HOLE'S ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY

LEARN · PRACTICE · ASSESS

Charles J. Welsh

Fourteenth Edition

Mc Graw Hill

HOLE'S ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY

Fourteenth Edition

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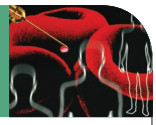

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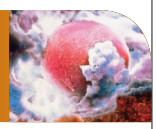

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ABOUT THE AUTHORS

Courtesy of Leeanna Smith

CHARLES J. WELSH began his Anatomy & Physiology teaching career upon graduating with a B.S. in Biology from the University of Pittsburgh in 1989. He entered graduate school in 1992 and continued teaching night classes. He accepted his first full-time teaching position at Clarion University of Pennsylvania in 1996. In 1997, he completed his Ph.D. in Comparative Anatomy, Evolutionary Biology, and Ornithology at the University of Pittsburgh. Teaching primarily in nursing and other allied health programs, he now brings his thirty years of classroom experience to the fourteenth edition of *Hole's Essentials of Human Anatomy & Physiology.* Since 2009, he has been teaching at Duquesne University in Pittsburgh, Pennsylvania. During this time, he has received several teaching awards, as well as the Mentor of the Year Award for training graduate students to teach Anatomy & Physiology. Chuck and his wife, Lori, have three children and three grandchildren. They live in the historic town of Harmony, thirty miles north of Pittsburgh, with their youngest son, where they raise chickens and have a huge garden.

CONTRIBUTOR

Cindy Prentice-Craver

CYNTHIA PRENTICE-CRAVER has been teaching human anatomy and physiology for over twenty years at Chemeketa Community College and is a member of the Human Anatomy and Physiology Society (HAPS). Cynthia's teaching experience both in grades 6–12 and in college, her passion for curriculum development, and her appetite for learning fuel her desire to write. Her M.S. in Curriculum and Instruction, B.S. in Exercise Science, and extended graduate course-work in biological sciences have been instrumental in achieving effective results in the online and on campus courses she teaches. Cynthia co-authored the Martin *Laboratory Manual for Human Anatomy & Physiology,* 4e. Beyond her professional pursuits, Cynthia's passions include reading and listening to books, attending exercise classes, walking outdoors, attending concerts, traveling, and spending time with her family.

DIGITAL AUTHORS

Leslie Day

LESLIE DAY earned her B.S. in Exercise Physiology from UMass Lowell, an M.S. in Applied Anatomy & Physiology from Boston University, and a Ph.D. in Biology from Northeastern University. She currently works for Texas A&M University in the College of Medicine teaching Anatomy and Neuroanatomy to dual major medical and engineering students. Leslie has won several university and national awards for her teaching, including the ADInstruments Sam Drogo Technology in the Classroom Award from the Human Anatomy and Physiology Society (HAPS). Her current research focuses on the effectiveness of technology and pedagogical approaches in an anatomy-based curriculum. She brings her love for anatomy and willingness to try new technology in the classroom, both in person and online, to make for a dynamic evidence-based teaching style that is inclusive for all students. She is excited to bring this approach to the digital content for this book.

Courtesy of Gary Pilcher

JULIE PILCHER began teaching during her graduate training in Biomedical Sciences at Wright State University, Dayton, Ohio. She found, to her surprise, that working as a teaching assistant held her interest more than her research. Upon completion of her Ph.D. in 1986, she embarked on her teaching career, working for many years as an adjunct in a variety of schools as she raised her four children. In 1998, she began teaching full-time at the University of Southern Indiana, Evansville. Her work with McGraw-Hill began with doing reviews of textbook chapters and lab manuals and in content development for LearnSmart. In her A&P course at USI, she used Connect and enjoyed the challenge of writing some of her own assignments. She later accepted the opportunity to be more involved in the authoring of digital content for McGraw-Hill, understanding the importance of such content to both the instructors and the students.

DEDICATION

To my wife, Lori, our three children, Leeanna, Timothy, and Brady, and our three grandchildren, Milla, Holden, and Carolina, for the love and joy they bring me.

To the memory of my parents, Margaret Susan and Herman Joseph Welsh, for their love and support of all my passions. Also to the memory of Dr. Robert J. Raikow, my mentor in graduate school. He saw the educator and scientist in me long before most. A true gentleman and scholar, his wisdom abounds throughout the pages of this book.

ACKNOWLEDGMENTS

I am honored and privileged to have directed the revision of this book that is based upon the hard work, efforts, and expertise of the previous authors: David Shier, Jackie Butler, Ricki Lewis, and John Hole, the original author of this classic work. I especially thank David Shier for his time and consultation during the revision. A project of this magnitude also requires the recognition of a large, dedicated, and talented team. I would like to thank the editorial team of Matt Garcia, Krystal Faust, and Michael Koot for their unwavering support and belief in my ability; marketing team Jim Connelly, Valerie Kramer, and Krissy Rellihan; and the production team of Ann Courtney, Sandy Ludovissy, David Hash, Beth Cray, and Brent dela Cruz. A thank you also goes to copyeditor Mike McGee and proofreaders Jennifer Grubba and Sharon O'Donnell for helping improve this work, and much thanks to Cindy Prentice-Craver for contributing considerably to the book with her keen eye and sharp pen. Provost Dr. David Dausey and the Dean, Dr. Philip Reeder of Duquesne University are thanked for their vision and support in granting me a leave during the preparation of the manuscript. Mark Cheskey and Glenn Sauer, my best friends since my formative years, are thanked for many hours of playing guitars and discussing music and sports when I needed such distractions. Most importantly, I thank my wife, Lori, for her love, patience, and more than thirty years of support for all of my academic endeavors.

REVIEWERS AND CONTRIBUTORS

A special thanks for the valuable contributions of all the professors, and their students, who have provided detailed recommendations for improving chapter content and illustrations, as well as suggestions regarding the development of ancillary resources for this new edition. They have played a vital role in building a solid foundation for *Hole's Essentials of Human Anatomy & Physiology.*

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A NOTE FROM THE AUTHOR

To the Student

Welcome! As you read this (with your eyes) and understand it (with your brain), perhaps turning to the next page (with muscle actions of your fingers, hand, forearm, and arm), you are using your body to do so. Indeed, some of you may be using your fingers, hand, forearm, and arm to read through the eBook on your computer, tablet, or smartphone. The structure and function of the human body can be complex, and comprehending the material might not always seem easy. But what could be more fascinating than learning about your own body? To assist your learning, the fourteenth edition of *Hole's Essentials of Human Anatomy & Physiology* continues the tradition of presenting material in a conversational, accessible style.

Many of you are on a path toward a career in health care, athletics, science, or education. If you have not yet committed to a particular area of study, be sure to check out the Career Corner in every chapter for ideas and inspiration. They present interesting options for future careers. Balancing family, work, and academics is challenging, but try to look at this course not as a hurdle along your way but as a stepping stone. The book has been written to help you succeed in your coursework and to help prepare you in your journey to a successful and rewarding career.

To the Teacher

Written for ease of readability and organized for classroom use, this text serves the student as well as the instructor. This fourteenth edition of *Hole's Essentials of Anatomy & Physiology* continues the Learn, Practice, Assess approach that has substantially contributed to instructional efficiency and student success.

Each chapter opens with Learning Outcomes, contains many opportunities to Practice throughout, and closes with Assessments that are closely tied to the Learning Outcomes. Instructors can assign these, and students can use these features not only to focus their study efforts, but also to take an active role in monitoring their own progress toward mastering the material. All of these resources are described in more detail in the Chapter Preview / Foundations for Success beginning on page 1. In addition, thanks to the expertise of Leslie Day and Julie Pilcher, the LearnSmart and Connect digital platforms continue to enhance the printed content and the Learn, Practice, Assess approach. We are proud to have developed and to offer the latest and most efficient technologies to support teaching and learning.

Chuck Welsh

NEW TO THIS EDITION

Global Changes

Chapter openers: Featuring new and contemporary chapter-opening vignettes that are relevant to today's students.

Chapter introductions: Revised for ease of readability and to capture student attention.

Chapter Assess Integrative Assessments/Critical Thinking: Questions added to every chapter.

Chapter structure: Streamlined section structures.

Facts of Life boxes: Are now titled "Of Interest."

Boxed material: Small boxes have been integrated into the text for better flow or have been transformed into Clinical Application boxes.

Art: Revised colors, and placement of colors, to create better contrast.

Learning and Practice Outcomes: Feature updated numbering structures to help streamline outcomes within the section.

Specific Chapter Changes

Chapter 1	Revised opening vignette.
	Figure 1.2 revised to show sense of hearing.
	Figure 1.3 revised to show levels of organization using the cardiovascular system.
	Figure 1.6 changed for ease of understanding.
Chapter 2	New opening vignette about gluten.
	Reorganized section on bonding.
	Figure 2.3 revised for better understanding.
	Figure 2.7 revised for better understanding.
	Reorganized and revised section on acids and bases.
	Rewrote section on pH.
Chapter 3	Figure 3.3 changed to better show various membrane proteins.
	Reorganized discussion of organelles.
	Reorganized and revised sections on membrane transport for clarity: diffusion, facilitated diffusion, osmosis, tonicity, and active transport.
	Figure 3.19 revised to show both pinocytosis and phagocytosis.
	Reorganized section on cell division.
Chapter 4	Figure 4.1 now gives a better explanation of anabolic versus catabolic reactions.
	Figures 4.2, 4.4, and 4.5 all now have hydrolysis and dehydration synthesis labels.
	Figure 4.9 shows the coupling of the anabolic and catabolic components of cellular respiration.
	Figure 4.10 edited for clarity.
Chapter 5	Reorganized Epithelial Tissues section.
	Rewrote section on glands.
	Figure 5.14 changed for clarity.
	Reorganized Connective Tissues section.
	Reorganized Types of Membranes section.
	Reorganized Muscle Tissues section.
	Rewrote Nervous Tissue section.
Chapter 6	New opening vignette about tattoos.
	Reorganized section on epidermis.
	Reorganized section on skin functions.
Chapter 7	New opening vignette about forensic skeletal analysis.
	Reorganized Bone Development, Growth, and Repair section.
	Reorganized sections on axial and appendicular skeleton.
Chapter 8	Rewrote section on muscle fatigue.
	Added discussion of fast versus slow muscle fibers.

continued next page–

NEW TO THIS EDITION

Specific Chapter Changes—*Continued*

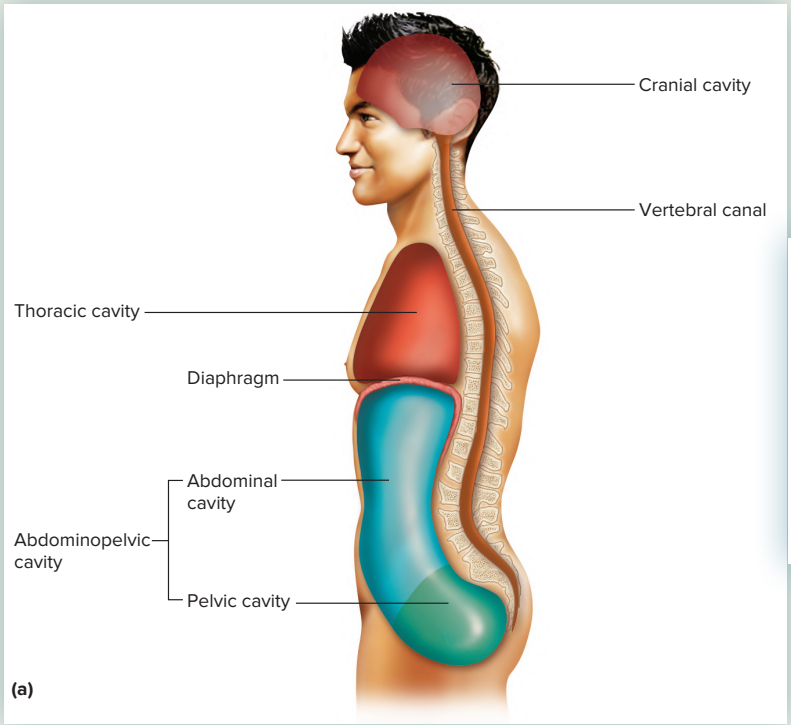
	Added discussion of isotonic versus isometric contraction.
	Revised Figure 8.13 for clarity and better color contrast.
	Reorganized Skeletal Muscle Actions section.
	Revised Figures 8.14 and 8.15 for clarity.
Chapter 9	New opening vignette about CTE.
	Figure 9.1 new to show nervous system input, integration, and output.
	Reorganized much of chapter for better flow and use in classroom.
	Reorganized section on neurons and neuroglia.
	Rewrote section on neuron structure.
	Added discussion of satellite cells.
	Figure 9.3 revised to show neurilemma.
	Rewrote sections on membrane potential and action potential for brevity and clarity.
	Figure 9.16 new to show graphs for excitation and inhibition.
Chapter 10	New opening vignette about cochlear implants.
	Added discussion of labeled line principle.
	Added section on proprioception and baroreceptors.
	Figure 10.2 new to show muscle spindles.
	Combined old Figure 10.2 with Figure 10.3 for clarity.
	Figure 10.24 new to show and explain nearsightedness and farsightedness.
Chapter 11	Reorganized chapter.
	Switched Figures 11.1 and 11.2 for better flow.
	Changed Figure 11.17 for clarity on the actions of insulin and glucagon.
	Made separate sections for the pineal and thymus glands.
Chapter 12	New opening vignette about blood doping.
	Revised sections on formed elements and red blood cell production.
	Figure 12.4 revised for clarity.
	Added new table for types of anemia.
	Figure 12.5 revised for clarity.
	Figure 12.7 revised for clarity.
	Revised section on white blood cell function.
	Revised sections on platelets and coagulation to include clinical relevance.
	Revised Figures 12.8, 12.9, and 12.20 for better coloring and clarity.
	Table 12.5 updated.
Chapter 13	Figure 13.2 new to add more detail.
	Section on blood flow through the heart, lungs, and tissues revised for clarity.
	Figure 13.6 now includes schematic of blood flow.
	Sections on heart actions reorganized and revised for clarity.
	Figure 13.23 changed to show more detail.
	Figure 13.24 expanded to show more detail.
Chapter 14	Reorganized chapter.
	Revised discussion on the complement system.
	Revised discussion of fever.
Chapter 15	Revised discussion of the teeth.
	Revised discussion of the pharynx and esophagus.
	Figure 15.12 now shows action of HCl on pepsinogen.
	Revised discussion of the liver and gallbladder.

Specific Chapter Changes—*Continued*

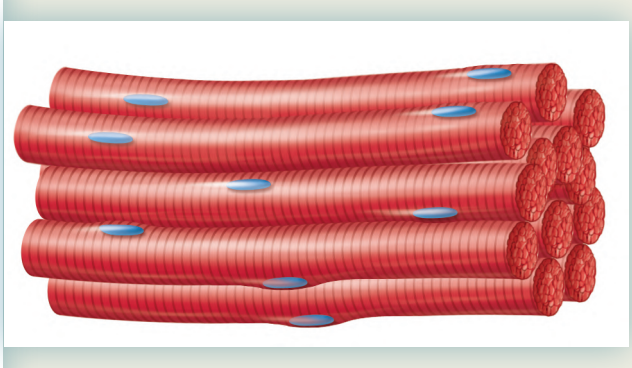
	Figure 15.17 now has hepatic triad labeled.
	Figure 15.18 now has schematic showing the blood flow into and out of a liver lobule.
Chapter 16	New opening vignette about the effects of cigarette smoke, and electronic cigarettes and vaping.
	Figure 16.1 edited for more detail.
	Revised discussion of pleural cavity.
	Figure 16.12 changed for more detail and clarity.
	Revised discussion of spirometry.
	Revised discussion of factors affecting breathing.
	Figure 16.17 changed to show neurological control over breathing.
	Figure 16.22 and 16.23 consolidated and revised to better show relationship between the bicarbonate buffering system, plasma, and red blood cells.
Chapter 17	Figure 17.1 revised to show transverse section.
	Reorganized and rewrote section on kidney structure for clarity.
	Section on renal blood supply revised for clarity.
	Figure 17.3 revised for clarity and to show two nephron types.
	Figure added to show renal blood flow.
	Section on nephron structure revised, along with associated Figure 17.7.
	Rewrote section on urine formation for clarity.
	Revised sections on glomerular filtration, filtration rate, and tubular reabsorption for clarity.
	Revised sections on the urethra and micturition and added discussion of incontinence.
Chapter 18	Revised discussion of body fluid composition.
	Edited label on Figure 18.1 for accuracy.
	Edited label on Figure 18.4.
	Revised introduction to electrolyte balance.
	Reorganized acid-base balance section.
Chapter 19	Revised Figure 19.2 for clarity and more detail.
	Reorganized section on organs of male reproductive system.
	Created new section on spermatogenesis.
	Created new section on oogenesis and the ovarian cycle.
	Figure 19.10 new for clarity and more detail.
Chapter 20	Created new section Aging: The Human Life Span.
	Reorganized Genetics section.
	Revised discussion of dominant and recessive inheritance.
	Figure 20.19 new to better show dominant and recessive inheritance.
	Created section on extensions to Mendelian inheritance to include discussions of pleiotropy, co-dominance, incomplete dominance, and multiple alleles.
	Expanded discussions of chromosomal inheritance and polygenic inheritance.
	Added figures to show inheritance of sex and trisomy 21.

DYNAMIC ART PROGRAM

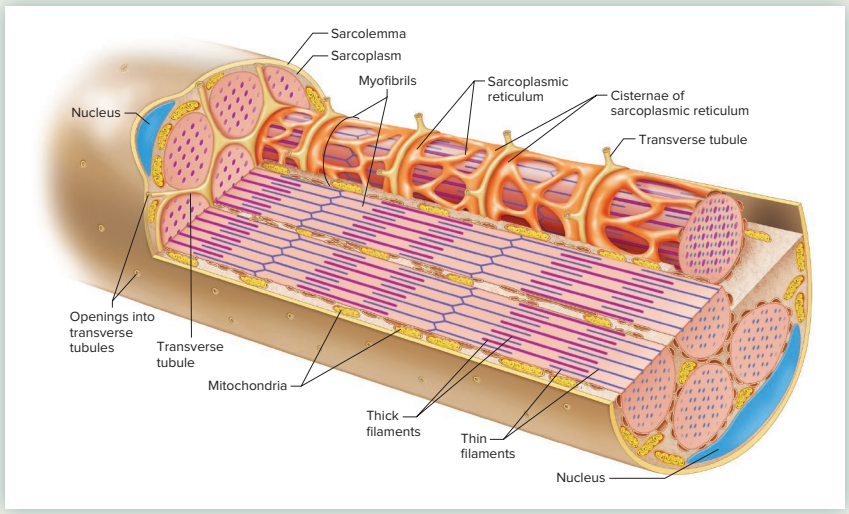
Art is vibrant, three-dimensional, and instructional. The authors examined every piece to ensure it was engaging and accurate. The fourteenth edition's art program will help students understand the key concepts of anatomy and physiology.



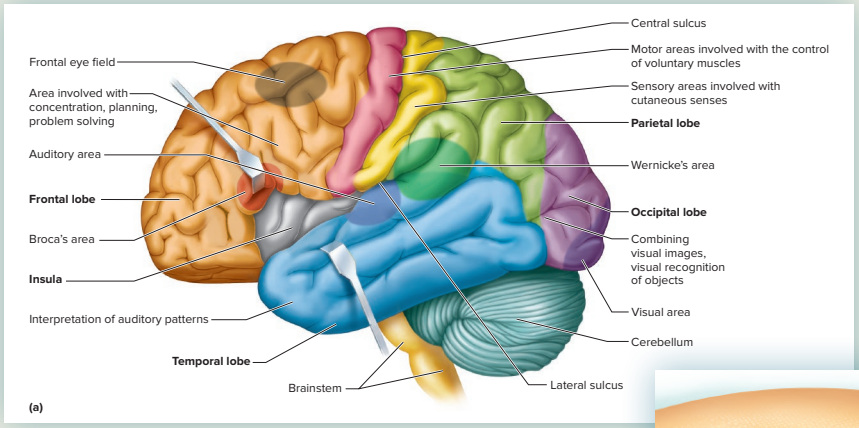
Realistic, three-dimensional figures provide depth and orientation.



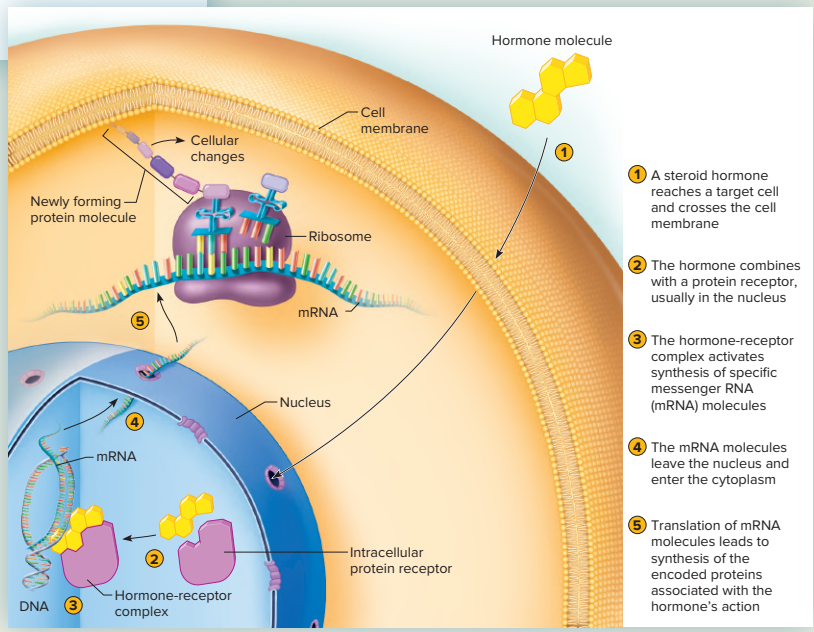
Line art for micrographs is three-dimensional to help students visualize more than just the flat microscopic sample.



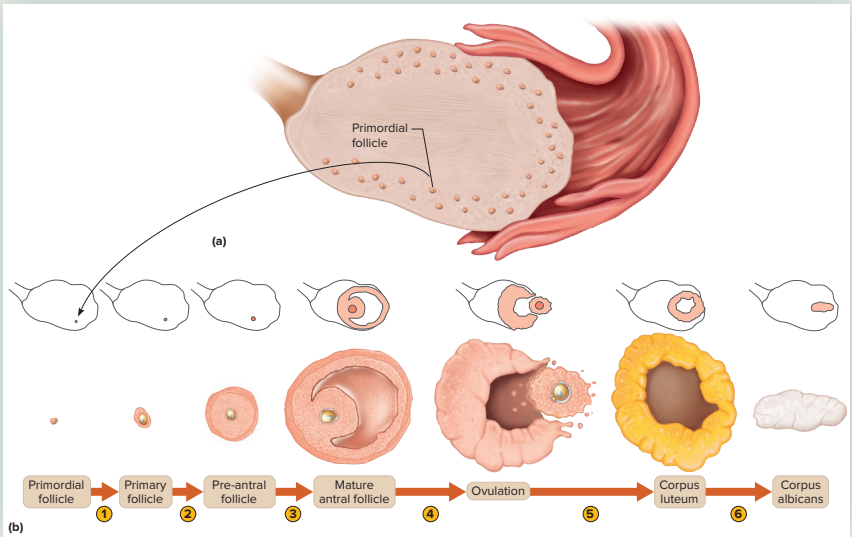
A longitudinal section shows the interior structures of a muscle fiber and reveals detail of the myofibrils, thick and thin filaments.



Colors readily distinguish functional areas.



The explanation is part of the figure, not lost in the legend.



Locator icons help portray the process more accurately.

Learn, Practice, Assess!

Learn

Learning Outcomes have been moved! They now follow the appropriate heading within the chapter. They continue to be closely linked to Chapter Assessments and Integrative Assessments/Critical Thinking questions found at the end of each chapter.

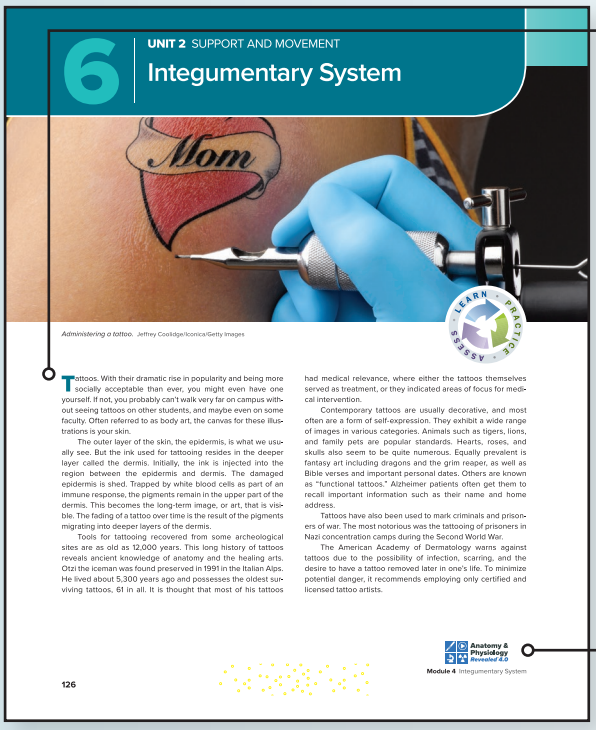
8.2 | Structure of a Skeletal Muscle

LEARN

1. Identify the structures that make up a skeletal muscle.
2. Identify the major parts of a skeletal muscle fiber, and the function of each.
3. Discuss nervous stimulation of a skeletal muscle.

Learning tools to help you succeed . . .

Check out the Chapter Preview, *Foundations for Success,* on page 1. The Chapter Preview was specifically designed to help you **LEARN** how to study. It provides helpful study tips.


UNIT 2 SUPPORT AND MOVEMENT

6 Integumentary System

Administering a tattoo. Jeffrey Coolidge/Iconica/Getty Images

Tattoos. With their dramatic rise in popularity and being more socially acceptable than ever, you might even have one yourself. If not, you probably can't walk very far on campus without seeing tattoos on other students, and maybe even on some faculty. Often referred to as body art, the canvas for these illustrations is your skin.

The outer layer of the skin, the epidermis, is what we usually see. But the ink used for tattooing resides in the deeper layer called the dermis. Initially, the ink is injected into the region between the epidermis and dermis. The damaged epidermis is shed. Trapped by white blood cells as part of an immune response, the pigments remain in the upper part of the dermis. This becomes the long-term image, or art, that is visible. The fading of a tattoo over time is the result of the pigments migrating into deeper layers of the dermis.

Tools for tattooing recovered from some archeological sites are as old as 12,000 years. This long history of tattoos reveals ancient knowledge of anatomy and the healing arts. Otzi the iceman was found preserved in 1991 in the Italian Alps. He lived about 5,300 years ago and possesses the oldest surviving tattoos, 61 in all. It is thought that most of his tattoos had medical relevance, where either the tattoos themselves served as treatment, or they indicated areas of focus for medical intervention.

Contemporary tattoos are usually decorative, and most often are a form of self-expression. They exhibit a wide range of images in various categories. Animals such as tigers, lions, and family pets are popular standards. Hearts, roses, and skulls also seem to be quite numerous. Equally prevalent is fantasy art including dragons and the grim reaper, as well as Bible verses and important personal dates. Others are known as "functional tattoos." Alzheimer patients often get them to recall important information such as their name and home address.

Tattoos have also been used to mark criminals and prisoners of war. The most notorious was the tattooing of prisoners in Nazi concentration camps during the Second World War.

The American Academy of Dermatology warns against tattoos due to the possibility of infection, scarring, and the desire to have a tattoo removed later in one's life. To minimize potential danger, it recommends employing only certified and licensed tattoo artists.

Anatomy & Physiology Revealed 4.0

Module 4 Integumentary System

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Vignettes lead into chapter content. They connect you to many areas of health care, including technology, physiology, medical conditions, historical perspectives, and careers.

Anatomy & Physiology REVEALED® (APR) icon at the beginning of each chapter tells you which system in APR applies to this chapter.

Aids to Understanding Words examines root words, stems, prefixes, suffixes, and pronunciations to help you build a solid anatomy and physiology vocabulary.

Reference Plates offer vibrant detail of body structures.

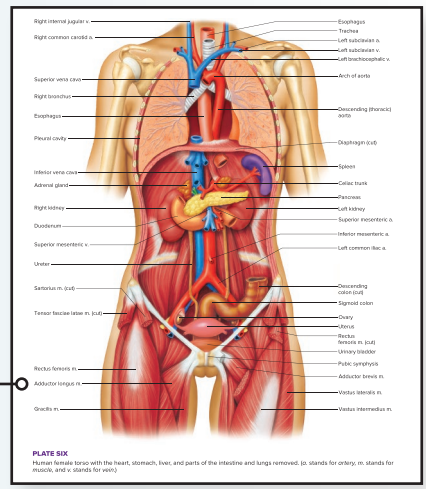


PLATE SIX

Human female torso with the heart, stomach, liver, and parts of the intestine and lungs removed. (a. stands for artery, m. stands for muscle, and v. stands for vein.)

Practice

Practice with a question or series of questions after major sections. They will test your understanding of the material.

Interesting applications help you practice and apply knowledge . . .

Figure Questions allow an additional assessment. They are found on key figures throughout the chapter.

PRACTICE 1.6

1. Which organ occupies the cranial cavity? The vertebral canal?
2. What does *viscera* mean?
3. Name the cavities of the head.
4. Describe the membranes associated with the thoracic and abdominopelvic cavities.

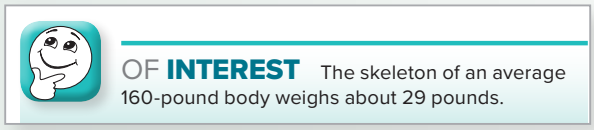
Figure 8.5 A neuromuscular junction includes the end of a motor neuron and the motor end plate of a muscle fiber. APR

PRACTICE FIGURE 8.5

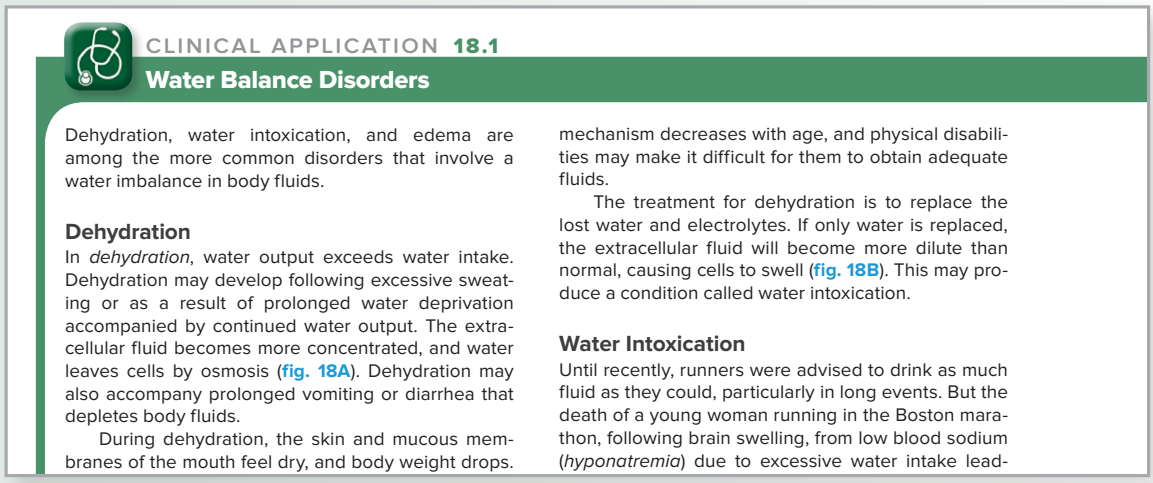
How does acetylcholine released into the synaptic cleft reach the muscle fiber membrane?

Answer can be found in Appendix E.

"Of Interest" boxes provide interesting bits of anatomy and physiology information, adding a touch of wonder to chapter topics.


OF **INTEREST** The skeleton of an average 160-pound body weighs about 29 pounds.

Clinical Application sections present disorders, physiological responses to environmental factors, and other topics of general interest and applies them to clinical situations.


CLINICAL APPLICATION **18.1**

Water Balance Disorders

Dehydration, water intoxication, and edema are among the more common disorders that involve a water imbalance in body fluids.

Dehydration

In *dehydration*, water output exceeds water intake. Dehydration may develop following excessive sweating or as a result of prolonged water deprivation accompanied by continued water output. The extracellular fluid becomes more concentrated, and water leaves cells by osmosis (fig. 18A). Dehydration may also accompany prolonged vomiting or diarrhea that depletes body fluids.

During dehydration, the skin and mucous membranes of the mouth feel dry, and body weight drops. mechanism decreases with age, and physical disabilities may make it difficult for them to obtain adequate fluids.

The treatment for dehydration is to replace the lost water and electrolytes. If only water is replaced, the extracellular fluid will become more dilute than normal, causing cells to swell (fig. 18B). This may produce a condition called water intoxication.

Water Intoxication

Until recently, runners were advised to drink as much fluid as they could, particularly in long events. But the death of a young woman running in the Boston marathon, following brain swelling, from low blood sodium (*hyponatremia*) due to excessive water intake lead-

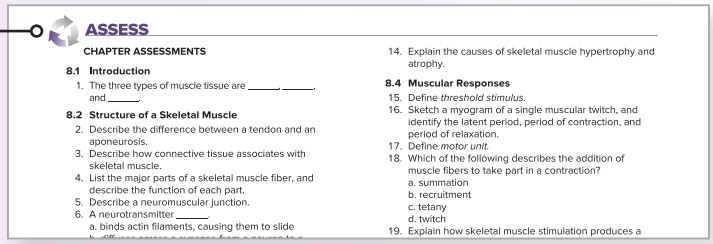
Assess

Tools to help you make the connection and master Anatomy and Physiology!

Chapter Assessments check your understanding of the chapter's learning outcomes.

Integrative Assessments/Critical Thinking questions allow you to connect and apply information from previous chapters, as well as information within the current chapter.

Chapter Summary Outlines help you review the chapter's main ideas.


ASSESS

CHAPTER ASSESSMENTS

8.1 Introduction

1. The three types of muscle tissue are _____, _____, and _____.

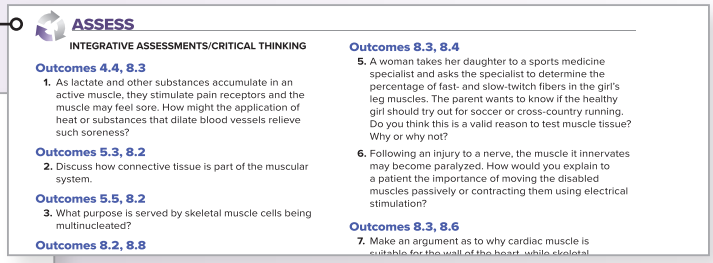
8.2 Structure of a Skeletal Muscle

2. Describe the difference between a tendon and an aponeurosis.
3. Describe how connective tissue associates with skeletal muscle.
4. List the major parts of a skeletal muscle fiber, and describe the function of each part.
5. Describe a neuromuscular junction.
6. A neurotransmitter _____.
   a. binds actin filaments, causing them to slide

14. Explain the causes of skeletal muscle hypertrophy and atrophy.

8.4 Muscular Responses

15. Define *threshold stimulus*.
16. Sketch a myogram of a single muscular twitch, and identify the latent period, period of contraction, and period of relaxation.
17. Define *motor unit*.
18. Which of the following describes the addition of muscle fibers to take part in a contraction?
    a. summation
    b. recruitment
    c. tetany
    d. twitch
19. Explain how skeletal muscle stimulation produces a


ASSESS

INTEGRATIVE ASSESSMENTS/CRITICAL THINKING

Outcomes 4.4, 8.3

1. As lactate and other substances accumulate in an active muscle, they stimulate pain receptors and the muscle may feel sore. How might the application of heat or substances that dilate blood vessels relieve such soreness?

Outcomes 5.3, 8.2

2. Discuss how connective tissue is part of the muscular system.

Outcomes 5.5, 8.2

3. What purpose is served by skeletal muscle cells being multinucleated?

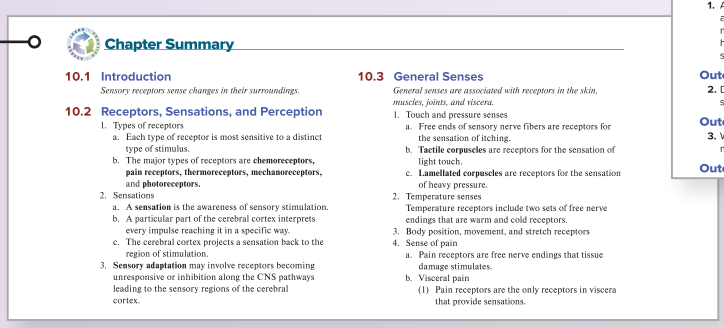
Outcomes 8.2, 8.8

Outcomes 8.3, 8.4

5. A woman takes her daughter to a sports medicine specialist and asks the specialist to determine the percentage of fast- and slow-twitch fibers in the girl's leg muscles. The parent wants to know if the healthy girl should try out for soccer or cross-country running. Do you think this is a valid reason to test muscle tissue? Why or why not?
6. Following an injury to a nerve, the muscle it innervates may become paralyzed. How would you explain to a patient the importance of moving the disabled muscles passively or contracting them using electrical stimulation?

Outcomes 8.3, 8.6

7. Make an argument as to why cardiac muscle is


Chapter Summary

10.1 Introduction

Sensory receptors sense changes in their surroundings.

10.2 Receptors, Sensations, and Perception

1. Types of receptors
   a. Each type of receptor is most sensitive to a distinct type of stimulus.
   b. The major types of receptors are **chemoreceptors, pain receptors, thermoreceptors, mechanoreceptors,** and **photoreceptors.**
2. Sensations
   a. A **sensation** is the awareness of sensory stimulation.
   b. A particular part of the cerebral cortex interprets every impulse reaching it in a specific way.
   c. The cerebral cortex projects a sensation back to the region of stimulation.
3. **Sensory adaptation** may involve receptors becoming unresponsive or inhibition along the CNS pathways leading to the sensory regions of the cerebral cortex.

10.3 General Senses

General senses are associated with receptors in the skin, muscles, joints, and viscera.

1. Touch and pressure senses
   a. Free ends of sensory nerve fibers are receptors for the sensation of itching.
   b. **Tactile corpuscles** are receptors for the sensation of light touch.
   c. **Lamellated corpuscles** are receptors for the sensation of heavy pressure.
2. Temperature senses
   Temperature receptors include two sets of free nerve endings that are warm and cold receptors.
3. Body position, movement, and stretch receptors
4. Sense of pain
   a. Pain receptors are free nerve endings that tissue damage stimulates.
   b. Visceral pain
      (1) Pain receptors are the only receptors in viscera that provide sensations.

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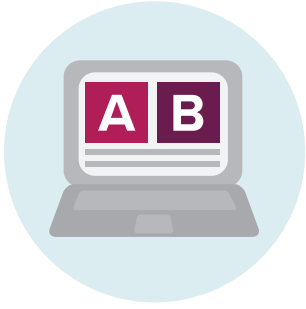

Practice Atlas for A&P is an interactive tool that pairs images of common anatomical models with stunning cadaver photography, allowing students to practice naming structures on both models and human bodies, anytime, anywhere. The result? Students are better prepared, engaged, and move beyond basic memorization.

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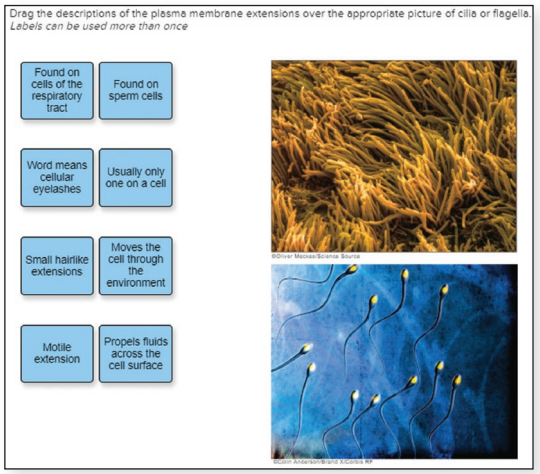
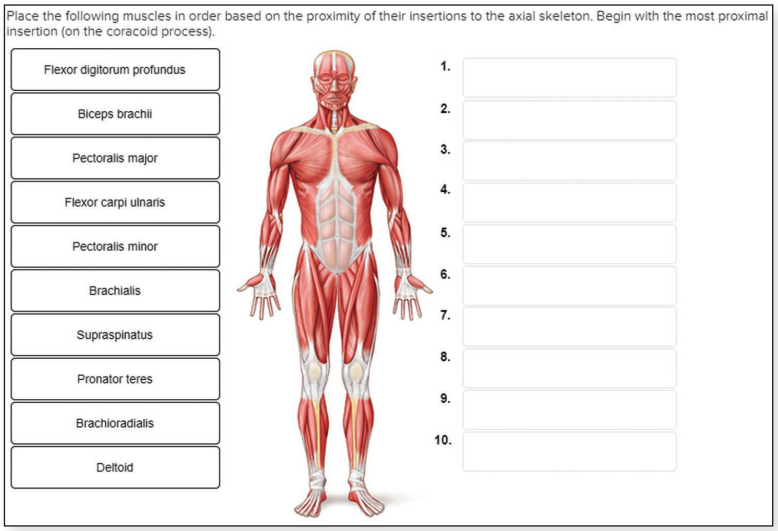
*Statistic courtesy of *The New England Journal of Higher Education*

DIGITAL & LAB EXPERIENCE

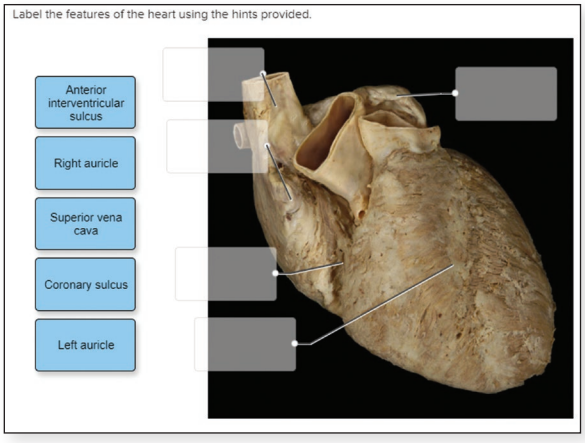
In this edition of *Hole's Essentials of Human Anatomy & Physiology,* the digital author team, Leslie Day and Julie Pilcher, worked hand-in-hand with the print author team to deliver a seamless experience for instructors and students.

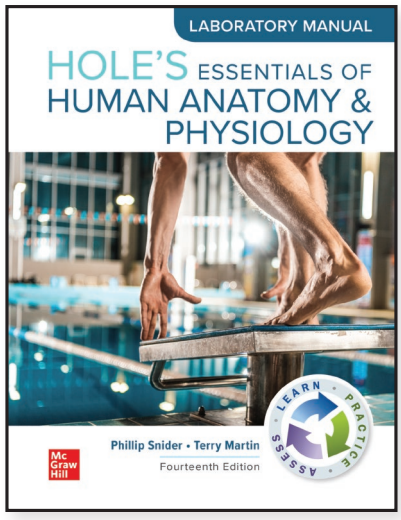
The digital authors make sure there is a variety of questions with different Bloom's Taxonomy levels. In this edition, we have increased the number of questions that are higher-level Bloom's to about 30 percent.





Leslie and Julie ensure that there is an appropriate number of questions for each learning outcome in the chapter. They tagged questions to textbook learning outcomes and to the Human Anatomy & Physiology Society (HAPS) learning outcomes. This makes it easy for instructors to find questions to assign in their course.





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Laboratory Manual

Laboratory Manual for Hole's Essentials of Human Anatomy & Physiology, Fourteenth Edition, by Phillip Snider, Gadsden State Community College, and Terry R. Martin, Kishwaukee College, is designed to accompany the fourteenth edition of *Hole's Essentials of Human Anatomy & Physiology.*

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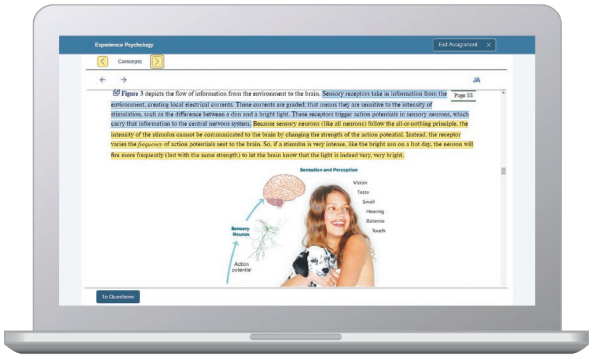

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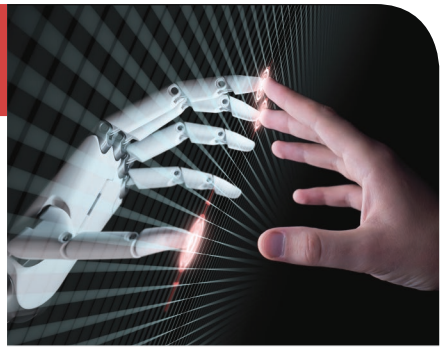

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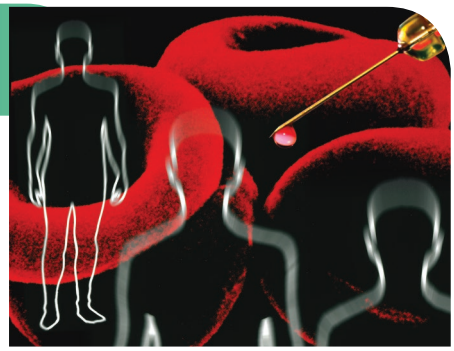

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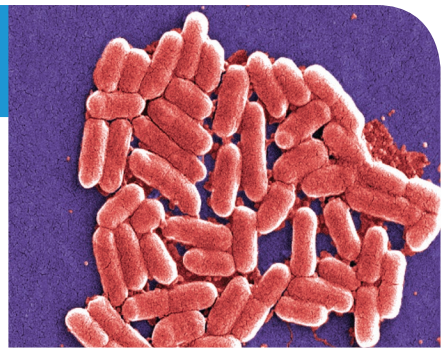

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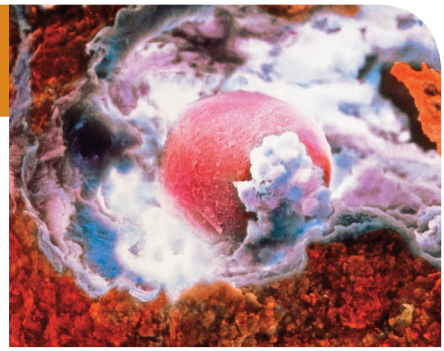

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PREVIEW

Foundations for Success

A photo on the opening page for each chapter generates interest.
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AN OPENING VIGNETTE discusses current events or research news relating to the subject matter in the chapter. These vignettes apply the concepts learned in the study of anatomy and physiology.

Pay attention. It is a beautiful day. You can't help but stare wistfully out the window, the scent of spring blooms and sound of birds making it impossible to concentrate on what the instructor is saying. Gradually the lecture fades as you become aware of your own breathing, the beating of your heart, and the sweat that breaks out on your forehead in response to the radiant heat from the glorious day. Suddenly your reverie is cut short—a classmate has dropped a human anatomy and physiology textbook on the floor. You jump. Your heart hammers and a flash of fear grips your chest, but you soon realize what has happened and recover.

The message is clear: Pay attention. So you do, tuning out the great outdoors and focusing on the class. In this course, you will learn all about the events you have just experienced, including your response to the sudden stimulation. This is a good reason to stay focused.

This chapter Preview not only provides great study tips to offer a foundation for success, but it also offers tips on how to utilize this particular text. Those tips will be found in boxes just like this.

This digital tool, as indicated below and with the APR icons within the chapters, allows you to explore the human body in depth through simulated dissection of cadavers and histology preparations. It also offers animations on chapter concepts.

Anatomy & Physiology Revealed 4.0

LEARNING OUTLINE

After studying this chapter, you should be able to complete the "Learning Outcomes" that follow the major headings throughout the chapter.

P.1 Introduction
P.2 Strategies for Your Success

Each chapter has a learning outline introducing what will be discussed in the chapter.

The section below introduces building blocks of words that your instructor may assign. Learning them is a good investment of your time, because they can be used over and over and apply to many of the terms you will use in your career. Appendix A has a comprehensive list of these prefixes, suffixes, and root words.

AIDS TO UNDERSTANDING WORDS

ana- [up] *ana*tomy: the study of breaking up the body into its parts.

multi- [many] *multi*tasking: performing several tasks simultaneously.

physio- [relationship to nature] *physio*logy: the study of how body parts function.

(Appendix A has a complete list of Aids to Understanding Words.)

Major divisions within a chapter are called "A-heads." They are numbered sequentially and set in very large, blue type to designate major content areas.

P.1 | Introduction

After each A-head is a list of learning outcomes indicating the knowledge you should gain as you work through the section. (Note the blue learn arrow preceding the "LEARN" heading.) These outcomes are intended to help you master the similar outcomes set by your instructor. The outcomes are tied directly to assessments of knowledge gained.

LEARN

1. Explain the importance of an individualized approach to learning.

Studying the human body can be overwhelming at times. The new terminology, used to describe body parts and how they work, can make it seem as if you are studying a foreign language. Learning all the parts of the body, along with the composition of each part, and how each part fits with the other parts to make the whole requires memorization. Understanding the way each body part works individually, as well as body parts working together, requires a higher level of knowledge, comprehension, and application. Identifying underlying structural similarities, from the macroscopic to the microscopic levels of body organization, taps more subtle critical thinking skills. This chapter will catalyze success in this active process of learning. (Remember that although the skills and tips discussed in this chapter relate to learning anatomy and physiology, they can be applied to other subjects.)

Learning occurs in different ways or modes. Most students use several modes (multimodal), but are more comfortable with and use more effectively one or two, often referred to as learning styles. Some students prefer to read the written word to remember it and the concept it describes, or to actually write the words; others learn best by looking at visual representations, such as photographs and drawings. Still others learn most effectively by hearing the information or explaining it to someone else. For some learners, true understanding remains elusive until a principle is revealed in a laboratory or clinical setting that provides a memorable context and engages all of the senses. This text accommodates the range of learning styles. Read-write learners will appreciate the lists, definitions (glossary), and tables. Visual learners will discover many diagrams, flow charts, and figures, all with consistent and purposeful use of color. For example, a particular bone is always the same color in figures where bones are color-coded. Auditory learners will find pronunciations for new scientific terms to help sound them out, and kinesthetic learners can relate real-life examples and applications to their own activities.