpura
heart failure, 316 hyperaldosteronism, 349	hypermagnesemia and, 591 hyperparathyroidism, 345	sympatholytic drugs and, 243 Hypothalamic/pituitary drugs	(ITP), 427 rituximab for, 443
immunosuppressants, 120	hypoparathyroidism, 344	clinical use and adverse effects	IDL (intermediate-density
intraparenchymal hemorrhage,	renal osteodystrophy, 603	of, 354	lipoprotein), 94
513	thyroidectomy, 343	Hypothalamic-pituitary hormones,	IFN-γ (Interferon-γ)
leflunomide, 486	tumor lysis syndrome, 435	328	cachexia and, 227
lipohyalinosis and, 514	Hypochlorhydria hypergastrinemia, 379	Hypothalamus	Ifosfamide, 441
local anesthetics, 550 loop diuretics for, 608	Hypocretin, 568	ADH secretion, 329 homeostasis and, 498	hemorrhagic cystitis, 251 IgA and IgG deamidated gliadin
MDMA, 571	Hypodermis, 473	nuclei of, 498	peptide autoantibody, 115
microangiopathic anemia, 423	Hypofibrinogenemia, 214	reproductive hormone control, 656	IgA antibodies, 105
minoxidil, 658	Hypogammaglobulinemia, 228	sleep cycle role of, 497	anti-endomysial autoantibody, 115
PCP, 571	Hypoglossal nerve (CN XII), 506	TRH sensitivity, 331	anti-tissue transglutaminase
pheochromocytomas, 350	lesion in, 532	Hypothenar muscles, 450	autoantibody, 115
polyarteritis nodosa, 314 in pregnancy, 243, 643	with stroke, 514 tongue, 493	Klumpke palsy, 448 Hypotheses (statistical), 262	ataxia-telangiectasia, 117 breast milk, 636
pseudoephedrine/phenylephrine,	Hypoglycemia	Hypothyroidism, 340, 341	in celiac disease, 381
686	fructose intolerance, 80	amiodarone and, 323	hyper-IgM syndrome, 117
renal cyst disorders, 604	glucagon production with, 333	anemia, 420	passive immunity, 110
renal failure, 603	gluconeogenesis and, 78	carpal tunnel syndrome with, 459	Peyer patches and, 374
renovascular disease and, 604	insulinomas, 351	drug reaction and, 249	selective deficiency in, 116
sleep apnea, 679 thiazides for, 609	neonatal, 614 Von Gierke disease, 87	hormone replacement, 354 lithium, 574	IgA nephropathy, 596 IgA protease, 129
		,	G F,

FAS1_2019_21_Index_749-806.indd 775 11/21/19 12:27 PM

INDEX

IgD antibodies, 105
IgE antibodies, 105
ataxia-telangiectasia, 117 eczema, 477
hyper-IgM syndrome, 117
mast cells and, 408
type I hypersensitivity, 112 IgG antibodies, 105
ataxia-telangiectasia, 117
complement activation and, 106 hepatitis A (HAV), 174
multiple sclerosis, 523
as passive immunity, 110
type II hypersensitivity reaction, 480
type III hypersensitivity reactions,
113
IgM antibodies, 105 in biliary cirrhosis, 395
complement activation and, 106
hepatitis A (HAV), 174
hyper-IgM syndrome, 117 overproduction, 431
in sclerosing cholangitis, 395
splenic dysfunction, 98 Ileum, 362
basal electric rhythm, 362
Ileus, 386
bacterial peritonitis (spontaneous) 390
gallstone, 396
Iliacus, 452
Iliohypogastric nerve, 452 Iliotibial band syndrome, 461
Illness anxiety disorder, 566
Iloperidone, 573
Imatinib, 433, 443 IMG registration timeframe, 6
Imipenem
seizures with, 251
Imipramine, 575 Immature ego defenses, 555
Immature teratoma, 647
Immune checkpoint interactions, 222
Immune complex, 113
Immune evasion
in cancer, 221
Immune responses acute-phase reactants, 102
antibody structure and function,
104–117 antigen type and memory, 105
Bordetella pertussis, 143
cell surface proteins, 110
complement, 106 cytokines, 108
hypersensitivity types, 114–115
immunoglobulin, 105 passive vs active, 110
respiratory burst, 109
Salmonella/Shigella spp, 144
transfusion reactions, 114 Immune system organs
cellular components, 99
lymph nodes, 96
thymus, 98 Immunocompromised patients
acyclovir/famciclovir/valacyclovir,
201 Candida albicano in 152
Candida albicans in, 153 common organisms affecting, 179
Cryptococcus neoformans, 153
Cryptosporidium, 155
esophagitis in, 377

fungal infections, 186
Listeria monocytogenes, 139 Pneumocystis jirovecii, 154
Immunodeficiency syndromes
flow cytometry diagnosis, 54 infections in, 118
syndromes, 116 –117 Immunoglobulin A vasculitis, 315
Immunoglobulins
adaptive immunity and, 99 breast milk and, 636
isotypes of, 105
for Kawasaki disease, 314 Immunohistochemical stains, 227
Immunology, 96–122 cellular components, 98
immune responses, 104–117
immunosuppressants, 120 –122 lymphoid structures, 96–98
pathogen recognition in, 99
Immunomodulator signaling pathways, 337
Immunophenotype assessment, 54 Immunosuppressants
for aplastic anemia, 421
targets, 121 transplant rejection, 120
Immunosuppression vitamin A deficiency, 66
vitamin C deficiency, 69
Immunotherapy, 121 Impaired colleague, 269
Imperforate hymen, 644 Impetigo, 136, 475
crusts with, 479
Imprinting disorders, 58 Inactivated (killed) vaccine, 111
Incidence vs prevalence, 259 in medical error corrections, 259
Inclusions
Cowdry A, 166 mulberry-like (morulae), 150
Negri bodies, 171 "owl eye," 165
reticulate bodies, 148
Incomplete penetrance, 56 Incontinence (fecal/urinary), 453
Incus, 533, 620
Incus (ossicles) pharyngeal arch derivative, 620
India ink stain, 125 Indicator media, 126
Indinavir
HIV therapy, 203 Indirect bilirubin, 375
Indirect cholinomimetic agonists, 240 Indirect Coombs test
unbound antibody detection, 112
Indirect inguinal hernia, 370 Indirect sympathomimetics, 242
Indirect (unconjugated) hyperbilirubinemia, 393
Indomethacin, 486
for diabetes insipidus, 338 IFN-α (Interferon-α)
clinical uses, 121 myopathy, 250
natural killer cells, 101
Infant development, 635 Infarction
blood-brain barrier effects, 496 of bone, 463
Infarcts
atherosclerosis, 302 calcification in, 211

pituitary, 339
regions susceptible to, 210
types of, 210 IFN-β (Interferon-β)
clinical uses, 121
natural killer cells, 101 Infections
ESR in, 214
in immunodeficiency, 118 Inferior colliculi, 504
Inferior gluteal nerve, 453
Inferior mesenteric artery, 363 , 364 horseshoe kidney, 579
Inferior oblique muscle, 540
Inferior rectal artery, 366 Inferior rectal vein, 365
Inferior rectus muscle, 540
Inferior sagittal sinus, 503 Inferior vena cava, 360
diaphragm, 663
gonadal drainage and, 624
Infertility clomiphene, 656
cystic fibrosis, 60
ectopic pregnancy, 641 Kallmann syndrome, 639
Kartagener syndrome, 49
leuprolide for, 656 mumps, 170
salpingitis, 185
septate uterus, 623 varicoceles, 651
IFN-γ (Interferon-γ), 108 , 116
clinical uses, 121 Infiltrative cardiomyopathy, 308
Inflammasome, 214
Inflammation acute, 214
in atherosclerosis, 302
cardinal signs, 213 chronic, 216
ESR in, 214
Extrinsic (death receptor) pathway 208
IL-1 in, 108
Intrinsic (mitochondrial) pathway 208
wound healing, 216
Inflammatory bowel disease (IBD), 382
azathioprine for, 440
colorectal cancer and, 388 erythema nodosum, 482
infliximab/adalimumab for, 487
methotrexate for, 440
sclerosing cholangitis and, 395 spondyloarthritis, 469
therapeutic antibodies, 122
Inflammatory breast disease, 649 , 65 Inflammatory demyelinating
polyradiculopathy, 524
Infliximab, 122, 487 for Crohn disease, 382
for ulcerative colitis, 382
Influenza, 169 orthomyxovirus, 167
pneumonia, 683
treatment/prevention, 201 Informed consent, 265
Infraspinatus muscle
Erb palsy, 448 rotator cuff, 446
Infundibulopelvic ligament, 625
Ingested seafood toxins, 247 Inguinal canal, 369
O

Inguinal hernia, 370
Inguinal ligament, 368, 369
Inguinal triangle, 370
Inhalational injury, 676
Inhaled anesthetics, 550
Inheritance modes, 59
Inhibin
Sertoli cell secretion of, 628
Inhibitors of complement activation,
106
Inhibitory pathway, 500
Injury (unintentional), 272
Innate immune system
in acute inflammation, 214
Innate immunity, 99
Inositol trisphosphate (IP ₃), 337
Inotropes, 310
Inotropy, 286
INR (international normalized ratio)
426
Insomnia
barbiturates for, 546
nonbenzodiazepine hypnotics, 546
ramelteon for, 547
stimulants causing, 570
suvorexant, 547
Inspiratory capacity (IC), 664
Inspiratory reserve volume (IRV), 664
Insulin, 334
anabolic effects of, 334
diabetic ketoacidosis, 347
fructose bisphosphatase-2 and, 76
GIP effect on, 371
glucagon and, 333
glycogen regulation, 73, 85
hypokalemia from, 590
potassium shifts wit, 590
in pregnancy, 334
production of, 329
secretion of, 334
somatostatin and, 371
somatostatinomas and, 351
Insulin deficiency, 590
diabetes mellitus diagnosis, 346
Insulin-like growth factor 1 (IGF-1)
acromegaly, 339
signaling pathways for, 337
Insulinoma, 351
insulin and C-peptide in, 334
MEN 1 syndrome, 351
pancreatic cell tumor 351
pancreatic cell tumor, 351
Insulin preparations, 352
Insulin preparations, 352 Insulin resistance, 633
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166 Intellectual disability, 557
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166 Intellectual disability, 557 autism and, 557
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166 Intellectual disability, 557 autism and, 557 cri-du-chat syndrome, 64
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166 Intellectual disability, 557 autism and, 557 cri-du-chat syndrome, 64 Down syndrome, 63
Insulin preparations, 352 Insulin resistance, 633 acanthosis nigricans and, 482 acromegaly, 339 cortisol, 336 DM type 2, 347 GH, 329 non-alcoholic fatty liver disease, 391 polycystic ovarian syndrome, 645 Insurance disregarding in treatment, 269 Medicare/Medicaid as, 272 types of plans, 271 Integrase inhibitors, 203 Integrins epithelial cells, 474 viral receptor, 166 Intellectual disability, 557 autism and, 557 cri-du-chat syndrome, 64

FAS1_2019_21_Index_749-806.indd 776 11/21/19 12:27 PM

phenylketonuria, 84	Intestinal gastric cancer, 379	Iritis, 536	J
Williams syndrome, 64	Intestinal obstruction	Iron	JAK2 gene, 224
Intellectualization, 555	hernias, 370	absorption of, 69, 374	myeloproliferative disorders, 433
Intention tremor, 519 cerebellar lesions, 511	superior mesenteric artery	anemia, 388, 418 anemia of chronic disease, 421	Janeway lesions, 311
Interdigital tinea pedis, 152	syndrome, 363 Intimate partner violence, 269	colorectal cancer, 388	Jarisch-Herxheimer reaction, 148
Interferons, 109	Intoxication (psychoactive drugs), 570	excess, 67	Jaundice, 393
Interferon-γ release assay (IGRA), 140	Intracellular bacteria, 127	in hemochromatosis, 395	biliary tract disease, 395
for tuberculosis, 140	Intracellular fluid (ICF), 581	lab values in anemia, 419	cholangitis, 368, 397 drug reaction and, 249
Interleukin 1 (IL-1), 108	Intracellular receptors	sideroblastic anemia, 419	fructose intolerance, 80
cachexia and, 227	endocrine hormone and, 337	toxicity of, 69	galactosemia, 80
endotoxins, 133	Intracranial hemorrhage, 513	toxicity treatment, 248	graft-versus-host disease, 119
Interleukin 2 (IL-2), 108	eclampsia, 643	Iron poisoning, 426	hepatitis B, 184
cyclosporine and, 120	Intracranial hypertension	Iron studies	hepatocellular carcinoma, 392
natural killer cells and, 101 sirolimus and, 120	vitamin A toxicity, 66 idiopathic, 521	interpretation of, 419–444 Irritable bowel syndrome (IBS)	hereditary hyperbilirubinemias,
tacrolimus and, 120	Intracranial pressure (ICP)	antispasmodic drugs, 241	394
Interleukin 2 receptor (IL-2R), 120	cerebral ischemia, 296	criteria and symptoms for, 383	with leptospirosis, 147
Interleukin 3 (IL-3), 108	hydrocephalus, 522	Isavuconazole	newborn hemolytic disease, 405
Interleukin 4 (IL-4), 108	papilledema, 538	mucormycosis treatment, 153	pancreatic cancer, 398
Interleukin 5 (IL-5), 108	superior vena cava syndrome, 685	Ischemia, 210 , 669	TORCH infections, 182
Interleukin 6 (IL-6), 108	venous sinus thrombosis, 503	acute tubular necrosis from, 602	yellow fever, 168 Jaw jerk reflex, 507
cachexia and, 227	Intraductal papilloma, 649	atherosclerosis, 302	JC virus (John Cunningham virus)
endotoxins, 133	Intraepithelial adenocarcinoma, 644	colonic, 386	HIV-positive adults, 177
Interleukin 8 (IL-8), 108	Intraocular pressure (IOP), 536	digital, 472	immunocompromised patients,
neutrophils and, 406	Intraparenchymal hemorrhage, 513	in gastrointestinal tract, 386	118
Interleukin 10 (IL-10), 108 Interleukin 12 (IL-12), 108	Intrauterine device (IUD)	mesenteric, 386 necrosis and, 209	polyomaviruses, 164
natural killer cells and, 101	copper, 657 Intrauterine growth restriction	watershed areas, 210	Jejunal and ileal atresia, 359
receptor deficiency, 116	(IUGR)	Ischemic brain disease, 512	Jejunum, 362
Interleukin receptor modulators	low birth weight, 635	Ischemic heart disease	Jervell and Lange-Nielsen syndrome,
naming conventions for, 254	substance abuse, 614	contraindicated antiarrhythmics,	294
Intermediate filaments	Intravascular hemolysis, 421	322	Jimson weed, 241
cytoskeletal element, 48	paroxysmal nocturnal	heart murmurs in, 291	Job syndrome, 116
Intermenstrual bleeding (IMB), 633	hemoglobinuria, 107	manifestations of, 304	Jod-Basedow phenomenon, 342 Joint hypermobility, 51, 62
Internal capsule	Intravenous anesthetics, 550	Ischemic priapism, 651	J point in ECG, 293
intraparenchymal hemorrhage, 513	Intraventricular hemorrhage, 512	Islet cell cytoplasmic antibodies, 115	Jugular foramen, 503
stroke effects, 514	neonatal respiratory distress	Islets of Langerhans, 325	Jugular venous distention (JVD),
Internal carotid artery cavernous sinus, 542	syndrome, 661 Intrinsic factor, 372 , 373	Isocarboxazid, 575 Isocitrate dehydrogenase	309 , 685
Internal hemorrhoids, 366	Intrinsic hemolytic anemias, 422	metabolic pathways, 74	Jugular venous pulse, 287
Internal iliac artery, 282	Intrinsic pathway, 208	rate determining enzyme, 73	Justice (ethics), 265
Internal iliac lymph nodes, 624	coagulation defects of, 426	Isodisomy, 57	Juvenile polyposis, 387
Internal inguinal ring, 370	heparin and, 437	Isoflurane, 550	Juxtaglomerular apparatus (JGA), 589
Internal jugular vein, 503	Intrinsic renal failure, 601	Isolation of affect, 555	renin secretion, 588
Internal oblique muscle, 369	Introns	Isoleucine	Juxtaglomerular cells
Internal rotation	splicing out, 41	classification of, 81	tumors in, 349
arm (rotator cuff), 446	vs exons, 43	maple syrup urine disease and, 84	K
hip, 451	Intussusception, 385	Isoniazid, 197 cytochrome P-450, 252	Kala-azar, 158
Internal spermatic fascia, 369 International Foundations of	Meckel diverticulum, 384 Inulin	hemolysis in G6PD deficiency, 250	Kallikrein
Medicine (IFOM), 12	glomerular filtration rate and, 582	hepatitis, 249	C1 esterase inhibitor deficiency,
Internuclear ophthalmoplegia, 511,	in proximal convoluted tubules,	Mycobacterium tuberculosis, 196	107
543	587	seizures, 251	neutrophil chemotaxis and, 406
Interossei muscles, 450	Inulin clearance, 582	Isoproterenol	Kallmann syndrome, 498, 639
Klumpke palsy, 448	Invariant chain, 100	norepinephrine vs, 243	Kaposi sarcoma, 478
ulnar nerve, 447	Invasive carcinoma, 219	sympathomimetic action, 242	AIDS and, 184
Interpersonal therapy, 572	cervix, 645	Isosorbide dinitrate, 318	bacillary angiomatosis vs, 478
Interpreting study results, 261	Invasive lobular carcinoma (breast), 650	Isosorbide mononitrate, 318	HHV-8, 165 HIV-positive adults, 177
Intersex, 639 Interstitial fluid, 297	Inversion, 453	Isotretinoin cystic acne, 66	oncogenic microbes and, 226
Interstitial lung disease, 466, 675	In vivo biofilm-producing bacteria,	teratogenicity, 614	Kartagener syndrome, 49 , 280
Interstitial nephritis	128	Isovolumetric contraction, 287	obstructive lung disease, 675
acute, 601	Involuntary treatment, 267	Isovolumetric relaxation, 287	Karyotyping, 55
as drug reaction, 251	Iodine	Itraconazole	KatG, 197
NSAID toxicity, 486	deficiency in, 341, 342	azoles, 199	Kawasaki disease, 314
penicillins, 188	infection control, 204	Sporothrix schenckii, 154	Kayser-Fleischer rings, 395
Interstitial pneumonia, 683	teratogenicity, 614	systemic mycoses, 151	K cells, 371
Interstitium	Iodophors, 204	Ivabradine, 324	K complexes/sleep spindles, 497
leukocyte extravasation and, 215 Interventricular foramen, 281	IPEX syndrome, 102 Ipratropium, 241, 687	IV drug use common organisms, 179	Kegel exercises, 599 Keloid scars, 218
Interventricular septal rupture, 305,	Irinotecan/topotecan, 442	Ivermectin, 200	Keratinocytes, 216
307	targets of, 438	"Ivory white" plaques, 677	Keratin pearls, 684
"Intestinal angina," 386	topoisomerase (TOP) I inhibition,	IV phlebitis, 199	Keratoacanthoma, 484
Intestinal atresia, 359	38	Ixodes ticks, 146, 149	Keratoconjunctivitis, 164

FAS1_2019_21_Index_749-806.indd 777 11/21/19 12:27 PM

INDEX Keratoconjunctivitis sicca, 468

Keratomalacia, 66 Keratosis actinic, 482 hyperkeratosis, 475 parakeratosis, 475 seborrheic, 477 Kernicterus, 194, 204, **393**–394 Ketamine, 550 Ketoacidosis, 72, 90 Ketoconazole, 658 cytochrome P-450, 252 gynecomastia from, 649 mechanism and clinical use, 199 Ketogenesis diabetic ketoacidosis, 347 metabolic site, 72 rate-determining enzyme for, 73 Ketone bodies, 90 brain metabolism, 334 in diabetic ketoacidosis, 347 production of, 90 Ketorolac, 486 Kidney disease acute injury, 601 hypertension, 300 prenatal diagnosis of, 579 Kidneys anatomy, 580 blood flow regulation, 297 calcification in, 211 chronic graft nephropathy, 119 embryology of, **578** endocrine functions, 589 glomerular structure, 580 hormones acting on, 590 ischemia in, 210 retroperitoneal location of, 360 sclerosis, 473 solitary functioning, 579 transplant prophylaxis, 120 Kidney stones Crohn disease association, 382 electrolyte disturbances, 591 hematuria with, 594 hydronephrosis, 599 hyperparathyroidism, 345 presentation and findings with, 598 risk factors for, 593 UTIs, 181 Kiesselbach plexus, 671 Killian triangle, 384 Kinases, 73 Kinesin movement of, 48 Kinin cascade/pathways, 412 Klebsiella pneumoniae cephalosporins, 189 encapsulation, 127 UTIs caused by, 181 Klebsiella spp, 145 alcoholism, 179 currant jelly sputum, 145, 186 nosocomial infections, 185 pneumonia, 683 urease-positive, 127 urinary tract infections, 600 Klinefelter syndrome, 638 chromosome association, 64 gynecomastia, 649 Klumpke palsy, 448 Klüver-Bucy syndrome, 511 Knee examination, 454 Knee injuries/conditions Baker cyst, 460 iliotibial band syndrome, 461

ligament and meniscus, 460 Osgood-Schlatter disease, 461 prepatellar bursitis, 460 Knees common conditions of, 460 Knock-out/Knock-in genes, 56 KOH preparation, 152 Koilocytes condylomata acuminata, 184 Koilocytosis, 47 Koplik spots, 183 Korsakoff syndrome, 66, 558, 571 Krabbe disease, 88, 524 KRAS gene, 224 adenomatous colonic polyps and, lung cancer and, 684 Krukenberg tumors, 379 Kübler-Ross grief model, 562 Kulchitsky cells, 684 Kuru, 178 Kussmaul respirations in diabetic ketoacidosis, 347 Kussmaul sign, **316** Kwashiorkor, 71 Kyphoscoliosis, 531 Kyphosis in homocystinuria, 84 $K_{\rm m}$, 230 L Labetalol, 245 hypertension in pregnancy, 316 hypertensive emergency, 318 Labia, 625 Labile cells, 46 Lachman test, 454 Lac operons, 40 Lacrimation reflex, 507 Lactase deficiency, 81 Lactation, 636 oxytocin's role in, 328 progesterone and, 630 prolactin and, 330 Sheehan syndrome and, 339 Lactational mastitis, 649 Lactic acid dehydrogenase, 77 Lactic acidosis ethanol metabolism and, 72 exercise and, 670 MELAS syndrome, 59 pyruvate dehydrogenase complex deficiency, 77 Lactoferrin in neutrophils, 406 in respiratory burst, 109 Lactose-fermenting enteric bacteria, 126, **144** Lactose intolerance, 381 Lactose metabolism genetic response to environmental change, 40 Lactulose for hepatic encephalopathy, 391 Lacunar infarcts, 514 Ladd bands, 385 Lambert-Eaton myasthenic syndrome, autoantibody, 115

as paraneoplastic syndrome,

small cell lung cancer, 684

Peyer patches in, 374

in Whipple disease, 381

Lamina propria

Lamins, 48

Lamivudine, 203 HIV therapy, 203 Lamotrigine epilepsy, 544 rash caused by, 250 Lancet-shaped diplococci, 136 Landmarks (anatomical) for dermatomes, 510 midclavicular line, 663 pudendal nerve block, 453 Langerhans cell histiocytosis, 434 pulmonary, 675 Lansoprazole, 399 Laplace law, 284, 661 Large cell carcinoma, 684 Large-vessel vasculitis presentation and pathology, 314 Larva migrans, 159 Laryngopharyngeal reflux, 377 Laryngospasm, 359 drug-induced, 569 Larynx muscles, 620 Lassa fever encephalitis, 167 Latanoprost, 552 Latent errors, 274 Lateral cerebellar lesions, 499 Lateral collateral ligament (LCL) injury, 454
Lateral corticospinal tract, 508, **509**, 514 Lateral epicondylitis, 459 Lateral femoral cutaneous nerve, 452 Lateral geniculate nucleus (LGN), Lateral medullary syndrome, 514 Lateral nucleus (hypothalamus), 498 Lateral pterygoid muscle, 507 Lateral rectus muscle, 540 Lateral spinothalamic tract, 508 Lateral thoracic artery, 455 Lateral ventricles optic radiation, 542 ventricular system, 504 Laxatives, 401 LD50 (lethal median dose), 234 tumor burden indicator, 226 LDL (low-density lipoprotein), 94 PCSK9 enzyme, 93 receptor binding, 93 Leaden paralysis, 561 Lead poisoning anemia with, 419 foot drop, 419 mechanism, 425 memory loss with, 425 sideroblastic anemia, 419 treatment of, 248, 419 Lead-time bias, 261 Leber hereditary optic neuropathy, 59 Lecithinase, 133, 138 Lecithin-cholesterol acetyltransferase (LCAT) activation of, 93 Lecithin-cholesterol acyltransferase,

Left bundle branch, 293 Left circumflex coronary artery, 283 Left heart disease, 679 Left heart failure, 309 Left horn of sinus venosus, 281 Left main coronary artery, 283 Left marginal artery, 283 Left shift, 424 Left-to-right shunts, 299 Legg-Calvé-Perthes disease, 461, 463 Legionella pneumophila, 143 Legionella spp atypical organism, 179 culture requirements, 126 facultative intracellular organisms, 127 Gram stain of, 125 macrolides, 193 nosocomial infection, 185 intracellular organism, 127 pneumonia, 683 silver stain, 125 Legionnaires' disease, 143 Leiomyoma (fibroid), 648 nomenclature for, 220 uterine bleeding with, 633 Leiomyosarcoma, 220, **648** Leishmaniasis, 158, 200 Length-time bias, 261 Lens collagen in, 50 infantile cataracts, 80 Lens subluxation Elastin syndrome, 52 in homocystinuria, 52, 84 Lenticulostriate artery, 514 Lentiform nucleus, 500 Leonine facies, 141 Leprosy (Hansen disease), **141** Leptin, 336 hypothalamus, 498 Leptospira spp Gram stain of, 125 spirochete, 146 zoonotic infections, 149 Leptospira interrogans, 147 Leptospirosis, 149 symptoms of, 147 Lesch-Nyhan syndrome inheritance, 61 purine salvage deficiency, 37 Leser-Trélat sign, 228, 477 stomach cancer, 379 Lesser omental sac, 361 Letrozole, 656 Leucine classification of, 81 maple syrup urine disease and, 84 Leucovorin, 440 Leukemias, **432** carcinogens, 225 cell type, 220 cyclophosphamide for, 441 cytarabine for, 440 doxorubicin for, 439 epidemiology, 222 etoposide/teniposide for, 442 immunohistochemical stain for, lymphoma comparison, 429 mucormycosis, 153 nomenclature for, 220 oncogenic microbes, 225

suppressor genes, 224

vinca alkaloids for, 441

TRAP tumor marker, 227

FAS1_2019_21_Index_749-806.indd 778 11/21/19 12:27 PM

Lectin pathway (complement

Ledipasvir, 204

Leflunomide, 486

activation), 106

dihydroorotate dehydrogenase

myocardial infarction and, 305

inhibition, 36

Left anterior descending artery

coronary circulation, 283

Leukocoria, 538	Linear viruses, 163	cystic fibrosis, 60	LPS endotoxin, 124, 131, 133, 145
Leukocyte adhesion deficiency, 117 ,	Lines of Zahn, 672	hepatosteatosis, 72	LTB ₄ (Leukotriene B4), 406, 485
215	Lineweaver-Burk plot, 230	hereditary, 394	Lumbar puncture, 507, 521
Leukocyte alkaline phosphatase (LAP), 406	Linezolid, 193 highly resistant organisms, 198	ischemia in, 210 metastases to, 223	Lumbosacral radiculopathy, 455 Lumbrical muscles, 450
Leukocyte esterase, 181, 600	protein synthesis inhibition, 191	serum markers, 390	Klumpke palsy and, 448
Leukocytes	Lingula (lung), 663	target cells in, 415	median and ulnar nerves, 447
extravasation, 214, 215	Linkage disequilibrium, 57	Wilson disease and, 395	Lumefantrine, 200
leukemias, 432	Liothyronine (T3), 354	Liver failure	Lunate bone, 449
in urine, 181 , 594, 600	Lipase	Budd-Chiari syndrome and, 392	Lung abscesses, 685
Leukocytoclastic vasculitis, 173	pancreatic secretions, 373	movement disorder in, 519	Lung and chest wall expansion, 665
Leukocytosis, 213	in pancreatitis, 397	Liver fluke	Lung cancer
diabetic ketoacidosis, 347	Lipid-lowering agents	hyperbilirubinemia with, 393	asbestosis and, 677
nosocomial infections, 185 Leukodystrophies, 494, 524	mechanism and adverse effects, 320 –321	as oncogenic microbe, 226 Liver function tests	carcinogens causing, 225 cisplatin/carboplatin for, 442
Leukoerythroblastic reaction, 424	Lipid metabolism	cholestatic pattern of, 395	erlotinib for, 442
Leukopenias, 424	fatty acids, 73	serum markers for, 390	hypercalcemia and, 228
cytarabine, 440	Lipids	Liver markers	incidence/mortality in, 222
ganciclovir, 202	key enzymes in, 93	in alcohol use, 570	metastases to, 223
trimethoprim, 194	transport of, 92 –93	Liver tumors, 392	non-small cell, 684
Leukoplakia, 479	Lipodystrophy	Living wills, 266	oncogenes and, 224
Leukotrienes	protease inhibitors, 203	Loa loa, 159	paraneoplastic syndromes and,
basophils and, 408	tesamorelin for, 328	Loading dose, 231	228
cortisol effects, 336 Levator veli palatini muscle, 620	Lipofuscin, 211 Lipoic acid, 76	Lobar pneumonia natural history of, 683	presentation and complications, 684
Levetiracetam, 544	Lipolysis	organisms and characteristics, 683	small cell, 684
Levodopa, 548, 549	cortisol and, 336	physical findings with, 680	topotecan for, 442
Levofloxacin	insulin and, 334	Lobular carcinoma (breast), 650	Lung diseases
fluoroquinolones, 195	sympathetic receptors and, 238	Local anesthetics, 550	obstructive, 674–675
Pseudomonas aeruginosa, 143	thyroid hormone and, 331	Localized amyloidosis, 212	restrictive, 675
Levomilnacipran, 575	Lipomas, 220	Locked-in syndrome	Lungs
Levonorgestrel, 657	Lipophilic drug	osmotic demyelination syndrome,	anatomical relationships, 663
Levothyroxine, 354 Lewy bodies, 520, 521	drug metabolism of, 232 Lipoprotein lipase, 93	524 stroke, 515	blood flow regulation, 297 development of, 660
dementia, 521	Lipoproteins, 93	Locus ceruleus, 495	physical findings, 680
Leydig cells	functions of, 94	Locus heterogeneity, 57	sclerosis of, 473
cryptorchidism, 651	Liposarcomas, 220	Löffler endocarditis, 308	transfusion-related injury, 114
endocrine function, 628, 638	Lipoteichoic acid	Löffler medium, 126	Lung volumes, 664
genital embryology, 622	cytoplasmic membrane, 124	Corynebacterium diphtheriae, 139	Lung zones, 669
tumors of, 653	Liquefactive necrosis, 209	Lomustine, 441	Lupus
LFA-1 antigens, 215	Liraglutide, 353	Lone Star tick (disease vector), 149	autoimmune hemolytic anemia
Libido in geriatric patients, 270	Lisch nodules, 525 Lisdexamfetamine, 572	Long-chain fatty acid (LCFA) metabolism of, 89	and, 423 azathioprine for, 440
testosterone and, 636	Lisinopril, 610	Long QT syndrome	drug-induced, 115
Libman-Sacks endocarditis, 470	Lispro, 352	congenital, 294	isoniazid, 197
Lice	Lissencephaly, 491	ranolazine, 319	lymphopenia, 424
disease vectors, 149	Listeria monocytogenes	sudden cardiac death, 304	marantic endocarditis in, 311
head/scalp, 161	β-hemolysis, 135	Long thoracic nerve	microangiopathic hemolytic
treatment, 200	neonates, 182	arm abduction, 446	anemia,, 423
Lichen planus, 173, 475, 482 Lichen sclerosus, 644	penicillins for, 188 transmission of, 139	neurovascular pairing, 455 Loop diuretics, 608	nephritis, 470 neutropenia, 424
Lichen simplex chronicus, 644	Listeria spp	for heart failure, 309	Lupus anticoagulant, 115
Liddle syndrome, 586	facultative intracellular organisms,	toxicity of, 251	Lupus-like syndrome
markers in, 591	127	Loop of Henle, 608	α-methyldopa, 243
Lidocaine, 322, 550	intracellular organism, 127	Bartter syndrome and, 586	hydralazine, 318
Life support	Lithium	ethacrynic acid effect on, 608	procainamide, 322
withdrawal, 269	diabetes insipidus and, 249, 338	"loose associations," 559	Lurasidone, 573
Li-Fraumeni syndrome osteosarcomas, 465	hypothyroidism, 341	Looser zones (osteomalacia), 463	Luteal phase of menstrual cycle, 632
tumor suppressor genes in, 46, 224	mechanism and use, 574 prenatal exposure, 298 , 300	Loperamide, 400 , 551 Lopinavir	Luteinizing hormone (LH) clomiphene effect, 656
Ligaments	teratogenicity, 614	HIV therapy, 203	contraception, 657
female reproductive anatomy, 625	therapeutic index of, 234	Loratadine, 686	estrogen/progesterone, 630
gastrointestinal anatomy, 361	thyroid functions with, 249	Lorazepam	hCG and, 617
Ligamentum arteriosum, 282	toxicity of, 569	alcohol withdrawal, 572	ovulation, 631
Ligamentum teres hepatis, 282, 361	Live attenuated vaccines, 111	Losartan, 610	PCOS, 645
Ligamentum venosum, 282	Liver	Low birth weight, 635	premature ovarian failure, 636
Ligand receptors, 208 Lightheadedness, 534	blood supply and innervation of, 364 in gastrointestinal anatomy, 361	Löwenstein-Jensen agar/medium, 126 Lower esophageal sphincter (LES)	secretion of, 327 sex development disorders, 639
Likelihood ratio (LR), 257	lipid transport and, 92	achalasia and, 376	signaling pathways of, 337
Limbic system, 499	tissue architecture, 367	in Barrett esophagus, 377	spermatogenesis, 628
Limited scleroderma (CREST	Liver/biliary disease	nitric oxide and, 371	testosterone, 658
syndrome), 115, 473	acanthocytes in, 414	Lower extremity nerves, 452 –453	Lyme disease
Linagliptin, 353	alcoholic, 391	Lower left quadrant (LLQ) pain, 383	animal transmission, 149
Lindane, 200	anemia, 420	Lower motor neuron (LMN) lesions,	AV block in, 295
Linea alba, 369 Linear ulcers, 377	autoimmune, 389, 392, 395 cirrhosis, 71, 80, 389	530, 531 facial nerve, 532	Borrelia burgdorferi, 146 ceftriaxone, 189
Emical diccis, 7//	Cittiosis, / 1, 00, 307	racial fictive, 772	certifiazone, 107

FAS1_2019_21_Index_749-806.indd 779 11/21/19 12:27 PM

Lymphadenopathy Corynebacterium diphtheriae, 132 hilar, 675-676 Lymphogranuloma venereum, 184 mediastinal, 676 mononucleosis, 165 rubella, 169, 182-183 serum sickness, 113 syphilis, 147, 184 tinea capitis, 152 Toxoplasma gondii, 182 Trypanosoma brucei, 156 in viral infections, 96 Lymphatic filariasis (elephantiasis) Wuchereria bancrofti, 159 Lymph drainage gonadal, 624 superficial inguinal nodes, 624 Lymph nodes absent or scanty, 116 drainage sites, 96-97 structure and function, 96 T cell differentiation, 102 tumor metastases, 223 Lymphocyte-depleted lymphoma, 429 Lymphocyte-rich lymphoma, 429 Lymphocytes, 409 breast milk and, 636 CLL/small cell lymphocytic lymphoma, 432 corticosteroid effect on, 424 lymph nodes, 96 non-Hodgkin lymphoma, 430 spleen, 98 thymus, 98 Lymphocytic choriomeningitis virus (LCMV), 167 Lymphocytic infiltrates Bordetella pertussis, 143 Lymphocytosis, 98 Lymphogranuloma venereum, 184 Chlamydia trachomatis, 149 Lymphoid hyperplasia, 383 Lymphoid neoplasms, 432 Lymphoid structures, 96-97 Peyer patches, 362, 374 Lymphomas carcinogens causing, 225 celiac disease and, 381 cyclophosphamide for, 441 cytarabine for, 440 doxorubicin for, 439 EBV and, 165 etoposide/teniposide for, 442 Hodgkin, 429 hypercalcemia and, 228 leukemia comparison, 429 methotrexate for, 440 nomenclature for, 220 non-Hodgkin, 430 oncogene for, 208, 224 oncogenic microbes, 226 paraneoplastic syndromes with, 228 of stomach, 379 testicular, 653 Lymphopenias, 424 ataxia-telangiectasia, 117 corticosteroid effect on, 424 Lynch syndrome, 388 mismatch repair and, 40 Lyonization (x-inactivation) Barr body formation, 61 Lysergic acid diethylamide (LSD), 571 classification of, 81 in cystinuria, 85

kidney stones, 598 for pyruvate dehydrogenase complex deficiency, 77 Lysogenic phage infection, 130 Lysosomal storage diseases, 47 causes and effects of, 88 Lysosomal trafficking regulator gene, Lysosomal α-1,4-glucosidase, 87 Lysozyme innate immunity, 99 in neutrophils, 406 LYST gene, 117 Lytic bone lesions adult T-cell lymphoma and, 430 Langerhans cell histiocytosis, 434 MacConkey agar, 126, 144 "Machine-like" murmur, 291 Macroangiopathic hemolytic anemia, Macrocytic anemia, 420 Macroglobulinemia, 431 Macrolides cytochrome P-450 and, 252 hypertrophic pyloric stenosis and, 359 Legionella pneumophila, 143 mechanism and use, **193** Mycoplasma pneumoniae, 150 naming convention for, 253 protein synthesis inhibition, 191 torsades de pointes, 248 Macroorchidism, 62 Macro-ovalocytes, 415 Macrophages, 407 alveolar, 662 apoptosis and, 208 binding of, 104 breast milk and, 636 cell surface proteins, 110 cytokine secretion, 108 endotoxin activation, 133 innate immunity, 99 in lymph node, 96 lymphocyte interaction, **102** in MI, 305 necrosis and, 209 pneumoconioses, 677 splenic, 98 in wound healing, 216 Macrosomia, 614 Macula densa juxtaglomerular apparatus, 589 Macular cherry-red spot, 88, 538 Macular degeneration, 536 Macules, 475 melanocytic nevus, 477 Maculopapular rash graft-versus-host disease, 119 measles, 170 syphilis, 147 Magnesium antacid use, 399 antiarrhythmic treatment, 324 cardiac glycoside toxicity, 321 in laxatives, 401 PTH regulation, 332 torsades de pointes and, 294 Magnesium hydroxide, 399 Magnesium sulfate preeclampsia/eclampsia, 643

Maintenance dose, 231

Maintenance stage, substance

addiction, 568

Major basic protein (MBP), 408 Major depressive disorder (MDD) diagnostic symptoms for, 561 peripartum onset, 562 vortioxetine use, 576 Malabsorption syndromes, 381-382 fat-soluble vitamin deficiencies, 65 inflammatory bowel disease, 382 Malaria artesunate for, 200 Plasmodium, 157 quinidine/quinine for, 200 Malassezia spp, 152, 476 Malathion, 200 Male/female genital homologs, 623 Male genital embryology, 622 Male reproductive anatomy, 626 Male sexual response, 627 Malformation, 613 Malignancy marantic endocarditis in, 311 uterine bleeding with, 633 Malignancy/hyperplasia uterine bleeding with, 633 Malignant hypertension microangiopathic hemolytic anemia, 423 Malignant hyperthermia, 550-551 Malignant mesothelioma, 227 Malignant tumors, 220 bones, 465 Malingering, 566 Malleus (ossicles), 533, 620 Mallory bodies in alcoholic hepatitis, 391 Mallory-Weiss syndrome, 377 Malnutrition, 71 superior mesenteric artery syndrome and, 363 Malrotation, **385** "Maltese cross" appearance, 157, 594 MALT lymphomas Helicobacter pylori, 146 oncogenic microbes and, 226 Sjögren syndrome, 468 Mammary glands, 613 Mammillary bodies, 511 limbic system, 499 Wernicke-Korsakoff syndrome, 571 Mandibular process, 620 Mango flies (disease vector), 159 Manic episode, **560** Man-in-the-barrel syndrome, 502 Mannitol, 607 Mantle cell lymphomas, 430, 434 Mantle zone spleen, 98 Maple syrup urine disease, 84 Marantic endocarditis, 228, 311 Marasmus, 71 Maraviroc, 203 Marburg hemorrhagic fever, 167 Marcus Gunn pupils, 539 multiple sclerosis, 523 Marfanoid habitus homocystinuria, 84 MEN 2B syndrome and, 351 Marfan syndrome aortic dissection and, 303 cardiac defect association, 300 cataracts, 535 chromosome association, 64 elastin and, 52 heart murmur with, 291 thoracic aortic aneurysm and, 302 Marginal zone lymphoma, 430, 434

Marijuana intoxication and withdrawal, 571 Marine omega-3 fatty acids, 320 Masseter muscle, 507 Mast cells, 408 IgE antibody and, 105 Mast cell stabilizers, 687 Mastectomy, 448 Mastication muscles, 507 Mastoid air cells, 621 Mastoiditis brain abscesses, 180 Wegener granulomatosis, 315 Maternal diabetes cardiac defect association, 300 Maternal PKU, 84 Maternal (postpartum) blues, 562 Maternal pregnancy complication, Mature cystic teratoma, 647 Mature ego defenses, 555 Maxillary artery, 619 Maxillary process, 620 Mayer-Rokitansky-Küster-Hauser syndrome, 622 McArdle disease, 87 McBurney point, 383 McCune-Albright syndrome, 57 McMurray test, 454 MDMA (ecstasy), 571 Mean (statistics), 262 Mean arterial pressure, 501 equation for, 285 Measles, 183 paramyxovirus, 167, 169 rubeola virus, 170 unvaccinated children, 186 vitamin A for, 66 Measurement bias, 260 Measures of central tendency, 262 Measures of dispersion, 262 Mebendazole, 200 microtubules and, 48 mecA gene penicillin resistance and, 135 Meckel diverticulum, **384**, 618 Meconium ileus, 386 cystic fibrosis, 60 MECP2 gene, 62 Medial calcific sclerosis, 301 Medial cerebellar lesions, 499 Medial collateral ligament (MCL) injury in "unhappy triad," 460 Medial epicondylitis, 459 Medial femoral circumflex artery, Medial geniculate nucleus (MGN), 498 Medial lemniscus, 514 Medial longitudinal fasciculus (MLF), 511, 543 Medial malleolus, 455 Medial medullary syndrome, 514 Medial meniscal tear, 460 Medial pterygoid muscle, 507 Medial rectus muscle, 540 Medial tibial stress syndrome, 461 Medial umbilical ligament, 282, 369 Median (statistics), 262 "Median claw," 451 Median nerve carpal tunnel syndrome, 459 injury to, 447 neurovascular pairing, 455 Median umbilical ligament, 369

FAS1_2019_21_Index_749-806.indd 780 11/21/19 12:27 PM

index 781

Mediastinal lymphadenopathy, 676
Mediastinal pathology, 672
Mediastinitis, 672
in pulmonary anthrax, 137 Medical abortion
ethical situations, 268
methotrexate for, 440
Medical errors analysis of, 274
assessment of, 268
types of, 274
Medical insurance plans, 271 Medical power of attorney, 266
Medicare/Medicaid, 272
Medication errors, 274 Medication noncompliance, 268
Medium-chain acyl-CoA
dehydrogenase deficiency
89 Medium-vessel vasculitis
presentation and pathology, 314
Medroxyprogesterone, 657
Medulla (brain) adrenal cortex and, 327
cranial nerves and nuclei, 505
development of, 490
spinal tracts and, 509
strokes in, 514–515 Medulla (lymph nodes)
lymph nodes, 96
thymus, 102 Medullary breast carcinomas, 650
Medullary cystic kidney disease,
604
Medullary thyroid carcinomas, 343, 351
Medulloblastoma, 350, 528
"Medusa head" appearance, 137
Mefloquine, 157 Megacolon
Chagas disease, 158
in Hirschsprung disease, 384
Megakaryocytes in essential thrombocythemia, 433
Megaloblastic anemia, 420
cytarabine, 440
Diphyllobothrium latum, 160 drug reaction and, 250
orotic aciduria, 420
trimethoprim, 194
tropical sprue, 381 vitamin B ₉ deficiency, 68
vitamin B ₁₂ deficiency, 69
Megestrol, 657
Meglitinides, 353 Meissner corpuscles, 494
Meissner plexus, 384
Melanocytes
tumor nomenclature in, 220 Melanocyte-stimulating hormone
(MSH)
function of, 328 secretion of, 327
signaling pathways of, 337
Melanocytic nevus, 477
Melanoma, 484
common metastases, 223 immunohistochemical stain for,
227
nomenclature for, 220 oncogene, 224
origin of, 220
recombinant cytokines for
metastatic, 121 tumor suppressor gene, 224
Melarsoprol, 156, 200
* '

Melasma (chloasma), 476
MELAS syndrome, 59
Melatonin circadian rhythms and, 497
Melatonin receptor agonist
Ramelteon as, 547
Melena
Meckel diverticulum, 384, 618
polyarteritis nodosa, 314
Meloxicam, 486
Memantine, 549
Membrane attack complex (MAC),
104
complement and, 106 Membranoproliferative
glomerulonephritis
(MPGN), 596
hepatitis B and C, 173
Membranous glomerular disorders,
594
hepatitis B and C, 173
Membranous interventricular
septum, 281
Membranous nephropathy, 597
primary autoantibody, 115
Membranous ossification, 458
Membranous urethra injury, 627 Membranous ventricular septum, 281
Memory
neural structures and, 499
Memory loss
anti-NMDA receptor encephalitis,
228
lead poisoning, 425
Wernicke-Korsakoff syndrome, 511
MEN1 gene, 224, 352
Ménétrier disease, 379
Ménière disease, 534
Menin, 224
Menin, 224 Meninges, 496
Menin, 224 Meninges, 496 Meningiomas, 526
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal prophylaxis, 198
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal prophylaxis, 198 Meningococcal vaccine, 127
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningococcal prophylaxis, 198 Meningococcal vaccine, 127 Meningococcemia
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus pneumoniae, 136 Meningococcal prophylaxis, 198 Meningococcal prophylaxis, 198 Meningococcal prophylaxis, 198 Meningococcemia endotoxins, 131 Meningococci, 131, 142
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus pneumoniae, 136 Streptococcus pneumoniae, 136 Meningococcal vaccine, 127 Meningococcal vaccine, 127 Meningococcemia endotoxins, 131 Meningococci, 131, 142 Meningoencephalitis
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningococcal prophylaxis, 198 Meningococcal vaccine, 127 Meningococcemia endotoxins, 131 Meningococci, 131, 142 Meningococci, 132 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal prophylaxis, 198 Meningococcal vaccine, 127 Meningococcemia endotoxins, 131 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningococcal prophylaxis, 198 Meningococcal prophylaxis, 198 Meningococcal vaccine, 127 Meningococcal vaccine, 127 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156 West Nile virus, 167
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal prophylaxis, 198 Meningococci, 131, 142 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156 West Nile virus, 167 Meningomyelocele, 491
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal vaccine, 127 Meningococci, 131, 142 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156 West Nile virus, 167 Meningomyelocele, 491 Menkes disease
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningococel, 491 Meningococcal prophylaxis, 198 Meningococcal prophylaxis, 198 Meningococcemia endotoxins, 131 Meningococcemia endotoxins, 131 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156 West Nile virus, 167 Meningomyelocele, 491 Menkes disease mechanism and symptoms, 51
Menin, 224 Meninges, 496 Meningiomas, 526 Psammoma bodies in, 227 Meningitis ceftriaxone, 189 chloramphenicol, 192 coccidioidomycosis, 151 common causes, 180 Cryptococcus neoformans, 153 CSF findings in, 180 fluconazole, 199 flucytosine, 199 Haemophilus influenzae, 142 headaches with, 518 HIV-positive adults, 177 Listeria monocytogenes, 139 meningococci, 142 mumps, 170 in neonates, 182 rifamycin prophylaxis, 196 Streptococcus pneumoniae, 136 Streptococcus agalactiae, 137 unvaccinated children, 186 Meningocele, 491 Meningococcal vaccine, 127 Meningococci, 131, 142 Meningococci, 131, 142 Meningoencephalitis HSV-2, 182 Naegleria fowleri, 156 West Nile virus, 167 Meningomyelocele, 491 Menkes disease

Melasma (chloasma), 476

Menopause, 636
hormone replacement therapy, 657
primary ovarian insufficiency, 645
Turner syndrome, 638
Menorrhagia, 633
anemia with, 418
Menstrual cycle estrogens for, 656
heavy bleeding (AUB/HMB), 633
phases of, 632
Meperidine, 551
Mepivacaine, 550
Mercury poisoning, 248
Merkel discs, 494
Merlin protein, 224
MERS (Middle East respiratory syndrome), 167
Mesalamine, 382
Mesangial cells
juxtaglomerular apparatus, 589
Mesencephalon, 490
Mesenchymal tumors
nomenclature of, 220
Mesenteric arteries, 363
Mesenteric ischemia, 386
Mesocortical pathway, 499 Mesoderm, 490
branchial arches derivation, 619
derivatives of, 613
Mesolimbic pathway, 499
Mesometrium, 625
Mesonephric (Wolffian) duct, 622
Mesonephros, 578
Mesosalpinx, 625 Mesothelioma, 678
carcinogens causing, 225
Psammoma bodies in, 227
Mesovarium, 625
Mestranol, 656
Meta-analysis, 263, 264
Metabolic acidosis, 592 adrenal insufficiency, 349
renal failure, 603
symptoms of, 593
symptoms of, 593 Metabolic alkalosis, 592
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis,
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94 ethanol, 72, 232
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94 ethanol, 72, 232 fatty acid, 89
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94 ethanol, 72, 232 fatty acid, 89 fuel use, 91
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94 ethanol, 72, 232 fatty acid, 89 fuel use, 91 gluconeogenesis, 78
symptoms of, 593 Metabolic alkalosis, 592 hyperaldosteronism, 349 in hypertrophic pyloric stenosis, 359 loop diuretics, 608 nephron transport, 586 thiazides, 609 Metabolic disorders fructose, 80 galactose, 80 glycogen storage, 87 lysosomal storage diseases, 88–89 Metabolic fuel use, 91 Metabolic syndrome with antipsychotic drugs, 573 non-alcoholic fatty liver disease and, 391 Metabolism, 72–94 amino acid derivatives, 83 amino acids, 81 apolipoproteins, 93 cellular sites of, 72 disorders of, 81, 84–85 drugs, 232 dyslipidemias, 94 ethanol, 72, 232 fatty acid, 89 fuel use, 91

rate-determining enzymes, 73 summary of pathways, 74 TCA cycle, 7 tyrosine catabolism, 83 urea cycle, 82 Metacarpal neck fracture, 459 Metacarpophalangeal (MCP) joints, Metachromatic granules Corynebacterium diphtheriae diagnosis, 139 Metachromatic leukodystrophy, 88, Metalloproteinases, 216 Metal storage diseases, 210 Metanephros, 578 Metaphase, 46 Metaplasia, 206 benign breast disease, 649 esophagus, 378 intestinal, 379 specialized intestinal, 378 Metastases common, 223 Metastasis, 219, 223 gastric cancer, 379 heart tumors from, 316 liver cancer, 392 lung, cancer, 684 Metastatic calcification, 211 Metastatic melanoma vemurafenib for, 444 Metatarsophalangeal (MTP) joints gout, 467 Metencephalon, 490 Metformin, 353 diarrhea with, 249 Methacholine, 240 Methadone, 551 heroin addiction, 576 intoxication and withdrawal, 570 Methamphetamine, 572 Methanol toxicity, 248 Methemoglobin, 666 toxicity treatment, 248 Methemoglobinemia, 666 local anesthetics and, 550 Methicillin, 249 Methimazole, 354 agranulocytosis, 250 aplastic anemia, 250 teratogenicity, 614 Methionine classification of, 81 start codons, 44 sulfonamides and, 194 Methotrexate, 440 folate deficiency, 420 hydatidiform moles, 642 megaloblastic anemia, 250 pulmonary fibrosis, 251 pyrimidine synthesis and, 36 rheumatoid arthritis, 466 targets of, 438 teratogenicity, 614 vitamin B₉ deficiency, 68 as weak acid, 233 Methoxyflurane, 550 Methylation histones, 45 Methyldopa Coombs-positive hemolytic anemia, 250 hypertension in pregnancy, 316 Methylene blue, 248

FAS1_2019_21_Index_749-806.indd 781 11/21/19 12:27 PM

pyruvate, 77

Methylenetetrahydrofolate reductase Micromelia, 614 (MTHFR) deficiency, 84 Methylmalonic acid vitamin B₁₂ deficiency, 69 vitamin B₉ deficiency, 68 Microsporum, 152 Methylmalonyl-CoA mutase, 69 Methylmercury teratogenicity, 614 Microtubules, 48 Methylnaltrexone, 551 Methylphenidate AĎĤD, 557, 572 CNS stimulant, 572 Methyltestosterone, 658 Midbrain brain, 490 Methylxanthines, 687 Metoclopramide, 400 Parkinson-like syndrome, 251 tardive dyskinesia, 251 Metolazone, 609 Metoprolol, 245, 323 Metronidazole bacterial vaginosis, 148 clindamycin vs, 192 Clostridium difficile, 138 for Crohn disease, 382 disulfiram-like reaction, 251 Midgut Giardia lamblia, 155 Helicobacter pylori, 146 mechanism and use, 195 vaginal infections, 181 Midodrine, 242 Mifepristone, 657 vaginitis, 158 Miglitol, 353 Mevalonate synthesis, 320 Mexiletine, 322 Meyer loop, 542 MHC (major histocompatibility complex) I and II, 100 triptans for, 547 Micafungin, 200 Michaelis-Menten kinetics, 230 Miconazole, 199 Microalbuminuria, 346 Milnacipran, 575 Mineralocorticoids Microangiopathic hemolytic anemia (MAHA), 423 hypertensive emergency and, Mineral oil, 65 intravascular hemolysis in, 421 Microarrays, 54 Microbiology, 123-204 Minocycline, 192 antimicrobials, 187-204 bacteriology, 124-134 clinical bacteriology, 134-150 mycology, 151-154 oncogenic organisms, 226 parasitology, 155–161 systems, 178–186 virology, 162-177 Microbiome Mirabegron, 242 in innate immunity, 99 Microcephaly, 63 cri-du-chat syndrome, 64 Misoprostol, 399 fetal alcohol syndrome, 615 maternal phenylketonuria, 84 maternal X-ray exposure, 614 Patau syndrome, 63 Mitochondria with zika virus, 171 Microcytic, hypochromic anemia, 418–419 Ancylostoma, 161 Microcytosis, 214 Microdeletion Mitosis, 46 congenital, 64 fluorescent in situ hybridization and, 55 in MI, 305 22q11, 116 Microfilaments, 48 Mitral stenosis, 288 Microglia, 490, 493 murmurs caused by, 291 Micrognathia Mitral valve Edwards syndrome, 63 in cardiac cycle, 287 Pierre Robin sequence, 620 regurgitation in, 312

Microphthalmia, 63 MicroRNA (miRNA), 42, 56 Microscopic polyangiitis, 315 Microtubule inhibitors, 441 drugs acting on, 48 structure and function of, 48 Micturition center, 237 Midazolam, 546, 550 cranial nerve nuclei of, 505 lesions in, 511 Middlebrook medium, 126 Middle cerebral artery (MCA) cortical distribution, 502 saccular aneurysms, 516 stroke effects, 514 Middle meningeal artery epidural hematoma and, 513 Middle rectal vein, 365 blood supply/innervation of, 364 development of, 358 Midgut volvulus, 386 Migraine headaches, 518 hormonal contraception contraindication, 657 Migrating motor complexes (MMC), Migratory polyarthritis, 312 adrenal insufficiency, 349 adrenal steroids and, 335 Minimal alveolar concentration, Minors, consent for, 265 Minoxidil, **658** Minute ventilation, 664 cholinomimetic agents, 552 Horner syndrome, 531, 540 pupillary control, 539 sympatholytic drugs, 243 Mirtazapine, 244, 576 major depressive disorder, 561 Mismatch repair, 40 Missense mutations, 39 Mites/louse treatment, 200 high altitude and, 670 metabolism in, 72 Mitochondrial encephalopathy, 59 Mitochondrial inheritance, 59 Mitochondrial myopathies, 59 griseofulvin, 200 Mitral regurgitation, 288 murmurs caused by, 290, 291

Mitral valve prolapse, 291 fragile X syndrome, 62 Marfan syndrome, 52 renal cyst disorders and, 604 Mittelschmerz, 631 Mixed cellularity lymphoma, 429 Mixed connective tissue disease, 470 autoantibody, 115 Raynaud phenomenon, 472 Mixed cryoglobulinemia, 315 Mixed transcortical aphasia, 516 MMR vaccine, 170 Mobitz AV blocks, 295 Moccasin distribution (tinea pedis), 152 Modafinil, 568 Mode (statistics), 262 Molecular mimicry autoimmune response in rheumatic fever, 129 Molecular motor proteins, 48 Molluscum contagiosum, 164, 479 Mönckeberg sclerosis, 301 "Monday disease," 318 Monoamine oxidase (MAO) inhibitors atypical depression, 561 mechanism and clinical use, 575 Parkinson disease, 549 selegiline/rasagiline, 549 tyramine and, 244 Monobactams, 190 Pseudomonas aeruginosa, 143 Monoclonal antibodies drug names for, 254 Monoclonal immunoglobulin (Ig) overproduction, 431 Monocytes, 407 innate immunity, 99 morulae in, 150 Monospot test, 165 Monozygotic ("identical") twins, 616 Montelukast, 687 Mood oxytocin's role in regulating, 328 Mood disorder, 560 readmissions with, 272 Mood stabilizing drugs, 561 Morbidly adherent placenta, 640 Moro reflex, 510, 635 Morphine, 551 for acute coronary syndromes, 307 intoxication and withdrawal, 570 Morphogenesis of heart, 280-281 errors in, 613 Morulae, 150 Mosaic bone architecture, 464 Mosaicism, 57 Mosquitoes (disease vectors) lymphatic filariasis, 159 malaria, 157 Zika virus, 171 Motilin, 371 Motion sickness, 241 Motor cortex, 514 descending spinal tracts, 509 topographic representation, 502 ventral lateral thalamus and, 498 Motor innervation derivation of, 620 lower extremity, 452 tongue, 493 Motor neuron signs, 529 Movement disorders, 519 dopaminergic pathways and, 499 Moxifloxacin, 195 M phase, 46

MPO-ANCA/p-ANCA autoantibody, 115 M protein rheumatic fever and, 136 as virulence factor, 129 mRNA aminoglycosides, 191 hepatitis viruses, 172 pre-mRNA splicing, 42 processing, 41 protease inhibitors, 203 stop codons, 44 MRSA (methicillin-resistant Staphylococcus aureus) cephalosporins, 189 highly resistant, 198 nosocomial infections, 135 oxazolidinones, 193 vancomycin, 190 mTOR sirolimus (rapamycin) inhibition of, 120 Mucicarmine stain polysaccharide capsule staining, 125 Mucinous cystadenocarcinoma, 646 Mucinous cystadenoma, 646 Mucociliary escalator, 662 Mucocutaneous lymph node syndrome, 314 Mucoepidermoid carcinomas, 376 Mucopolysaccharides Periodic acid-Schiff stain, 125 Mucopolysaccharidoses, 88 Mucormycosis diabetic ketoacidosis, 347 Mucor spp amphotericin B for, 199 opportunistic infection, 153 Mucosa, 362 Mucosal cells, 372 Mucosal neuromas, 351 Mucosal polyps, 387 Mucositis methotrexate, 440 Mucus, 238 "Muddy brown" casts (urine), 594 Mulberry molars, 147 Müllerian duct agenesis, 622 anomalies of, 623 derivatives of, 622 Müllerian inhibitory factor (MIF), 622 Sertoli cell production, 628 Multicystic dysplastic kidney, 578, 579 Multidrug resistance protein 1 , (MDR1), 227 Multifactorial pulmonary hypertension, 679 Multiorgan drug reactions, 251 Multiple endocrine neoplasias (MEN syndromes), 351 Zollinger-Ellison syndrome, 351 Multiple gestations, 633 Multiple myeloma bortezomib/carfilzomib in, 443 common metastases, 223 ESR in, 214 metastatic calcification, 211 monoclonal gammopathy transition to, 431 plasma cell dyscrasia, 409 Multiple personality disorder, 558 Multiple sclerosis, **523** drug therapy for, 551 HLA-DR2 and, 100 internuclear ophthalmoplegia, 543

FAS1_2019_21_Index_749-806.indd 782 11/21/19 12:27 PM

natalizumab for, 122
recombinant cytokines for, 121 Mumps, 170
acute pancreatitis with, 397
paramyxovirus, 167, 169 Munchausen syndrome, 566
Munchausen syndrome by proxy, 566
Murphy sign, 396 Muscarinic acetylcholine (ACh)
receptors, 236 Muscarinic agonists, 237
Muscarinic antagonists, 237, 241, 687
multiple sclerosis, 523 neuromuscular blocking drugs,
550, 551
Parkinson disease, 548 Muscarinic receptor
detrusor muscle, in, 237
Muscle conduction/contraction skeletal, 456
smooth muscle, 457 Muscle proprioceptors, 458
Muscles
atrophy of, 42 in starvation, 91
metabolism in, 86
ragged red fibers in, 59 Muscle spindled, 458
Muscular dystrophies, 61
frameshift mutation, 61 X-linked recessive disorder, 61
Muscularis externa, 362 Muscular ventricular septum, 281
Musculocutaneous nerve
injury presentation, 447 Musculoskeletal drug reactions, 250
Musculoskeletal paraneoplastic
syndromes, 228 Musculoskeletal system
anatomy, 446–454 common conditions, 461
pathology, 459–467
pharmacology, 485–487 Mutase, 73
Mutations BRAF, 432
BRCA1 gene, 56
COL3AI, 51 de novo, 62
drug resistance mechanisms, 196
in HbS and HbC, 410 JAK2, 433
locus heterogeneity in, 57
muscular dystrophies, 61 myelodysplastic syndromes, 432
non-Hodgkin lymphoma, 430 in PBPs, 187
same locus, 57
STAT3, 116 thalassemia and, 418
tumor suppressor genes, 46, 525
WT1 deletion, 606 Myalgias
Ebola virus, 171 fluoroquinolones, 195
genital herpes, 184
Jarisch-Herxheimer reaction, 148 Leptospira interrogans, 147
Lyme disease, 146
meningitis, 186 <i>Trichinella spiralis</i> , 159, 161
trichinosis, 159 vasculitides, 314
Myasthenia gravis, 472
autoantibody, 115 diagnosis of, 240
0 / "

HLA subtype association, 100
neostigmine for, 240
as paraneoplastic syndrome, 228
pyridostigmine for, 240
restrictive lung diseases, 675
MYCL1 gene, 224
MYCN gene, 224
Mycobacterial cells, 196 Mycobacterium spp, 140
Gram stain, 125
intracellular organism, 127
Ziehl-Neelsen stain, 125
Mycobacterium avium-intracellulare,
140
HIV-positive adults, 177
prophylaxis with HIV, 198
vertebral osteomyelitis, 180
Mycobacterium leprae
animal transmission, 149
diagnosis, 141
rifamycins/dapsone, 196
Mycobacterium marinum, 140
Mycobacterium pneumoniae, 126
Mycobacterium scrofulaceum, 140
Mycobacterium spp
facultative intracellular organisms,
127
Mycobacterium tuberculosis
culture requirements for, 126
osteomyelitis, 180
reactivation site, 140
symptoms of, 140
therapeutic agents, 196, 197
Mycolic acid
isoniazid, 197
synthesis of, 196 Mycology, 151–154
Mycophenolate mofetil, 120 inosine monophosphate
dehydrogenase inhibition, 36
Mycoplasma spp
atypical organisms, 179
Gram stain, 125
macrolides, 193
pneumonia caused by, 150 , 179, 683
tetracyclines, 192
Mycoses
cutaneous, 152
systemic, 151
Mycosis fungoides, 430
Mydriasis
glaucoma treatment and, 552
G-protein-linked second receptor,
238
muscarinic antagonists for, 241
pupillary control, 539
saccular aneurysm, 516
Myelencephalon, 490
Myelin, 494
Myeloblasts (peripheral smear), 432
Myelodysplastic syndromes, 432
sideroblastic anemia, 419
Myelofibrosis, 433
Myeloid neoplasms, 432
Myelomeningocele, 63, 492
Myeloperoxidase, 109
H ₂ O ₂ degradation, 128
in neutrophils, 406
Myeloproliferative disorders
in AML, 432 chronic, 433
hydroxyurea for, 442
Myeloschisis, 491
Myelosuppression
alkylating agents, 441
antimetabolites, 440
Entertail Office, 110

drugs causing, 444 hydroxyurea, 442
irinotecan/topotecan, 442 Myenteric plexus, 362
Mylohyoid muscle, 620
Myocardial action potential, 292 Myocardial depression, 550
Myocardial infarction (MI), 304 antiarrhythmics after, 322
β-blockers for, 245
complications of, 307 diabetes mellitus, 346
diagnosis of, 306
on ECG, 293 ECG localization of STEMI, 306
evolution of, 305
heart failure caused by, 309 heparin for, 436
homocystinuria, 84
hypertensive emergency and, 300 shock caused by, 310
thrombolytics for, 437
Myocardial O ₂ consumption/ demand, 284
angina treatment, 319 Myocarditis, 313
adenovirus, 164
coxsackievirus, 167 diphtheria, 139
picornaviruses, 167
Toxocara canis, 159 Myoclonic seizures, 517
Myoclonus, 519, 521
Myofibroblasts, 216 Myoglobin, 665
ooxygen-hemoglobin dissociation
curve, 666 Myoglobinuria
acute tubular necrosis, 602
McArdle disease, 87 Myonecrosis, 138
Myopathy
daptomycin, 195 drug reaction and, 250
Myophosphorylase, 87 Myopia, 535
retinal detachment, 537
Myotonic dystrophy, 61 cataracts and, 535
Myxedema
thyroid hormones for, 354 Myxomas, 316
Myxomatous degeneration, 291
N
N-acetylglucosaminyl-1-
phosphotransferase, 47 N-acetylcysteine, 686
for acetaminophen toxicity, 248 for cystic fibrosis, 60
NADH (reduced nicotinamide
adenine dinucleotide) electron transport chain, 78
fructose metabolism, 80
TCA cycle, 77 Nadolol, 245
NADPH (reduced nicotinamide
adenine dinucleotide phosphate)
ethanol metabolism, 72
HMP shunt and, 79 respiratory burst and, 109
universal electron acceptors, 75
Naegleria fowleri, 156 Nafcillin
characteristics of, 188

Nails
clubbing, 60
glomus tumors under, 478
hemorrhages in bed of, 311
with psoriatic arthritis, 469
Naïve T cell activation, 103
Naked viral genome infectivity, 163
Nalbuphine, 551
Naloxone
dextromethorphan overdose, 686
heroin detoxification, 576
for opioid toxicity, 248, 551
opioid toxicity, 570
Naltrexone
alcoholism, 571
heroin detoxification, 576
opioid toxicity, 551
2-naphthylamine, 225
Naproxen, 486
acute gout drugs, 487
Narcissistic personality disorder, 565
Narcolepsy
amphetamines for, 242
characteristics/treatment, 568
hypnagogic/hypnopompic
hallucinations, 568
Narrow-angle glaucoma, 536
Nasal congestion, 686
Nasal decongestion
ephedrine for, 242
Nasal polyps
cystic fibrosis, 60
Nasal septum perforation, 315
Nasopharyngeal carcinoma
EBV and, 165
oncogenic microbes and, 226
Natalizumab, 122
multiple sclerosis, 523
Nateglinide, 353
National Board of Medical Examiners
(NBME), 2, 11
Natriuresis, 588
Natriuretic peptide, 296
Natural killer (NK) cells, 101, 409
cell surface proteins, 110 function of, 409
innate immunity, 99
Nausea
adverse drug effects, 400
antiemetics for, 401
with appendicitis, 383
biliary colic, 396
with MI, 305
migraine headaches, 518
ranolazine, 319
renal failure, 603
vitamin A toxicity, 66
vitamin C toxicity, 69
Nebivolol, 245
Necator spp
disease associations, 161
infection routes, 158
Necator americanus, 159
Neck and head cancer, 671
cetuximab for, 442
Necrosis, 209
acute pancreatitis, 397
Arthus reaction, 113
benign tumors, 220
Budd-Chiari syndrome, 392
calcification, 211
enterocolitis, 386
femoral head, 120, 461, 463
fibrinoid, 466
glioblastoma multiforme, 526
hepatic, 485

FAS1_2019_21_Index_749-806.indd 783 11/21/19 12:27 PM

INDEX

Necrosis (continued)	jaundice in, 393	Neuroblastomas, 350	IL-8 and, 108
hernias and, 370	kernicterus, 194, 204	incidence and mortality, 222	innate immunity, 99
jaw, 486	Listeria monocytogenes in, 139	oncogenes and, 224	left shift, 424
mesenteric ischemia, 386	low birth weight, 635	paraneoplastic syndromes with, 228	in leukocyte adhesion deficiency,
nonalcoholic fatty liver disease,	meningitis in, 182	Neurocutaneous disorders, 525	117
391	necrotizing enterocolitis and, 386	Neurodegenerative disorders,	LTB4, 485
			· · · · · · · · · · · · · · · · · · ·
saponification, 209	obesity risk factors, 636	520 –522	megaloblastic anemia, 420
scaphoid avascular, 449	pneumonia in, 149	drug therapy for, 549	in MI, 305
transplant reaction, 119	primitive reflexes in, 510	Neuroectoderm, 490	necrosis and, 209
warfarin, 436	sickle cell anemia in, 422	derivatives of, 612	nonmegaloblastic anemia, 420
Necrotizing enterocolitis, 386	Streptococcus agalactiae in, 137	pituitary gland, 327	pseudo-Pelger-Huet anomaly, 432
Necrotizing fasciitis, 479	TORCH manifestations in, 182	Neuroendocrine tumors, 350	stimulation of, 44
Streptococcus pyogenes (Group A	Neoplasia	Neurofibromatosis, 535	wound healing, 216
strep), 136	pathology of, 219 –226, 518	chromosome association, 64	Nevi, 220
Necrotizing glomerulonephritis, 315	Neoplastic progression, 219	inheritance, 60	Nevirapine
Negative predictive value (NPV), 257	Neoplastic transformation, 216	tumor suppressor genes and, 224	cytochrome P-450 and, 252
Negative punishment, 554	adenomatous polyps, 387	typesI and II, 525	HIV therapy, 203
Negative reinforcement, 554	Neostigmine, 240	variable expressivity, 56	NF1/NF2 genes, 224
Negative skew distribution, 262	Nephritic-nephrotic syndrome	Neurofilaments	N-formylmethionine (fMet), 44
Negative-stranded viruses, 168	etiology and presentation, 595	cytoskeletal element, 48	NF-κB, 120
Neglect (child), 556	Nephritic syndrome, 596 –597	immunohistochemical stain for,	Niacin
Negri bodies, 171	etiology and presentation, 595	227	cutaneous flushing, 248
Neisseria gonorrhoeae	Nephritis, 608	Neurogenic ileus, 240	gout, 250
culture requirements, 126	Nephroblastoma, 606	Neurohypophysis, 327	hyperglycemia, 249
epididymitis and orchitis, 654	Nephrocalcinosis, 211	hypothalamus and, 498	myopathy caused by, 250
osteomyelitis, 180	Nephrogenic diabetes insipidus, 211,	Neuroleptic malignant syndrome	Nicardipine, 318
septic arthritis, 468	338	(NMS), 551, 569	Nicotinamides, 75
STI, 184	lithium toxicity, 569	Neurological signs	Nicotine
UTIs with, 600	treatment, 609		intoxication and withdrawal, 571
		proximal upper and lower	
Neisseria meningitidis	Nephrolithiasis, 606	extremity, 502	teratogenicity, 614
chloramphenicol, 192	calcium oxalate, 69	Neurologic drug reactions, 251	Nicotinic acetylcholine receptors,
culture requirements, 126	Nephron physiology, 585	Neurology and special senses,	166, 236
encapsulation, 127	Nephropathy	490–544	Niemann-Pick disease, 88
meningitis, 180	diabetes mellitus, 346	anatomy/physiology, 493–515	Nifedipine, 316, 318 , 643
penicillin G/V for, 187	hypertension and, 300	embryology, 490–492	Nifurtimox, 158, 200
Waterhouse-Friderichsen	protease inhibitors, 203	ophthalmology, 534-541	Night terrors
syndrome, 349	transplant rejection, 119	otology, 533–534	benzodiazepines for, 497
Neisseria spp	Nephrotic syndrome, 597	pathology, 511–518	Nigrostriatal pathway, 499
C5-C9 deficiencies, 107	early-onset, 606	pharmacology, 544–551	Nikolsky sign
cephalosporins, 189	ESR in, 214	Neuromuscular blocking drugs, 551	blistering skin disorders, 480
fluoroquinolones, 195	etiology and presentation, 595	Neuromuscular disorders	scalded skin syndrome, 479
	fatty casts in, 594		Nilotinib, 443
gram-negative algorithm, 142	TBG and, 331	paraneoplastic syndromes, 228	
IgA protease, 129		Neuromuscular junction	Nimodipine, 318 , 513
intracellular organism, 127	Nephrotoxicity	skeletal muscle, 236	Nipple (40)
transformation in, 130	aminoglycosides, 191	diseases of, 472	intraductal papilloma, 649
Nelson syndrome, 348	amphotericin B, 199	Neurons, 493	lactational mastitis, 649
Nematodes, 159	cidofovir, 202	in ascending spinal tracts, 509	Nissl bodies, 46
infection routes, 158	cisplatin/carboplatin, 442	local anesthetics, 550	Nissl substance
Neomycin	cladribine, 440	origins of, 490	chromatolysis, 495
aminoglycosides, 191	drug reaction and, 251	Parkinson disease, 548	neurons, 493
Neonatal abstinence syndrome, 615	drugs causing, 444	primary motor cortex, 509	Nitazoxanide, 155
Neonatal conjunctivitis	immunosuppressants, 120	Neuron-specific enolase, 226, 350	Nitrates, 319
Chlamydia trachomatis, 149	inhaled anesthetics, 550	Neuropathic pain, 515	mechanism and clinical use, 318
Neonatal pneumonia	streptomycin, 197	Neuropathy	Nitric oxide, 371
Group B streptococci, 179	sulfonamides, 194	diabetes mellitus, 346	free radical injury and, 210
Neonatal respiratory distress	Nerve blockade (local anesthetics),	Neurosyphilis, 147	Nitrites
syndrome (NRDS), 661	550	Neurotoxicity	
	Nerve fibers, 495	cladribine, 440	urinary tract infections, 181
Neonates 615		· · · · · · · · · · · · · · · · · · ·	Nitroblue tetrazolium dye reduction
abstinence syndrome, 615	Nerves	immunosuppressants, 120	test, 117
Apgar score, 634	lower extremity, 452, 453	methylmercury exposure, 614	Nitrofurantoin
Candida albicans in, 153	upper extremity, 446, 447	methylxanthines, 687	hemolysis in G6PD deficiency, 250
coagulation cascade in, 413	Nerve trunk, 495	vincristine, 441	pulmonary fibrosis, 251
conjunctivitis, 142, 149	Nesiritide, 296	Neurotransmitters	Nitroglycerin, 318
deprivation effects, 556	Neural crest	bacterial toxin effects, 132	acute coronary syndromes, 307
esophageal atresia in, 359	derivatives of, 613	changes with disease, 495	angina, 304
flora with C-section, 178	Neural crest cells, 490, 494	vomiting center receptors, 496	Nitroprusside, 318
galactosemia in, 80	Neural development, 490	Neurovascular pairing, 455	Nitrosamines
gastroenteritis, 168	Neural plate, 490	Neutralization (antibody), 104	as carcinogens, 225
gray baby syndrome in, 192	Neural tube, 490	Neutropenia, 424	stomach cancer and, 379
hemolytic anemia in, 422			
	derivatives, 613	ganciclovir, 202	Nitrosoureas, 441
herpes in, 164	formation, 612	rheumatoid arthritis, 466	Nitrous oxide, 550
hyperthermia in, 241	Neural tube defects, 491	ticlopidine, 437	Nizatidine, 399
hypertrophic pyloric stenosis in,	maternal diabetes, 614	Neutrophils, 406	NMDA receptor antagonist
359	prevention, 68	chemotaxis, 44, 106, 133, 406, 485,	ketamine as, 550
indirect inguinal hernia in, 370	valproic acid, 544	487, 691	memantine as, 549
intraventricular hemorrhage, 512	Neuraminidase, 169–170	corticosteroid effect on, 424	N-myc oncogene, 350
-			

FAS1_2019_21_Index_749-806.indd 784 11/21/19 12:27 PM

INDEX

NNRTIs, 203	peptic ulcer disease and, 380	Null hypothesis, 263
Nocardia spp	rheumatoid arthritis, 466	Number needed to harm (NNH),
aerobic culture requirements, 126 comparison with <i>Actinomyces</i> spp,	tor sialadenitis, 376	258
139	Non-ST-segment elevation MI (NSTEMI)	Number needed to treat (NNT), 258
effects and treatment, 139	diagnosis of, 306	Nursemaid's elbow, 461
necrosis and, 209	STEMI vs, 304	Nutcracker syndrome, 363
sulfonamides for, 194	treatment, 307	Nutmeg liver, 309, 392
urease-positive, 127 Ziehl-Neelsen stain, 125	Noradrenergic drugs, 574 Norepinephrine (NE)	Nutrition, 65–72 Nyctalopia, 66
Nocturia, 654	adrenal medulla secretion, 327	Nystagmus
Nocturnal enuresis, 329	amphetamines and, 239	cerebellum, 499
Nodes of Ranvier, 494	bupropion effect on, 576	common lesions with, 511
Nodular phlebitis, 314 Nodular sclerosis lymphoma, 429	changes with disease, 495 circadian rhythm, 497	Friedreich ataxia, 531 internuclear ophthalmoplegia,
Noise-induced hearing loss, 533	direct sympathomimetic, 242	543
Nonadherent patients, 268	isoproterenol vs, 243	PCP, 571
Nonalcoholic fatty liver disease, 389,	male sexual response, 627	phenytoin, 544
390, 391 , 392 Nonbacterial endocarditis, 311	MAO inhibitor effects, 575 opioid effect on, 551	stroke and, 514 Nystatin, 199
Nonbacterial thrombotic	pheochromocytoma secretion, 350	Tystatiii, 199
endocarditis, 228	release regulation, 239	0
Nonbenzodiazepine hypnotics, 546	REM sleep and, 497	Obesity
Noncaseating granulomas sarcoidosis, 676	vitamin B ₆ and, 67 Norethindrone, 657	amphetamine for, 242
Noncommunicating hydrocephalus,	Norfloxacin, 195	anovulation with, 645 cholelithiasis and, 396
522	Normal distribution, 262	DM type 2 and, 347
Noncompetitive agonists, 234	Normal flora	esophageal cancer and, 378
Noncompetitive antagonist, 234	colonic, 137 female genital tract, 136	hypertension risk factors, 300
Noncompetitive inhibitors, 230 Noncompliant patients, 268	GI tract, 127	hypoventilation syndrome, 679 lateral femoral cutaneous nerve,
Nondepolarizing neuromuscular	neonates, 178	452
blocking drugs, 551	oropharynx, 136	osteoarthritis/rheumatoid arthritis,
Nondominant parietal cortex lesions,	skin, 135	466
511 Non-frameshift mutations	Normal pressure hydrocephalus, 522 Normal splitting, 289	renal cell carcinoma association, 605
deletions, 61	Normocytic anemia, 421	sleep apnea, 679
Nonhemolytic, normocytic anemia,	Norovirus, 167	stress incontinence and, 599
421	Northern blot, 53	Obligate intracellular organisms,
Non-Hodgkin lymphoma, 430 corticosteroids, 120	Nortriptyline, 575 Nosocomial infections, 274	127 Observational studies, 256
Hashimoto thyroiditis and, 341	Acinetobacter baumannii, 142	errors in, 260–261
hepatitis C, 173	Ebola, 171	Observer-expectancy bias, 260
HIV-positive adults, 177	enterococci, 137	Obsessive-compulsive disorder
Hodgkin lymphoma vs, 429 oncogenes and, 224	Klebsiella, 145	(OCD)
rituximab for, 443	MRSA, 135 pneumonias, 179	diagnostic criteria/treatment, 563 drug therapy for, 572
vinca alkaloids for, 441	Pseudomonas aeruginosa, 143	SSRIs for, 575
Nonhomologous end joining, 40	risk factors, 185	Tourette syndrome and, 557
Nonmaleficence (ethics), 265	UTIs as, 181	venlafaxine for, 575
Nonmegaloblastic macrocytic anemia, 420	Notochord, 490 , 612–613 postnatal derivative of, 282	Obsessive-compulsive personality disorder, 566
Nonnormal distributions, 262	Novobiocin	Obstructive jaundice, 398
Nonoverlapping genetic code, 37	gram-positive antibiotic test, 134	Obstructive lung diseases, 674-675
Nonreceptor tyrosine kinase, 337	Staphylococcus epidermidis, 135	flow volume loops in, 673
Non-REM sleep stages, 497 Nonselective antagonists, 245	NRTIs, 203 NS3/4A inhibitors, 204	Obstructive shock, 310 Obstructive sleep apnea, 679
Nonsense mutations, 39	NS5A inhibitors, 204	pulsus paradoxus in, 310
Nonsteroidal anti-inflammatory drugs	NS5B inhibitors, 204	Obturator nerve, 452
(NSAIDs), 486	Nuchal translucency, 63	Occipital cortex, 515
acute pericarditis, 313 aplastic anemia, 250	Nucleic acids pathogen-associated molecular	Occipital lobe, 501 Occipital sinus, 503
Beers criteria, 247	pattogen-associated molecular pattern (PAMP), 99	Occult bleeding, 387
calcium pyrophosphate deposition	Nucleosome, 34	FOBT for, 388
disease, 467	Nucleotide excision repair, 40	Octreotide, 371, 400
colorectal cancer	Nucleotides, 35	acromegaly, 339
chemopreventative, 389 esophagitis from, 377	deamination reactions, 35 synthesis, 72	GH excess, 329 hypothalamic/pituitary drugs, 354
gastritis with, 379	Nucleus accumbens, 495	Ocular motility, 540
GFR effects of, 589	Nucleus ambiguus, 506	Oculomotor nerve (CN III), 506
gout, 467 , 487	Nucleus cuneatus, 509	ocular motility, 540
headaches, 518 interstitial nephritis, 249	Nucleus pulposus collagen in, 50	palsy of, 513, 541 pupillary contraction, 539
loop diuretics and, 608	fetal precursor, 282	Odds ratio (OR), 256, 258
misoprostol use with, 399	Nucleus tractus solitarius (NTS),	Ofloxacin, 195
osteoarthritis, 466	496	Okazaki fragments, 38

"OK gesture," 451 Olanzapine, 573 Olfaction hallucinations, 559 limbic system in, 499 Olfactory nerve (CN I), 506 Oligoclonal bands, 523 Oligodendrocytes, **494** Oligodendroglia, 490 in multiple sclerosis, 494 Oligodendrogliomas, 526 Oligohydramnios, 578, 641 Oligomenorrhea, 633 Oligomycin, 78 Oligospermia, 400 Olive-shaped mass, 359 Omalizumab, 122, **687** Ombitasvir, 204 Omental foramen, 361 Omeprazole, 399 Omphalocele, 358 Omphalomesenteric cysts, 384 Omphalomesenteric (vitelline) duct, 618 Onchocerca volvulus, 159 Oncocytoma (renal), 605 Oncogenes, 224 Oncogenic microbes, 226 Ondansetron, 400 torsades de pointes, 248 1,25-(OH)₂D₃ kidney endocrine function, 589 "100-day cough," 132 Onion skin periosteal reaction, 465 Onychomycosis terbinafine, 199 tinea unguium, 152 Oocysts acid-fast stain, 155 Toxoplasmosis, 156 Ziehl-Neelsen stain, 125 Oogenesis, 631 Oophorectomy, 625 Open-angle glaucoma, 536 carbachol for, 240 pilocarpine for, 240 Operant conditioning, **554** Ophthalmology, 534–541 Ophthalmoplegia cavernous sinus syndrome, 542 common lesions with, 511 internuclear, 543 Wernicke-Korsakoff syndrome, Opioid analgesics, 551 agonists, 551 Beers criteria, 247 detoxification and relapse prevention, 576 intoxication and withdrawal, 570 mechanism and use, 551 mixed agonist/antagonist analgesics, 552 receptor binding, 234 sleep apnea, 679 toxicity treatment, 248 Opisthotonos tetanospasmin, 138 Opponens digiti minimi muscle, 450 Opponens pollicis muscle, 450 Opportunistic fungal infections, 153-154 Oppositional defiant disorder, 557 Opposition (thumb), **450**, 451 Opsoclonus-myoclonus syndrome, **228**, 350

FAS1_2019_21_Index_749-806.indd 785 11/21/19 12:27 PM

INDEX

Opsonization, 104, 106	
antibodies in, 112	
complement in, 106	
encapsulated organisms, 98	-
Optic disc	
papilledema in, 538	
Optic nerve (CN II), 506 embryologic derivation, 613	
Optic neuritis, 523	
Optic neuropathy, 197	
Optochin	
gram-positive antibiotic test, 134	
Oral advance directives, 266	
Oral contraceptives (OCPs)	
hepatic adenomas and, 392 prolactin effects on, 330	
reproductive hormones, 656	
SHBG effects on, 337	
venous sinus thrombosis with, 503	-
Oral glucose tolerance test, 346	
Oral hairy leukoplakia, 177	
Oral/intestinal ganglioneuromatosis, 351	
Oral rehydration therapy, 146	
Oral thrush, 177	
Orange body fluids, 196	
Orchiectomy, 651	
Orchiopexy, 651	
Orchitis, 170, 654 Orexigenic effect, 336	
Orexin, 568	
hypocretin receptor antagonist,	
Suvorexant as, 547	-
Organ failure, in acute pancreatitis, 397	
Organic acidemias, 85	
Organ of Corti, 533	
Organogenesis	
embryologic derivatives, 612, 613	
errors in, 613	
errors in, 613 fetal development, 612	
errors in, 613 fetal development, 612 teratogens, 614	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates	
errors in, 613 fetal development, 612 teratogens, 614	,
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580	,
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168 influenza viruses, 169 Orthopedic conditions, 460 lower extremity, 460, 461	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168 influenza viruses, 169 Orthopedic conditions, 460 lower extremity, 460, 461 Orthopnea, 309	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168 influenza viruses, 169 Orthopedic conditions, 460 lower extremity, 460, 461 Orthopnea, 309 Orthostatic hypotension	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168 influenza viruses, 169 Orthopedic conditions, 460 lower extremity, 460, 461 Orthopnea, 309 Orthostatic hypotension adrenal insufficiency, 349	
errors in, 613 fetal development, 612 teratogens, 614 Organophosphates toxicity treatment, 248 Organ transplants azathioprine for, 440 cytomegalovirus, 186 hairy leukoplakia and, 479 kidneys, 580 WBC casts, 594 Organum vasculosum of the lamina terminalis (OVLT), 498 Orientation, 557 Origin of replication, 38 Orlistat, 400 diarrhea, 249 Ornithine cystinuria, 85 kidney stones and, 598 urea cycle, 82 Ornithine transcarbamylase, 74 Ornithine transcarbamylase deficiency, 61, 83 Orotic acid, 83 Orotic acid, 83 Orotic aciduria, 420 "Orphan Annie" eyes (nuclei), 343 Orthomyxoviruses, 168 characteristics of, 167, 168 influenza viruses, 169 Orthopedic conditions, 460 lower extremity, 460, 461 Orthopnea, 309 Orthostatic hypotension	

Ortolani maneuver, 461
Oseltamivir, 201
Osgood-Schlatter disease, 461 Osler nodes, 311
Osler-Weber-Rendu syndrome, 316
Osmotic demyelination syndrome, 524
SIADH and, 338
Osmotic diarrhea, 381 Osmotic laxatives, 401
Ossicles, 533
conductive hearing loss and, 51 Ossification, 458
Osteitis deformans, 463
Osteitis fibrosa cystica, 345 , 459, 464 Osteoarthritis, 466
celecoxib for, 486
vs rheumatoid arthritis, 466 Osteoarthropathy, hypertrophic
cancer association, 228
Osteoblastoma, 464 Osteoblasts, 459
bone formation, 458
cortisol effect on, 336
Paget disease of bone, 463 teriparatide effect on, 487
Osteochondroma, 464
Osteoclasts, 459 bisphosphonate effects, 486
bone formation, 458
osteopetrosis, 463 Paget disease of bone, 463
Osteodystrophy
renal, 345, 603 Osteogenesis imperfecta
bisphosphonates, 486
collagen and, 50 collagen synthesis and structure
in, 51
Osteogenic sarcoma, 463, 465 Osteoma, 220, 464–465
nomenclature for, 220
Osteomalacia hypophosphatemia, 591
lab values with rickets, 464
rickets, 463 Osteomyelitis, 180
Pseudomonas aeruginosa, 143
sickle cell anemia, 422 Staphylococcus aureus, 135
Osteonecrosis, 463, 486
Osteopenia, 463 Osteopetrosis, 463 , 464
Osteophytes, 466
Osteoporosis, 462 bisphosphonates, 486
corticosteroids, 120
denosumab, 122 drug reaction and, 250
estrogen, 459
Gaucher disease, 88 heparin, 436
homocystinuria, 84
hormone replacement therapy, 657 lab values in, 464
pituitary prolactinomas, 328
raloxifene, 443, 656 teriparatide for, 487
thiazides for, 609
Osteosarcoma, 220, 464–465 Otitis media
brain abscesses with, 180
Haemophilus influenzae, 128, 142
Langerhans cell histiocytosis, 434 Streptococcus pneumoniae, 136
Wegener granulomatosis and, 315

Otology, 533
Ototoxicity
aminoglycosides, 191 , 204, 614 cisplatin/carboplatin, 442
drug reaction and, 251
ethacrynic acid, 608
loop diuretics, 608 Ouabain
sodium-potassium pump and, 49
Outcome (quality measurement), 273
Outer membrane, 124
Outflow tract formation, 281
Outpatient follow-up, 272 "Oval fat bodies," 594
Ovarian artery, 625
Ovarian cancer breastfeeding and, 636
cisplatin/carboplatin for, 442
epidemiology of, 643 hypercalcemia and, 228
irinotecan/topotecan for, 442
Lynch syndrome and, 388
oncogenes and, 224 paclitaxel for, 441
Psammoma bodies in, 227
tumor suppressor genes and, 224 Ovarian cycle, 632
Ovarian cysts, 646
Ovarian ligament, 625
Ovarian neoplasms classification and characteristics,
646
epithelial tumors, 646 germ cell tumors, 647
sex cord stromal tumors, 647
Ovarian teratomas
paraneoplastic syndrome, 228 Ovaries
anatomy of, 625
descent of, 624 epithelial histology, 626
estrogen production, 630
lymphatic drainage, 624 Overflow incontinence, 599
Overuse injury
elbow, 459
knee, 461 radial nerve, 447
wrist, 459
Ovotesticular disorder, 638 Ovulation
anovulation causes, 645
progesterone and, 630 prolactin effect on, 330
regulation of, 631
Ovulatory uterine bleeding, 633
"Owl eyes" inclusions, 165, 429 Oxacillin
characteristics of, 188
Oxaliplatin, 442 Oxazepam, 546
Oxazolidinones
mechanism and use, 193 Oxidative burst, 109
Oxidative phosphorylation, 78
metabolic site, 72
poisons, 78 Oxybutynin, 237, 241
Oxygen
deprivation, 669 in blood, 666
for carbon monoxide poisoning,
248 cluster headaches, 518
exercise and, 670

	hemoglobin, 665
	toxicity, 210
	Oxygen-hemoglobin dissociation
	curve, 666
	Oxytocin
	functions of, 328
	hypothalamus production, 498
	lactation and, 636
)	pituitary gland and, 327
	signaling pathways for, 337
	**B
	P
	P-450, 197
	P2Y12 receptor
	inhibitors and, 437
	thrombogenesis and, 411
	P53 gene mutation
	dominant negative mutation, 56
	Pacemaker action potential, 292
	Pacinian corpuscles, 494
	Paclitaxel, 441
	microtubules and, 48
	targets of, 438
	Paget disease
	in breast, 650
	Paget disease (extramammary), 644
	Paget disease of bone, 463
	bisphosphonates, 486
	lab values in, 464
	osteosarcomas and, 465
	woven bone in, 458
	Pain
	with headaches, 518
	loss in syringomyelia, 492
	post-stroke syndrome, 515
	receptors for, 494
	spinal tracts for, 509
	thalamic nuclei and, 498
	treatment in multiple sclerosis,
	523
	unilateral visual loss and, 523
	Pale (anemic) infarct, 210
	Paliperidone, 573
	Palivizumab, 122
	pneumonia prophylaxis, 169
	Pallor in aplastic anemia, 421
	Palmar interossei, 450
	Palmar reflex, 510
	PALM-COEIN uterine bleeding
	classification, 633
	PALP, 653
	Panacinar emphysema, 392, 674
	p-ANCA
	sclerosing cholangitis and, 395
	ulcerative colitis, 382
	Pancoast tumor, 685
	lung cancer, 684
	superior vena cava syndrome, 685
	thoracic outlet syndrome, 448
	Pancreas
	annular, 360
	biliary structures and, 368
	blood supply and innervation of,
	364
	buds, 360
	divisum, 360
	embryology, 360
	Pancreatic cancer
	5-fluorouracil for, 440
	adenocarcinomas, 398
	biliary cirrhosis and, 395
	carcinogens causing, 225
	hyperbilirubinemia with, 393
	oncogenes and, 224
	paraneoplastic syndromes with, 228
	tumor suppressor genes and, 224

FAS1_2019_21_Index_749-806.indd 786 11/21/19 12:27 PM

Pancreatic ducts, 360, 368	Parame
Pancreatic insufficiency, 381 , 397	
Pancreatic islet cell tumors, 351	extra
Pancreatic lipase, 93	Parame
Pancreatic secretions, 373 Pancreatitis	Parame
acute, 397	1 aranne
acute respiratory distress syndrome	Paramy
and, 678	chara
alcoholism, 571	croup
chronic, 397 corticosteroids and, 249	mum
drug reactions and, 249	Paraneo Paranoi
hyperchylomicronemia, 94	LSD
hyperparathyroidism, 345	Parasite
hypertriglyceridemia, 94	infec
mumps, 170	
necrosis and, 209 NRTIs, 203	Parasitio
valproic acid, 544	Danasita
Pancytopenia, 421	Parasito Parasyn
Chédiak-Higashi syndrome, 117	crani
cytarabine, 440	male
Gaucher disease, 88	recep
leishmaniasis, 158 osteopetrosis and, 463	VIP a
with immunosuppressants, 120	Parathy
Panic disorder	hype: MEN
drug therapy for, 572	Parathy
SSRIs for, 563, 575	Parathy
symptoms and treatment, 563	phary
venlafaxine for, 575 Panitumumab, 442	Parathy
Panniculitis, 482	1
Pantoprazole, 399	bone bone
Pantothenic acid, 67	calcit
Papillary carcinomas, 220	calcii
Papillary cystadenoma lymphomatosum, 376	in hy
Papillary muscle	osteo
blood supply to, 307	Paget signa
rupture, 305, 307	thym
Papillary thyroid carcinomas, 343 carcinogens for, 225	Paraum
Psammoma bodies in, 227	Paraven
Papilledema, 521, 538	Parenta
hypertensive emergency and, 300	Paresth vitan
Papillomas, 220	Parietal
Papillomaviruses characteristics of, 164	Parietal
DNA viruses, 163	Parietal
genome, 163	Parietal
Pappenheimer bodies, 416	Parinau
Papules, 475	Parkins benz
capillary, 478 molluscum contagiosum, 479	dopa
Para-aminohippuric acid (PAH), 582	Lewy
Para-aortic lymph nodes, 624	meto
Paracoccidioidomycosis, 151	
Paracortex (lymph node), 96	nigro restir
Paracrine, 589 Paradoxical splitting, 289	seboi
Paraesophageal hiatal hernia, 370	
Parainfluenza	thera
croup, 170	trihe
paramyxovirus, 167, 169	ubiqı Parkina
Parakeratosis, 475 Paralysis	Parkins Parotid
conversion disorder and, 566	embi
of face, 514	enlar
Guillain-Barré syndrome, 524	stone
poliovirus, 186	tumo
rabies, 171 stroke effects, 514	Parotitis mum
unvaccinated children, 186	Paroxet
Paralytic ileus, 441	Paroxys
•	•

aramedian pontine reticular
formation
extraocular movements, 497 aramedian pontine reticular
formation lesions, 511
aramesonephric (Müllerian) duct, 622
aramyxoviruses, 169 characteristics of, 167, 168
croup, 170
croup, 170 mumps, 170
araneoplastic syndromes, 228 , 605 aranoia
LSD, 571
arasites infections with immunodeficiency,
118
arasitic infections myocarditis with, 313
myocarditis with, 313 arasitology, 155– 161
arasympathetic nervous system
male erection, 627
arasympathetic nervous system cranial nerves, supply of, 236 male erection, 627 receptor targets, 236 VIP and, 371
arathyroid adenomas
hyperparathyroidism caused by, 345
MEN 1/MEN 2A syndromes, 351 arathyroid disease diagnosis, 343
arathyroid glands
pharyngeal pouch derivation, 621 arathyroid hormone (PTH), 332 ,
590
bone disorders, 464 bone formation, 459
calcitonin and, 333
calcium homeostasis and, 333 in hyperparathyroidism, 345
osteomalacia/rickets, 463
Paget disease of bone, 463 signaling pathways of, 337
thymic aplasia, 116
araumbilical vein, 365
araventricular nucleus, 498 arental consent, 265
aresthesias
vitamin B ₁₂ deficiency, 69, 530 arietal cells (stomach), 372
arietal cortex lesions, 511
arietal lobe, 501 arietal peritoneum, 369
arinaud syndrome, 511 , 528
arkinson disease, 520 benztropine for, 241
dopaminergic pathways, 499
Lewy bodies, 520 metoclopramide contraindication,
400
nigrostriatal pathway and, 499 resting tremor in, 519
seborrheic dermatitis association,
476 therapy for, 548
trihexyphenidyl, 241
ubiquitin-proteasome system in, 48 arkinson-like syndrome, 251
arotid gland
embryologic derivation, 613
enlargement of, 468 stones in, 376
tumors in, 376
arotitis mumps, 170
aroxetine, 575
aroxysmal nocturnal dyspnea, 309

Paroxysmal nocturnal
hemoglobinuria, 422
CD55 deficiency, 107
eculizumab for, 122
flow cytometry diagnosis, 54 intravascular hemolysis in, 421
Partial agonists, 234
Partial (focal) seizures, 517
drug therapy for, 544
Partial thromboplastin time (PTT), 426
Parvovirus
characteristics of, 164
DNA viruses, 163
naked viruses, 163 Parvovirus B19
hereditary spherocytosis, 422
hydrops fetalis, 182
rash, 183
Passive aggression, 555
Passive immunity, 110 Pasteurella multocida
osteomyelitis, 180
transmission, 149, 186
Patau syndrome, 63
cataracts, 535 chromosome association, 64
Patches (skin)
pityriasis rosea, 482
psoriatic arthritis, 469
Patellar reflex, 510 Patellofemoral syndrome, 461
Patent ductus arteriosus (PDA)
congenital rubella, 300
fetal alcohol syndrome, 300
heart murmur with, 291 indomethacin for, 486
mechanism and treatment, 299
neonatal respiratory distress
syndrome and, 661
Patent foramen ovale
atrial septal defect vs, 299 septal fusion failure, 280
Patent urachus, 618
Pathogen-associated molecular
patterns (PAMPs), 99
Pathogen recognition features, 99 Pathologic grief, 562
Pathology
cardiovascular, 298–312
endocrine, 338–354
gastrointestinal, 376–397 hematologic/oncologic, 404–424,
414–434
musculoskeletal/skin/connective
tissue, 459–467
neoplasia, 219–226 neurological, 511–518
psychiatric, 556–570
renal, 594–605
reproductive, 638–652
respiratory, 671–681 USMLE Step 1 preparation for,
277
Pautrier microabscess, 430
Pavlovian (classical) conditioning,
554 Payment models for healthcare, 271
P-bodies, 41
PCP (phencyclidine)
intoxication and withdrawal, 571
PCSK9, 93 PCSK9 inhibitors 320
PCSK9 inhibitors, 320 PCV13 (pneumococcal conjugate
vaccine), 127
PDSA cycle, 273

Pearson correlation coefficient(r), 264 Peau d'orange, 650
Pectinate line, 366 Pectineus, 451, 452
Pectoriloquy (whispered), 680 Pediatric patients
arthritis in, 468 brachial plexus injury, 448
common causes of death, 272 common fractures, 462
common orthopedic conditions, 461
cystic fibrosis, 60 dactinomycin for, 439
failure to thrive, 556 growth retardation in, 603
hemolytic disease of newborn, 405 hyperbilirubinemia (newborns), 393
infant deprivation effects, 556 intraventricular hemorrhage, 512 juvenile polyposis syndrome in, 387
leukocoria in, 538 Munchausen syndrome by proxy,
566 neglect in, 556
neuroblastomas in, 350 precocious puberty, 57, 335 primary brain tumors, 528
rashes, 183 renal malignancy in, 606
rhabdomyomas in, 316 scalded skin syndrome, 479
sleep terror disorder in, 568 strawberry hemangiomas in, 478
tetracycline side effects, 192 unvaccinated, 186 Wilms tumors in, 606
Pegloticase, 487 Pegvisomant, 339
Pellagra, 67 Pelvic inflammatory disease (PID),
185 Actinomyces spp, 139
chlamydia, 148, 184 Chlamydia trachomatis, 149
clinical features, 185 copper IUD, 657
ectopic pregnancy, 641 gonorrhea, 184
Neisseria spp, 142 Pelvic splanchnic nerves, 236
Pelvis fracture and nerve injury, 452
nerve injury with surgery, 452 Pemphigus vulgaris, 480
acantholysis and, 475 autoantibody, 115
type II hypersensitivity, 112 Pencil-in-cup deformity (X-ray), 469
Penicillamine for lead poisoning, 248
myopathy, 250 for Wilson disease, 395
Penicillin Actinomyces spp, 139
antipseudomonal, 188 Coombs-positive hemolytic
anemia, 250 penicillinase-resistant, 188
penicillinase-sensitive, 188 prophylaxis, 198
rash, 250 for rheumatic fever, 312 Penicillings recitant penicilling 188
Penicillinase-resistant penicillins, 188

FAS1_2019_21_Index_749-806.indd 787 11/21/19 12:27 PM

788 INDEX

Penicillinase-sensitive penicillins, 188 smudge cells, 432 Phagocytes, 117 vitamin Bo deficiency, 68 Penicillin-binding proteins (PBPs) spherocytes and agglutinated Phagocytosis zero-order elimination of, 232 RBCs, 423 dendritic cells, 408 Pheochromocytomas, 350 in bacteria, 124 Penicillin G, V, 187 Peripheral edema eosinophils, 408 MEN 2A/MEN 2B and, 351 meningococci, 142 calcium channel blockers, 318 group A streptococcal inhibition, phenoxybenzamine for, 244 prophylaxis, 198 heart failure, 309 Philadelphia chromosome M protein prevention of, 129 β-hemolytic bacteria inhibition Penile cancer, 226 Peripheral facial palsy, 532 in myeloproliferative disorders, 433 Peripheral nerves, 495 translocations of, 434 Penis Peripheral nervous system (PNS) Phlebitis congenital abnormalities, 624 of, 135 IV amphotericin B, 199 female homolog, 624 origins of, 490 Phalen maneuver, 459 lymphatic drainage, 624 Peripheral neuropathy Pharmaceutical company Phlebotomy sponsorship, 269 Pharmacokinetics, **231** pathology of, 651 alcoholism, 571 for hemochromatosis, 395 drug reactions and, 251 Phobias, 563 Pentamidine, 154 Pharmacology, 230–254 autonomic drugs, 236–245 Pentazocine, 551, **552** Fabry disease, 88 isoniazid, 197 agoraphobia, 563 Pentobarbital, 546 social anxiety disorder, 563 cardiovascular, 316-322 Pentose phosphate pathway Krabbe disease, 88 Phocomelia, 614 functions of, 79 NRTIs, 203 endocrine, 352-354 Phonophobia, migraine headache, oxazolidinones, 193 gastrointestinal, 398-400 Pentostatin, 432 hematologic/oncologic, 435-443 Phosphatases, 73 PEP carboxykinase, 74 sorbitol 81 vincristine, 444 Phosphodiesterase (PDE) inhibitors, Pepsin, 372 musculoskeletal/skin/connective tissue, 485–487 neurology, 544–551 Pepsinogen vitamin B₆ deficiency, 67 246, 658, 686 location of, 373 Peripheral precocious puberty, 637 Phosphoenolpyruvate carboxykinase, somatostatin and, 371 Peripheral resistance, 243 pharmacodynamics, 232-234 Phosphofructokinase-1 (PFK-1) glycolysis and, 73 Peripheral vascular disease, 302 pharmacokinetics, 230–231 Peptic ulcer disease, 380 psychiatric, 572–576 Peripheral vertigo, 534 glycopyrrolate for, 241 renal, 607-610 metabolic pathways, 74 Periplasm H pylori and, 146 H₂ blockers for, 399 in bacteria, 124 reproductive, 655-658 Phospholipid bilayer sac misoprostol for, 399 Peristalsis respiratory, 686-687 in bacteria, 124 proton pump inhibitors for, 399 Zollinger-Ellison syndrome, 352 toxicities and side effects, 248–251 USMLE Step 1 preparation for, Phospholipids, 374 motilin receptor agonists and, 371 visible, 359 Phosphorus in Paget disease of bone, Peptidoglycan Peritoneum, 360 463 in gram negative bacteria, 124 hernias and, 370 Pharyngeal apparatus, 619 Phosphorylases, 73 Peptostreptococcus spp irritation with Mittelschmerz, 631 Pharyngeal arch derivatives, 620 Phosphorylation, 45 alcoholism, 179 Percussion (chest), 680 Photophobia Peritonitis 1st pharyngeal arch, 620 appendicitis, 383 2nd pharyngeal arch, 620 leptospirosis, 147 diverticulitis, 383 migraine headache, 518 4th-6th pharyngeal arches, 620 Perforation (GI), 380 spontaneous bacterial, 389, 390 necrotizing enterocolitis, 386 Pharyngeal cleft derivatives, 619 rabies, 171 Periventricular plaques, multiple Pharyngeal pouch derivatives, 621 Photosensitivity drugs causing, 192, 194, 250 cytotoxic T cells and, 102 sclerosis, 523 1st pharyngeal pouch, 621 2nd pharyngeal pouch, 621 extrinsic pathway and, 208 Permethrin, 200 Phototherapy for jaundice, 393 natural killer cells and, 101 4th pharyngeal pouch, 621 for scabies, 161 Phrenic nerve, 663 Phyllodes tumor, 649 Performance anxiety, 567 Permissive action Pharyngitis Perfusion, and ventilation, 669 catecholamine responsiveness, 235 adenovirus, 164 Physical abuse (child), 556 Perfusion-limited gas exchange, 668 Pernicious anemia, 372 diphtheria, 139 Physician-assisted suicide, 268 Perfusion pressure regulation, 297 autoantibody, 115 mononucleosis, 165 Physician-patient relationship, 268 Periarteriolar lymphatic sheath (PALS), 98 prophylaxis (rheumatic fever), 198 Physiologic dead space, 664 B₁₂ deficiency, 69, **420** Physiologic neonatal jaundice, 393 Peroneus brevis, 453 Streptococcus pyogenes, 136 Pericardial effusion, 684 Peroneus longus, 453 unvaccinated children, 186 Physiology Pericarditis Peroxisome Pharyngoesophageal false cardiovascular, 284-298 acute, 313 metabolic processes, 47 diverticulum, 384 endocrine, 328-336 gastrointestinal, 371-375 fibrinous, 305 Persistent cervical sinus, 619 Pharynx, 662 jugular venous pulse in, 287 Persistent depressive disorder blood supply and innervation of, hematologic/oncologic, 410 neurological, 493-515 Kussmaul sign in, 316 (dysthymia), 561 picornaviruses, 167 Persistent thyroglossal duct, 326 Phenacetin, 606 renal, 581-592 postinfarction, 305, 307 Persistent truncus arteriosus, 281, 298 Phenelzine, 575 reproductive, 629-636 respiratory, 664–669 USMLE Step 1 preparation for, pulsus paradoxus in, 310 Personality, 565 Phenobarbital, 546 renal failure, 603 Personality disorders, 565 epilepsy, 544 as weak acid, 233 rheumatoid arthritis, 466 Cluster A, 565 276 Pericardium Cluster B, 565 Phenotypic mixing, 162 Physostigmine anatomy of, 283 Cluster C, 565, 566 Phenoxybenzamine, 244 anticholinergic toxicity treatment, calcification in, 211 Pertussis, 126 for pheochromocytomas, 350 Perineal straddle injury, 627 Pertussis toxin, 132, 143 Phentolamine, 244 anticholinesterase, 240 Perinephric abscesses, 600 glaucoma, 552 Phenylalanine Pes cavus Perineurium, 495 Friedreich ataxia, 531 classification of, 81 Pia mater, 496 Periodic acid-Schiff stain, 125 tyrosine catabolism, 83 Pica, 567 Petechiae glycogen storage diseases, 87 aplastic anemia, 421 Phenylephrine, 242, 686 Pick disease, 520 Periorbital edema Peutz-Jeghers syndrome, 220, 387 Phenylketones, 84 bodies, 520 thyroid disease and, 340 PEX genes, 47 Phenylketonuria Pickwickian syndrome, 679 Peyer patches, 362, **374** Picornaviruses, 163, 168 Trichinella spiralis, 161 tyrosine in, 84 IgA antibody production, 105 Phenytoin Peripartum mood disturbances, 562 characteristics, 167 Peripheral blood smear, 416 Salmonella/Shigella invasion, 144 cytochrome P-450 and, 252 genomes, 163 basophilic stippling, 419 Peyronie disease, 651 epilepsy, 544 Pierre Robin sequence, 620 folate deficiency caused by, 420 gingival hyperplasia, 250 postsplenectomy, 98, 423 PĞI₂, 485 Pigmented skin disorders, 476 Rouleaux formation, 431 P-glycoprotein, 227 Pigment-producing bacteria, 128 megaloblastic anemia, 250 schistocytes, 423 Pigment stones, 396 Schüffner stippling, 157 bacterial transduction, 130 peripheral neuropathy, 251 Pill-rolling tremor, 519

FAS1_2019_21_Index_749-806.indd 788 11/21/19 12:27 PM

Pilocarpine, 240 , 552
D:1 .: 520
Pilocytic astrocytoma, 528
Pilus, 124
Pimozide, 572
Pindolol, 245, 319
Pineal gland, 504
Pinealoma, 528
Pinworms, 159
Pioglitazone, 353
Piperacillin
* -
characteristics of, 188
Pseudomonas aeruginosa, 143
Piroxicam, 486
Pisiform bone, 449
Pitting edema, 309
Pituitary adenoma, 339, 527
Pituitary apoplexy, 339
Pituitary drugs, 354
Pituitary gland, 327
Pituitary prolactinomas, 328
Pituitary tumors
diabetes insipidus, 338
MEN 1 and, 351
Pityriasis rosea, 482
Pityrosporum spp, 152
pKa, 233
PKD genes
renal cyst disorders and, 604
Placebo, 256
Placenta
estrogen production, 630
fetal component, 617
hormone secretion by, 633
maternal component, 617
progesterone production, 630
Placenta accreta/increta/percreta, 640
Placental aromatase deficiency, 639
Placental insufficiency
oligohydramnios and, 641
Potter sequence, 578
preeclampsia, 643
DI
Placenta previa, 640
Plague 149
Plague, 149
Plague, 149 Plantar aponeurosis, 461
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantaris, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma rotein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200 Plasmodium malariae, 157
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200 Plasmodium malariae, 157 Plasmodium malariae, 157
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200 Plasmodium malariae, 157
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200 Plasmodium malariae, 157 Plasmodium ovale, 157 Plasmodium vivax, 157
Plague, 149 Plantar aponeurosis, 461 Plantar fasciitis, 461 Plantar fasciitis, 461 Plantar flexion, 453 Plantaris, 453 Plantar reflex, 510 Plaques (skin), 475 actinic keratosis, 482 basal cell carcinoma, 484 hairy leukoplakia, 479 lichen planus, 482 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 squamous cell carcinoma, 484 Plasma cell dyscrasias, 431 Plasma cells, 409 Plasmalogens, 47 Plasma membrane sodium-potassium pump, 49 structure of, 49 Plasma osmolality DI treatment, 338 Plasmapheresis, 524, 596 Plasma protein concentration, 583 Plasma volume measurement, 581 Plasminogen, 437 Plasmodium spp chloroquine, 200 Plasmodium falciparum, 157, 200 Plasmodium malariae, 157 Plasmodium malariae, 157

Platelet-derived growth factor
(PDGF)
in wound healing, 216
signaling pathways for, 337
Platelet disorders, 426, 427
transfusion for, 429
Platysma muscle, 620
Pleiotropy, 56 Pleomorphic adenomas, 376
Pleural effusion, 681
asbestosis, 677
lung cancer, 684
mesothelioma, 678
physical findings, 680
Pleuritis, 466
Pleuroperitoneal membrane, 370
Plicae circulares, 362 Plummer-Vinson syndrome, 377, 418
Pneumatosis intestinalis, 386
Pneumococcal vaccine, 127
Pneumoconioses, 675, 677
Pneumocystis jirovecii, 154
dapsone, 194
fluorescent antibody stain, 125
HIV-positive adults, 177
immunocompromised patients, 179
prophylaxis, 198 silver stain for, 125
TMP-SMX, 194
Pneumocytes, 661
Pneumomediastinum, 672
Pneumonia, 683
acute respiratory distress syndrome,
678
adenovirus, 164 chlamydiae, 148
coccidioidomycosis, 151
common causes, 179
Haemophilus influenzae, 142
measles-associated death, 170
Pneumocystis jirovecii, 154
PPI adverse effects, 399
Q fever, 150 readmissions with, 272
Staphylococcus aureus, 135
Streptococcus pneumoniae, 136
Streptococcus agalactiae, 137
VZV, 165
Pneumoperitoneum, 380
Pneumothorax, 680, 682
Podocytes glomerular filtration barrier and,
581 , 595
Poikilocytosis, 407
Point of service plan, 271
bol gene, 175
Poliomyelitis, 531
restrictive lung disease, 675
Poliovirus, 531 immunodeficient patients, 118
medical importance, 167
picornavirus, 168
unvaccinated children, 186
Polyadenylation signal, 41
Polyangiitis, microscopic
autoantibody, 115
Polyarteritis nodosa, 173, 314
Polyarthralgias
gonococcal arthritis, 468 rubella, 182
Polycystic disease (kidney), 604
Polycystic disease (kidney), 60 i Polycystic ovarian syndrome (PCOS),
645
anovulation, 645
antiandrogens, 658
clomiphene, 656

Polycythemia, 434 blood oxygen in, 666 Eisenmenger syndrome, 299 ESR in, 214 paraneoplastic syndromes, 228 Polycythemia vera, 433 Budd-Chiari syndrome and, 392 hepatocellular carcinoma, 392 Polydactyly, 63 Polydipsia, 346 Polyhydramnios, 491, 641 esophageal atresia and, 359 Polymerase chain reaction (PCR), 52 Polymorphic ventricular tachycardia, 294 Polymyalgia rheumatica, 470 ÉSŘ in, 214 giant cell arteritis and, 314 Polymyositis autoantibody, 115 Polymyositis/dermatomyositis, 471 Polymyxin B, 143, **193**, 198 Polymyxins, 198 mechanism and use, 193 Polyneuritis, 66 Polyneuropathy, 425 familial amyloid, 212 Polyomaviruses characteristics of, 164 DNA viruses, 163 genome, 163 naked viruses, 163 Polyostotic fibrous dysplasia, 57 Polyposis syndromes, 387 Polyps adenomatous, 387 APC gene, 387 colonic, 387 hyperplastic, 387 inflammatory pseudopolyps, 387 KRAS gene, 387 mucosal, 387 nasal (cystic fibrosis), 60 neoplastic transformation of, 387 non-neoplastic, 387 serrated, 387 submucosal, 387 uterine, 650 Polysaccharide capsule antigens carrier proteins with, 127 Polvuria diabetes insipidus, 338 diabetes mellitus, 346 hyperparathyroidism, 345 lithium, 574 Pompe disease, 87 Pons cranial nerve nuclei of, 505 development of, 490 Pontiac fever, 143 Pontine syndrome, 514 "Pope's blessing" (median nerve injury), 451 Popliteal artery, 455 atherosclerosis in, 302 Popliteal fossa, 455 Popliteus, 453 Porcelain gallbladder, 396, 397 Porphobilinogen deaminase, 425 Porphyria, 425, 546 Porphyria cutanea tarda, 425 Portal hypertension ARPKD, 604 cirrhosis and, 389 pulmonary arterial hypertension,

Schistosoma spp, 161 serum markers for, 390 varices and, 365 Portal triad, 361, 367 Portal vein, 361, 367 in fetal circulation, 282 Portosystemic anastomoses, 365 Positive predictive value (PPV), 257, 259 Positive punishment (aversive stimulus), 554 Positive reinforcement, 554 Positive skew distribution, 262 Posterior cerebral artery, 502, 515 Posterior circulation strokes, 514 Posterior circumflex artery, 455 Posterior communicating artery in saccular aneurysm, 516 Posterior cruciate ligament (PCL) injury, 454 Posterior descending artery (PDA), Posterior drawer sign, 454 Posterior fossa malformations, 492 Posterior hypothalamus, 498 Posterior inferior cerebellar artery stroke effects, 514 Posterior malleolus, 455 Posterior pituitary gland, 327 Posterior tibial artery, 455 Posterior urethral valves, 579 Postherpetic neuralgia, 165 Postinfectious encephalomyelitis, 524 Postoperative ileus, 240 Postpartum hemorrhage, 641 Postpartum mood disturbances, 562 Postpartum psychosis, 562 Postpartum thyroiditis, 341 Postprandial pain, 363 Postrenal azotemia, 601 Poststreptococcal glomerulonephritis (acute), 596 Post-traumatic stress disorder (PTSD) acute stress disorder, 564 diagnostic criteria/treatment, 564 dissociative identity disorder, 558 drug therapy for, 572 prazosin for, 244 SSRIs for, 575 venlafaxine, 575 Postural hypotension midodrine for, 242 trazodone, 576 Postviral infections, 179 Potassium amphotericin B, 199 in cardiac muscle, 292 diabetic ketoacidosis, 347 shifts in, 590 torsades de pointes and, 294 Potassium channel blockers, 323 Potassium channels myocardial action potential, 292 opioid effect, 551 Potassium chloride, 249 Potassium iodide Sporothrix schenckii, 154 for thyroid storm, 342 Potassium-sparing diuretics, 609 Potency of drugs vs efficacy, 233 Potentiation of drugs, 235 Pott disease, 180

FAS1_2019_21_Index_749-806.indd 789 11/21/19 12:27 PM

INDEX

D (1)	.:III : .1 102	D: ::: 201	D 11245 222 242
Potter sequence (syndrome)	stillbirth, 182	Primitive ventricle, 281	Propranolol, 245, 323, 342
ARPKD, 604	Streptococcus agalactiae in, 137	Pringle maneuver, 361	essential tremor, 519
oligohydramnios and, 578 , 641	syphilis in, 147	PR interval, 293, 295	Proprioception
pulmonary hypoplasia, 660	ŤBG in, 331	antiarrhythmic effects, 323, 324	Friedreich ataxia, 531
Poxvirus, 164, 479	termination of, 657	prolonged, 295	Propylthiouracil
PPD test	TORCH infections, 182	shortened, 294	agranulocytosis, 250
for tuberculosis, 140	Turner syndrome and, 638	Prinzmetal angina	aplastic anemia, 250
PPSV23 (pneumococcal	twinning in, 616	calcium channel blockers for, 318	thionamides, 354
polysaccharide vaccine),	urinary tract infections, 181	ischemic manifestations, 304	for thyroid storm, 342
127	venous sinus thrombosis in, 503	propranolol adverse effects, 323	Prostacyclin analogues, 686
PR3-ANCA/c-ANCA autoantibody,	vitamin B ₉ deficiency, 68	Prions, 178	Prostaglandin analogs, 254
115	Pregnancy complications, 640–641	Privacy and confidentiality, 267	Prostaglandins
Practice tests, 21	Prehn sign, 654	Probenecid, 252	aspirin effects, 486
Prader-Willi syndrome	Preload in cardiac output, 284	cidofovir with, 202	cortisol effect on, 336
chromosome association, 64	Premature ejaculation, 575	gout, 487	glaucoma treatment, 552
ghrelin in, 336 , 371	Premature labor and delivery	Procainamide, 322	kidney functions, 589
Pramlintide, 249, 353	cryptorchidism and, 651	Procaine, 550	Prostate cancer
Prasugrel, 411, 437	low birth weight with, 635	Procarbazine, 251, 441	adenocarcinomas, 654
Praziquantel	murmur in prematurity, 291	Procedure bias, 260	incidence/mortality of, 222
antihelminthic therapy, 200	Premature ovarian failure, 636, 645	Process improvement model, 273	leuprolide for, 656
tapeworms, 160	Premotor cortex, 501	quality measurement, 273	metastases of, 223
trematodes, 160	Preoptic nucleus, 498	Processus vaginalis, 624	Prostate gland
Prazosin, 244			
,	Prepatellar bursitis, 460	Procoagulation, 413	lymphatic drainage of, 624
Precision vs accuracy, 259	Preprocollagen, 51	Progesterone	with urethral injury, 627
Precocious puberty	Preproinsulin, 334	lactation and, 636	Prostate-specific antigen (PSA), 227,
adrenal steroids and, 335	Prerenal azotemia, 601	menstrual cycle, 632	654
leuprolide, 656	Presbycusis, 270, 533	ovulation, 632	Prostatic acid phosphatase (PAP), 654
McCune-Albright syndrome, 57	Presbyopia, 535	signaling pathways for, 337	Prostatic adenocarcinoma, 654
pinealoma, 528	Preschool age development, 635	source and function of, 630	Prostatitis, 654
types, 637	Presenilin, 520		gonorrhea, 184
		Progestins, 657	
Precontemplation stage, substance	Pressure-volume loops, 287	Progressive multifocal	Prosthetic devices
addiction, 568	Presynaptic α2-autoreceptor, 239	leukoencephalopathy	Staphylococcus epidermidis, 135
Predictive value, 257	Pretectal nuclei, 539	(PML), 494, 524	Prosthetic heart valves, 423
Prednisolone	Preterm birth	HIV-positive adults, 177	Protamine sulfate, 248, 436
for thyroid storm, 342	common cause of death, 272	polyomaviruses, 164	Protease inhibitors
Preeclampsia, 643	Pretest probability, 257	rituximab, 443	fat redistribution, 250
hydatidiform moles, 642	Prevalence	Proguanil, 200	HIV therapy, 203
	diagnostic test evaluation, 257	Projection, 555	
Preferred provider organization plan,			hyperglycemia, 249
271	incidence vs, 259	Prokaryotes	naming convention for, 253
Prefrontal cortex, 501	observational studies, 256	DNA replication in, 38	Proteases, 373
Pregnancy	Prevotella spp, 179	mRNA start codons, 44	Proteasome, 48
advanced maternal age, 63	Priapism, 651	RNA polymerases in, 42	Protein A, 129
aliskiren contraindication, 610	sickle cell anemia, 422	Prolactin, 330	Proteinases, 406
amniotic fluid abnormalities, 641	trazodone and, 576	circadian rhythm, 497	Protein C/S deficiency, 428
anemia caused by, 418	Primaquine, 157	function of, 328	Protein-energy malnutrition, 71
carpal tunnel syndrome in, 459	hemolysis in G6PD deficiency, 250	lactation and, 636	Protein kinase A
charia carrier area and 642			
choriocarcinomas and, 642	Primary adrenal insufficiency, 349	secretion of, 327	fructose bisphosphatase-2 and, 76
contraindicated antimicrobials, 204	Primary amyloidosis, 212	signaling pathways for, 337	Protein metabolism
ESR in, 214	Primary bacterial peritonitis, 390	tuberoinfundibular pathway, 499	amino acids, 81
estrogen in, 630	Primary biliary cholangitis, 395	Prolactin-inhibiting factor, 328	Proteins
ethical situations, 268–269	Primary central nervous system	Prolactinomas	free radical effect on, 210
fetal circulation, 282	lymphoma, 430	dopamine agonists for, 330	Protein synthesis
fetal respiration, 660	Primary ciliary dyskinesia, 49	Proliferative glomerular disorders,	elongation, 45
folate deficiency caused by, 420	Primary disease prevention, 270	594	inhibitors, 191 , 253
folic acid supplementation, 68	Primary glomerular disease, 594	Prometaphase, 46	initiation of, 44, 45
heparin in, 436	Primary hemostasis, 411	Promoters (gene expression), 41	insulin and, 334
hypertension and treatment in,	Primary hyperaldosteronism, 349	Promyelocytic leukemia, 66	metabolic site, 72
243, 316, 643	hypertension with, 300	Pronephros, 578	posttranslational modification, 45
hypothyroidism in, 341	markers in, 591	Proopiomelanocortin, 327	sequence of, 45
insulin in, 334	Primary hyperparathyroidism, 345,	Propafenone, 322	termination, 45
Listeria monocytogenes in, 139	464	Proper hepatic artery, 361	trimming, 45
lithium in, 298, 300	Primary hypertension, 316	Prophase, 46	Proteinuria
maternal complications, 272	Primary hypogonadism, 639	Prophylaxis	ACE inhibitors for, 610
		antimicrobial, 197, 198	
maternal phenylketonuria, 84	Primary ovarian insufficiency, 645	· · · · · · · · · · · · · · · · · · ·	angiotensin II receptor blockers,
opiate use during, 615	Primary polycythemia, 433	antimycobacterial drugs for, 196	610
parental consent and, 265	Primary sclerosing cholangitis, 395	HIV/AIDS patients, 198	diabetes mellitus, 346
physiologic adaptations in, 633	ulcerative colitis, 382	in HIV/AIDS patients, 198	nephritic syndrome, 595
pituitary infarcts with, 339	Primary spontaneous pneumothorax,	Pneumocystis jirovecii, 154	nephrotic syndrome, 595, 597
posterior urethral valve diagnosis,	682	rabies postexposure, 171	preeclampsia, 643
579	Primase	for RSV, 169	renal papillary necrosis and, 602
progesterone in, 630	replication initiation by, 38	Trichomonas vaginalis, 158	serum sickness, 113
prolactin and, 330			Proteolysis
	Primidone, 519	Propionyl-CoA carboxylase	
pyelonephritis, 600	Primitive atrium, 281	metabolic pathways, 74	cortisol and, 336
pyogenic granulomas and, 478	Primitive pulmonary vein, 281	vitamin B ₇ and, 68	Proteolytic processing, in collagen
sex hormone-binding globulin, 337	Primitive reflexes, 510	Propofol, 550	synthesis, 50

FAS1_2019_21_Index_749-806.indd 790 11/21/19 12:27 PM

Proteus spp	vancomycin for, 190	Pterygoid muscles, 507	Punishment, 554
struvite stones with, 127	watery diarrhea, 179	PTH-related peptide (PTHrP), 332	Pupil
urease-positive, 127	Pseudomembranous pharyngitis	PTHrP (parathyroid hormone-related	Argyll Robertson, 147
xanthogranulomatous	diphtheria, 139	protein), 228	CN III palsy, 541
pyelonephritis, 600 Proteus mirabilis	Pseudomonas spp aeruginosa, 143	Ptosis	control, 507, 539
cephalosporins, 189	biofilm production, 128	CN III damage, 541 Horner syndrome, 540	light reflex, 539 pupillary light reflex, 539
penicillins for, 188	ceftazidime, 189	myasthenia gravis, 472	syphilis, 147, 184
urinary tract infections, 181, 600	culture requirements for, 126	saccular aneurysm, 516	Pure motor stroke, 514
Prothrombin	cystic fibrosis, 60, 179	Puberty	Pure red cell aplasia, 228
complex concentrate transfusion,	encapsulated, 127	GnRH and, 328	thymoma and, 98
429	epididymitis and orchitis, 654	Kallmann syndrome and, 639	Purines, 194
warfarin effect on, 436	exotoxin production, 132	precocious, 57, 335	de novo synthesis, 36, 73
Prothrombin gene mutation, 428 Prothrombin time, 390	fluoroquinolones, 195 immunodeficient patients, 118	Tanner stages, 637 Pubic tubercle, 370	Lesch-Nyhan syndrome, 37
Protofilament, 48	multidrug-resistant, 198	Public health sciences, 256–273	salvage deficiencies, 37
Proton pump inhibitors, 254, 399	nosocomial infection, 179, 185	Pudendal nerve, 366, 453	structure of, 35 Purkinje cells
Beers criteria, 247	osteomyelitis, 180	Pulmonary anthrax, 137	cerebellum, 499
for Helicobacter pylori, 146	penicillins for, 188	Pulmonary arterial hypertension	of cerebellum, 210
gastrin and, 371	pigment production, 128	(PAH), 679	in paraneoplastic cerebellar
Protozoa	pyocyanin of, 109	Pulmonary artery, 619	degeneration, 228
CNS infections, 156	tricuspid valve endocarditis, 311 UTIs, 181	fetal circulation, 282	Purkinje fibers, 293
GI infections, 155 hematologic infections, 157	Pseudo-Pelger-Huet anomaly, 432	Pulmonary artery stenosis, 300 Pulmonary capillary wedge pressure	Purpura
miscellaneous, 158	Pseudopseudohypoparathyroidism,	(PCWP), 297, 668	aplastic anemia, 421
watery diarrhea, 179	344	Pulmonary circulation, 668	Pustular psoriasis, 475 Pustules, 475
Proximal convoluted tubules	Pseudotumor cerebri, 521	Pulmonary edema, 309	acne, 477
(PCT)	drug reactions and, 251	consolidation in, 680	pseudofolliculitis barbae, 477
in ATN, 602	vitamin A toxicity, 66	LV failure, 307	rosacea, 477
defects in, 586	Pseudovirion, 162	mannitol, 607	Putamen, 500
diuretics and, 609	Psittacosis, 149 Psoriasis, 477	nitrates for, 318 opioids for, 551	neurodegenerative disorders, 520
dopamine secretion by, 589 glucose clearance and, 584	arthritis and, 469	preeclampsia and, 643	Pyelonephritis, 600
ischemia susceptibility, 210	cyclosporine, 120	Pulmonary embolism, 672	kidney stones, 598
relative concentrations in, 587	etanercept for, 487	chronic thromboembolism, 679	urinary tract infections, 181, 600
renal cell carcinoma and, 605	hyperkeratosis/parakeratosis, 475	direct factor Xa inhibitors for,	WBC casts in, 594 Pygmalion effect, 260
Proximal interphalangeal (PIP) joints,	infliximab/adalimumab for, 487	437	Pyloric sphincter, 373
451	methotrexate for, 440	heparin for, 436	Pyloric stenosis, 359
Proximal renal tubular acidosis	skin lesions, 475	tamoxifen/raloxifene and, 443	Pyloromyotomy, 359
(type 2), 593 PRPP (glutamine-phosphoribosyl-	therapeutic antibodies, 122 Psoriatic arthritis, 469	thrombolytics for, 437 ventilation/perfusion with, 669	Pyoderma gangrenosum
pyrophosphate)	HLA-B27 and, 100	Pulmonary fibrosis	inflammatory bowel disease, 382
amidotransferase, 73	leflunomide for, 486	amiodarone and, 323	Pyogenic granulomas, 478
Pruritus	psoriasis and, 477	bleomycin, 439	Pyramidal cells, 210
anal, 159	Psychiatric emergencies	busulfan, 441	Pyramidalis muscle, 369 Pyramidal tract demyelination,
atopic dermatitis, 477	acute dystonia, 569	diffusion in, 668	multiple sclerosis, 523
biliary tract disease, 395	delirium tremens, 569	drug reaction and, 251	Pyrantel pamoate, 200
chloroquine, 200 cutaneous mycoses, 152	hypertensive crisis, 569 lithium toxicity, 569	methotrexate, 440 restrictive lung disease, 675	Pyrazinamide, 197
ectoparasites, 161	neuroleptic malignant syndrome,	Pulmonary hypertension, 679	gout, 250
histamine receptors and, 238	569	cor pulmonale, 668	hepatitis, 249
hyperchylomicronemia, 94	serotonin syndrome, 569	drug therapy, 686	Mycobacterium tuberculosis, 196
lichen planus, 482	tricyclic antidepressant overdose,	Schistosoma, 160	Pyridostigmine, 240
pseudofolliculitis barbae, 477	569	Pulmonary hypoplasia, 660	myasthenia gravis treatment, 472 Pyridoxal phosphate, 67
urticaria, 477	Psychiatry, 554–576	Pulmonary infections	Pyridoxine, 67
Prussian blue stain, 677 Psammoma bodies, 211, 227	pathology, 556–570 pharmacology, 572–576	in immunocompromised patients, 139	Pyrimethamine, 200
mesotheliomas, 678	psychology, 554–555	Pulmonary Langerhans cell	effect on purine synthesis, 36
papillary thyroid carcinoma, 343	Psychoactive drug intoxication/	histiocytosis, 675	Pyrimidine dimers, 40
Pseudoappendicitis	withdrawal, 570–571	Pulmonary surfactant	Pyrimidines
Yersinia enterocolitica, 144	Psychological child abuse, 556	club cells, 660, 661	de novo synthesis, 36
Pseudocysts, 397	Psychology, 554–555	NRDS, 661	structure of, 35
Pseudoephedrine, 686	Psychosis, 559	Pulmonary vascular resistance (PVR),	Pyrimidine synthesis, 486 Pyruvate carboxylase, 77, 78
Pseudofolliculitis barbae, 477 Pseudofractures, 463	corticosteroids, 120 diabetic ketoacidosis, 347	668 Pulmonic stenosis	metabolic pathways, 74
Pseudoglandular stage	drug therapy for, 573	wide splitting in, 289	vitamin B ₇ and, 68
(development), 660	LSD and, 571	Pulmonic valves, 281	Pyruvate dehydrogenase
Pseudogout, 467	major depressive disorder with, 561	"Pulseless disease," 314	complex, 76
Pseudoĥermaphrodites, 639	PCP and, 571	Pulse pressure	deficiency, 77
Pseudohypoparathyroidism, 344	postpartum, 562	equation for, 285	metabolic pathways, 74
Pseudomembranous colitis	Psychotherapy, 572	Pulsus paradoxus, 310	vitamin B ₁ and, 66
clindamycin, 192 Clostridium difficile, 138	oppositional defiant disorder, 557 Psychotic disorders	croup, 170 "Punched out" bone lesions (X-ray),	Pyruvate kinase, 74 deficiency, 422
drug reaction and, 249	readmissions with, 272	431	Pyruvate metabolism, 77
penicillins, 188	PTEN gene, 224	Punched-out ulcers, 377	Pyuria, 601
	=		

FAS1_2019_21_Index_749-806.indd 791 11/21/19 12:27 PM

INDEX

Q	Rapidly progressive	Red cell casts, 315	recombinant cytokines, 121
Q fever	glomerulonephritis	Red-green color blindness, 197	therapeutic antibodies, 122
	(RPGN), 596	Red hemorrhagic infarct, 210	Renal clearance, 582
rickettsial disease, 150	Rasagiline, 549	Red hepatization, 683	Renal cortex
transmission, 149			
QRS complex, 293	Rasburicase, 444	Red nucleus (midbrain), 511–552	atrophy of, 599
QT interval	RAS gene, 343	Redox reactions	Renal disorders/failure
atypical antipsychotic effect on, 573	Rashes	free radical injury and, 210	consequences of, 603
Class IA antiarrhythmic effects, 322	"blueberry muffin," 169	vitamin B ₂ and, 67	diabetes mellitus, 346
	carbapenems, 190	Red pulp (spleen), 98	diffuse cortical necrosis, 602
congenital long QT syndrome, 294	childhood, 183	Red rashes of childhood, 183	ESR in, 214
drug-induced long, 294	cytomegalovirus, 182	Reduced filling (cardiac cycle), 287	Fabry disease, 88
ECG, 293	desquamating, 314	Redundant/degenerate genetic code,	features of, 591
ondansetron effect on, 400		redundant/degenerate genetic code,	_ 1
in torsades de pointes, 294	fluoroquinolones, 195	2/ D 10: 1 11 420	gout and, 467
Quadrantanopia, 542	heliotrope, 228	Reed-Sternberg cells, 429	in utero, 578
Quadriceps, 452	macrolides, 193	Refeeding syndrome, anorexia	markers for, 591
Quality measurements, 273	palms and soles, 150	nervosa, 567	myoclonus in, 519
Quality measurements, 273	penicillinase-sensitive penicillins,	Referred pain	NSAIDs, 589
Quantifying risk, 258	188	cholecystitis, 396	preeclampsia and, 643
Quaternary amines, 204	rickettsial infections, 150	from diaphragm, 663	renal cyst disorders, 604
Quaternary disease prevention, 270	rubella, 169, 182	Reflex bradycardia, 588	tetracycline use in, 192
Quetiapine, 573			
Quiescent (stable) cells, 46	syphilis, 147, 184	Reflexes	waxy casts in, 594
Quinidine, 157, 200, 322	unvaccinated children, 186	clinical, 510	Wilson disease, 395
cinchonism, 251	Rathke pouch, 327, 528	cranial nerve, 507	Renal/genitourinary drug reactions,
	tumor, 613	motor neuron sign, 529	251
Quinine, 200	Rationalization, 555	primitive, 510	Renal hypoxia, 666
Quinolone	Raynaud phenomenon, 472	Reflex tachycardia, 244	Renal ischemia, 486
Legionella pneumophila, 143	Buerger disease, 314	Refractive errors (vision), 535	Renal medulla
Quinupristin, 198	calcium channel blockers for, 318	Refractory hypertension, 658	hydronephrosis, 599
R	scleroderma and, 473	Refsum disease, 47	Renal oncocytoma, 605
Rabies, 171	Razor bumps, 477	Refusing care	Renal osteodystrophy, 345, 603
active and passive immunity, 110	RBC casts (urine), 594	minors, 269	Renal papillary necrosis, 602
	RBC inclusions, 416–444	Regadenoson, 304	pyelonephritis and, 600
rhabdovirus, 167	RBC morphology (pathologic), 414	Regan-Lowe medium, 126	sickle cell anemia, 422
viral receptors, 166	Rb gene, 224	Regional specification (brain), 490	Renal plasma flow, 582
Rachischisis, 491	Reabsorption/secretion rate	Registering for exam, 5–6	glomerular dynamics and, 583
Rachitic rosary, 463	calculation, 584	Regression, 555	Renal sympathetic discharge, 588
Radial head subluxation, 461	Reaction formation, 555	Regulation of cell cycle	
Radial nerve, 447			Renal toxicity
neurovascular pairing, 455	Reactive arthritis, 469	Cyclin-dependent kinases (CDKs),	ganciclovir, 202
Radiation exposure	Campylobacter jejuni, 145	46	Renal tubular acidosis (RTA), 593
	chlamydia, 148, 184	p53, 46	Renal tubular defects, 585, 586
acute myelogenous leukemia and,	HLA-B27 and, 100	Tumor suppressors, 46	Renal vascular smooth muscle, 238
432	Reactive attachment disorder, 556	Regulation of gene expression, 41	Renin, 588
aplastic anemia, 421	Readmission recurrences, 272	Regulatory T cells, 102	ACE inhibitor effect on, 610
apoptosis caused by, 208	Reassortment (viral), 162	cell surface proteins, 110	aliskiren effect on, 610
as carcinogen, 225	Recall bias in studies, 260	Regurgitation	in hyperaldosteronism, 349
free radical injury caused by, 210			
hypopituitarism, 339	Receiving operating characteristic	in GERD, 377	renal disorders and, 591
Radiation therapy	curve, 260	Reheated rice syndrome, 138	sympathetic receptors and, 238
	Receptor binding, 234	Reichert cartilage, 620	Renin-angiotensin-aldosterone
acute pericarditis and, 313	Receptor fusion proteins	Reid index, 674	system, 327, 588
angiosarcomas, 478	naming conventions for, 254	Reinforcement, 554	Renovascular disease, 604
lymphopenia, 424	Receptor-mediated endocytosis, 47	Relapse stage, substance addiction, 568	Renovascular hypertension, 349
neutropenia, 424	Receptors (viral), 166	Relapsing fever	Reoviruses
osteosarcoma and, 465	Receptor tyrosine kinase	animal transmission, 149	characteristics, 167
pancreatic cancer, 398	hormone messenger, 337	lice, 161	genome, 163
papillary thyroid carcinoma risk,	as oncogene product, 224	Relationship with patients, 268	naked viruses, 163
343	Recessive inheritance, 59	Relative risk reduction (RRR), 258	segmented, 168
readmissions with, 272			
	Recklinghausen disease, 525	Relative risk (RR), 256, 258 , 263	Repaglinide, 353
Radiculopathy	Recombinant cytokines, 121	Reliability, 259	Reperfusion injury, 210
lumbosacral, 455	Recombination (viral), 162	Remodeling (tissue), 216	Reperfusion therapy, 307
Radon	Recruiting study participants, 260	REM sleep, 497	Replication fork, 38
as carcinogen, 225	Rectal sparing, 382	Renal agenesis	Reportable diseases
Ragged red muscle fibers, 59	Rectosigmoid junction	bilateral, 578	confidentiality exceptions, 267
Rales, 309	blood supply to, 363	unilateral, 579	Repression, 555
Raloxifene, 443, 656	Rectum	Renal artery, 580	Repressor proteins
Raltegravir, 203	blood supply and innervation, 364	stenosis, 610	lactose effects on, 40
Ramelteon, 547			
	familial adenomatous polyposis,	Renal blood flow (RBF), 363, 580	Reproductive/endocrine drug
Ramipril, 610	387	acute injury and, 602	reactions, 249
Ranitidine, 399			Reproductive hormones, 655
	Hirschsprung disease, 384	NSAID effects on, 589	
RANKL (RANK ligand), 332, 459		renal plasma flow and, 582	Reproductive system, 612–653
Ranolazine	Hirschsprung disease, 384		
	Hirschsprung disease, 384 ischemia susceptibility, 210	renal plasma flow and, 582	Reproductive system, 612–653
Ranolazine mechanism and clinical use, 319	Hirschsprung disease, 384 ischemia susceptibility, 210 portosystemic anastomosis, 365 Rectus abdominis muscle, 369	renal plasma flow and, 582 Renal cell carcinoma, 605 bevacizumab for, 442	Reproductive system, 612–653 anatomy, 624–627 embryology, 612–623
Ranolazine mechanism and clinical use, 319 Raphe nucleus, 495	Hirschsprung disease, 384 ischemia susceptibility, 210 portosystemic anastomosis, 365 Rectus abdominis muscle, 369 Recurrent branch (median nerve),	renal plasma flow and, 582 Renal cell carcinoma, 605 bevacizumab for, 442 carcinogens for, 225	Reproductive system, 612–653 anatomy, 624–627 embryology, 612–623 pathology, 638–652
Ranolazine mechanism and clinical use, 319 Raphe nucleus, 495 Rapid automated broth cultures, 126	Hirschsprung disease, 384 ischemia susceptibility, 210 portosystemic anastomosis, 365 Rectus abdominis muscle, 369 Recurrent branch (median nerve), 447	renal plasma flow and, 582 Renal cell carcinoma, 605 bevacizumab for, 442 carcinogens for, 225 chromosome association, 64	Reproductive system, 612–653 anatomy, 624–627 embryology, 612–623 pathology, 638–652 pharmacology, 655–658
Ranolazine mechanism and clinical use, 319 Raphe nucleus, 495 Rapid automated broth cultures, 126 Rapid-eye movement (REM) sleep,	Hirschsprung disease, 384 ischemia susceptibility, 210 portosystemic anastomosis, 365 Rectus abdominis muscle, 369 Recurrent branch (median nerve), 447 Recurrent laryngeal nerve	renal plasma flow and, 582 Renal cell carcinoma, 605 bevacizumab for, 442 carcinogens for, 225 chromosome association, 64 hypercalcemia and, 228	Reproductive system, 612–653 anatomy, 624–627 embryology, 612–623 pathology, 638–652 pharmacology, 655–658 physiology, 629–636
Ranolazine mechanism and clinical use, 319 Raphe nucleus, 495 Rapid automated broth cultures, 126	Hirschsprung disease, 384 ischemia susceptibility, 210 portosystemic anastomosis, 365 Rectus abdominis muscle, 369 Recurrent branch (median nerve), 447	renal plasma flow and, 582 Renal cell carcinoma, 605 bevacizumab for, 442 carcinogens for, 225 chromosome association, 64	Reproductive system, 612–653 anatomy, 624–627 embryology, 612–623 pathology, 638–652 pharmacology, 655–658

FAS1_2019_21_Index_749-806.indd 792 11/21/19 12:27 PM

Rescheduling exam, 6	Retinal vein occlusion, 537	Ribavirin, 204	Rivastigmine, 240, 549
Reserpine	Retinitis	contraindicated in pregnancy, 204	RNA
Parkinson-like syndrome, 251	AIDS, 165	purine synthesis, 36	capping, 41
Residual volume (RV), 664	cidofovir, 202	Riboflavin, 67	interference, 56
Resistance in vessels, 286 Respiration	foscarnet, 202 Retinitis pigmentosa, 538	Ribose, 79 Ribosomes, 46	processing (eukaryotes), 41 RNA polymerases
exercise response, 670	Retinoblastoma	Rice-water diarrhea	types and functions of, 42
high altitude response, 670	chromosome association, 64	organisms causing, 179	RNA viruses, 167
in diabetic acidosis, 347	heterozygosity loss, 56	Vibrio cholerae, 146	genome, 163
Kussmaul, 347	Retinoblastomas	Richter transformation, 432 Rickets, 463	Robertsonian translocation, 64
Respiratory acidosis, 592 Respiratory alkalosis, 592	osteosarcomas, 465 Retinoids, 477	hypophosphatemic, 591, 593	Rocker-bottom feet, 63 "Rocket tails," 139
high altitude, 670	Retinopathy	lab values in, 464	Rocky Mountain spotted fever, 150
Respiratory burst, 109	Alport syndrome, 596	vitamin D and, 70	animal transmission, 149
free radical injury and, 210	chloroquine, 200	Rickettsia	chloramphenicol, 192
Respiratory depression anesthetics, 550	diabetes mellitus, 346 hypertension, 300	Gram stain, 125 Rickettsial diseases, 150	Romaña sign, 158 Romano-Ward syndrome, 294
barbiturates, 546, 570	of prematurity, 210, 661	Rickettsia prowazekii, 150	Romberg sign, 147, 530
benzodiazepines, 544, 570	sorbitol, 81	transmission of, 149, 161	Romiplostim (TPO analog), 121
epilepsy drugs, 544	Retrograde amnesia, 558	Rickettsia rickettsii, 150	Root cause analysis, 274
inhaled anesthetics, 550	Retroperitoneal fibrosis, 599	animal transmission, 149	Rooting reflex, 510
opioids, 551, 570 psychoactive drug intoxication, 570	Retroperitoneal structures, 360 Retrospective studies, 260	chloramphenicol, 192 <i>Rickettsia</i> spp	Ropivacaine, 550 Rosacea, 477
tricyclic antidepressants, 575	Retroviruses	intracellular organism, 127	Rose gardener's disease, 154
Respiratory drug reactions, 251	characteristics, 167	tetracyclines, 192	Rosenthal fibers, 528
Respiratory syncytial virus (RSV)	genomes, 163	Rickettsia typhi, 149, 150	Roseola
paramyxovirus, 167, 169 pneumonia, 179, 683	Rett syndrome, 61, 62	Riedel thyroiditis, 341	HHV-6/HHV-7, 165 rash, 183
prophylaxis, 122	Reverse transcriptase, 175 Telomerase, 38	Rifabutin, 196 Rifampin, 196	Rosiglitazone, 353
Respiratory system, 660–683	Reverse transcriptase polymerase	cytochrome P-450 and, 252	Rotator cuff muscles, 446
anatomy, 662–663	chain reaction, 52	Hansen disease, 141	Rotavirus, 168
change in elderly, 665	Reye syndrome, 390	hepatitis, 249	diarrhea, 167
embryology, 660 pathology, 671–681	Reynolds pentad, 397 Rhabdomyolysis	Mycobacterium leprae, 196 Mycobacterium tuberculosis, 196	Rotenone, 78 Roth spots, 311
pharmacology, 686–687	daptomycin, 195	as prophylaxis, 198	Rotor syndrome, 393, 394
physiology, 664–669	Rhabdomyomas, 316	prophylaxis with Haemophilus	Rough endoplasmic reticulum, 46
Respiratory tract infections	nomenclature for, 220	influenzae for contacts, 142	Rouleaux formation, 431
C3 deficiency, 107	Rhabdomyosarcomas	protease inhibitors and, 203	Round ligament of uterus, 625
Respiratory tree, 662 Respiratory zone, 662	dactinomycin for, 439 nomenclature for, 220	RNA polymerase inhibition, 42 Rifamycins, 196	Rovsing sign, 383 Rubella, 169
Resting tremor, 519	variant, 644	Rifaximin, 391	cardiac defect association, 300
Restless legs syndrome, 519	Rhabdoviruses	Rift Valley fever, 167	cataracts, 535
Restricting type of anorexia nervosa,	characteristics, 167	Right anterior cardinal vein, 281	heart murmur with, 291
567 Restrictive cardiomyopathy, 308	negative-stranded, 168 Rhagades, 147	Right bundle branch, 293 Right bundle branch block, 289	rash, 183 TORCH infection, 182
hemochromatosis, 395	Rh blood classification, 405	Right common cardinal vein, 281	unvaccinated children, 186
Restrictive lung diseases, 675	newborn hemolysis, 405	Right coronary artery (RCA)	Rubeola (measles) virus, 170
ankylosing spondylitis, 469	Rheumatic fever, 312	coronary circulation, 283	Ruffini corpuscles, 494
flow volume loops, 673	chorea with, 519 heart murmur with, 291	occlusions of, 305	Ryanodine receptor, 456 RYR1 gene, 550
sarcoidosis, 6/6 Reteplase (rPA), 437	myocarditis with, 313	Right heart failure, 309 Right horn of sinus venosus, 281	KIKI gene, 770
Rete testis, 652	Streptococcus pyogenes, 136	Right lower quadrant (RLQ) pain, 384	S
RET gene, 224	streptolysin O, 133	Right marginal artery, 283	S-100, 227
carcinoma risks with, 343	type II hypersensitivity, 112	Right-to-left shunts, 298 Right upper quadrant (RUQ) pain, 397	Saber shins
Hirschsprung disease, 384 Reticular activating system, 511	Rheumatoid arthritis, 457, 466 autoantibody, 115	Right ventricular hypertrophy (RVH)	congenital syphilis, 147 syphilis, 182
Reticular fibrous framework (spleen),	azathioprine for, 440	high altitude, 670	Sabin poliovirus vaccine, 167
98	carpal tunnel syndrome and,	pulmonary hypertension, 679	Sabouraud agar, 126
Reticulate bodies, 148	459	Riluzole, 549	Saccular aneurysms, 516
Reticulin, 50 Reticulocyte index (RI), 417	celecoxib for, 486 etanercept for, 487	Ringed sideroblasts, 416 ring-enhancing lesions (MRI)	Ehlers-Danlos syndrome, 51 renal cyst disorders and, 604
Reticulocytes, 407	HLA-DR4 and, 100	Toxoplasma gondii, 156	Saccular (development stage), 660
in aplastic anemia, 421	immunosuppressants, 120	Ringworm	Sacrococcygeal teratomas, 652
intravascular hemolysis, 421	infliximab/adalimumab for, 487	griseofulvin, 200	Sacubitril
Retina chronic hyperglycemia, 537	leflunomide for, 486 methotrexate for, 440	tinea corporis, 152 Risedronate, 486	mechanism and clinical use, 319 Saddle embolus, 672
embryologic derivation of, 613	rituximab for, 443	Risk assessment, 258	Saddle nose
Retinal hemorrhage	Rheumatoid factor, 115	Risk quantification, 258	syphilis, 182
hypertensive emergency, 300	Rhinitis	Risperidone, 573	Safety culture, 273
Retinal pathology degeneration, 536	phenylephrine for, 242	Ristocetin, 411	Salicylates toxicity treatment for, 248
degeneration, 550 detachment, 537	Rhinophyma, 477 Rhinosinusitis, 671	risus sardonicus tetanospasmin, 138	as weak acids, 233
hemorrhage, 537	Rhinovirus	Ritonavir	Salivary gland tumors, 376
retinitis, 536	picornavirus, 167, 168	HIV therapy, 203	Salivary stimulation, 240
vein occlusion, 537	receptors for, 166	Rituximab, 122, 443	Salmeterol, 242, 687
visual field defects, 542	Rhizopus spp, 153	Rivaroxaban, 437	Salmonella, 118

FAS1_2019_21_Index_749-806.indd 793 11/21/19 12:27 PM

INDEX

Salmonella spp animal transmission, 149 bloody diarrhea, 179 encapsulated bacteria, 127 food poisoning, 178 intracellular organism, 127 Shigella spp vs, **144** osteomyelitis, 180 penicillins for, 188 reactive arthritis, 469 TMP-SMX for, 194 Salmonella typhi, 144 Salpingitis ectopic pregnancy and, 641 Sampling bias, 260 "sand"(orange) in diaper, 37 Sandflies (disease vectors), 158 Sandfly fever, 167 SA node, 292 Saponification, 209 Saprophyticus urease-positive, 127 Saguinavir, 203 Sarcoidosis erythema nodosum, 482 restrictive lung disease, 676 Sarcoma botryoides, 644 Sarcomas metastases of, 223 methotrexate for, 440 nomenclature of, 220 Sarcoplasmic reticulum, 456 Sargramostim (GM-CSF), 121 SARS (sudden acute respiratory syndrome), 167 Satiety/hunger regulation, 498 Saturday night palsy, 447 "Saw-tooth" crypt pattern, 387 Saxagliptin, 353 SBLA cancer syndrome, 224 Scabies, 161, 200 Scalded skin syndrome Staphylococcus aureus, 135 toxic shock syndrome toxin, 133 Scales (skin), 475 basal cell carcinoma, 484 pityriasis rosea, 482 psoriasis, 477 seborrheic dermatitis, 476 Scaphoid bone, 449 Scar formation, 218 Scarlet fever presentation, 136 rash with, 183 Streptococcus pyogenes, 136 S cells, 371 Schatzki rings, 377 Schaumann bodies, 676 Schilling test, 420 Schistocytes, 414 in extrinsic hemolytic anemias, 423 HELLP syndrome, 643 in intravascular hemolysis, 421 in microangiopathic anemia, 423 Schistosoma haematobium bladder cancer, 226 disease association, 161 squamous cell carcinoma of bladder, 606 Schistosoma spp, 160, 161 Schistosomiasis portal hypertension, 389 pulmonary arterial hypertension, 679 Schizoaffective disorder, 560 Schizoid personality disorder, 565

Schizophrenia, 572 atypical antipsychotics for, 573 diagnostic criteria, 560-576 neurotransmitters for, 495 readmissions with, 272 Schizophrenia spectrum disorders, 560 Schizophreniform disorder, 560 Schizotypal personality, 560, 565 Schüffner stippling in blood smear, 157 Schwann cells, 494 Guillain-Barré syndrome, 524 origin of, 490 Schwannomas, 494, 527 Sciatic nerve, 452 SCID (severe combined immunodeficiency), 37, 117 adenosine deaminase deficiency, lymphopenia caused by, 424 thymic shadow in, 98 Sclerae alkaptonuria, 84 osteogenesis imperfecta, 51 Scleritis, 466 Sclerodactyly, 473 Scleroderma, 473 Scleroderma (diffuse) autoantibody, 115 Sclerodermal esophageal dysmotility, Sclerosing adenosis, 649 Sclerosing cholangitis, 393, 395 ulcerative colitis association, 382 Scombroid poisoning, 247 Scopolamine, 241 Scoring of USMLE Step 1 exam, 7, 8–9 Scorpion sting, 397 Scotoma, 542 Scrotal hematoma, 627 Scrotum, 627 lymphatic drainage of, 624 masses in, 652 Scurvy collagen synthesis and, 50 vitamin C deficiency, 69 Seafood toxins, 247 Seal-like barking cough, 170 Seborrheic dermatitis, 476 Sebum, 477 Secobarbital, 546 Secondary adrenal insufficiency, 349 Secondary amyloidosis, 212 Secondary biliary cholangitis, 395 Secondary disease prevention, 270 Secondary glomerular disease, 594 Secondary hyperaldosteronism, 349 Secondary hyperparathyroidism, 345, Secondary polycythemia, 433 Secondary spontaneous pneumothorax, 682 Second-degree AV block, 295 Second messengers G-protein linked, 238 Second-wind phenomenon, 87 regulatory substances, 371 secretory cell location, 373 somatostatinomas and, 351

Secretion rate calculation, 584

Segmented viruses, 168

Secretory (exported) protein synthesis,

Seizures anti-NMDA receptor encephalitis, 228 barbiturates for, 546 benzodiazepine withdrawal, 546, 570 β-blockers, 245 brain injury with recurring, **517** bupropion, 576 clozapine use and, 573 cytomegalovirus, 182 drug reaction and, 251 with eclampsia, 643 electrolyte disturbances, 591 enflurane, 251 foscarnet, 202 during heat stroke, 517 herpesviruses and, 164, 165, 183 high fever, 165 imipenem/cilastatin, 251 isoniazid, 197 medium-chain acyl-CoA dehydrogenase deficiency, meropenem, 190 nitrosourea toxicity, 441 parasite infestation and, 161 PCP, 571 phenylketonuria, 84 psychoactive drug intoxication/ withdrawal, 570–571 Rett syndrome, 62 Sturge-Weber syndrome, 525 Taenia solium, 160, 161 tramadol and, 552 types of, 517 venous sinus thrombosis, 503 visceral larva migrans, 159 vitamin B₆ deficiency, 67 Zellweger syndrome, 47 Selection bias, 260 Selective estrogen receptor modulators (SERMs), 443, 462, **656** Selective IgA deficiency, 116 Selective media, 126 Selective mutism, 557 Selectivity β-blockers, 245 Selegiline, 548, **549**, 575 Selenium sulfide tinea versicolor, 152 Self-fulfilling prophecies, 260 Self-image of patient, 268 Self-mutilation Lesch-Nyhan syndrome, 37 Semimembranosus, 451, 452 Seminal vesicles, 622 Seminiferous tubules, 626, 628, 629 Seminoma, 653 Semitendinosus, 451, 452 Sensitivity (diagnostic tests), 257 Sensorineural hearing loss, 533 Sensory cortex, 514 topographic representation, 502 Sensory innervation derivation of, 620 lower extremity, 452, 453 tongue, 493 upper extremity nerve injury, 447 Sensory loss conversion disorder and, 566 stroke effects, 514 Sensory modalities/pathways receptors for, **494** spinal tracts in, 509 thalamus in, 498 Separation anxiety disorder, 557

Separation anxiety (infants), 635 Sepsis ARDS, 678 immunodeficient patients, 118 lymphopenia with, 424 neutropenia with, 424 shock with, 310 Streptococcus agalactiae, 137 Septate uterus, 623 Septation of heart chambers, 280 Septic arthritis, 468 gonococci, 142 Staphylococcus aureus, 135 Septicemia Listeria monocytogenes, 139 readmissions with, 272 Waterhouse-Friderichsen syndrome, 349 Septic shock diffuse cortical necrosis (renal), 602 macrophages and, 407 norepinephrine for, 242 Septum primum, 280 Septum secundum, 280 Sequence (morphogenesis error), 613 Serine, 224 Serologic markers hepatitis, 174 Seronegative spondyloarthritis, **469** Serosa, 362 Serotonergic drugs, 574 Serotonin changes with disease, 495 vitamin B₆ and, 67 Serotonin syndrome, 400, 547, 552, atypical antidepressants, 576 dextromethorphan, 686 MAOIs, 575 MDMÁ, 571 oxazolidinones, 193 Serous cystadenocarcinoma, 227, 646 Serous cystadenoma, 646 Serpentine cord, 140 Serrated colon polyps, 387 Serratia marcescens, 128 treatment of, 189 in immunodeficiency, 128 UTIs, 181 Serratia spp immunodeficient patients, 118 Serratus anterior muscle, 448 Sertoli cells secretions of, 622, 628 sexual determination, 622 tumors of, 653 Sertoli-Leydig cell tumor, 647 Sertraline, 575 Serum amyloid A, 213 Serum markers (liver pathology), 390 Serum osmolarity antidiuretic hormone regulation of, 329 Serum protein electrophoresis (SPEP) in plasma cell dyscrasias, 431 Serum tumor markers, 226 Sevelamer, 355 17α-hydroxylase, 335 17-hydroxyprogesterone, 335 Sevoflurane, 550 Sex chromosome disorders, 638 Sex cord stromal tumors, 647 Sex development disorders phenotypic and gonadal disagreement in, 639 physical characteristics, 639

FAS1_2019_21_Index_749-806.indd 794 11/21/19 12:27 PM

INDEX

Con homeono hindina alabulia
Sex hormone–binding globulin
(SHBG), 337
Sex hormone disorder diagnosis, 639 Sex pilus (bacterial genetics), 130
Sex steroid replacement, 339
Sexual abuse, 556, 558
Sexual behavior
hypothalamus regulation of, 498
Sexual differentiation, 622 , 636
Sexual dysfunction
β-blockers and, 245, 323
cimetidine, 399
differential diagnosis of, 567
Lambert-Eaton myasthenic
syndrome, 472
Peyronie disease and, 651
tuberoinfundibular pathway, 499
Sexually transmitted infections (STIs)
clinical features, 184
parental consent with, 265
Sézary syndrome, 430
Shawl and face rash, 471
Sheehan syndrome, 339
Sheep (disease vectors), 160
Shiga-like toxin (SLT), 145
cytokine release and, 132
Shiga toxin, 130, 132, 144
Shigella boydii, 144
Shigella dysenteriae, 144
Shigella flexneri, 144
Shigella sonnei, 144
Shigella spp
bloody diarrhea, 179
penicillinase-sensitive penicillins
for, 188
reactive arthritis, 469
TMP-SMX, 194
vs Salmonella spp, 144
Shingles, 165
Shin splints, 461
Shock, 310
dopamine for, 242
Ebola, 171
endotoxins, 131
in pulmonary anthrax, 137
norepinephrine for, 242
Waterhouse-Friderichsen syndrome
and, 349
short-chain fatty acids
in anaerobic organisms, 127
SIADH, 338
drug raction and, 249
markers in, 591
paraneoplastic syndrome, 228
Sialadenitis, 376
Sialolithiasis, 376
Sialyl Lewis ^x , 215
Sibling studies, 256
Sickle cell disease, 422 , 651
ESR in, 214
osteonecrosis and, 463
postsplenectomy state in, 98
Streptococcus pneumoniae, 136
Sickle cells, 415
Sideroblastic anemia
causes and treatment, 419
lead poisoning, 419
vitamin B ₆ deficiency, 67
Sigmoid colon, 383
Sigmoid sinus, 503
Sigmoid volvulus, 386
Signaling pathways
endocrine hormones, 337
steroid hormones, 337
Signal recognition particle (SRP), 47
Signet ring cells, 379

Sign of Leser-Trélat, 228
Sildenafil, 651
Silencer (gene expression), 41 Silicosis, 677
Silver stain, 125, 143
Simeprevir, 204
Simple partial seizures, 517 Simple pneumothorax, 680
Simple renal cysts, 604
Single nucleotide (point) mutation, 39
Single nucleotide polymorphisms (SNPs), 54
Single nucleotide substitutions, 39
Single-stranded binding proteins, 38 Sinusitis
brain abscesses, 180
C3 deficiency and, 107 Kartagener syndrome, 49
Streptococcus pneumoniae, 136
Wegener granulomatosis, 315 Sinus venosus, 281
Sirolimus
immunosuppressant, 120
Sister Mary Joseph nodules, 379 Sitagliptin, 353
Situs inversus, 49
6-mercaptopurine, 440 azathioprine, 120
for ulcerative colitis, 382
purine synthesis, 36
targets of, 438 Sjögren syndrome, 468
autoantibody, 115
pilocarpine for, 240 rheumatoid arthritis, 466
Skeletal muscles
ACh receptors in, 236
blood flow regulation in, 297 glycogen metabolism in, 86
somatic nerve, supply of, 236
Skewed distributions, 262 Skin
blood flow regulation in, 297
collagen in, 50 normal flora of, 135
pigmentation, 56
wrinkles of aging, 52
Skin anatomy, 473–483 layers of, 473
microscopic terms, 475
morphology, 475 Skin cancer, 484
albinism and, 476
Lynch syndrome and, 388 Skin drug reactions, 250
Skin flora, 178
Skin lesions
autoimmune disorders, 480 bulla, 475
burns, 483
café-au-lait spots, 57 cancer, 222
common disorders, 477
crust, 475 dermatitis herpetiformis, 381
erythema multiforme, 151
Gottron papules, 228
hyperlipidemia signs, 300, 301 hyperpigmentation, 395
inflammatory bowel disease, 382
Kaposi sarcoma, 165 kwashiorkor, 71
macule, 475
papule 475

papule, 475 patch, 475

petechiae, 407	
pigmentation disorders, 475, 476	
plaque, 475	
pustule, 475 scale, 475	
scaling, 152	
scaly, 66	
seborrheic keratoses, 228 splinter hemorrhages, 311	
striae, 348	
T-cell lymphoma, 430	
telangiectasia, 316, 473	
ulcers, 158 vascular tumors, 478	
vasculitides, 314	
verrucous, 151 vesicle, 475	
wheal, 475	
Skip lesions, 382	
Skull thickening, 463	
Slapped cheek rash, 183 Sleep	
ghrelin/leptin production, 336	
Sleep disturbance	
apnea, 679 benzodiazepines and, 570	
β-blockers, 245	
delirium and, 558	
generalized anxiety disorder, 563 in geriatric patients, 270	
hypnagogic hallucinations, 559	
hypnopompic, 559	
paralysis, 568 paroxysmal nocturnal dyspnea,	
309	
pulsus paradoxus in, 310	
sleep terror disorder, 567, 568 varenicline, 576	
Sleep physiology, 497	
stages in, 497	
Sleepwalking sleep stages and, 497	
SLE (systemic lupus erythematosus),	,
470	
antiphospholipid syndrome and, 470	
autoantibodies, 115	
DPGN, 596	
HLA subtypes, 100 kidney disease with, 596	
Raynaud phenomenon, 472	
Sliding hiatal hernia, 370	
Slime (S) layer, 124 Slipped capital femoral epiphysis,	
461	
osteonecrosis, 463	
Slow acetylators, 232 Small bowel disease, 374	
Small cell carcinoma of lung, 684	
carcinogens for, 225	
immunohistochemical stains for, 227	
oat cell carcinoma, 684	
paraneoplastic syndromes, 228	
Lambert-Eaton myasthenic syndrome, 472	
topotecan for, 442	
Small interfering RNA (siRNA) 56	
Small intestine, 371	١
Small lymphocytic lymphoma (SLL) 432	1,
Small molecule inhibitors	
naming conventions for, 254	
Smallpox, 164 Small-vessel vasculitis	

presentation and pathology, 314

Smoking abdominal aortic aneurysms and, atherosclerosis and, 302 Buerger disease and, 314 bupropion for cessation, 576 carcinogenicity of, 225 cataracts, 535 colorectal cancer and, 388 emphysema, 674 esophageal cancer and, 378 head and neck cancer, 671 hormonal contraception, 657 Legionnaires' disease, 143 lung cancer, 684 pancreatic cancer and, 398 renal cell carcinoma, 605 saccular aneurysms, 516 squamous cell carcinoma of bladder, 606 stomach cancer and, 379 teratogenic effects, 614 transitional cell carcinoma, 606 varenicline for cessation, 576 Smooth brain, 491 Smooth endoplasmic reticulum, 46 Smooth muscle BMPR2 gene, 679 contraction of, 457 glomus tumors, 478 respiratory tree, 662 tumor nomenclature in, 220 Smooth muscle (vascular) in arteriolosclerosis, 301 atherosclerosis and, 302 calcium channel blocker action, Smudge cells, 432 SNARE proteins in neurotransmission, 138 SNc (substantia nigra pars compacta), SNRIs (serotonin-norepinephrine reuptake inhibitors) clinical use, 572 major depressive disorder, 561 mechanism and clinical use, 575 Snuffles, 147 "Soap bubble" appearance/lesions giant cell tumor, 464 Cryptococcus neoformans, 153 Social anxiety disorder, 563 drug therapy for, 572 SSRIs for, 575 venlafaxine for, 575 Social engagement infant deprivation effects, 556 Sodium channel blockers, **322** Sodium channels cystic fibrosis, 60 epilepsy drug effects, 544 local anesthetic effects, 550 pacemaker action potential and, 292 permethrin, 200 Sodium-glucose co-transporters (SGLT), 334, 353, 373, 584 Sodium oxybate (GHB) narcolepsy treatment, 568 Sodium-potassium channels, 236 Sodium-potassium pump, 49 Sodium stibogluconate, 158, 200 Sofosbuvir, 204 Solifenacin, 241 Solitary functioning kidney, 579 Solitary nucleus of medulla, 296

FAS1_2019_21_Index_749-806.indd 795 11/21/19 12:27 PM

INDEX

Somatic hypermutation, 101	Spirochetes, 146	SSRIs (selective serotonin reuptake	Statins
Somatic mosaicism	Spironolactone, 609, 658	inhibitors), 575	for acute coronary syndromes, 307
Sturge-Weber syndrome, 525	for heart failure, 309	anxiety disorders, 562	hepatitis, 249
Somatic mosaicism, 57	Splay (glucose clearance), 584	atypical depression, 561	myopathy, 250
Somatic nerves	Spleen	clinical use, 572	Statistical distribution, 262
male sexual response, 627	bacterial clearance by, 127	major depressive disorder, 561	Statistical hypotheses, 262
Somatic symptom disorder, 566	blood supply and innervation of,	mechanism and clinical use, 575	confidence interval, 263
	364		correct result, 263
Somatic symptoms		obsessive-compulsive disorder, 563	
characteristics of, 566	embryology, 360	panic disorder, 563	incorrect results, 263
conversion disorder, 566	in gastrointestinal anatomy, 361	phobias, 563	test for, 264
illness anxiety disorder, 566	ischemia susceptibility, 210	postpartum depression, 562	Status epilepticus, 517
somatic symptom disorder, 566	structure and function, 98	SIADH caused by, 249	treatment, 544
Somatomedin, 329	thrombocytes in, 407	Stable angina, 304	Stavudine, 203
Somatosensory cortex (primary), 501	Splenectomy, 422	Stable (quiescent) cells, 46	Steady state, 231
thalamic relays to, 498	peripheral blood smear after, 423	Stab wounds and winged scapula, 448	Steatohepatitis, 389
Somatostatin	Splenic artery, 364	Staghorn calculi, 598	Steatorrhea
function of, 328	Splenic flexure	Stains (bacterial), 125	chronic pancreatitis, 397
glucagon and, 333	blood supply to, 363	Standard deviation	cystic fibrosis, 60
hypothalamic/pituitary drugs, 354	Splenomegaly	dispersion, 262	malabsorption syndromes and, 381
production of, 329	anemia, 157	variability, 259	octreotide effect, 400
regulatory substances, 371	cirrhosis, 389	Standard error of the mean, 262	Steatosis (hepatic), 390, 391
secretory cell locations, 373	,		
	hairy cell leukemia, 432	Stapedial artery, 619	Steeple sign (x-ray), 170
Somatostatinoma, 351	hereditary spherocytosis, 422	Stapedius muscle, 620	Stellate cells, 367
pancreatic cell tumor, 351	malaria, 157	Stapes (ossicles), 533, 620	Stellate ganglion, 685
Somatotropin, 329	myelofibrosis, 433	Staphylococcal scalded skin	Stem cells
Sorbitol metabolism, 81	rheumatoid arthritis, 466	syndrome, 479	in aplastic anemia, 421
Sotalol, 323	visceral leishmaniasis, 158	Staphylococcal toxic shock syndrome	bone marrow, 108
Southern blot, 53	Splenorenal ligament, 361	(TSS), 135	CD34 protein, 110
Southwestern blot, 53	Splicing of pre-mRNA, 42	Staphylococcus aureus, 135	myelodysplastic syndromes and,
Space of Disse, 367	alternative splicing, 43	bacterial endocarditis, 311	431, 432
Spaghetti and meatballs appearance,	Splinter hemorrhages, 311	β-hemolytic nature of, 135	Steppage gait, 453
152	Splitting, 555	brain abscesses, 180	Sterilization/disinfection methods,
Spasmolytics, 551	Splitting of heart sounds, 288, 289	cephalosporins, 189	204
Spastic paralysis	Spondyloarthritis (seronegative), 469	cystic fibrosis, 60 , 179	Steroid hormone signaling pathways,
tetanospasmin, 138	Spongiosis, 475	dapsone, 195	337
Spastic paresis, 529	Spontaneous abortion	exotoxin production, 133	Steroids
Special senses	antiphospholipid syndrome, 470	food poisoning, 178	acute pancreatitis, 397
ophthalmology, 534–543	Listeria monocytogenes, 139	immunocompromised patients, 179	adrenal insufficiency, 349
otology, 533–534	syphilis, 182	influenza, 169	berylliosis, 677
Specificity equation, 257	vitamin A excess, 614	IV drug use, 179	CRH levels in, 328
Specific learning disorder, 557	Spontaneous bacterial peritonitis,	nosocomial infection, 179, 185	multiple sclerosis, 523
Spermatic cord, 369	389, 390	osteomyelitis and, 180	synthesis of, 46, 72
Spermatocele, 652	Spontaneous pneumothorax, 682	penicillins for, 188	TBG and, 331
Spermatocytes, 628	Sporadic porphyria cutanea tarda,	pigment production, 128	Stevens-Johnson syndrome, 194, 481 ,
Spermatogenesis, 628	173	pneumonia, 683	544
	Spara forming hasteria 120 128	postviral infection, 179	atypical variant of, 150
cryptorchidism and, 651	Spore-forming bacteria, 129 , 138		
process of, 629	Spores, 124	prophylaxis for, 198	drug reaction and, 250
prolactin effect on, 330	Sporothrix schenckii, 154	septic arthritis, 468	sulfa drug allergies, 252
Spermatogonia, 628	Sporotrichosis, 154	skin infections, 479	Stimulants
Spermiogenesis, 629	Sprain (ankle), 455	Staphylococcus epidermidis, 135	for ADHD, 557
Sphenomandibular ligament, 620	Sprue	gram-positive testing, 134	intoxication and withdrawal, 570
Sphenoparietal sinus, 503	fat-soluble vitamin deficiencies	in vivo biofilm production, 128	laxative, 401
Spherocytosis, 415	and, 65	normal flora, 178	St. John's wort, 252
autoimmune hemolytic anemia, 415	vitamin B ₁₂ deficiency, 69	nosocomial infection, 185	St. Louis encephalitis, 167
extrinsic hemolytic anemia, 423	"Spur cells," 414	osteomyelitis, 180	Stomach
hereditary, 421, 422	Sputum	urease-positive, 127	basal electric rhythm, 362
Sphincter of Oddi, 368, 371	currant jelly, 145	vancomycin for, 190	blood supply to, 364
Sphingolipidoses, 88	Klebsiella spp, 186	Staphylococcus gallolyticus, 137	cholecystokinin effect on, 371
Sphingomyelin, 88	Streptococcus pneumoniae, 136	Staphylococcus pyogenes	in gastrointestinal anatomy, 361
Sphingomyelinase, 88	rusty, 136	skin infections, 479	histology of, 362
Spina bifida	Squalene epoxidase, 199	Staphylococcus saprophyticus, 136	regulatory substances, 371
neural tube defect, 491			
	Squamous cell carcinoma, 484	gram-positive testing, 134	sclerosis of, 473
Spinal cord	anus and cervix, 177	urinary tract infections, 600	secretin effect on, 371
embryologic derivation, 613	bladder, 160, 606	UTIs, 181	Stone bone, 463
lesions of, 530	carcinogens in, 225	Staphylococcus spp	Straight sinus, 503
lower extent of, 507	cervix, 645	antibiotic tests for, 134	Stranger anxiety (infants), 635
nerve nuclei of, 505	esophagus, 378	facultative anaerobic metabolism,	Strategies
nerves of, 507	head and neck, 671	127	clinical vignette, 23
tracts of, 508 , 509	hypercalcemia and, 228	Starling curves, 285, 297	test-taking, 22–23
Spinal cord syndromes	lungs, 684	Starling forces, 297	Strawberry cervix, 181 , 184
multiple sclerosis, 523	pectinate line and, 366	"Starry sky" appearance of B cells,	Strawberry hemangiomas, 478
Spinal muscular atrophy, 530	penis, 651	430	Strawberry tongue, 136
splicing of pre-mRNA in, 42	of skin, 482	Start and stop codons, 44	Kawasaki, 314
Spinothalamic tract, 509	Squamous epithelium, 662	Startle myoclonus, 521	scarlet fever, 136
thalamic relay for, 498	SRY gene, 622	Starvation phases, 91	Streak gonads, 622
didianine relay 101, 170	5111 60110, 022	carration phases, /1	one goriado, 022

FAS1_2019_21_Index_749-806.indd 796 11/21/19 12:27 PM

Streptococcus agalactiae (group B	Studies	Suicide	Surgical procedures
strep), 137	error types, 256	deaths from, 272	readmissions with, 272
β-hemolytic nature of, 135	Studying for USMLE Step 1 exam	physician-assisted, 268	Surrogate decision-maker, 266
encapsulated bacteria, 127	timeline for, 16–19	risk factors for, 562	Suvorexant, 547
gram-positive testing, 134	Sturge-Weber syndrome, 525	Sulbactam, 189	Swallowing
in neonates, 182	Stylohyoid ligament, 620	Sulfadiazine, 194	tongue movement in, 493
		,	Swan-Ganz catheter, 297
prophylaxis for, 198	Stylohyoid muscle, 620	Toxoplasma gondii, 156	
Streptococcus bovis, 137	Styloid process, 620	Sulfa drugs, 252	Swarming, 181
Streptococcus mutans	Stylopharyngeus, 620	megaloblastic, 250	Sweat glands, 236
biofilm production, 128	Subacute combined degeneration	rash, 250	embryologic derivation, 613
normal flora, 178	(SCD), 69, 530	Sulfamethoxazole (SMX), 194	pilocarpine effects, 240
Streptococcus pneumoniae, 136	Subacute endocarditis	Sulfapyridine, 400	Swiss cheese model, 273
chloramphenicol, 192	enterococci, 137	Sulfasalazine, 252, 400 , 466	Sydenham chorea, 312, 519
cystic fibrosis, 179	Staphylococcus gallolyticus, 137	Sulfatides, 140	Sylvian fissure, 501
encapsulated bacteria, 127	Subacute granulomatous thyroiditis,	Sulfisoxazole, 194	Sympathetic nervous system
gram-positive testing, 134	341	Sulfonamides	denervation of face, 540
IgA protease and, 129	Subarachnoid hemorrhage, 513, 518	cytochrome P-450 and, 252	male sexual response, 627
influenza, 169	aneurysms, 516	hemolysis in G6PD deficiency, 250	receptor targets, 236
IV drug use and, 179	nimodipine for, 318	hypothyroidism, 249	venous return and, 286
meningitis, 179, 180	Subarachnoid space, 507	mechanism and use, 194	Sympatholytic drugs, 243
penicillin G/V for, 187	Subclavian arteries, 619	Nocardia spp, 139	Sympathomimetics
pneumonia, 179, 683	Subcutaneous fat	photosensitivity, 250	direct, 242
postviral infection, 179	erythema nodosum in, 482	pregnancy contraindication, 204	indirect, 242
transformation in, 130	skin layers, 473	trimethoprim, 194	Syncope
α-hemolysis, 135	Subcutis, 473	vitamin B ₉ deficiency, 68	during exercise, 308
Streptococcus pyogenes (group A	Subdural hematomas, 513	Sulfonylureas, 353	pulsus parvus et tardus, 291
strep), 130, 133, 136	Subendocardium, 210	disulfiram-like reaction, 251	Synctiotrophoblasts, 617, 633
β-hemolysis, 135	Sublimation, 555	insulin and, 334	β-hCG and, 226
lab testing, 134	Sublingual gland	Sulfur granules, 128, 139	hCG secretion by, 633
in renal disease, 596	stones in, 376	Sumatriptan, 547	Syndrome of apparent
M protein and, 129	Submandibular gland	cluster headaches, 518	mineralocorticoid excess,
rash, 183	stones in, 376	coronary vasospasm with, 248	586
treatment of, 187, 192	Submucosa, 362	Sunburn, 482	markers in, 591
Streptococcus pyogenes toxic shock—	Submucosal polyps, 387	Sunburst pattern (X-ray), 465	Syndrome of inappropriate
like syndrome	Subscapularis muscle, 446	Superficial inguinal nodes, 624	antidiuretic hormone
skin infection with, 135	Substance abuse	Superior colliculi, 504	secretion (SIADH), 338
Streptococcus sanguinis, 128	adult T-cell lymphoma and, 430	Superior gluteal nerve, 453	Synergism
Streptococcus spp	Candida albicans, 153	Superior mesenteric artery (SMA),	Aspirin and, 235
antibiotic tests for, 134	delirium with, 558	364	of drugs, 235
facultative anaerobic metabolism,	dissociative identity disorder and, 558	syndrome, 363	Syphilis, 147
127	parental consent, 265	Superior oblique muscle, 540	fluorescent antibody stain for, 125
septic arthritis, 468	torsades de pointes in, 294	Superior olive (nucleus), 498	STI, 184
Streptogramins, 198	tricuspid valve endocarditis and,	Superior ophthalmic vein, 503	syphilitic heart disease, 312
Streptokinase, 437	311	Superior rectal vein, 365	tabes dorsalis, 530
Streptolysin O, 133	Substance P, 551	Superior rectus muscle, 540	testing for, 148
Streptomycin, 191, 197	Substance P antagonist, 401	Superior sagittal sinus, 503	thoracic aortic aneurysms and, 302
Stress incontinence, 599	Substance use disorder, 568	Superior sulcus tumor, 685	TORCH infection, 182
Stress-related disorders, 564	addiction, stages of change in	Superior vena cava	Syringomyelia, 492
		embryologic development of, 281	spinal cord lesions, 530
Striated muscle, 220	overcoming, 568		
Striatum, 500 , 514	Substantia nigra pars compacta	in fetal circulation, 282	Syrinx, 492
String sign (x-ray), 382	(SNc), 500	Superior vena cava syndrome, 98, 685	Systemic amyloidosis, 212
Stroke, 512	Subthalamic nucleus, 500	lung cancer, 684	Systemic juvenile idiopathic arthritis,
ADP receptor inhibitors for, 437	lesions in, 511	Pancoast tumor, 685	468
atrial fibrillation and, 295	Subunit vaccines, 111	Superoxide dismutase, 109	Systemic lupus erythematosus (SLE),
central post-stroke pain syndrome,	Succimer	free radical elimination by, 210	470
515	heavy metal toxicity, 248	Supination	Systemic mycoses, 151
direct factor Xa inhibitors for, 437	lead poisoning, 419	Erb palsy, 448	Systemic primary carnitine
eclampsia, 643	Succinate dehydrogenase, 67, 78	forearm, 447	deficiency, 89
effects of, 514–515	Succinylcholine, 551, 590	Supportive therapy, 572	Systemic sclerosis, 473
homocystinuria, 84	Succinyl-CoA	Suppression, 555	Systemic senile amyloidosis, 212
hypertension, 300	gluconeogenesis, 78	Suprachiasmatic nucleus (SCN),	Systolic ejection, 287
hypertensive emergency and, 300	TCA cycle, 77	497–498	Systolic murmur, 308
sickle cell anemia, 422	Sucking reflex, 510	sleep physiology and, 497	0,00000
syphilis, 147	Sucralfate, 399	Supracondylar fracture, 447	T
thrombolytics for, 437	Sudden death	Supraoptic nucleus, 498	T3 (liothyronine), 354
Stroke volume, 284	cardiac death, 304, 313	Suprascipular nerve, 446	T4 (levothyroxine), 354
equation for, 285	cocaine use, 571	Supraspinatus muscle, 446 , 448	Tabes dorsalis, 147 , 184
Strongyloides spp, 158, 159	cor pulmonale, 679	Supraventricular tachycardia	spinal cord lesions, 530
Structural quality measurement,	with myocarditis, 313	adenosine for diagnosing, 324	Tachyarrhythmia
273	sleep apnea, 679	β-blockers for, 245, 323	isoproterenol for evaluating, 242
Struvite stones	Sudden infant death syndrome	calcium channel blockers for, 324	thyroid storm, 342
with Proteus spp, 127	(SIDS), 635	Suramin, 200	Tachycardia
ST segment, 293	Suicidal patients, 268	Surface F protein, 169	β-blockers, 245
ST-segment elevation MI (STEMI)	confidentiality exceptions and, 267	Surfactant (pulmonary), 661	drug-induced, 318
diagnosis of, 304	elderly, 270	Surgical neck of humerus, 455	MDMA, 571

FAS1_2019_21_Index_749-806.indd 797 11/21/19 12:27 PM

INDEX

Tachycardia (continued)	Tearing stimulation, 240	Terminal deoxynucleotidyl transferase	Theophylline, 687
metronidazole, 195	Teenagers	(TdT), 104	therapeutic index of, 234
with myocarditis, 313	common causes of death, 272	Tertiary adrenal insufficiency, 349	Therapeutic antibodies, 121, 122
PCP, 571	Teeth	Tertiary disease prevention, 270	Therapeutic index (TI), 234
phenoxybenzamine, 244	congenital syphilis, 147	Tertiary hyperparathyroidism, 345	Therapeutic window, 234
reflex, 244	dentinogenesis imperfecta, 51	Tesamorelin, 328	Thermogenin, 78
stimulants and, 570	discoloration, 192, 204, 250, 614	Testes	Theta rhythm (EEG), 497
supraventricular, 245	Gardner syndrome, 387	descent of, 624	Thiamine, 66
thyroid hormones, 354	osteogenesis imperfecta, 51	lymphatic drainage of, 624	Thiazide diuretics, 609
Wolff-Parkinson-White syndrome,	Sjögren syndrome and, 468	progesterone production, 630	in gout, 250
294	Telangiectasias	Testicular atrophy	in heart failure, 309
Tachyphylaxis, 235	basal cell carcinomas, 484	alcoholism, 571	in hypertension, 316
Tacrolimus	hereditary hemorrhagic, 316	muscular dystrophy, 61	Thiazides, 609
hyperglycemia, 249	Telencephalon, 490	Testicular cancer, 439, 442, 653	Thionamides, 354
immunosuppression, 120	Tellurite agar, 126	Testicular torsion, 651	Thiopental, 546, 550
Tactile hallucinations, 559	Telomerase	Testicular tumors	Thioridazine, 573
cocaine, 571	action of, 38	germ cell, 652–653	Third-degree (complete) AV block,
Taenia solium, 160, 161	Telophase, 46	non-germ cell tumors, 653	295
Takayasu arteritis, 314	Temazepam, 546	Testing agencies, 24	3rd pharyngeal pouch, 621
Tamm–Horsfall mucoprotein, 594	Temperature receptors, 494	Testis-determining factor, 622	3rd pharyngeal arch, 620
Tamoxifen, 443 , 656	Temperature regulation, 498	Testosterone, 636, 658	Thirst
hot flashes with, 249	Temperature sensation	androgen insensitivity syndrome,	hypothalamus and, 498
Tamsulosin, 244, 658	cape-like distribution loss, 492, 530	639	30S inhibitors, 191
Tanner stages (sexual development), 637	loss with strokes, 514	Leydig cell secretion, 628	Thoracic aortic aneurysm, 300, 302
Tardive dyskinesia	Temporal arteritis, 314	Sertoli cells, 628 SHBG effect on, 337	Thoracic outlet syndrome, 448, 684
antipsychotic drugs and, 573	Temporalis muscle, 507		Threadworms, 159 Threonine, 81
metoclopramide adverse effect,	Temporal lobe, 501 , 514	signaling pathways for, 337 spermatogenesis, 628	Threonine kinase, 224
400	Temporal lobe encephalitis, 164	Testosterone-secreting tumors, 639	Thrombi
nigrostriatal pathway, 499	Tendinopathy (rotator cuff), 446	Testosterone synthesis, 199	atherosclerosis, 302
Target cells, 415	Tendinous xanthomas, 301	Test-taking strategy, 22–23	mural, 305, 307
postsplenectomy, 98	familial hypercholesterolemia, 94	Tetanospasmin, 132	post-MI, 305
Tarsal tunnel syndrome, 453	Tendonitis	blocks release of GABA, 138	Thrombin, 436
Taste	drug reaction and, 250	Tetanus	Thromboangiitis obliterans, 314
cranial nerve lesions and, 532	fluoroquinolones, 195	exotoxins, 131	Thrombocytes (platelets), 407
loss with stroke, 514	Tendons	Tetanus toxin, 110	disorders, 426–427
thalamic relay for, 498	collagen in, 50	Tetany	function tests of, 426
TATA box, 41	Tenecteplase (TNK-tPA), 437 Teniposide, 442	hypocalcemia, 591	heparin adverse effects, 436
Taxanes, 441	Tennis elbow, 459	hypoparathyroidism, 344	leukemias, 432
Tay-Sachs disease	"Tennis rackets" (Birbeck) granules,	Tetrabenazine	liver markers, 390
lysosomal storage disease, 88	434	Huntington disease, 549	mixed coagulation disorders, 428
Tazobactam, 189	Tenofovir, 203	Tourette syndrome, 572	thrombolytics and, 437
TCA cycle, 77	Tenosynovitis, 468	Tetracaine, 550	transfusion of, 421, 429
hyperammonemia, 82	Tension headaches, 518	Tetracyclines, 192	in wound healing, 216
metabolic site, 72	Tension pneumothorax, 680, 682	esophagitis, 249	Thrombocythemia (essential), 433
pyruvate metabolism, 77	Tensor fascia latae muscle, 453	Fanconi syndrome, 251	Thrombocytopenia, 407
rate-determining enzyme for, 73	Tensor tympani muscle, 620	photosensitivity, 250	Class IA antiarrhythmics, 322 cytarabine, 440
TCA toxicity treatment of, 233	Tensor veli palatini muscle, 620	protein synthesis inhibition, 191 pseudotumor cerebri and, 521	drug reaction and, 250
T cells, 127, 409	Teratogens	teratogenicity, 204, 614	Escherichia coli, 145
activation, 103	ACE inhibitors, 610	tooth discoloration, 250	ganciclovir, 202
adaptive immunity, 99	aminoglycosides, 191	Tetrahydrobiopterin (bh4)	glycoprotein IIb/IIIa inhibitors, 438
anergy, 110	angiotensin II receptor blockers,	in phenylketonuria, 84	heparin adverse effects, 436
cell surface proteins, 110	610	Tetrahydrofolic acid (THF), 68 ,	oxazolidinones, 193
corticosteroid effects, 120	in fetal development, 612	194	protease inhibitors, 203
cytokine production, 101, 108	fetal effects of, 614	Tetralogy of Fallot, 298	recombinant cytokines, 121
cytotoxic, 102	griseofulvin, 200 , 204	22q11 syndromes, 300	sulfa drug allergies, 252
delayed (type IV) hypersensitivity,	leflunomide, 486	fetal alcohol syndrome, 300	TORCH infections, 182
101	lithium as, 574	outflow tract formation, 281	transfusion for, 429
differentiation and maturation,	methimazole as, 354	Tetrodotoxin, 247	Wiskott-Aldrich syndrome, 117
98, 102	propylthiouracil in pregnancy, 354	TGF-β	Thrombocytosis
disorders of, 116, 117	ribavirin, 204	in wound healing, 216	postsplenectomy, 98
functions, 101	vitamin A, 66 warfarin as, 436	neural development, 490	Thromboembolic event
leflunomide effects, 486	Teratoma	regulatory T cells, 102	atrial fibrillation, 295
lymph nodes, 96	immature, 647	Thalamus development of, 490	Thrombogenesis, 411
macrophage interaction, 102 major functions of, 101	mature cystic, 647	limbic system and, 498	Thrombolytic drugs, 413, 437 Thrombophlebitis
neoplasms, 430	testicular, 653	neuropathic pain, 515	pancreatic cancer, 398
polysaccharide antigens and, 127	Terazosin, 244	Thalassemia, 418	Thrombopoietin, 121
regulatory, 102	Terbinafine, 199	target cells in, 415	signaling pathways, 337
sirolimus effect, 120	Terbutaline, 242	Thalidomide	Thrombosis
spleen, 98	Teres minor, 446	teratogenicity, 614	celecoxib, 486
thymus, 98	Teriparatide, 462, 487	Thayer-Martin agar, 126	contraceptive and hormone
untreated HIV, 176	Terminal bronchioles, 660	Theca-lutein cysts, 642, 646	replacement, 250
Tea-colored urine, 425	Terminal complement deficiencies	Thecoma, 647	essential thrombocythemia, 433
"Teardrop" RBCs, 414 , 433	(C5–C9), 107	Thenar muscles, 447, 448, 450	homocystinuria, 84

FAS1_2019_21_Index_749-806.indd 798 11/21/19 12:27 PM

Thrombotic stroke, 512
Thrush, 117
Candida albicans, 153
hairy leukoplakia vs, 479
HIV-positive adults, 177
nystatin, 199
"Thumbprint" sign (imaging) colonic ischemia, 386
"Thumb sign" (X-ray) flu, 142
Thymic aplasia, 116
chromosome association, 64
lymphopenia with, 424
Thymic cortex
T cell selection in, 102
Thymic hyperplasia
myasthenia gravis association, 472
Thymic shadow, 117 Thymidine, 194
Thymidine kinase, 201
Thymidylate, 36
Thymoma
disease associations with, 98
myasthenia gravis and, 228, 472
paraneoplastic syndromes, 228
Thymus
benign neoplasm, 98
fetal development, 326
pharyngeal pouch derivation, 621 T cell differentiation, 102
T cell origination in, 409
Thymus-dependent antigens, 105
Thymus-independent antigens, 105
Thyroglossal duct cyst, 326
Thyroid adenomas, 342
Thyroid cancer, 343
amyloidosis in, 212
carcinogens in, 225
metastases to, 223 Psammoma bodies in, 227
Thyroid cartilage, 620
Thyroid development, 326
pharmacal pauch derivation 621
pharyngeal pouch derivation, 621
Thyroidectomy, 343
Thyroidectomy, 343 Thyroid hormones, 331
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH)
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotopin-releasing hormone (TRH), 328 , 330 Thyroxine, 339
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-regulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotoxicosis, 339 Thyroxine, 339 Thyroxine, 339 Thyroxine-binding globulin (TBG),
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG),
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity)
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328, 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyrotoxicosis, 331 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418 Tibialis anterior, 453
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-regulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TRH), 328, 330 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328, 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418 Tibialis anterior, 453 Tibial nerve, 452–453
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418 Tibialis anterior, 453 Tibial nerve, 452–453 neurovascular pairing, 455
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroiditis, 341 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-regulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TRH), 328, 330 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328, 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418 Tibialis anterior, 453 Tibial nerve, 452–453
Thyroidectomy, 343 Thyroid hormones, 331 signaling pathways for, 337 in toxic multinodular goiter, 342 Thyroiditis, 341 Thyroidization of kidney, 600 Thyroid peroxidase, 331 Thyroid-regulating hormone (TRH) signaling pathways for, 337 Thyroid-stimulating hormone (TSH) Graves disease and, 342 secretion of, 327 signaling pathways of, 337 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid-stimulating immunoglobulin (TSI), 331 Thyroid storm, 342 Thyrotoxicosis, 331 Thyrotropin-releasing hormone (TRH), 328 , 330 Thyroxine, 339 Thyroxine-binding globulin (TBG), 331 TIBC (total iron-binding capacity) anemia of chronic disease, 421 lab values in anemia, 419 microcytic anemia, 418 Tibialis anterior, 453 Tibial nerve, 452–453 neurovascular pairing, 455 Ticagrelor, 437

Ticks (disease vectors), 149–150

Ticlopidine, 411, 437
Tics (Tourette syndrome), 557
Tidal volume (TV), 664 Tigecycline, 192
Tight junctions, 474 , 496
Timolol, 245, 323, 552
Tinea, 152 , 200
Tinea capitis, 152 Tinea corporis, 152
Tinea cruris, 152
Tinea pedis, 152
Tinea unguium, 152
Tinea versicolor, 152
Tinel sign, 459 Tinnitus
streptomycin, 197
Tiotropium, 241, 687
Tirofiban, 411, 438
Tissue factor activation, 133 Tissue plasminogen activator (tPA)
for ischemic stroke, 512
Tizanidine, 243, 551
TMP-SMX, 194
for Pneumocystis jirovecii, 154
prophylaxis, 198 TNF-α, 108, 133, 208
TNF-α inhibitors, 487
TNF (tumor necrosis factor), 227
Tobramycin, 191
Tocolytics, 657 Toddler development, 635
Togaviruses
characteristics of, 167
genomes of, 163
rubella as, 169 Toll-like receptors (TLRs), 99
Tolterodine, 241
Tolvaptan, 354
Tongue
development, 493 as ectopic thyroid tissue, 326
glossoptosis, 620
pharyngeal arch derivation, 620
Tonic-clonic seizures, 517
drug therapy for, 544 Tonic seizures, 517
Tonsils
agammaglobulinemia, 116
immune system organ, 96
pharyngeal pouch derivation, 621 Tooth abnormalities
opalescent teeth, 51
Tophus formation, 467
Topiramate
epilepsy, 544 migraine headaches, 518
pseudotumor cerebri, 521
Topoisomerases, 195
Topotecan, 442
TORCH infections, 169, 182 cataracts, 535
neonatal manifestations, 182
Torsades de pointes, 294
adenosine for, 324
Class IA antiarrhythmics, 322 drug reaction and, 248
hypomagnesemia, 591
ibutilide, 323
sotalol, 323
Torsemide, 608
Torticollis, 519 Torus (buckle) fracture, 462
Total anomalous pulmonary venous
return (TAPVR), 298

Total peripheral resistance (TPR),
286 Tourette syndrome, 557
drug therapy for, 572 obsessive-compulsive disorder and,
563 sympatholytic drugs for, 243
Toxic dose, 234 Toxicities and side effects of drugs,
120, 248–253 Toxic megacolon
Clostridium difficile, 138 Tovio multipodular goiter, 342
Toxic multinodular goiter, 342 Toxic shock-like syndrome, 136
Toxic shock syndrome, 133
exotoxin A, 133 presentation, 135
Staphylococcus aureus, 135
toxin, 133
Toxins
myocarditis with, 313 seafood (ingested), 247
Toxins (bacterial)
anthrax, 137 endotoxins, 132
enterotoxins, 132
erythrogenic, 136
exfoliative, 133 , 135 exotoxins, 132–133
features of, 131
lysogenic phage encoding, 130
toxin-mediated disease, 135 Toxocara canis, 159
Toxocara spp, 158
Toxoid, 111
Toxoplasma gondii, 156 HIV-positive adults, 177
TORCH infection, 182
Toxoplasma spp, 180
Toxoplasmosis primary central nervous system
lymphoma vs, 430
prophylaxis, 194, 198
pyrimethamine, 200 TP53 gene, 224
Trabecula
spleen, 98 Trachea
bifurcation of, 663
fetal development, 326
respiratory tree, 662 Tracheal deviation, 680, 682
Tracheoesophageal fistula (TEF)/
anomalies, 359
Traction apophysitis, 461 Tractus solitarius, 506
Tramadol, 552
seizures, 251
"Tram-track" appearance, 596 Transcortical aphasia, 516
Transcription factor, 224
Transduction (bacterial genetics), 130 Transference, 554
Transferrin, 213
free radical elimination by, 210
indirect measure of, 419 lab values in anemia, 419
Transformation (bacterial genetics),
130
Transformation zone (cervix) dysplasia, 645
histology of, 626
Transfusion reaction, 114
Transient arthritis in Lyme disease, 146
Transient ischemic attack (TIA), 512

Transitional cell carcinomas, 225 Transition metals and free radical injuries, 210 Transjugular intrahepatic portosystemic shunt (TIPS), 365 Transketolase metabolic pathways, 74 vitamin B₁ and, 66 Translocation Down syndrome, 63 fluorescence in situ hybridization, in protein synthesis, 45 Robertsonian, 64 Transmural inflammation fistulas, Transpeptidases, 187 Transplants immunosuppressants in, 120 rejection, 101, **119** t(8;14), 430, 434 t(9;22) (Philadelphia), 434 t(14;18), 430, **434** t(15;17), 434 Transposition (bacterial genetics), Transposition of great vessels, 298 embryologic development, 281 maternal diabetes and, 300 Transposon in bacterial genetics, 131 Transsexualism, 567 Transversalis fascia, 369 Transverse sinus, 503 Transversion mutation, 39 Transversus abdominis, 369, 452 Transvestism, 567 Tr antigens, 228 Tranyleypromine, 575 Trapezium bone, 449 Trapezoid bone, 449 TRAP (tartrate-resistant acid phosphatase), 227, 342 Trastuzumab, 122, 444–443 Trauma pneumothorax, 682 psychiatric disorders due to, 564 Traumatic aortic rupture, 303 Traumatic pneumothorax, 682 Travelers' diarrhea, 145 Trazodone, 576, 651 Treacher Collins syndrome, 620 "tree bark" appearance (aorta), 312 Trematodes, 160 Tremor, 519 immunosuppressants, 120 Trench fever, 161 Trendelenburg sign, 453 Treponema, 146 Gram stain, 125 Treponema pallidum penicillin G/V for, 187 STI, 184 Triamterene, 609 Triazolam, 546 Triceps reflex, 510 Triceps surae, 453 Trichinella spiralis, 159, 161 Trichinosis, 159 $Trichomonas\ {\rm spp}$ vaginitis, 181 Trichomonas vaginalis, 158, 181, 184 Trichomoniasis, 184 Trichophyton spp, 152

return (TAPVR), 298 Total lung capacity (TLC), 664

Total parenteral nutrition (TPN), 396

INDEX

Trichotillomania, 563	Truncal ataxia, 499	Type IV hypersensitivity reactions
Trichuris, 158	Truncus arteriosus	contact dermatitis, 477
Tricuspid atresia, 281, 298 Tricuspid regurgitation, 287	22q11 syndromes, 300 Trypanosoma brucei, 156 , 200	Typhoid fever, 144 Typhus, 150
Ebstein anomaly and, 298	Trypanosoma cruzi, 158	transmission of, 149 , 161
heart murmurs with, 291	achalasia and, 376	Tyramine, 244
Tricuspid valve endocarditis, 311	nifurtimox for, 200	Tyramine-induced hypertensive crisi
Tricyclic antidepressants (TCAs)	Trypsin, 373	procarbazine, 441
antimuscarinic reaction, 251	Trypsinogen, 373	Tyrosinase, 476
mechanism and clinical use, 575 naming convention for, 253	Tryptase, 408 Tryptophan, 81	Tyrosine in phenylketonuria, 84
torsades de pointes, 248	TSC1/TSC2 genes, 224	Tyrosine kinase
toxicity of, 569	Tsetse flies (disease vectors), 156	endocrine hormone messenger, 33
toxicity treatment, 248	TSST-1 superantigen, 135	insulin and, 334
as weak bases, 233	<i>t</i> -tests, 264	as oncogene product, 224
Trientine, 395	T-tubule membrane, 456	Tzanck test, 166
Trifluoperazine, 573	Tuberculosis, 140	U
Trigeminal nerve (CN V), 506 lesion of, 532	Addison disease, 349 corticosteroids and, 336	Ubiquitination, 45
neuralgia, 518	erythema nodosum, 482	Ubiquitin-proteasome system, 48
pharyngeal arch derivation, 620	isoniazid, 197	UDP-glucuronosyltransferase
thalamic relay for, 498	necrosis and, 209	physiologic neonatal jaundice, 393
tongue, 493	silicosis, 677	Ulcerative colitis, 382
Triglycerides	Tuberin protein, 224, 525	autoantibody, 115
hypertriglyceridemia, 94 insulin and, 334	Tuberous sclerosis	spondyloarthritis, 469
Von Gierke disease, 87	Tuberous sclerosis chromosome abnormalities, 525	sulfasalazine for, 400 Ulcers (gastrointestinal)
Trihexyphenidyl, 241	tumor suppressor genes and, 224	bismuth/sucralfate for, 399
acute dystonia treatment, 241	Tubular necrosis, 594, 602	complications of, 380
Trimethoprim, 187, 194	Tubulointerstitial inflammation	Crohn disease, 382
folate deficiency with, 420	WBC casts in, 594	Curling, 379
mechanism and use, 194	Tubulointerstitial nephritis, 601	Cushing, 379
pyrimidine synthesis and, 36 teratogenicity, 614	Tularemia, 149 Tumor grade vs stage, 220	esophageal, 377 Helicobacter pylori, 146
Trimming (protein synthesis), 45	Tumor lysis syndrome, 434–435	palatal/tongue, 151
Trinucleotide repeat expansion	Tumor markers (serum), 226	peptic, 379
diseases, 62	acute lymphoblastic leukemia,	Zollinger-Ellison syndrome, 352
Friedreich ataxia, 62	432	Ulcers (skin)
Huntington disease, 62	colorectal cancer, 388	Raynaud syndrome, 472
myotonic dystrophy, 62	pancreatic adenocarcinomas, 398 Tumors	Ulipristal, 657 Ulnar claw, 447, 451
Triose kinase, 80 Triple-blinded studies, 256	benign vs malignant, 220	Ulnar nerve, 447 , 459
Triptans, 547	grade vs stage, 220	Ulnar nerve injury, 449
angina and, 304	immunohistochemical stains for,	Ultrasonography
for migraine headaches, 518	227	fetal cardiac activity on, 612
Triquetrum bone, 449	nomenclature of, 220	kidney disease/disorder diagnoses,
Trismus (lockjaw)	Tumor suppressor genes, 46, 224	579
tetanospasmin, 138 Trisomies, autosomal, 63	Tunica albuginea, 651 Tunica vaginalis, 624	renal cysts on, 604 Umbilical artery, 282, 618
Trisomy 13 (Patau syndrome), 63 , 64	Turcot syndrome, 387	Umbilical cord, 618
disease associations with, 491	Turner syndrome, 638	Umbilical hernia
hCG in, 633	cardiac defect association, 300	congenital, 358
Trisomy 18 (Edwards syndrome),	coarctation of aorta and, 299	Umbilical vein, 618
63, 64	T wave (ECG), 293	blood in, 282
disease associations with, 535 hCG in, 633	21-hydroxylase, 335 22q11 deletion syndromes, 116, 300	postnatal derivative of, 282 Umbilicus
Trisomy 21 (Down syndrome), 62,	Twin concordance studies, 256	portosystemic anastomosis, 365
63 , 64	Twinning, 616	UMP synthase, 420
disease associations with, 226, 299–	Thromboxane A ₂ (TXA), 411, 486	Unambiguous genetic code, 37
300, 384, 395, 432, 535	aspirin effects, 486	Uncal herniation, 529
tRNA	thrombogenesis, 411	Uncinate process, 360
structure, 44	Tympanic membrane, 533	Unconjugated bilirubin, 375
Trochlea, 540 Trochlear perve (CN IV), 506	Type I bypersensitivity 105, 112 , 408	Unconjugated (indirect)
Trochlear nerve (CN IV), 506 ocular motility, 540	Type I hypersensitivity, 105, 112 , 408 Type II errors in hypothesis testing,	hyperbilirubinemia, 393 Uncoupling agents, 78
palsy of, 541	263	Undifferentiated thyroid carcinomas,
Tropheryma whipplei, 125, 381	Type II hypersensitivity, 112	343
Tropical sprue, 381	organ transplants, 119	Undulant fever, 149
Tropicamide, 241	Type II hypersensitivity reactions	"Unhappy triad" (knee injuries), 460
Troponins, 304, 306, 456	rheumatic fever, 312	Unilateral renal agenesis, 579
Irousseau sign, 344 , 591 Trousseau syndrome	Type III hypersensitivity reactions, 113	Uniparental disomy, 57
Irousseau syndrome		Universal electron acceptors, 75 Universal genetic code, 37
pancreatic cancer 398	Organ transplants 119	
pancreatic cancer, 398 paraneoplastic syndrome, 228	organ transplants, 119 Type IV hypersensitivity	
pancreatic cancer, 398 paraneoplastic syndrome, 228 True-negative rate, 257	Type IV hypersensitivity DRESS syndrome, 250	Unnecessary procedure requests, 268–269

Unvaccinated children, 186 Upper extremity nerves, 447 Upper motor neuron lesion facial nerve, 532 Urachal cysts, 618 Urachus, 282, 618 Urea cycle, 82 metabolic site, 72 ornithine transcarbamylase deficiency and, 83 rate-determining enzyme for, 73 Ureaplasma spp, 125, 127 Urease, 181 Urease-positive organisms, 127 Uremia acute pericarditis, 313 renal failure, 603 Ureter, 625 bifid, 579 constrictions in, 583 course of, 581 embryology, 578 gynecological exam damage to, 581 obstruction of, 579, **599** Ureteric bud, 579 Ureteropelvic junction development of, 578 Urethra BPH, 654 injury to, 627 posterior valves in, 579 Urethritis chlamydia, 148, 184 Chlamydia trachomatis, 149 gonorrhea, 184 reactive arthritis, 469 Urge incontinence, 599 drug therapy for, 241 Uric acid Lesch-Nyhan syndrome, 37 Von Gierke disease, 87 Uric acid (kidney stones), 598 Urinalysis in renal disease, 601 reducing sugar, 80 Urinary incontinence drug therapy for, 241 ephedrine for, 242 hydrocephalus, 522 mechanisms and associations of, urgency incontinence, 237 Urinary retention, 237 atropine, 241 bethanechol for, 240 delirium, 558 neostigmine for, 240 post-void residual, 599 treatment of, 237 Urinary tract infections (UTIs), 181 antimicrobial prophylaxis for, 198 BPH, 654 cystitis, 600 duplex collecting system and, 579 enterococci, 137 epididymitis and orchitis with, 654 as, Klebsiella, 145 pyelonephritis, 600 Staphylococcus saprophyticus, 136 50 sulfa drugs for, 252 sulfonamides for, 194 TMP-SMX for, 194 Urinary tract obstruction, 599 Urine Bence Jones proteinuria, 431 casts in, 594

FAS1_2019_21_Index_749-806.indd 800 11/21/19 12:27 PM

DEX 801

diuretic effects on, 609	Vagal nuclei, 506	Vasculitides, 314–315	Ventricular fibrillation
leaks with urethral injury, 627	Vagina	Vasculitis	ECG tracing, 295
osmolality in acute injury, 601	anatomy of, 626	focal necrotizing, 315	torsades de pointes, 294
pregnancy test, 633	drainage of, 624	immunoglobulin A, 315	Ventricular filling
renal tubular acidosis, 593	epithelial histology of, 626	intraparenchymal hemorrhage,	early diastole, 287
Urine acidification, 233	genital embryology, 622	513	ECG and, 293
Urine alkalization, 233	Vaginal bleeding	large-vessel, 314	Ventricular free wall rupture, 307
Urine pH and drug elimination, 233	cervical cancer, 645	leukoclastic, 173	Ventricular myocytes, 296
Urobilinogen	Vaginal candidiasis	medium-vessel, 314	Ventricular noncompliance, 287
extravascular hemolysis, 421 intravascular hemolysis, 421	nystatin, 199 Vaginal infections, 181	methotrexate for, 440 small-vessel, 314	Ventricular septal defect (VSD), 299
Urogenital fold, 624	Vaginal tumors, 644	Vasculopathy	congenital rubella, 300
Urosepsis, 600	Vaginismus, 567	noninflammatory, 473	cri-du-chat syndrome, 64
Urothelial carcinoma (bladder), 606	Vaginitis	Vas deferens, 626	Down syndrome, 300
Urticaria, 475, 477	Trichomonas spp, 158 , 181	Vasoactive intestinal polypeptide	fetal alcohol syndrome, 300
ethosuximide, 544	trichomoniasis, 184	(VIP), 371	heart murmurs, 291
scombroid poisoning, 247	Vagus nerve (CN X), 506	Vasoconstriction, 589	outflow tract formation, 281
serum sickness, 113	baroreceptors/chemoreceptors	Vasoconstrictors, 550	Ventricular system, 504
sulfa drug allergies, 252	and, 296	Vasodilation	Ventriculomegaly, 520, 522
as type I hypersensitivity, 112	cardiac glycoside effects, 321	sympathetic receptors, 238	Ventromedial nucleus
USMLE Step 1 exam	Curling ulcers and, 379	Vasodilators	(hypothalamus), 498
check-in process, 7	diaphragm innervation, 663	afterload effects, 284	Verapamil, 308, 318 , 319, 321, 518
clinical vignette strategies, 23	gastrointestinal regulation	aortic dissections, 303	Verrucae, 477
content areas covered in, 3	substances and, 371	atrial natriuretic peptide as, 296	Vertebral compression fractures,
goal-setting for, 12	lesions of, 532	coronary steal syndrome, 304	462
leaving exam early, 8	pharyngeal arch derivation, 620	nitrates as, 318	Vertebral landmarks
overview of, 2 passing rates for, 10	structures innervated, 373	Vasogenic edema, 496	diaphragm, 663 Vertigo, 534
practice exams for, 11, 21–22	tongue, 493	Vasopressin, 329 receptors, 238	posterior circulation stroke, 514
registering for, 5–6	Valacyclovir, 201	Vasopressors, 286	streptomycin, 197
rescheduling, 6	Validity, 259	V(D)J recombination, 99	Vesicles (skin), 475
score notifications for, 7	Valine	VDRL false positives, 148	varicella zoster virus, 479
scoring of, 8–9	classification of, 81	Vector-borne illnesses, 150	Vesicourachal diverticulum, 618
testing agencies, 24	maple syrup urine disease, 84	Veganism and B ₁₂ deficiency, 420	Vesicoureteral reflux, 579
testing locations, 6	Valproic acid	Vegetative state	hydronephrosis, 599
test-taking strategies, 22–23	cytochrome P-450, 252	axonal injury and, 515	pyelonephritis, 600
time budgeting during, 7–8	epilepsy, 544	VEGF (vascular endothelial growth	Vesicular monoamine transporter
types of questions on, 8	hepatic necrosis, 249	factor), 216	(VMAT), 549
Ustekinumab, 122	migraine headaches, 518	Velocardiofacial syndrome, 116	Vesicular tinea pedis, 152
Uterine conditions	pancreatitis, 249	Vemurafenib, 444 , 484	Vesicular trafficking proteins, 47
non-neoplastic, 648	Valsartan, 610	Venlafaxine, 575	Vestibular schwannomas, 527
Uterine (Müllerian duct) anomalies, 622–623	Valvular disease	clinical use, 572	Vestibulocochlear nerve (CN VIII), 506
Uterine neoplasms, 648	pressure-volume loops, 288 Valvular dysfunction, 310	panic disorder, 563 phobias, 563	VHL gene, 224
Uterovaginal agenesis, 639	Vancomycin, 190	PTSD, 564	Vibrio cholerae, 146
Uterus	Clostridium difficile, 138	Venodilators, 284	exotoxin production, 132
anomalies of, 623	cutaneous flushing, 248	Venous gonadal drainage, 624	watery diarrhea, 179
collagen in, 50	meningitis, 180	Venous return, 286	Vibrio parahaemolyticus, 178
epithelial histology, 626	MRSA, 198	Venous sinus thrombosis, 503	Vibrio vulnificus, 178
genital embryology, 622	toxicity of, 251	Venous thrombosis	Vigabatrin, 544
zygote implantation, 633	Vanillylmandelic acid (VMA)	heparin for, 436	Vilazodone, 576
Uveitis, 536	in neuroblastomas, 350	paroxysmal nocturnal	Vimentin, 48, 227
inflammatory bowel disease, 382	Vanishing bile duct syndrome,	hemoglobinuria, 422	Vinblastine, 441
in sarcoidosis, 676	119	Ventilation, 664	microtubules and, 48
seronegative spondyloarthritis, 469	Varenicline, 576	high altitude, 670	Vinca alkaloids, 438
U wave in ECG, 293	Variable expressivity, 56	perfusion and, 669 Ventilation/perfusion (V/Q) defects,	Vincristine, 441
V	Variance, 262 Variant angina, 304	664	microtubules and, 48 toxicities of, 444
Vaccines	Variceal bleeding, 245	Ventilation/perfusion (V/Q) ratio	Vinyl chloride
B-cell disorders, 116	Varicella zoster virus (VZV), 165 ,	exercise response, 670	angiosarcomas, 392, 478
Bordetella pertussis, 143	475, 479	mismatch, 669	as carcinogen, 225
capsular polysaccharide and	guanosine analogs, 201	Ventral lateral (VL) nucleus, 498	VIPomas
protein conjugates in, 127	immunodeficient patients, 118	Ventral pancreatic bud, 360	MEN 1 syndrome, 351
diphtheria, 139	meningitis, 180	Ventral posterolateral (VPL) nucleus,	octreotide for, 400
encapsulated bacteria, 127	rash, 183	498	regulatory substances, 371
Haemophilus influenzae, 142 , 180	vaccine, 110	Ventral posteromedial (VPM)	Viral envelopes, 163
Poliovirus, 167	Varices	nucleus, 498	Virchow nodes, 379
PPSV23, 105	Budd-Chiari syndrome, 392	Ventral tegmentum, 495	Viridans streptococci, 136
rabies, 171	Varicocelectomy, 651	Ventricles	α-hemolysis, 135
rotavirus, 168	Varicocele (scrotal), 628, 651	contractility of, 285	bacterial endocarditis, 311
Salmonella typhi, 144	Vasa previa, 641 Vasa vasorum	embryology, 281	biofilm production, 128
splenectomy and, 98 thymus-independent antigens,	syphilis, 147	morphogenesis of, 281 Ventricular action potential, 292	brain abscesses, 180 gram-positive algorithm, 134
105	Vascular dementia, 521	Ventricular action potential, 272 Ventricular aneurysm	normal flora, 178
toxoids as, 131	Vascular function curves, 286	pseudoaneurysm, 307	Virilization, 335
types of, 111	Vascular tumors of skin, 478	true, 305, 307	Virology, 162–177
* *	,		₩ .

FAS1_2019_21_Index_749-806.indd 801 11/21/19 12:27 PM

INDEX

Virulence factors bacterial, 129 Bordetella pertussis, 143 Escherichia coli, 145 Salmonella/Shigella, 144 Staphylococcus aureus, 135 Streptococcus pneumoniae, 136 β-hemolytic bacteria, 135 Viruses diarrhea with, 179 fluorescent antibody stain, 125 genetics, 162 immunocompromised patients, 179 in immunodeficiency, 118 as cause of myocarditis, 313 negative-stranded, 168 pneumonia, 179 receptors for, 166 segmented, 168 skin, 479 structure of, 162 Visceral leishmaniasis, 158 Viscosity (blood), 286 Visual cortex, 501, 515 Visual disturbance drug-related, 251 Visual field defects, 542 saccular aneurysms and, 516 with stroke, 514, 515 Visual hallucinations, 559 Vital capacity (VC), 664 Vitamin A (retinol), 66 free radical elimination by, 210 idiopathic intracranial hypertension, 251, **521** measles morbidity and mortality, 170 teratogenicity, 614 Vitamin B₁ (thiamine), **66** brain lesions and, 511 deficiency of, 66 functions of, 74 pyruvate dehydrogenase complex, solubility of, 65 Vitamin B₂ (riboflavin), **67** pyruvate dehydrogenase complex, solubility, 65 Vitamin B₃ (niacin), **67** pyruvate dehydrogenase complex, solubility, 65 vitamin B₆ and, 67 Vitamin B₅ (pantothenic acid), **67** pyruvate dehydrogenase complex and, 76 solubility of, 65 Vitamin B₆ (pyridoxine), **67** deficiency, 67 isoniazid, 197 sideroblastic anemia, 419 Vitamin B₇ (biotin), **68** activated carriers, 75 functions of, 73 pyruvate metabolism, 77, 78 solubility of, 65 Vitamin Bo (folate), 68 deficiency, 406, 420 functions, 68 solubility, 65 Vitamin B₁₂ (cobalamin), **69** absorption of, 374 deficiency, 160, 161

solubility, 65 spinal cord lesions, 530 Vitamin C (ascorbic acid) free radical elimination by, 210 functions, 69 methemoglobin treatment, 248 solubility of, 65 Vitamin D excess, 70 functions, 70 hyperparathyroidism, 464 hypervitaminosis lab values, osteomalacia/rickets, 463, 464 osteoporosis prophylaxis, 462 signaling pathways for, 337 solubility of, 65 vitamin D (calciferol) calcitriol production, 589 Vitamin E free radical elimination by, 210 function, 70 solubility of, 65 Vitamin K cephalosporins, 189 coagulation cascade, 413 deficiency, 413, 426 solubility of, 65 vitamin E interaction, 71 for warfarin toxicity, 436 Vitamin/mineral absorption, 374 Vitamins fat-soluble, **65** water-soluble, 65 Vitelline duct/fistula, 618 Vitiligo, 476 Vitreous body collagen in, 50 VLDL (very low-density lipoprotein), Volume contraction alkalemia from diuretics, 609 Volume of distribution, 231 Volumetric flow rate (Q), 286 Volvulus, 385, **386** Meckel diverticulum, 384 midgut, 386 Onchocerca, 158 sigmoid, 386 Vomiting annular pancreas, 360 biliary colic, 396 bilious, 359, 384 diabetic ketoacidosis, 347 Ebola virus, 171 fructose intolerance, 80 glycylcyclines, 192 Histoplasma capsulatum, 177 intestinal atresia, 359 Legionella spp, 185 lithium toxicity, 569 Mallory-Weiss syndrome, 377 maple syrup urine disease, 84 metoclopramide for, 400 MI and, 305 ondansetron for, 400 posttussive, 143 pyloric stenosis, 359 receptors for, 496 Salmonella spp, 149 in stroke, 514

toxic shock syndrome, 135

treatment of, 400, 401

trichinosis, 159 vitamin C toxicity, 69 Von Gierke disease, 87 von Hippel-Lindau disease, 525 chromosome association, 64 renal cell carcinoma and, 605 tumor suppressor genes and, 224 von Willebrand disease, 411, 428 Voriconazole, 199 Vortioxetine, 576 VRE (vancomycin-resistant enterococci) daptomycin, 195 enterococci, 137 highly resistant, 198 oxazolidinones, 193 Vulnerable child syndrome, **556** Vulvar carcinoma, 644 Vulvar lymphatic drainage, 624 Vulvar pathology, 644 neoplastic, 644 non-neoplastic, 644 Vulvovaginitis, 153, 181 vWF (von Willebrand factor) receptor for, 407 in thrombocytes, 407 in thrombogenesis, 411 V_{max} , 230 WAGR complex/syndrome, 606

"Waiter's tip" (Erb palsy), 448 Waiving right to confidentiality, 267 Waldenstrom macroglobulinemia, 431 Walking milestone, 635 Wallenberg syndrome, 514 Wallerian degeneration, 495 Wall tension, 284, 285 Warburg effect, 221 Warfarin, 436 adverse effects of, 428 coagulation cascade, 413 griseofulvin and, 200 heparin vs, 436, 437 PT measurement, 426 teratogenicity, 614 therapeutic index of, 234 toxicity treatment, 248, 429 vitamin K antagonist, 71 Warthin-Finkeldey giant cells, 170 Warthin tumors, 376 Waterhouse-Friderichsen syndrome, meningococci, 142 Watershed zones, 210, 502 Water-soluble vitamins, 65 Waxy casts (urine), 594 WBC casts (urine), **594**, 600 Weak acid overdose treatment, 233 Weak bases overdose treatment, 233 "Wear and tear" pigment, 211 Wegener granulomatosis, 315 autoantibody, 115 restrictive lung disease, 675 Weight gain danazol, 658 duodenal ulcer, 380 mirtazapine, 576 Weight loss

adrenal insufficiency, 349

cholelithiasis and, 396

chronic mesenteric ischemia, 386 diabetes mellitus, 346 esophageal cancer, 378 gastric ulcers, 380 glucagonoma, 351 Histoplasma capsulatum, 177 malabsorption syndromes, 381 Mycobacterium avium intracellulare, 177 orlistat for, 400 pancreatic cancer, 398 polyarteritis nodosa, 314 polymyalgia rheumatica, 470 pseudotumor cerebri treatment, renal cell carcinoma, 605 sleep apnea, 679 stomach cancer, 379 for stress incontinence, 599 tuberculosis, 140 Weil disease, 147 Well-patient care, 270-271 Wenckebach AV block, 295 Werdnig-Hoffmann disease, 530 Wernicke aphasia, 514, 516 Wernicke area, 501 stroke effects, 514 Wernicke encephalopathy, 66, 571 Wernicke-Korsakoff syndrome, 511, 571 vitamin B₁ deficiency, 66 Western blot, 53 West Nile virus, 167, 180 Wet beriberi, 66 Wharton duct, 376 Wharton jelly, 618 Wheal urticaria, 477 Wheals, 475 Wheezing lung cancer, 684 Whipple disease, 381 periodic acid-Schiff stain for, 125 Whipple procedure for pancreatic cancer, 398 Whipple triad insulinomas and, 351 Whispered pectoriloquy, 680 White matter axonal injury, 515 demyelinating disorders, 524 glial cells in, 494 multiple sclerosis, 523 White pulp (spleen), 98 Whooping cough Bordetella pertussis, 143 pertussis toxin, 132 Wickham striae, 482 Wide splitting, 289 Williams syndrome, 64 cardiac defect association, 300 Wilms tumor, 606 dactinomycin for, 439 neuroblastomas vs, 350 tumor suppressor genes and, 224 Wilson disease, 395 ATP7B protein in, 51 autosomal recessive inheritance, 60 chromosome association, 64 Fanconi syndrome, 586 free radical injury and, 210 Winged scapula, 448

Winters formula, 592

FAS1 2019 21 Index 749-806.indd 802 11/21/19 12:27 PM

INDEX

"Wire looping" of capillaries, 596 "Wire lupus," 596 Wiskott-Aldrich syndrome, 117 X-linked recessive disorder, 61 Withdrawal (psychoactive drugs), 570 Wobble, 37 Wolff-Chaikoff effect, 341 Wolffian duct, 622 Wolff-Parkinson-White syndrome, 294 Woolsorter's disease, 137 'word salad," 559 Wound healing keratinocytes, 216 phases of, 216 scar/keloid formation, 218 Woven bone, 458 Wright-Giemsa stain, 407 Wright stain Borrelia spp, 146 Wrinkles of aging, 52 injuries of, 459 bones, 449 Wrist drop, 447 lead poisoning, 419 Written advance directives, 266 WT1/WT2 genes in renal disease, 224, 606 oncogenicity of, 224 Wuchereria bancrofti, 158, 159

X Xanthine oxidase inhibitors, 467 Xanthogranulomatous pyelonephritis, Xanthomas familial dyslipidemias, 94 hyperlipidemia and, 301 Xeroderma pigmentosum DNA repair defects in, 40 Xerosis cutis, 66 Xerostomia, 240, 243, 468 X-inactivation (lyonization) Barr body formation, 61 X-linked agammaglobulinemia, 116 X-linked dominant inheritance, 59 X-linked recessive disorders, 61 agammaglobulinemia, 116 hyper-IgM syndrome, 117 Menkes disease, 51 NADPH oxidase defect, 117 Wiskott-Aldrich syndrome, 117 X-linked recessive inheritance, 59 X-ray/imaging findings Apple core lesion, 388 bamboo spine, 469 Bird's beak sign, 376 Bone-in-bone, 463 Codman triangle, 465

Coffee bean sign, 386

Coin lesion, 684

Crew cut (skull x-ray), 422
kidney stones, 598
pencil-in-cup, 469
punched out bone lesions, 431
Steeple sign (x-ray), 170
String sign, 382
Sunburst pattern, 465
Thumbprint sign (imaging), 386
Thumb sign, 142
X-ray teratogenicity, 614
Υ
Yellow fever, 167, 168
liver anatomy and, 367
Yersinia enterocolitica, 179
transmission and treatment, 144
Yersinia pestis
animal transmission, 149
facultative intracellular organisms,

Z

Zafirlukast, 687 Zaleplon, 546

127

Yo antigens, 228

ovarian, 647

testicular, 653

reactive arthritis, 469

Yolk sac tumor

Yersinia spp

Zanamivir, 201 Zellweger syndrome, 47 Zenker diverticulum, 384 Zero-order elimination, 232 Zidovudine, 203 Ziehl-Neelsen stain, 125 Zika virus, 171 Zileuton, 687 Zinc, 71 Wilson disease, 395 Ziprasidone, 573 Zoledronic acid, 486 Zollinger-Ellison syndrome, 352 duodenal ulcer, 380 gastrin in, 371 MEN 1 syndrome, 351 proton pump inhibitors for, 399 Zolpidem, 546 Zona fasciculata, **327**, 336 Zona glomerulosa, 327 Zona reticularis, 327 Zoonotic bacteria, 149 Zymogens, 373

FAS1_2019_21_Index_749-806.indd 803 11/21/19 12:27 PM

► NOTES	

FAS1_2019_21_Index_749-806.indd 804 11/21/19 12:27 PM

▶ NOTES	

FAS1_2019_21_Index_749-806.indd 805 11/21/19 12:27 PM

► NOTES	

FAS1_2019_21_Index_749-806.indd 806 11/21/19 12:27 PM

▶ NOTES	

FAS1_2019_22_About the Editors.indd 807 11/8/19 8:35 AM

About the Editors



Tao Le, MD, MHS

Tao developed a passion for medical education as a medical student. He currently edits more than 15 titles in the *First Aid* series. In addition, he is Founder and Chief Education Officer of USMLE-Rx for exam preparation and ScholarRx for undergraduate medical education. As a medical student, he was editor-in-chief of the University of California, San

Francisco (UCSF) *Synapse*, a university newspaper with a weekly circulation of 9000. Tao earned his medical degree from UCSF in 1996 and completed his residency training in internal medicine at Yale University and fellowship training at Johns Hopkins University. Tao subsequently went on to cofound Medsn, a medical education technology venture, and served as its chief medical officer. He is currently chief of adult allergy and immunology at the University of Louisville.



Vikas Bhushan, MD

Vikas is a writer, editor, entrepreneur, and teleradiologist on extended sabbatical. In 1990 he conceived and authored the original *First Aid for the USMLE Step 1*. His entrepreneurial endeavors included a student-focused medical publisher (S2S), an e-learning company (medschool.com), and an ER teleradiology practice (24/7 Radiology). Trained on the Left

Coast, Vikas completed a bachelor's degree at the University of California Berkeley; an MD with thesis at UCSF; and a diagnostic radiology residency at UCLA. His eclectic interests include technology, cryptoeconomics, information design, South Asian diasporic culture, and avoiding a day job. Always finding the long shortcut, Vikas is an adventurer, knowledge seeker, and occasional innovator. He enjoys intermediate status as a kiteboarder and father, and strives to raise his three children as global citizens.



Matthew Sochat, MD

Matthew is a third-year hematology/oncology fellow at St. Louis University in St. Louis, Missouri. He completed his internal medicine residency training at Temple University Hospital in Philadelphia. He completed medical school in 2013 at Brown University and is a 2008 graduate of the University of Massachusetts. Amherst, where he studied

biochemistry and the classics. Pastimes include skiing, cooking/baking, traveling, the company of friends/loved ones (especially his wonderful wife), the Spanish language, and computer/video gaming. Be warned: Matt also loves to come up with corny jokes at (in)opportune moments.



Vaishnavi Vaidyanathan, MD

Vaishnavi is a second-year child neurology resident at Phoenix Children's Hospital in Phoenix, Arizona. She is a graduate of the University of Missouri-Kansas City School of Medicine, where she earned her bachelor's and medical degrees. Her interests include medical education and health advocacy. Outside of medicine, she loves to dance, learn new languages, and watch Bollywood movies.



Sarah Schimansky, MB BCh BAO

Sarah is a third-year ophthalmology resident in the UK. She grew up in Germany before moving to Dublin, Ireland, to study medicine at the Royal College of Surgeons in Ireland. She has a keen interest in medical education and is currently enrolled in a Masters in Surgical Education program at Imperial College London. An avid traveler, Sarah is always

on the lookout for new destinations to explore and new countries to call home. When she is not on the road, she enjoys yoga, long walks, and red wine in the company of friends and family.



Jordan Abrams

Jordan is a fourth-year medical student at St. George's University School of Medicine who hopes to pursue residency training in anesthesiology. He graduated magna cum laude from the University of Delaware, earning a bachelor's degree in neuroscience with minors in medical humanities and biological sciences. Combining his creative

mindset and passion for drawing, Jordan founded theHYMedicine.com, an educational website that offers free medical study guides, tutoring, and study schedules for students worldwide. Aside from medicine, Jordan enjoys traveling, reading, and playing soccer.



Kimberly Kallianos, MD

Originally from Atlanta, Kimberly graduated from the University of North Carolina at Chapel Hill in 2006 and from Harvard Medical School in 2011. She completed her radiology residency and fellowship at UCSF and is currently an Assistant Professor of Clinical Radiology at UCSF in the Cardiac and Pulmonary Imaging section.

FAS1_2019_22_About the Editors.indd 808 11/8/19 8:35 AM

SECTION IV

Top-Rated Review Resources

"Some books are to be tasted, others to be swallowed, and some few to be chewed and digested."

-Sir Francis Bacon

"Always read something that will make you look good if you die in the middle of it."

-P.J. O'Rourke

"So many books, so little time."

—Frank Zappa

"If one cannot enjoy reading a book over and over again, there is no use in reading it at all."

-Oscar Wilde

▶ How to Use the Database	2
▶ Question Banks and Books	4
► Web and Mobile Apps	6
▶ Comprehensive	10
Anatomy, Embryology and Neuroscience	, 12
▶ Behavioral Science	14
▶ Biochemistry	15
▶ Cell Biology and Histology	16
► Microbiology and Immunology	17
▶ Pathology	19
▶ Pharmacology	21
▶ Physiology	22

► HOW TO USE THE DATABASE

This section is a database of top-rated basic science review books, sample examination books, websites, apps, and commercial review courses that have been marketed to medical students studying for the USMLE Step 1. At the end of the section is a list of publishers and independent bookstores with addresses and phone numbers. For each recommended resource, we list (where applicable) the **Title**, the **First Author** (or editor), the **Series Name** (where applicable), the **Current Publisher**, the **Copyright Year**, the **Number of Pages**, the **ISBN**, the **Approximate List Price**, the **Format** of the resource, and the **Number of Test Questions**. We also include **Summary Comments** that describe their style and overall utility for studying. Finally, each recommended resource receives a **Rating**. Within each section, resources are arranged first by Rating and then alphabetically by the first author within each Rating group.

A letter rating scale with six different grades reflects the detailed student evaluations for **Rated Resources**. Each rated resource receives a rating as follows:

A+	Excellent for boards review.
A A–	Very good for boards review; choose among the group.
B+ B	Good, but use only after exhausting better resources.
В-	Fair, but there are many better resources in the discipline; or low-yield subject material.

The Rating is meant to reflect the overall usefulness of the resource in helping medical students prepare for the USMLE Step 1. This is based on a number of factors, including:

- The cost
- The readability of the text
- The appropriateness and accuracy of the material
- The quality and number of sample questions
- The quality of written answers to sample questions
- The quality and appropriateness of the images and illustrations
- The quality of the user interface and learning experience, for web and mobile apps
- The length of the text (longer is not necessarily better)
- The quality and number of other resources available in the same discipline
- The importance of the discipline for the USMLE Step 1

Please note that ratings do not reflect the quality of the resources for purposes other than reviewing for the USMLE Step 1. Many books with

FAS1_2019_23_BookRev_ONLINE.indd 2 11/8/19 6:49 AM

lower ratings are well written and informative but are not ideal for boards preparation. We have not listed or commented on general textbooks available in the basic sciences.

Evaluations are based on the cumulative results of formal and informal surveys of thousands of medical students at many medical schools across the country. The summary comments and overall ratings represent a consensus opinion, but there may have been a broad range of opinion or limited student feedback on any particular resource.

Please note that the data listed are subject to change in that:

- Publisher and app store prices change frequently.
- Retail and online bookstores may set their own prices.
- New editions and app versions come out frequently, and the quality of updating varies.
- The same book may be reissued through another publisher.

We actively encourage medical students and faculty to submit their opinions and ratings of these basic science review materials so that we may update our database. In addition, we ask that publishers and authors submit for evaluation review copies of basic science review books, including new editions and books not included in our database. We also solicit reviews of new books, mobile apps, websites, flash cards, and commercial review courses.

Disclaimer/Conflict of Interest Statement

None of the ratings reflects the opinion or influence of the publisher. All errors and omissions will gladly be corrected if brought to the attention of the authors through our blog at www.firstaidteam.com. Please note that USMLE-Rx and the entire First Aid for the USMLE series are publications by certain authors of First Aid for the USMLE Step 1; the following ratings are based solely on recommendations from the student authors of First Aid for the USMLE Step 1 as well as data from the student survey and feedback forms.

FAS1 2019 23 BookRev ONLINE.indd 3 11/8/19 6:49 AM

▶ QUESTION BANKS AND BOOKS



UWorld Qbank UWorld

\$249-\$749 Test/2400 q

www.uworld.com

Questions demand multistep reasoning and are often more difficult than those on the actual Step 1 exam. Offers detailed explanations with figures and tables. Features a number of test customization and analysis options. Users can see cumulative results both over time and compared to other test takers. In addition to a desktop version, it can be accessed through iOS or Android mobile apps.



NBME Practice Exams

\$60 Test/200 q

National Board of Medical Examiners

www.nbme.org/students/sas/Comprehensive.html

The official practice exams published by the NBME are comprised of retired Step 1 questions. NBME research found that they show a "moderate correlation" with actual Step 1 performance. The exams will show you which questions you answered incorrectly, but they will not show any explanations. You will also not be able to review correctly answered questions. Students generally use these as rough gauges of their score progression over their study time. Note that you can sign up to for an in-person practice exam for an additional \$75 to be taken at Prometric, for students who want to practice the logistics of exam day.



AMBOSS

\$9-\$365 Test/3500 q

AMBOSS

www.amboss.com

Integrated question bank for Step 1 and Step 2 CK exams with an additional interactive online library of medical resources. Contains numerous illustrations within the clinical vignettes. Allows for the selection of questions by difficulty level. Includes personalized study plan. Free trial available, accessible through iOS or Android mobile apps.



USMLE-Rx Qmax USMLE-Rx

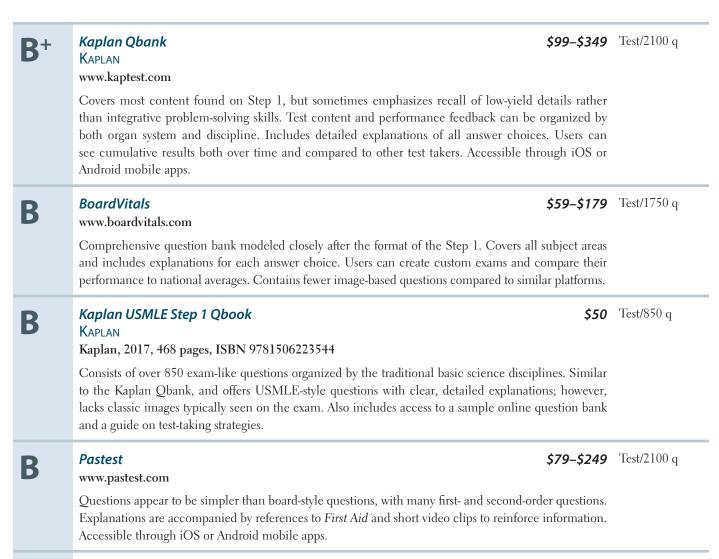
\$89-\$339 Test/2300 q

www.usmle-rx.com

Offers Step 1–style questions accompanied by thorough explanations. Omits obscure material and distills high yield information. Each explanation includes references from *First Aid*. However, the proportion of questions covering a given subject area does not always reflect the actual exam's relative emphasis. Question stems occasionally rely on "buzzwords." Most useful to help memorize *First Aid* facts. Provides detailed performance analyses. Free trial available, accessible through iOS or Android mobile apps.

B

www.truelearn.com



TrueLearn Review \$159–\$399 Test/2200 q

Includes over 2200 USMLE-style practice questions with topics mapped to the NBME blueprint. Uses national benchmarking to show students where they stand in comparison to peers.

FAS1_2019_23_BookRev_ONLINE.indd 5 11/8/19 6:49 AM

▶ WEB AND MOBILE APPS

Anki

www.ankisrs.net

Free Flash cards

\$19–\$249 Review

\$30-\$150 Review

Flash card-making resource designed for retention of facts through spaced repetition. Free access via desktop and smartphone for Windows, Mac, and Android. The iOS app must be purchased for \$25. Available in different languages.

A

Boards and Beyond

www.boardsbeyond.com

Includes over 400 videos averaging ~26 minutes each, covering the breadth of Step 1 material. Membership includes access to the companion books as PDFs. A collection of videos is offered as free samples on the website. Also includes over 1300 practice questions.

Physeo

www.physeo.com

Online review containing 32 hours of review videos covering physiology. Accessible via website or mobile app. Includes a supplemental full-color PDF textbook. Videos are concise and focus on highyield material, and board-style practice questions are included after each topic to help solidify understanding. Similar structure to Pathoma, but with physiology focus.

A

SketchyMedical

www.sketchymedical.com

\$99–\$369 Review

Video library of narrated lectures with thorough explanations that present microbiology, pharmacology, and pathology in a memorable style. Access to the entire gram-positive cocci section is free at signup. Additional content can be purchased on a subscription basis.

 A^-

Cram Fighter

www.cramfighter.com

\$29-\$159

Study plan

Helps organize a study schedule. Highly flexible with customizable settings. Supports more than 650 of the most popular books, video lectures, question banks, and flash cards. Mobile apps available for iOS and Android.

First Aid Step 1 Express

www.usmle-rx.com

\$69-\$299 Review/Test

More than 80 hours of high-yield videos explaining material from First Aid for the USMLE Step 1. Videos include more than 600 extra images and multimedia clips. Step-by-step analysis of USMLE-style questions with each video. Subscription includes a color workbook with over 200 pages.

B⁺

First Aid Step 1 Flash Facts

www.usmle-rx.com

\$29-\$149 Flash cards

Access to 12,000+ flash cards with intelligent spaced repetition integrated with First Aid for the USMLE Step 1, of which 3500+ are case based. Updated each year to reflect the newest edition of the book; students can access the past 3 editions' worth of flash cards. Searchable by organ system, discipline, and topic.

FAS1 2019 23 BookRev ONLINE.indd 6 11/8/19 6:49 AM



Free online learning and collaboration community for students preparing for their exams. Supplements medical school coursework and Step 1 studying with simplified, to-the-point online search platform that is best used as a reference. Recently added premium content for \$80-\$250 includes an online question bank and adaptive learning system.

Free Review Medical School Pathology B⁺

www.medicalschoolpathology.com

supplemental flash cards for integrated learning.

www.lab.anhb.uwa.edu.au/mb140

Offers lectures and slides based on the Robbins Pathology textbook. Lectures can be downloaded.

Free Review **OnlineMedEd** B⁺ www.onlinemeded.org

A video lecture series covering primarily clinical science material, with recent addition of biochemistry, cell biology, and immunology topics. Video access is free with registration. A subscription of \$10-\$70/month gains access to ad-free videos, lecture notes, flash cards, question bank, and downloadable audio lectures.

\$179-\$279 Test **Osmosis** B⁺ www.osmosis.org

Web platform that includes exam study scheduling tool, 27,000+ variable quality multiple choice questions, flash cards with spaced repetition, and 3000+ curated concept cards with videos, memory anchors, and reference articles. Includes a curriculum analysis and search engine, collaboration features for study groups, and a mobile app with quizzes and videos.

\$2-\$10 Test/1400 q **USMLE Step 1 Mastery** B⁺

builtbyhlt.com/medical/usmle-step-1-mastery Question bank accessible through website or via free mobile app. Covers all USMLE topics and includes vignettes, images, and mnemonics. Question formatting is generally less representative of actual USMLE questions compared with other widely used question banks. Mobile app contains

WebPath: The Internet Pathology Laboratory Free Review/ B⁺ Test/1300 q webpath.med.utah.edu

Features more than 2700 gross and microscopic images, clinical vignette questions, and case studies. Includes nine general pathology exams and 11 system-based pathology exams with approximately 1300 questions. Also features 170 questions associated with images. Questions are useful for reviewing boards content but are typically untimed, easier, and shorter. No multimedia practice questions. Not regularly updated with regard to high-yield Step 1 material.

Free Review/Test **Blue Histology** B

Provides access to 400+ histologic images with thorough explanations. Images searchable by topic, stain, keyword. Website also contains multiple choice practice questions.

FAS1 2019 23 BookRev ONLINE.indd 7 11/8/19 6:49 AM 8 **SECTION IV**

TOP-RATED REVIEW RESOURCES

Digital Anatomist Project: Interactive Atlases B

Free Review

University of Washington

da.si.washington.edu/da.html

Contains an interactive neuroanatomy course along with a three-dimensional atlas of the brain, thorax, and knee. Atlases have computer-generated images and cadaver sections. Each atlas also has a quiz in which users identify structures in the slide images. However, questions do not focus on high-yield anatomy for Step 1.

Dr. Najeeb Lectures B

\$99 Review

www.drnajeeblectures.com

Hundreds of hours of video lectures covering basic medical sciences and clinical medicine with thousands of hand-drawn illustrations and mnemonics. Website provides mobile video support on smartphones and tablets. Free lectures accessible at www.drnajeeblectures.com/free-medical-videos.html.

Firecracker B FIRECRACKER INC. \$39-\$660

Review/ Test/2800 q

firecracker.lww.com

Learning platform divided into modules. The Step 1 module is divided into organ systems and includes review of preclinical lecture material, periodic quizzes on flagged reviewed material, and USMLE-style questions in interface simulating the actual exam. Contains page references to First Aid for the USMLE Step 1 and high-yield diagrams from various textbooks. Users can grade how well they remember the quiz answers (1-5), which allows the program to customize future quizzes. Features detailed performance analysis and a calendar for personalized study plans. Accessible on all smartphones and tablets. Comprehensive; best if started early in preclinical years.

KISSPrep \$99–\$135 Review B www.kissprep.com

Online lecture videos focused on select subjects from the Step 1 exam. Focuses on harder-to-learn content and teaches it in a simple, easy-to-understand manner. Quizzes and other interactive tools are available to help with knowledge retention. Not all Step 1 content is covered on this platform.

\$50-\$300 Review/ Lecturio B Test/2150 q www.lecturio.com

Online platform for comprehensive exam preparation, including over 250 hours of lectures, a flash card deck, quizzes, and a question bank. Organized by subject matter and allows users to customize their learning experience. Some content may be beyond the scope of the exam and better suited for medical school coursework. Lectures and quizzes may be accessed for free. iOS and Android apps are available.

\$19-\$239 Flash cards **Memorang** B MEMORANG INC.

www.memorangapp.com

Platform utilizing spaced repetition, available both in website and app form. Utilizes custom and/or premade flash card "study sets" derived from 15,000 flash cards that focus on specific subject areas and are then tested via various games and quizzing methods. Free 7-day trial, or monthly/annual membership.

FAS1 2019 23 BookRev ONLINE.indd 8 11/8/19 6:49 AM

\$25-\$480 Review B **Picmonic**

www.picmonic.com

Helpful resource for visual learners. Unique images and stories with daily quizzes and spaced repetition. Contains 1400 images and includes study guides, webinars, and infographics that help cover 15,000+ facts of Step 1 material. Offered via both web and mobile platforms.

Free Cases/Test Radiopaedia.org B-

www.radiopaedia.org

A user-friendly website with thousands of well-organized radiology cases and articles. Encyclopedia entries contain high-yield bullet points of anatomy and pathology. Images contain detailed descriptions but no arrows to demarcate findings. Quiz mode allows students to make a diagnosis based on radiographic findings. Content may be too broad for boards review but is a good complement to classes and clerkships.

Free Review The Pathology Guy B-

FRIEDLANDER

www.pathguy.com

Contains extensive but poorly organized information on a variety of fundamental concepts in pathology. A high-yield summary intended for USMLE review can be found at www.pathguy.com/meltdown.txt, but the information given is limited by a lack of images and frequent digressions.

FAS1_2019_23_BookRev_ONLINE.indd 9 11/8/19 6:49 AM 1 () SECTION IV

TOP-RATED REVIEW RESOURCES

▶ COMPREHENSIVE

A

First Aid for the Basic Sciences: General Principles

\$55 Review

LE

McGraw-Hill, 2019, 816 pages, ISBN 9781260143676

Comprehensive review of the basic sciences covered in year 1 of medical school. Similar to the first part of *First Aid*, organized by discipline, and includes hundreds of color images and tables. Best if started with first-year coursework and then used as a reference during boards preparation.

A

First Aid Cases for the USMLE Step 1

\$50 Cases

LE

McGraw-Hill, 2018, 496 pages, ISBN 9781260143133

A recently updated series of hundreds of high-yield cases organized by organ system. Each case features a clinical vignette with relevant images, followed by questions and short, high-yield explanations. Offers coverage of many frequently tested concepts, and integrates subject matter in the discussion of the vignette. Helpful in reviewing material outlined in *First Aid for the USMLE Step 1*.



First Aid for the Basic Sciences: Organ Systems

\$72 Review

LE

McGraw-Hill, 2017, 912 pages, ISBN 9781259587030

A comprehensive review of the basic sciences covered in year 2 of medical school. Similar to the second part of *First Aid*, organized by organ system, and includes hundreds of color images and tables. Each organ system contains discussion of embryology and anatomy, physiology, pathology, and pharmacology. Best if started with second-year coursework and then used as a reference during boards preparation.



Crush Step 1: The Ultimate USMLE Step 1 Review O'CONNELL

\$45 Review

Elsevier, 2017, 704 pages, 9780323481632

Detailed, text-heavy review book with practice questions included. Coverage of many high-yield topics but includes some outdated information. Best if used with coursework, but also recommended as a supplemental reference for boards review. Limited student feedback.

A-

Cracking the USMLE Step 1

\$45 Review

PRINCETON REVIEW

Princeton Review, 2013, 832 pages, ISBN 9780307945068

Comprehensive review book with hundreds of illustrations, charts, and diagrams along with 2 full-length practice tests with detailed answer explanations available online. Limited student feedback.

B⁺

USMLE Step 1 Secrets in Color

\$43 Review

BROWN

Elsevier, 2016, 800 pages, ISBN 9780323396790

Clarifies difficult concepts in a concise, readable manner. Uses a case-based format and integrates information well. High-quality clinical images. Complements other boards study resources, with a focus on understanding preclinical fundamentals rather than on rote memorization. Slightly lengthy for last-minute studying.

FAS1 2019 23 BookRev ONLINE.indd 10

11/8/19 6:49 AM

B+ Step-Up to USMLE Step 1 2015 JENKINS

\$50 Review

Lippincott Williams & Wilkins, 2014, 528 pages, ISBN 9781469894690

An organ system—based review text with clinical vignettes that is useful for integrating the basic sciences covered on Step 1. Composed primarily of outlines, charts, tables, and diagrams. Limited scope of material covered. Includes access to a sample online question bank.

B+ USMLE Step 1 Lecture Notes 2018 KAPLAN

\$330 Review

Kaplan Medical, 2018, ~2700 pages, ISBN 9781506221229

Extremely comprehensive review of Step 1 topics through videos and lecture notes. Split into individual sections covering pathology, pharmacology, physiology, biochemistry and medical genetics, immunology and microbiology. Generally best used to fill gaps in understanding and to review unfamiliar topics that one has not come across, and therefore the notes are commonly used by foreign medical graduates. Some sections are quite detailed and go beyond the scope of the Step 1 exam.

B+ USMLE Images for the Boards: A Comprehensive Image-Based Review Tully

\$42 Review

Elsevier, 2012, 296 pages, ISBN 9781455709038

Contains more than 300 color images of content likely to be tested on the Step 1. Contains a wide variety of images including ECGs and radiographic studies. Some images may be low yield for boards studying, but still excellent as a supplement to preclinical courses.

BUSMLE Step 1 Made Ridiculously Simple CARL

\$30 Review/Test 1000 q

MedMaster, 2017, 416 pages, ISBN 9781935660224

Concise, succinct text. Online access to more than 1000 practice questions. Uses a table and chart format organized by subject, but some charts are poorly labeled. Consider as an adjunct to more comprehensive sources.

medEssentials for the USMLE Step 1

\$55 Review

MANLEY

Kaplan, 2012, 588 pages, ISBN 9781609780265

A comprehensive review divided into general principles and organ systems, organized using highyield tables and figures. Helpful for visual learners, but can be overly detailed and time consuming. Includes color images in the back along with a monthly subscription to online interactive exercises, although these are of limited value for Step 1 preparation. Comes with a free mobile version. **SECTION IV**

TOP-RATED REVIEW RESOURCES

► ANATOMY, EMBRYOLOGY, AND NEUROSCIENCE

High-Yield Gross Anatomy

\$43 Review

Lippincott Williams & Wilkins, 2014, 320 pages, ISBN 9781451190236

A good review of gross anatomy with some clinical correlations. Contains color clinical photos and well-labeled, high-yield radiographic images, but often goes into excessive detail that is beyond the scope of the boards.

A-

Clinical Anatomy Made Ridiculously Simple

\$30 Review

GOLDBERG

MedMaster, 2016, 175 pages, ISBN 9780940780972

An easy-to-read text offering simple diagrams along with numerous mnemonics, helpful charts, and amusing associations. The humorous style has variable appeal to students, so browse the content before purchasing. Offers good coverage of selected topics. Includes a CD-ROM atlas of normal radiographic anatomy. Best if used during coursework. Includes more detail than typically tested on Step 1.

B⁺

High-Yield Embryology

\$56 Review

DUDEK

Fix

Lippincott Williams & Wilkins, 2013, 176 pages, ISBN 9781451176100

A concise review of a relatively less-tested subject. Offers excellent organization with clinical correlations. Includes a high-yield list of embryologic tissue origins and USMLE-style case studies after each chapter. May not be suitable for dedicated Step 1 studying.

B⁺

High-Yield Neuroanatomy

\$40 Review/ Test/50 q

Lippincott Williams & Wilkins, 2015, 208 pages, ISBN 9781451193435

An easy-to-read, straightforward format with excellent diagrams and illustrations. Features a useful atlas of brain and spinal cord images, a glossary of important terms, and an appendix of neurologic lesions. Overall, a great resource and quick read, but more detailed than what is required for Step 1.

B⁺

Anatomy—An Essential Textbook **GILROY**

\$48 Text/

Test/400 q

Thieme, 2017, 528 pages, ISBN 9781626234390

A thorough, visually appealing approach to learning anatomy. Contains over 650 colorful, helpful illustrations. Presents material in bullet-point format and tables. Includes over 160 clinical correlates and 400 USMLE-style questions, with the opportunity to complete practice questions online.

B⁺

Netter's Anatomy Flash Cards

\$40 Flash cards

HANSEN

Saunders, 2018, 688 flash cards, ISBN 9780323530507

Netter's illustrations in a question/answer column format that allows for self-testing. Each card includes commentary on the structures with a clinical correlation. More effective as a supplement to coursework, and much too detailed for boards preparation. Lack of embryology correlates limits Step 1 usefulness. Includes online access with additional bonus cards and more than 400 multiple choice questions. Note: an iOS app has a similar cost and additional functionality.

13

\$45 Review B+ Crash Course: Anatomy

STENHOUSE

Elsevier, 2015, 288 pages, ISBN 9780723438540

Part of the Crash Course review series for basic sciences, integrating clinical topics. Offers two-color illustrations, handy study tools, and Step 1 review questions. Contains an up-to-date self-assessment section. Provides a solid review of anatomy for Step 1. Best if started early.

\$56 Review/ **BRS Embryology** B Test/220 q

Lippincott Williams & Wilkins, 2014, 336 pages, ISBN 9781451190380

An outline-based review of embryology that is typical of the BRS series. Offers a good review and includes much more detail than is required for Step 1. A discussion of congenital malformations is included at the end of each chapter, along with over 220 USMLE-style questions with answers and explanations. The comprehensive exam at the end of the book is high yield. Includes access to a searchable online text on the free companion website, which also features interactive quizzing.

\$60 Flash cards Anatomy Flash Cards: Anatomy on the Go B **GILROY**

Thieme, 2013, 752 flash cards, ISBN 9781604069105

Flash card deck containing high-quality illustrations and a question/answer format that allows for self-testing. Occasional radiographic image. Best if used with coursework; too long for efficient boards preparation.

\$26 Review/Test/ Clinical Neuroanatomy Made Ridiculously Simple B Few q

MedMaster, 2014, 90 pages + CD-ROM, ISBN 9781935660194

An easy-to-read, memorable, and simplified format with clever diagrams. Offers a quick, high-yield review of clinical neuroanatomy, but not a comprehensive resource for boards review. Places appropriate emphasis on clinically relevant pathways, cranial nerves, and neurologic diseases. Includes a CD-ROM with CT and MR images, a tutorial on neurologic localization, and interactive quizzes covering classic neurology cases.

\$20 Review **Netter's Anatomy Coloring Book** B

Elsevier, 2018, 392 pages, ISBN 9780323545037

An easy-to-understand, detailed, interactive book that is an excellent companion to traditional textbooks during preclinical anatomy coursework. Provides multiple views and magnifications of anatomic structures as well as dissection layers. The coloring aspect of the book can be highly beneficial for visual learners. Contains few clinical correlations, which limits its usefulness during dedicated studying for Step 1.

Case Files: Anatomy \$35 Cases B Toy

McGraw-Hill, 2014, 416 pages, ISBN 9780071794862

Review text that includes 58 well-chosen cases with discussion, comprehension questions, and takehome pearls. Tables are helpful, but schematics are black and white and not representative of Step 1. A reasonable book to work through for those who benefit from problem-based learning.

FAS1 2019 23 BookRev ONLINE.indd 13 11/8/19 6:49 AM

TOP-RATED REVIEW RESOURCES

B-

Case Files: Neuroscience

\$35 Cases

Toy

McGraw-Hill, 2014, 432 pages, ISBN 9780071790253

Similar to other *Case Files* books, it includes 49 clinical cases with lengthy discussion and 3–5 multiple choice questions at the end of each case. Cases are helpful, but the discussion is too lengthy. Questions are not the most representative of those seen on boards. Limited student feedback.

▶ BEHAVIORAL SCIENCE



BRS Behavioral Science

\$52 Review/ Test/700 q

Fadem

Lippincott Williams & Wilkins, 2016, 384 pages, ISBN 9781496310477

An easy-to-read outline-format review of behavioral science. Offers detailed coverage of mostly high-yield topics, but at a level of depth that often exceeds what is tested on Step 1. Better used prior to dedicated study period. Incorporates tables and charts as well as a short but complete statistics chapter. Features over 700 review questions, including a 100-question comprehensive exam. References DSM-V criteria.

B⁺

High-Yield Biostatistics, Epidemiology, and Public Health GLASER

\$43 Review

Lippincott Williams & Wilkins, 2013, 168 pages, ISBN 9781451130171

A well-written, easy-to-read text that offers extensive coverage of epidemiology and biostatistics. Includes helpful review questions and tables, but somewhat lengthy given the low-yield nature of this subject on Step 1.

▶ BIOCHEMISTRY

Α-

Pixorize

\$100-\$130 Review

www.pixorize.com

Visual mnemonic system focusing primarily on biochemistry. Step-by-step videos and interactive images aid studying and review. Compare to Sketchy and Picmonic.

B⁺

Medical Biochemistry—An Illustrated Review Panini

\$40 Review/ Test/400 q

Thieme, 2013, 441 pages, ISBN 9781604063165

A comprehensive medical biochemistry study guide with an emphasis on images. Very detailed and may be better as a supplement to preclinical courses than as a review resource for the Step 1. Images and diagrams are helpful for solidifying knowledge. Online access available for additional content, including 400 USMLE-style practice questions.

Baron Lange Flash Cards Biochemistry and Genetics Baron

\$40 Flash cards

McGraw-Hill, 2017, 196 flash cards, ISBN 9781259837210

Flash card deck featuring clinical vignettes on one side and concise discussions on the other. Each section contains 2–3 cards on biochemistry principles. High level of detail may make this less ideal for dedicated boards studying. Note that no carrying case for the cards is included.

B Lippincott Illustrated Reviews: Biochemistry Ferrier

\$78 Review/ Test/200 q

Lippincott Williams & Wilkins, 2017, 560 pages, ISBN 9781496344496

An integrative and comprehensive review of biochemistry that includes good clinical correlations and effective color diagrams. Extremely detailed and requires significant time commitment, so it should be started with first-year coursework. High-yield summaries at the end of each chapter. Comes with access to the companion website, which includes over 200 USMLE-style questions.

BRS Biochemistry, Molecular Biology, and Genetics

\$54 Review/Test

Lippincott Williams & Wilkins, 2013, 432 pages, ISBN 9781451175363

A highly detailed review featuring many figures and clinical correlations highlighted in colored boxes. The biochemistry portion includes much more detail than required for Step 1, but may be useful for students without a strong biochemistry background or as a reference text. The molecular biology section is more focused and high yield. Also offers a chapter on laboratory techniques and a comprehensive, 120-question exam. Questions are clinically oriented.

Case Files: Biochemistry

\$35 Cases

Toy

McGraw-Hill, 2014, 480 pages, ISBN 9780071794886

Includes 51 clinical cases with comprehensive discussion and summary box, albeit too much depth and not enough breadth for boards preparation. Some cases will almost certainly *not* be tested. Questions at the end of each case are not representative of those on Step 1.

FAS1_2019_23_BookRev_ONLINE.indd 15

B⁺

16 SECTION IV

TOP-RATED REVIEW RESOURCES

PreTest Biochemistry and GeneticsWILSON

\$38 Test/500 q

McGraw-Hill, 2017, 592 pages, ISBN 9780071791441

500 questions with detailed, well-referenced explanations. Features a high-yield introduction and appendix, but may be overly detailed in some cases. A solid supplement to preclinical courses and board studying.

► CELL BIOLOGY AND HISTOLOGY

BRS Cell Biology and Histology
Gartner

\$54 Review/ Test/320 q

Lippincott Williams & Wilkins, 2018, 448 pages, ISBN 9781496396358

Covers concepts in cell biology and histology in an outline format. Can be used alone for cell biology study, but may have fewer histology images than some other resources. Includes more detail than is required for Step 1, and information is less high yield than that of other books in the BRS series. Interactive quizzes on the free companion website provide additional practice.

B+ Crash Course: Cell Biology and Genetics STUBBS

\$47 Review/Print + online

Elsevier, 2015, 216 pages, ISBN 9780723438762

Part of the Crash Course review series for basic sciences, integrating clinical topics. Offers two-color illustrations, handy study tools, and Step 1 review questions. Includes online access. High level of detail makes this resource best suited for coursework.

Wheater's Functional Histology
YOUNG

\$83 Text

Elsevier, 2013, 464 pages, ISBN 9780702047473

A color atlas with more than 900 high-quality illustrations of normal histology with image captions and accompanying text. Far too detailed to use for boards studying given the low-yield nature of the material, but useful as a coursework text or boards reference. Provides online access to the entire atlas and USMLE-style self-assessment questions.

► MICROBIOLOGY AND IMMUNOLOGY

Basic Immunology

\$70 Review

ABBAS

Elsevier, 2019, 336 pages, ISBN 9780323549431

A useful text that offers clear explanations of complex topics in immunology. Best if used in conjunction with coursework and later skimmed for quick Step 1 review. Includes colorful diagrams, images, tables, and a glossary for further study. Features online access.

A^{-}

Clinical Microbiology Made Ridiculously Simple **GLADWIN**

\$38 Review

MedMaster, 2019, 418 pages, ISBN 9781935660330

An excellent, easy-to-read, detailed review of microbiology that includes clever and memorable mnemonics. The sections on bacterial disease are most high yield, less emphasis placed on pharmacology. Recommended to read during coursework and review the concise charts at the end of each chapter during boards review. All images are cartoons; no microscopy images that appear on boards. Requires a supplemental source for immunology.

A^{-}

Medical Microbiology and Immunology Flash Cards ROSENTHAL

\$40 Flash cards

Elsevier, 2016, 192 flash cards, ISBN 9780323462242

Flash cards covering the microorganisms most commonly tested on Step 1. Each card features color microscopic images and clinical presentations on one side and relevant bug information in conjunction with a short case on the other side. Also includes Student Consult online access for extra features. Overemphasizes "trigger words" related to each bug. Not a comprehensive resource.

B⁺

Lippincott Illustrated Reviews: Immunology DOAN

\$75 Reference/Test/ Few q

Lippincott Williams & Wilkins, 2012, 384 pages, ISBN 9781451109375

A clearly written, highly detailed review of basic concepts in immunology. Features many useful tables and review questions at the end of each chapter. More than 300 color annotated illustrations. Offers abbreviated coverage of immunodeficiencies and autoimmune disorders. Best if started with initial coursework and used as a reference during Step 1 study.

B⁺

Microcards: Microbiology Flash Cards **H**ARPAVAT

\$53 Flash cards

Lippincott Williams & Wilkins, 2015, 312 flash cards, ISBN 9781451192353

A well-organized and complete resource for students who like to use flash cards for review. Cards feature the clinical presentation, pathobiology, diagnosis, treatment, and high-yield facts for a particular organism. Some cards also include excellent flow charts organizing important classes of bacteria or viruses. Overall, a good review resource, but at times it is overly detailed, requiring a significant time commitment. Also useful as an aid with coursework. Includes access to online USMLE-style questions with answers.

FAS1 2019 23 BookRev ONLINE.indd 17

TOP-RATED REVIEW RESOURCES

B⁺ Review of Medical Microbiology and Immunology

\$63 Review/ Test/654 q

McGraw-Hill, 2018, 832 pages, ISBN 9781259644498

A clear, comprehensive text with outstanding diagrams and tables. Includes an excellent immunology section. Contains a chapter summarizing details on medically important organisms. Can be used as reference for reviewing immunology concepts. Can be detailed and dense at points, so best if started early with coursework. Includes practice questions of mixed quality and does not provide detailed explanation of answers. Compare with Lippincott Illustrated Reviews: Microbiology.

How the Immune System Works

\$50 Review

SOMPAYRAC

Wiley-Blackwell, 2019, 168 pages, ISBN 9781119542124

A short overview of high-yield immunology designed for those with no prior immunology knowledge. Analogies and images create a "storybook" feel to spruce up a relatively dry subject. The 15 chapters offer a general overview with good supporting details.

Case Studies in Immunology: Clinical Companion B **G**EHA

\$62 Cases

W. W. Norton & Company, 2016, 384 pages, ISBN 9780815345121

A text that was originally designed as a clinical companion to Janeway's Immunobiology. Provides a great synopsis of the major disorders of immunity in a clinical vignette format. Integrates basic and clinical sciences. Features excellent images and illustrations from Janeway, as well as questions and discussions.

Pretest: Microbiology B

\$38 Test/500 q

KETTERING

McGraw-Hill, 2013, 480 pages, ISBN 9780071791045

Includes a short section on high-yield facts followed by 500 questions in a clinical vignette format. Questions are more difficult than encountered on the boards and some topics discussed are not likely to be tested. A good book to work through with coursework but too low yield for review purposes.

Case Files: Microbiology B

\$36 Cases

Toy

McGraw-Hill, 2014, 416 pages, ISBN 9780071820233

Provides 54 clinical microbiology cases followed by a clinical correlation, a discussion with boldfaced buzzwords, and questions. Cases are well chosen, but the text lacks the high-yield charts and tables found in other books in the Case Files series. Images are sparse, black and white, and of poor quality.

Lange Microbiology and Infectious Diseases Flash Cards, 3e B Somers, 2017

\$46 Flash cards

Clinical vignettes presented on one side of the card as a mini-case study of the disease and the flip side presents the etiology and epidemiology, pathogenesis, clinical manifestations, laboratory diagnosis, and treatment and prevention of the disorder. Good for reviewing clinical aspects of many infectious diseases including those caused by bacteria, viruses, and fungi.



Lippincott Illustrated Reviews: Microbiology Cornelissen

\$73 Review/Test/ Few q

Lippincott Williams & Wilkins, 2019, 448 pages, ISBN 9781496395856

A comprehensive, highly illustrated review of microbiology that is similar in style to other titles in the Illustrated Reviews series. Has more than 400 color illustrations and color-coded summaries to help visual learners. Contains several hundred USMLE-style review questions to help with exam preparation. Compare with Levinson's *Review of Medical Microbiology and Immunology*.

▶ PATHOLOGY



Pathoma: Fundamentals of Pathology

\$85-\$120 Review/Lecture

SATTAR

Pathoma, 2019, 218 pages, ISBN 9780983224631

Integrated approach to pathology review, combining a focused textbook with 35+ hours of online lectures. Book contains more than 350 color images. Videos combine "chalk talk" and slide formats to explain pathogenesis in an easy-to-understand manner. Online subscription needed for full access.



Rapid Review: Pathology GOLJAN

\$65 Review/ Test/500 q

Elsevier, 2018, 864 pages, ISBN 9780323476683

A comprehensive source for key concepts in pathology, presented in a bulleted outline format with many high-yield tables and color figures. Features detailed explanations of disease mechanisms. Integrates concepts across disciplines with a strong clinical orientation. Lengthy, so best if started early with coursework. Includes access to online question bank with more than 500 questions. Covers material for both Step 1 and Step 2 exams.



Robbins and Cotran Review of Pathology KLATT

\$55 Test/1100 q

Elsevier, 2014, 504 pages, ISBN 9781455751556

A question book that follows the main Robbins textbooks. Questions are more detailed, difficult, and arcane than those on the actual Step 1 exam, but the text offers a great review of pathology integrated with more than 1100 images. Thorough answer explanations reinforce key points. Requires significant time commitment, so best if started with coursework. 2014 edition table of contents closely follows the organization of *Robbins and Cotran Pathologic Basis of Disease*, 8th edition.



Crash Course: Pathology

\$40 Review

XIU

Elsevier, 2019, 438 pages, ISBN 9780702073540

Part of the Crash Course review series for basic sciences, integrating clinical topics. Offers two-color illustrations, handy study tools, and Step 1 review questions. Includes online access. Best if started during coursework.

FAS1 2019 23 BookRev ONLINE.indd 19 11/8/19 6:49 AM

TOP-RATED REVIEW RESOURCES

High-Yield Histopathology B

\$36 Review

DUDEK

Lippincott Williams & Wilkins, 2017, 320 pages, ISBN 9781496353344

Reviews the relationship of basic histology to the pathology, physiology, and pharmacology of clinical conditions that are tested on Step 1. Includes case studies, numerous light and electron micrographs, and pathology photographs. Given its considerable length, should be started with coursework or used as a reference to better identify images.

Pathophysiology of Disease: Introduction to Clinical B Medicine

\$90 Text

HAMMER

McGraw-Hill, 2018, 832 pages, ISBN 9781260026504

An interdisciplinary text useful for understanding the pathophysiology of clinical symptoms. Effectively integrates the basic sciences with mechanisms of disease. Features great graphs, diagrams, and tables. In view of its length, most useful if started during coursework. Includes 120 case studies, checkpoint questions that appear in every chapter, and a few non-boards-style questions. The text's clinical emphasis nicely complements BRS Pathology.

Haematology at a Glance B

\$49 Review

Мента

Blackwell Science, 2014, 136 pages, ISBN 9781119969228

A resource that covers common hematologic issues. Includes color illustrations. Presented in a logical sequence that is easy to read. Good for use with coursework.

Pocket Companion to Robbins and Cotran Pathologic B **Basis of Disease**

\$40 Review

MITCHELL

Elsevier, 2016, 896 pages, ISBN 9781455754168

A condensed version of Robbins and Cotran Pathologic Basis of Disease that is good for reviewing keywords associated with most important diseases. Presented in a highly condensed format, but the text is complete and easy to understand. Contains no photographs or illustrations but does include tables. Useful as a quick reference.

BRS Pathology B

\$54 Review/ Test/450 q

SCHNEIDER

Lippincott Williams & Wilkins, 2013, 480 pages, ISBN 9781451115871

An excellent, concise review with appropriate content emphasis. Chapters are organized by organ system and feature an outline format with boldfacing of key facts. Includes good questions with explanations at the end of each chapter plus a comprehensive exam at the end of the book. Offers well-organized tables and diagrams as well as photographs representative of classic pathology. Contains a chapter on lab testing and "key associations" with each disease. Contains excellent color images and access to an online test and interactive question bank. Most effective if started early in conjunction with coursework, as it does not discuss detailed mechanisms of disease pathology.

FAS1 2019 23 BookRev ONLINE.indd 20

11/8/19 6:49 AM

▶ PHARMACOLOGY

Crash Course: Pharmacology B⁺

\$40 Review

Elsevier, 2019, 336 pages, ISBN 9780702073441

Part of the Crash Course review series for basic sciences, integrating clinical topics. Offers two-color illustrations, handy study tools, and Step 1-style review questions with a self-assessment section. Includes online access. Gives a solid, easy-to-follow overview of pharmacology.

B⁺ Master the Boards USMLE Step 1 **Pharmacology Flashcards**

\$55 Flash cards

FISCHER

Kaplan, 2015, 200 flash cards, ISBN 9781618657947

Easy-to-read flash cards with drug and questions on one side and discussion on the other. Useful for a quick pharmacology review. Some drugs/material may be beyond the scope of the Step 1, or more appropriate at the Step 2 level.

B+ **BRS Pharmacology** Rosenfeld

\$55 Review/

Test/200 q

Lippincott Williams & Wilkins, 2019, 384 pages, ISBN 9781975105495

Features two-color tables and figures that summarize essential information for quick recall. A list of drugs organized by drug family is included in each chapter. Too detailed for boards review; best used as a reference. Also offers end-of-chapter review tests with Step 1-style questions and a comprehensive exam with explanations of answers. An additional question bank is available online.

Lange Pharmacology Flash Cards B BARON

\$39 Flash cards

McGraw-Hill, 2017, 266 flash cards, ISBN 9781259837241

A total of 230 pocket-sized flash cards of relevant drugs formatted with clinical vignettes on one side and relevant information on the other side (eg, mode of action, adverse effects, clinical uses). Particularly high-yield information is highlighted in bold. Mainly useful as a supplement for pharmacology knowledge, rather than as a primary resource. Printed on less durable material.

Pharmacology Flash Cards B

\$45 Flash cards

BRENNER

Elsevier, 2017, 230 flash cards, ISBN 9780323355643

Flash cards for more than 200 of the most commonly tested drugs. Cards include the name of the drug (both generic and brand) on the front and basic drug information on the back, with occasional cards covering high-yield pharmacology pathways. Divided and color coded by class, and comes with a compact carrying case. Lacks figures and clinical vignettes.

FAS1 2019 23 BookRev ONLINE.indd 21 11/8/19 6:49 AM

TOP-RATED REVIEW RESOURCES

Katzung & Trevor's Pharmacology: Examination B and Board Review

\$54 Review/ Test/800 q

TREVOR

McGraw-Hill, 2018, 592 pages, ISBN 9781259641022

A well-organized text with concise explanations. Features good charts and tables; the crammable list in Appendix I is especially high yield for Step 1 review. Also good for reviewing drug interactions and toxicities. Offers two 100-question practice exams. Text includes many low-yield/obscure drugs. Compare with Lippincott Illustrated Reviews: Pharmacology, both of which are better suited to complementing coursework than last-minute studying for boards.

Lippincott Illustrated Reviews: Pharmacology B

\$75 Review/ Test/380 q

Lippincott Williams & Wilkins, 2018, 576 pages, ISBN 9781496384133

A resource presented in outline format with practice questions, many excellent illustrations, and comparison tables. Effectively integrates pharmacology and pathophysiology. Best started alongside coursework, as it is highly detailed and requires significant time commitment. Focuses on basic principles.

▶ PHYSIOLOGY



BRS Physiology COSTANZO

\$54 Review/ Test/350 q

Lippincott Williams & Wilkins, 2018, 304 pages, ISBN 9781496367617

A clear, concise review of physiology that is both comprehensive and efficient, making for fast, easy reading. Includes excellent high-yield charts and tables, but lacks some figures from Costanzo's Physiology. Features high-quality practice questions with explanations in each chapter along with a clinically oriented final exam. An excellent reference during times of focused Step 1 studying, but best if started early in combination with coursework. Respiratory and acid-base sections are comparatively weak.



Pathophysiology of Heart Disease

\$57 Review

LILLY

Lippincott Williams & Williams, 2015, 480 pages, ISBN 9781451192759

Great resource that outlines an in-depth explanation of both cardiac physiology and pathology. Best used as a supplement when learning the material for the first time, as it helps build a strong foundation. Because the book itself is rather dense, it is not recommend as a primary resource during focused boards studying period



PreTest Physiology

\$38 Test/500 q

METTING

McGraw-Hill, 2013, 528 pages, ISBN 9780071791427

Contains questions with detailed, well-written explanations. One of the best of the PreTest series. Best for use by the motivated student after extensive review of other sources. Includes a high-yield facts section with useful diagrams and tables.

Color Atlas of Physiology A^{-}

\$50 Review

SILBERNAGL

Thieme, 2015, 472 pages, ISBN 9783135450070

Contains more than 180 high-quality illustrations of disturbed physiologic processes that lead to dysfunction. An alternative to standard texts, but not high yield for boards review.

BRS Physiology Cases and Problems B⁺

\$58 Cases

Costanzo

Lippincott Williams & Wilkins, 2012, 368 pages, ISBN 9781451120615

Presents 62 classic cases in vignette format with several questions per case. Includes exceptionally detailed explanation of answers along with supplemental diagrams. For students interested in an in-depth discussion of physiology concepts.

Physiology B⁺

\$60 Text

COSTANZO

Saunders, 2017, 528 pages, ISBN 9780323478816

A comprehensive, clearly written text that covers concepts outlined in BRS Physiology in greater detail. Offers excellent color diagrams and charts. Each systems-based chapter features a detailed summary of objectives and a Step 1-relevant clinical case. Includes access to online interactive extras. Requires time commitment, but helps develop a strong foundation in physiology concepts. Best if started alongside coursework. Practice questions at end of each chapter.

B⁺ Vander's Renal Physiology **EATON**

\$49 Text

McGraw-Hill, 2018, 224 pages, ISBN 9781260019377

Well-written text on renal physiology, with helpful but sparse diagrams and practice questions at the end of each chapter. Too detailed for Step 1 review, however. Best if used with organ-based coursework to understand the principles of renal physiology.

Acid-Base, Fluids, and Electrolytes Made B⁺ **Ridiculously Simple**

\$24 Review

PRESTON

MedMaster, 2017, 166 pages, ISBN 9781935660293

A resource that covers major acid-base and renal physiology concepts. Provides information beyond the scope of Step 1, but remains a useful companion for studying kidney function, electrolyte disturbances, and fluid management. Includes scattered diagrams and questions at the end of each chapter. Consider using after exhausting more high-yield physiology review resources.

Pulmonary Pathophysiology: The Essentials B⁺

\$57 Review/ Test/75 q

Lippincott Williams & Wilkins, 2017, 264 pages, ISBN 9781496339447

A volume offering comprehensive coverage of respiratory physiology. Clearly organized with useful charts and diagrams. Review questions at the end of each chapter provide answers but no explanations. Best used as a course supplement during the second year, less ideal for use immediately prior to Step 1.

FAS1 2019 23 BookRev ONLINE.indd 23 11/8/19 6:49 AM

TOP-RATED REVIEW RESOURCES

Rapid Review: Physiology B

\$39 Test/350 q

BROWN

Elsevier, 2011, 384 pages, ISBN 9780323072601

Offers a good review of physiology in a format typical of the Rapid Review series, albeit with more images. Includes online access to 350 questions with concise explanations, along with other extras. Compare with Robbins Physiology.

Endocrine Physiology B

\$59 Review

MOLINA

McGraw-Hill, 2018, 320 pages, ISBN 9781260019353

Questions at the end of each chapter are helpful solidify knowledge, but some are not representative of Step 1 questions. Provides more detailed explanations of endocrine physiology than Costanzo review offers, but much too lengthy for Step 1 review. May be useful as a coursework adjunct.

Netter's Physiology Flash Cards B-

\$40 Flash cards

MULRONEY

Saunders, 2015, 450 flash cards, ISBN 9780323359542

Flash cards contain a high-quality illustration on one side with question and commentary on the other. Good for self-testing, but too fragmented for learning purposes and not comprehensive enough for boards.

Get more e-books from www.ketabton.com Ketabton.com: The Digital Library