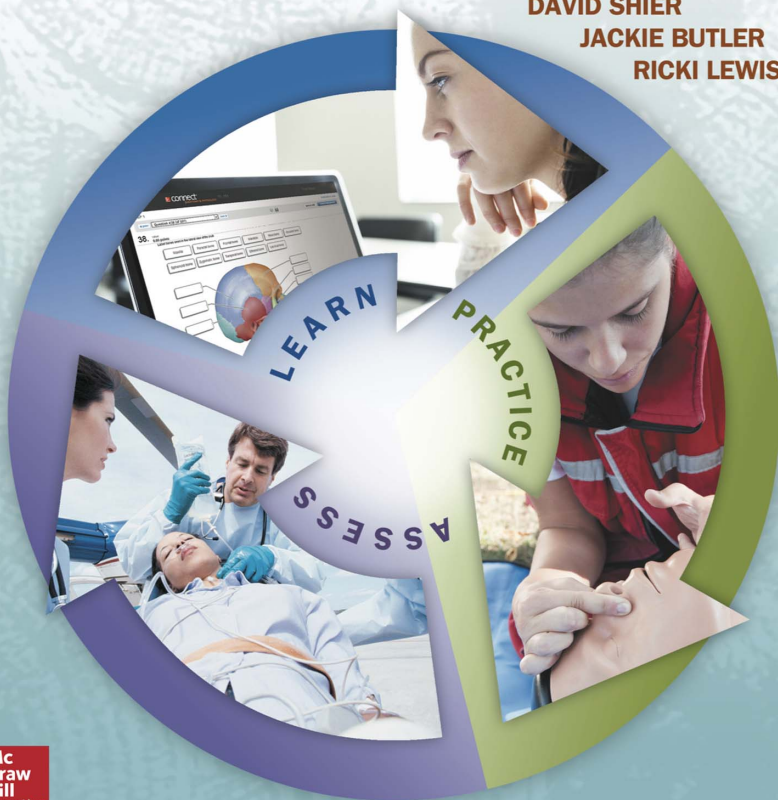


HOLE'S HUMAN ANATOMY & PHYSIOLOGY

FOURTEENTH EDITION

DAVID SHIER
JACKIE BUTLER
RICKI LEWIS



HOLE'S HUMAN ANATOMY & PHYSIOLOGY

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HOLE'S HUMAN ANATOMY & PHYSIOLOGY, FOURTEENTH EDITION

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ABOUT THE AUTHORS



DAVID SHIER

Washtenaw Community College

David Shier has more than thirty years of experience teaching anatomy and physiology, primarily to premedical, nursing, dental, and allied health students. He has effectively incorporated his extensive teaching experience into another student-friendly revision of *Hole's Essentials of Human Anatomy and Physiology* and *Hole's Human Anatomy and Physiology*. His interest in physiology and teaching began with a job as a research assistant at Harvard Medical School from 1976–1979. He completed his Ph.D. at the University of Michigan in 1984, and served on the faculty of the Medical College of Ohio from 1985–1989. He began teaching at Washtenaw Community College in 1990. David has recent experience in online course delivery, including recording lectures for so-called “flipped” classrooms. He has also been interested in the relationship between pedagogy and assessment, and the use of tools traditionally associated with assessment (e.g., lab quizzes) as pedagogical tools, often associated with group activities.



JACKIE BUTLER

Grayson College

Jackie Butler's professional background includes work at the University of Texas Health Science Center conducting research about the genetics of bilateral retinoblastoma. She later worked at Houston's M. D. Anderson Hospital investigating remission in leukemia patients. A popular educator for more than thirty years at Grayson College, Jackie has taught microbiology and human anatomy and physiology for health science majors. Her experience and work with students of various educational backgrounds have contributed significantly to another revision of *Hole's Essentials of Human Anatomy and Physiology* and *Hole's Human Anatomy and Physiology*. Jackie Butler received her B.S. and M.S. degrees from Texas A&M University, focusing on microbiology, including courses in immunology and epidemiology.



RICKI LEWIS

Alden March Bioethics Institute

Ricki Lewis's career communicating science began with earning a Ph.D. in Genetics from Indiana University in 1980. It quickly blossomed into writing for newspapers and magazines, and writing the introductory textbook *Life*. Since then she has taught a variety of life science courses and has authored the textbook *Human Genetics: Concepts and Applications* and books about gene therapy, stem cells, and scientific discovery. She is a genetic counselor for a large medical practice, teaches a graduate online course in “Genethics” at Albany Medical College, and writes for Medscape, the Multiple Sclerosis Discovery Forum, and Scientific American. Ricki writes the popular DNA Science blog at Public Library of Science and is a frequent public speaker.

Digital Authors



Leslie Day
Northeastern University

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 with her research on the kinematics of locomotion. She currently works as an Assistant Clinical Professor in the Physical Therapy Department of Northeastern University with her main teaching role in Gross Anatomy and Neuroanatomy courses. Students enjoy her clinical teaching style and use of technology. She has received the teaching with technology award three times and in 2009 was awarded the Excellence in Teaching Award. She has been asked to speak about teaching with technology at national conferences and to give workshops on gross anatomy to a variety of professionals. She has also worked as a personal trainer both in local fitness facilities and at clients' homes, a strength and conditioning coach for collegiate athletic teams, an Assistant Groups Exercise Director for Healthworks and Group Exercise, and Fitness Director of three sites for Gold's Gym.



Julie C. Pilcher
University of Southern Indiana

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 full-time at the University of Southern Indiana, Evansville. Her work with McGraw-Hill began several years ago, doing reviews of textbook chapters and lab manuals. More recently, she has been involved in content development for LearnSmart. In her A&P course at USI, she has also used Connect and has enjoyed the challenge of writing some of her own assignments. When the opportunity arose to become more involved in the authoring of digital content for McGraw-Hill, she could not pass it up. Based on her own experience, students are using more and more online resources, and she is pleased to be part of that aspect of A&P education.

ACKNOWLEDGMENTS

Any textbook is the result of hard work by a large team. Although we directed the revision, many “behind-the-scenes” people at McGraw-Hill were indispensable to the project. We would like to thank our editorial team of Marty Lange, Michael Hackett, Jim Connely, and Fran Simon; Jessica Cannavo, Marketing Manager, and our production team, which included Jayne Klein, Sandy

Ludovissy, Tara McDermott, and John Leland; and most of all, John Hole, for giving us the opportunity and freedom to continue his classic work. We also thank our wonderfully patient families for their support.

David Shier, Jackie Butler, Ricki Lewis

REVIEWERS

We would like to acknowledge the valuable contributions of all professors and their students who have provided detailed recommendations for improving chapter content and illustrations throughout the revision process for each edition. Hundreds of professors have played a vital role in building a solid foundation for *Hole’s Human Anatomy & Physiology*.

Patricia Adumanu Ahanotu, *Georgia Perimeter College*
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Ali Mustafa, *Hesser College/Kaplan*
Necia Morgan Nicholas, *Calhoun Community College*

DEDICATION

This book is dedicated with much affection and appreciation to Sherrie and Terry Martin, colleagues and friends whose passion for improving the learning experiences of their students has enriched our perspectives as teachers and as authors.

UPDATES AND ADDITIONS

Global Changes

- WHOLE PICTURE overview replaces chapter vignettes.
- Career Corner describes a specific career opportunity for each chapter.
- Updated small boxes.
- New art program throughout.
- We have consistently avoided the names of specific individuals in boxes and clinical application pieces. We feel that the interest gained by including names is outweighed by the need to instill in our students the importance of patient confidentiality.

SELECTED SPECIFIC CHANGES AT-A-GLANCE

Chapter	Topic	Change	Rationale
1	Fluid compartments	Introduced in more detail in text and with new figure 1.5	Clarity, detail
1	Organ systems	Reorganized and rewritten, old figure 1.5 relocated	Clarity, detail
1	Body regions	Terminology updated, new photos accompany figure 1.24	Clarity, consistency with usage
2	Atoms and elements	Text rewritten	Clarity
2	Polar bonds	Text rewritten	Clarity
2	Acidosis and alkalosis	Rewritten introduction of terms	Clarity
2	Protein structure	Figure 2.19 redesigned	Clarity
3	Membrane proteins	Integral, transmembrane, and peripheral proteins better described in text and in figure 3.7	Clarity, detail
3	Organelles	Endoplasmic reticulum, Golgi apparatus, and polysome sections rewritten	Clarity, accuracy
3	Organelles	Phospholipid bilayer membrane structure emphasized where appropriate	Accuracy, detail
3	Overview of secretion processes	Figure 3.11 redrawn	Accuracy, clarity
3	Nonmotile cilia	Description expanded and added to text	Update
3	Osmosis	Section rewritten	Clarity, accuracy
4	Catalysts	Enzymes described as organic catalysts	Clarity, accuracy, detail
4	Metabolic cycle	New figure 4.9 shows how a metabolic pathway can form a cycle, prior to introducing the citric acid cycle	Clarity
4	Protein synthesis	Series of figures redone	Clarity
5	Thin sections	New figure 5.2 to help students understand orientation of micrographs	Clarity
5	Connective tissue	Table 5.6 reorganized to clarify cellular versus matrix components	Clarity
5	Adipose tissue	New discussion of brown fat	New information
6	Squamous cell carcinoma	Figure added to Clinical Application 6.1	Expanded discussion
6	Nails	Figure 6.6 expanded to include a longitudinal section and a dorsal view	Clarity
6	Hair follicles	Hair bulge included in discussion and in art	Update
6	Sweat glands	Merocrine (eccrine) terminology explained	Clarity

—Continued

UPDATES AND ADDITIONS

SELECTED SPECIFIC CHANGES AT-A-GLANCE —Continued

Chapter	Topic	Change	Rationale
6	Apocrine sweat glands	Expanded discussion	New information
7	Types of bones	Figure 7.1 color coded to help students identify bone locations	Clarity
7	Intramembranous bones	Expanded discussion, table 7.1 steps rewritten, and new figure 7.8	Clarity
7	Vertebral column	Figure 7.37 color coded to help students identify bone locations	Clarity
7	Sulcus	Term added to table 7.4	Clarity
8	Joint movements	Nonaxial, uniaxial, and multiaxial added to discussion and to table 8.1	Terminology update
8	Joint movements	Lateral flexion added	Terminology update
9	Organization of muscle	New table 9.1 replaces part of figure 9.2	Clarity
9	Muscle locations	Descriptions do not use the term "extend" because of potential confusion with muscle action	Clarity
9	Thick and thin muscle filaments	Figure 9.4 redone	Accuracy, clarity
9	Stimulus for contraction	Reorganized and rewritten to include sodium and potassium ion gradients and the concept of an action potential	Clarity
9	Myoglobin	Description rewritten	Clarity, accuracy
9	Lactic acid	Relationship to lactate clarified and role in muscle fatigue rewritten	Accuracy, update
9	Interaction of skeletal muscles	Rewritten section on agonist, antagonist, prime mover, and synergist	Clarity, clinical relevance
9	Agonist versus prime mover	Rewritten	Clarity
9	Major skeletal muscles	New section on popular versus anatomical terminology	Clarity
9	Muscle actions	Terms for movements from chapter 8 are used throughout (e.g., elevates instead of raises)	Clarity, consistency
9	Scalene muscles	Added to list of muscles and actions, with reference to role in breathing	Detail
9	Ligamentum nuchae	Added to text and table 9.3	Detail
9	Movements at shoulder and hip	Shoulder and hip flexion and extension are clarified in their respective sections	Clarity
9	Pelvic floor	Central tendon now included in text, table 9.12, and figure 9.36	Accuracy, consistency
10	Ganglia and nuclei	Introduced with classification of neurons	Clarity
10	Electrical synapses	Introduced in new boxed material	Detail
10	Action potential	Section rewritten with redesigned figures showing relationship to graded potentials and threshold	Detail, clarity
10	Refractory period	Section rewritten	Clarity
10	Neurotransmitters	Rewritten section on excitatory and inhibitory effects of neurotransmitters	Clarity, detail

SELECTED SPECIFIC CHANGES AT-A-GLANCE —Continued

Chapter	Topic	Change	Rationale
11	Brain and spinal cord	Sections are reordered with brain first	Clarity
11	Brain	Improved lateral brain figure 11.8a and related pieces	Clarity
11	CSF	Reworked discussion	Clarity
11	Memory	Section rewritten	Clarity
11	Brainstem	Figure 11.11 revised with new location icon	Clarity
11	Types of sleep	Rewritten	Clarity
11	Cranial nerves	Section introduction rewritten	Clarity
11	Cranial nerves	New figure 11.25 with enlargement of olfactory nerve	Clarity, accuracy
11	Spinal nerves	Section on cauda equina rewritten	Accuracy
11	Segmental innervation	New figures 11.18 and 11.19 showing relationship among levels	Clinical relevance
11	Autonomic nervous system	New description of reciprocal innervation and functional relationships	Clarity
11	Autonomic nervous system	Figure 11.40 redesigned	Clarity, consistency
12	Visual pathways	New figure 12.40	Clarity
12	Vibration transfer in middle ear	Figure 12.12 redesigned	Clarity
12	Light	Rewritten without reference to particles or waves	Clarity, level
12	Refraction	Figure 12.35 redesigned	Accuracy
13	Chemical structures of hormones (throughout chapter)	Figures color matched with figures from chapter 2 (Chemistry)	Clarity
13	Mechanism of T3 and T4	Possible specific membrane transport mechanism added to discussion	Update
13	Phosphorylation	Text discussion expanded	Clarity, accuracy
13	Insulin and glucagon	Section partially rewritten	Clarity
13	Diabetes mellitus	New Clinical Application 13.4	Clarity, consistency
13	Stress response	Section partially rewritten	Clarity
14	Normal range of values	Blue box added	Clinical significance
14	Red blood cell formation	Nuclear extrusion clarified in text and in figure 14.4	Accuracy
14	Platelets	Section rewritten	Clarity, accuracy
14	Plasma	Section on plasma lipids expanded	Clinical significance
14	Coagulation	Terminology includes “tissue factor pathway” and “contact activation pathway”	Update
14	Antigens and antibodies	Section rewritten	Clarity
15	Pericardial membranes	Revised figure 15.3b	Clarity
15	Electrocardiogram	Updated figures for both normal and abnormal ECGs	Accuracy
15	SA node and depolarization pathway	Figure 15.18 redrawn	Accuracy

—Continued

UPDATES AND ADDITIONS

SELECTED SPECIFIC CHANGES AT-A-GLANCE —Continued

Chapter	Topic	Change	Rationale
15	Clinical Application 15.2	Rewritten sections on aneurysm and on edema	Clarity
15	Aortic bodies	Sensing blood pH added as a function	Accuracy, clinical relevance
16	Lymphatic vessels	Cisterna chyli added to text	Accuracy
16	Lymphatic capillaries	Figure 16.8 redesigned	Clarity
16	Primary and secondary immune response	“Anamnestic” and “antibody titer” added to discussion.	Accuracy
16	Hypersensitivity responses	New table 16.10	Clarity, clinical relevance
16	HIV/AIDS	Updated Clinical Application 16.1	Clinical relevance
17	Gut microbiome	Examples now appear throughout chapter	Clinical significance
17	Pharynx	Figure 17.13 redesign shows relationship of pharyngeal muscles and lumen more clearly	Clarity, accuracy
17	Swallowing	Figure 17.14 muscles are now shown in section in context of mucous membranes to better illustrate process	Clarity
17	Mesentery	Figure 17.31 redrawn with sectional plane and enlargement	Clarity
18	Obesity	Updated Clinical Application 18.1	Clinical relevance
18	Vitamin D requirements	Updated table 18.6	Clinical relevance
18	Water-soluble vitamins	Table 18.8 RDA values updated	Clinical relevance
18	Major minerals	Table 18.9 RDA values updated	Clinical relevance
18	Trace elements	Table 18.10 RDA values updated	Clinical relevance
18	Dietary supplements	New material and table added to Clinical Application 18.2	Clinical relevance
19	Pharynx	Section rewritten to include subdivisions	Clarity, accuracy
19	Air Pollution	New section added to Clinical Application 19.2	Clinical relevance
19	Inspiration	Scalene muscles added	Detail, accuracy
19	Respiratory volumes and capacities	Figure 19.26 color-coded to highlight relationships	Clarity
19	Alveolar ventilation	Section expanded	Clarity
19	Factors affecting breathing	Section rewritten	Clarity
19	Carbon monoxide	Clinical Application 19.3 rewritten	Update
19	Gas transport	Section on carbon dioxide transport rewritten, including its importance in acid-base balance	Update, clarity
20	Vasa recta	Introduced earlier under renal blood vessels	Accuracy, clarity
20	Cortical versus juxtamedullary nephrons	Introduced earlier in text and in new figure 20.6	Clarity
20	Nephron structure	New diagrammatic figure 20.10	Clarity
20	Overview of urinary system structures	New figure 20.12	Clarity

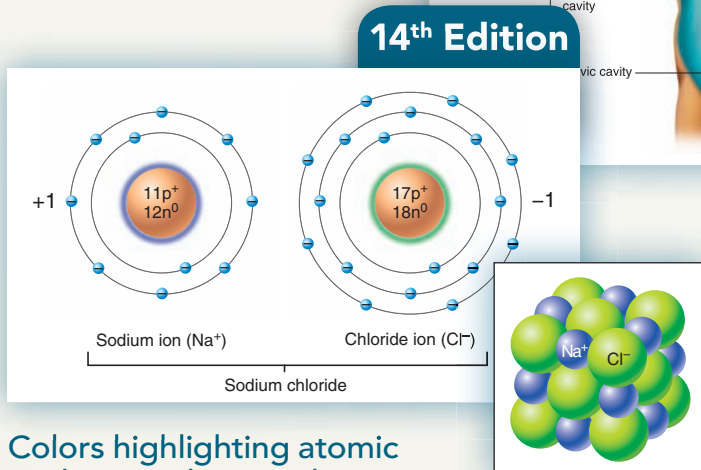
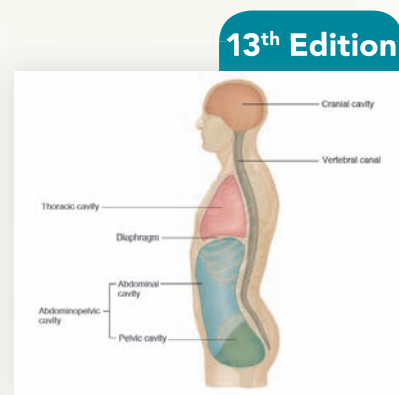
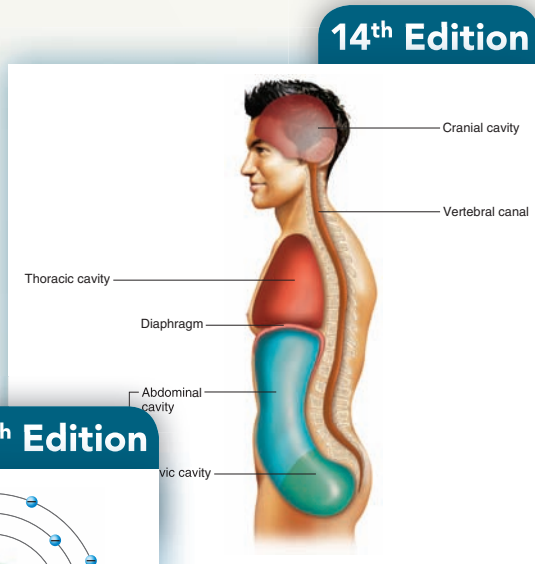
SELECTED SPECIFIC CHANGES AT-A-GLANCE —Continued

Chapter	Topic	Change	Rationale
20	Glomerular filtration	Section reorganized	Clarity
20	Basic renal processes	Redesigned summary figure 20.19	Update
20	Potassium secretion	Section rewritten and figure 20.21 simplified	Clarity, update
20	Urine concentration	Countercurrent exchanger added to expanded discussion of vasa recta	Clarity, accuracy
21	Thirst	New material in section on osmoreceptors regarding osmolarity, osmolality, and their relationship to osmotic pressure	Clarity
22	Sperm cell structure	Enzymes on membrane as well as in acrosome described in text	Accuracy
22	Follicle maturation	Section rewritten to describe process taking almost 300 days	Update
22	Follicle maturation	New figure 22.22 portrays events in ovary during follicle maturation	Accuracy, clarity
22	Female reproductive cycle	Section rewritten to describe role of various hormones on follicle development and ovulation, micrographs added to figure 22.31	Update, clarity
22	Breast cancer	Updated Clinical Application 22.4	Accuracy, update
22	Birth control	Section rewritten	Update
23	Fertilization	Redrawn figure 23.3 and changes to text better depict role of sperm enzymes	Clarity
23	Embryonic development	Section reordered for better flow	Clarity
24	Prenatal testing	Text discussion rewritten	Update
24	Genes and genomes	Section reworked	Clarity

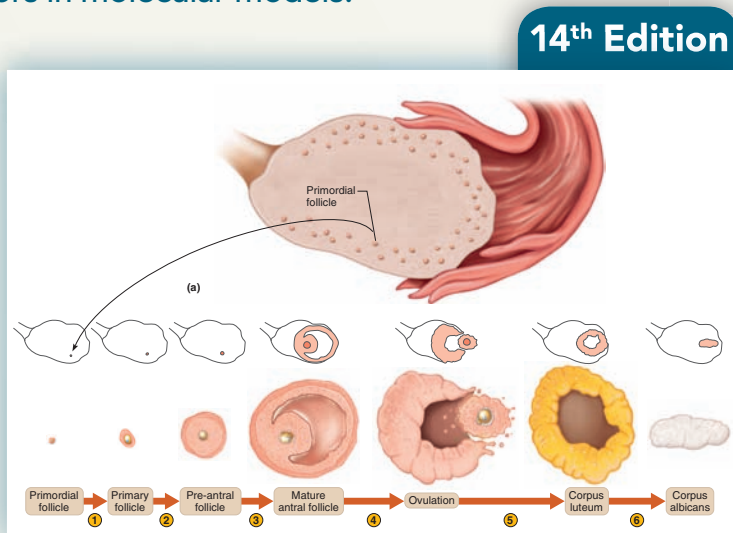
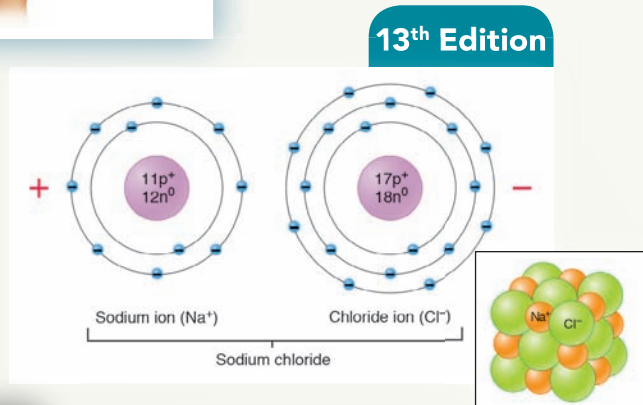
DYNAMIC NEW ART PROGRAM

Every piece of art has been updated to make it more vibrant, three-dimensional, and instructional. The authors examined every figure to ensure it was engaging and accurate. The fourteenth edition's art program will help with understanding the key concepts of anatomy and physiology.

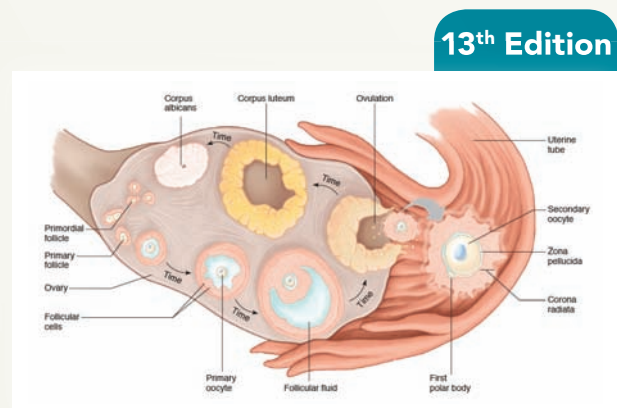
Realistic, three-dimensional figures provide depth and orientation.



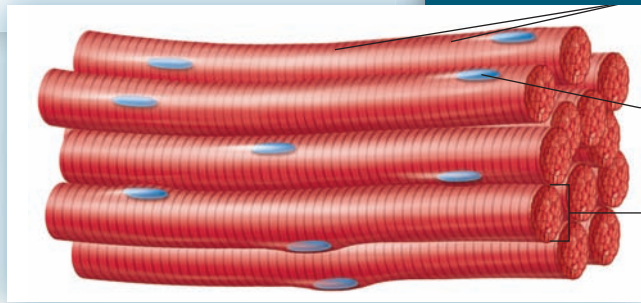
Colors highlighting atomic nuclei complement the atom colors in molecular models.



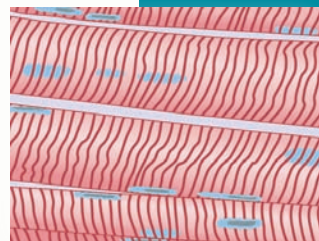
Process portrayed more accurately.



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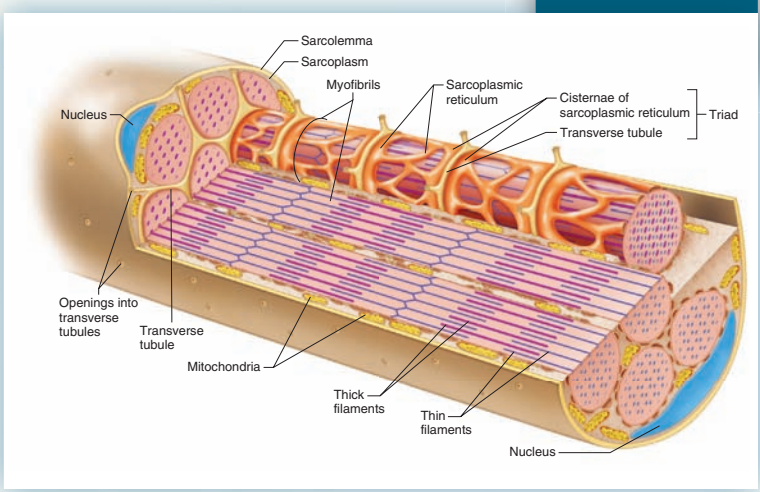


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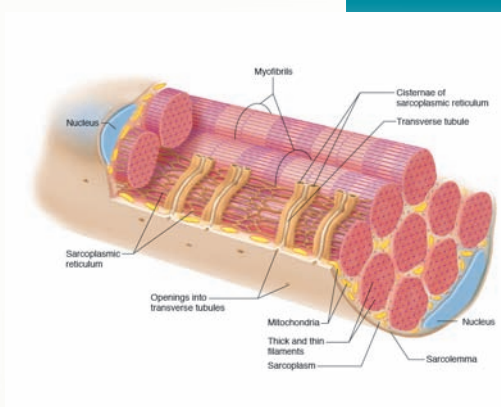


Line art for micrographs is three-dimensional to help visualize more than just the flat microscopic sample.

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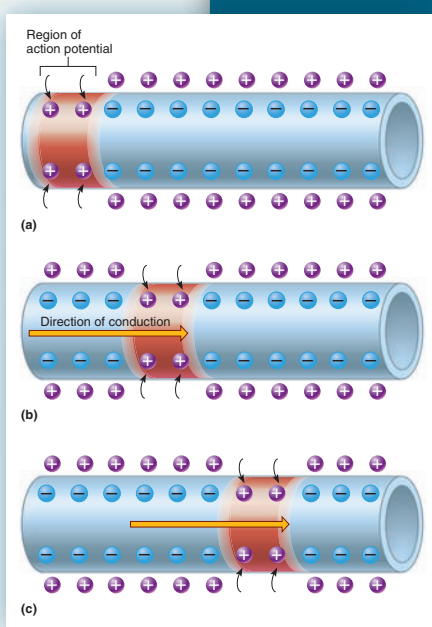


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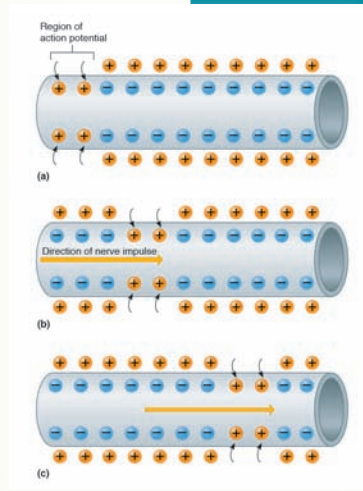


This longitudinal section shows the interior structures of a muscle fiber revealing more detail of the myofibrils, and thick and thin filaments.

14th Edition



13th Edition



Color follows the movement of the action potential.

LEARN, PRACTICE, ASSESS



Learn

Learning tools to help the student succeed. . .

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

Learning Outcomes open chapters, and are closely linked to Chapter Assessments and Integrative Assessments/Critical Thinking questions found at the end of each chapter. Learning Outcomes are also tied to Connect content.

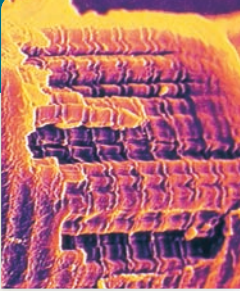


LEARNING OUTCOMES

After you have studied this chapter, you should be able to:

9.1 Structure of a Skeletal Muscle

- 1 Describe the structure of a skeletal muscle. (pp. 292–293)
- 2 Name the major parts of a skeletal muscle fiber and describe the functions of each. (pp. 293–296)



9 Muscular System

LEARNING OUTCOMES

After you have studied this chapter, you should be able to:

- 9.1 Structure of a Skeletal Muscle**
 - 1 Describe the structure of a skeletal muscle. (pp. 292–293)
 - 2 Name the major parts of a skeletal muscle fiber and describe the functions of each. (pp. 293–296)
- 9.2 Skeletal Muscle Contraction**
 - 3 Describe the neural control of skeletal muscle contraction. (p. 297)
 - 4 Identify the major events of skeletal muscle fiber contraction. (pp. 298–299)
 - 5 List the energy sources for skeletal muscle fiber contraction. (pp. 299–302)
 - 6 Describe oxygen debt. (pp. 302–303)
 - 7 Describe how a muscle may become fatigued. (p. 303)
- 9.3 Muscular Responses**
 - 8 Distinguish between a twitch and a sustained contraction. (pp. 304–306)
 - 9 Explain how various types of muscular contractions produce body movements and help maintain posture. (p. 306)
 - 10 Distinguish between fast and slow twitch muscle fibers. (pp. 306–307)
- 9.4 Smooth Muscles**
 - 11 Distinguish between the structures and functions of multiunit smooth muscle and visceral smooth muscle. (p. 307)
 - 12 Compare the contraction mechanisms of skeletal and smooth muscle fibers. (p. 308)
- 9.5 Cardiac Muscle**
 - 13 Compare the contraction mechanisms of skeletal and cardiac muscle fibers. (pp. 308–309)
- 9.6 Skeletal Muscle Actions**
 - 14 Explain how the attachments, locations, and interactions of skeletal muscles make possible certain movements. (pp. 311–312)
- 9.7 Major Skeletal Muscles**
 - 15 Identify and locate the skeletal muscles of each body region and describe the action(s) of each muscle. (pp. 312–340)
- 9.8 Life-Span Changes**
 - 16 Describe aging-related changes in the muscular system. (p. 340)
 - 17 Discuss how exercise can help maintain a healthy muscular system as the body ages. (p. 340)

THE WHOLE PICTURE

Everything we do to express ourselves uses muscles. Consciously controlled skeletal muscles are necessary for talking, smiling or frowning, raising a hand in class to ask a question, and even raising an eyebrow.

Behind the scenes, the involuntary, non-consciously controlled smooth muscle and cardiac muscle are active too. All muscles require energy from food, and it is smooth muscle that moves that food through the digestive tract. Cardiac muscle continuously pumps blood so that all cells, including muscle cells, can access the absorbed nutrients.

All of the force that muscles provide, whether it is moving your eyes in their sockets as you read this page or climbing up a flight of stairs, comes from one set of muscle proteins pulling on another set of muscle proteins. Individually these proteins do not generate much force, but collectively they are strong—as strong as you!

Module 6: Muscular System

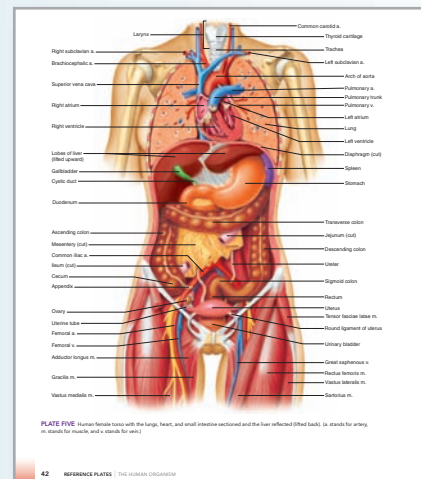
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NEW! The WHOLE Picture gives an introduction to the chapter. It answers the question: “What is the big picture of how this chapter relates to Human Anatomy and Physiology?”

Anatomy and Physiology Revealed (APR) icon at the beginning of each chapter tells which system in APR applies to this chapter.

Understanding Words helps the student remember scientific word meanings. Examine root words, stems, prefixes, suffixes, pronunciations, and build a solid anatomy and physiology vocabulary.

Reference Plates offer vibrant detail of body structures.



Practice

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

Interesting applications help practice and apply knowledge. . .

Figure Questions allow an additional assessment. Found on key figures throughout the chapter.



PRACTICE

- 9 What are the sources of energy used to regenerate ATP?
- 10 What are the sources of oxygen required for the aerobic reactions of cellular respiration?
- 11 How do lactic acid and oxygen debt relate to muscle fatigue?
- 12 What is the relationship between cellular respiration and heat production?

FIGURE 9.8 APR Neuromuscular junction. (a) A neuromuscular junction includes the end of a motor neuron and the motor end plate of a muscle fiber. (b) Micrograph of a neuromuscular junction (500 \times).

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

Answers can be found in Appendix G.

A few hours after death, the skeletal muscles partially contract, fixing the joints. This condition, called *rigor mortis*, may continue for seventy-two hours or more. It results from an increase in membrane permeability to calcium ions, which promotes cross-bridge formation, and a decrease in availability of ATP in the muscle fibers, which prevents myosin release from actin. Thus, the actin and myosin filaments of the muscle fibers remain linked until the proteins begin to decompose.

Boxed information applies ideas and facts in the narrative to clinical situations.



Clinical Applications present disorders, physiological responses to environmental factors, and other topics of general interest.



Genetics Connections explore the molecular underpinnings of familiar as well as not so familiar illnesses. Read about such topics as ion channel disorders, muscular dystrophy, and cystic fibrosis.



CLINICAL APPLICATION 9.1 Myasthenia Gravis

In an autoimmune disorder, the immune system attacks part of the body. In myasthenia gravis (MG), the part attacked is the muscular system. The name means “grave muscular weakness.” The body produces antibodies that target receptors for the neurotransmitter acetylcholine on skeletal muscle cells at neuromuscular junctions. People with MG have one-third the normal number of acetylcholine receptors on their skeletal muscle cells. On a whole-body level, this causes weak and easily fatigued muscles.

MG affects hundreds of thousands of people worldwide, mostly women beginning in their twenties or thirties, and men in their sixties and seventies. The specific symptoms depend upon the site of attack. For 85% of patients, the disease causes generalized muscle weakness. Many people develop a characteristic flat smile and nasal voice and have difficulty chewing and swallowing due to affected facial and neck muscles. Limb weakness is common. About 15% of patients experience the illness only in the

muscles surrounding their eyes. The disease reaches crisis level when respiratory muscles are affected, requiring a ventilator to support breathing. MG does not affect sensation or reflexes.

Most people with MG live a normal life span, with symptoms that are controlled with a combination of treatments that include the following:

- Drugs that inhibit acetylcholinesterase, the enzyme that normally breaks down acetylcholine, thus increasing levels of the neurotransmitter.
- Immunosuppressant drugs such as corticosteroids, cyclosporine, and rituximab, that decrease production of antibodies.
- Intravenous antibodies that bind and inactivate the antibodies causing the damage.
- Plasma exchange that rapidly removes the damaging antibodies from the bloodstream, helping people in crisis.



CAREER CORNER

Massage Therapist

The middle-aged woman feels something give way in her left knee as she comes down from a jump in her dance class. She limps away between her much younger classmates, in great pain.

The frequent jumping followed by lateral movements caused patella tendinitis, or “jumper’s knee.” The woman injured in dance class went home and used “RICE” treatment—rest, ice, compression, and elevation—and three days later, at her weekly appointment with a massage therapist for stress relief, mentioned the injury.



FROM SCIENCE TO TECHNOLOGY 5.2

Tissue Engineering: Building a Replacement Bladder

If an appliance part is damaged or fails, replacing it is simple. Not so for the human body. Donor organs and tissues for transplant are in short supply, so in the future spare parts may come from tissue engineering. In this technology, a patient’s cells, extracellular matrix, and other biochemicals are grown with a synthetic scaffold to form an implant. The cells come from the patient, so the immune system does not reject them. Tissue engineering has provided skin, cartilage, bone, and blood vessels. Combining engineered tissues into structures that can replace organs is where the creativity comes in. Consider the replacement bladder.

Each year in the United States, about 10,000 people need their urinary bladders repaired or replaced. Typically a urologic surgeon replaces part of the bladder with part of the large intestine. However, the function of the intestine is to absorb, and the function of the bladder is to hold waste. Tissue engineering is providing a better replacement bladder. The natural organ is balloon-

like, with layers of smooth muscle, connective tissue, and a lining called urothelium.

Researchers pioneered replacement bladders in children who have birth defects in which the malfunctioning bladder can harm the kidneys. Each patient donated a postage-stamp-size sample of bladder tissue that consisted of about a million cells, from which the researchers separated two types of progenitor cells—for smooth muscle and urothelium—and let them divide in culture in a specific “cocktail” of growth factors. Within seven weeks the million cells had divided to yield 1.5 billion cells, which were seeded onto domes made of a synthetic material. The confluent layers of cells that formed were attached to the lower portions of the patients’ bladders, after removing the upper portions. The scaffolds degenerated over time, leaving new bladders built from the patients’ own cells. Today tissue-engineered bladders are also used in adults whose bladders have been removed to treat cancer.

Assess

Tools to help make the connection and master anatomy & physiology!

Chapter Assessments check understanding of the chapter’s learning outcomes.

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

Chapter Summary Outlines help review the chapter’s main ideas.

Chapter Summary

9.1 Structure of a Skeletal Muscle (page 292)

Skeletal muscles are composed of nervous, vascular and various other connective tissues, as well as skeletal muscle tissue.

1. Connective tissue coverings
 - a. Fascia covers each skeletal muscle.
 - b. Other connective tissues surround cells and groups of cells within the muscle’s structure (epimysium, perimysium, endomysium).
- c. Fascia is part of a complex network of connective tissue that extends throughout the body.
2. Skeletal muscle fibers
 - a. Each skeletal muscle fiber is a single muscle cell, the unit of contraction.
 - b. Muscle fibers are cylindrical cells with many nuclei.
 - c. The cytoplasm contains mitochondria, sarcoplasmic reticulum, and myofibrils of actin and myosin.

- d. The arrangement of the actin and myosin filaments causes striations forming repeating patterns of sarcomeres. (I bands, Z lines, A bands, H zone and M line)
- e. Tropomyosin and troponin molecules associate with actin filaments.
- g. Transverse tubules extend from the cell membrane into the cytoplasm and are associated with the sarcoplasmic reticulum.

9.2 Skeletal Muscle Contraction (page 297)

Muscle fiber contraction results from a sliding movement of actin and myosin filaments overlapping that shortens the muscle fiber.

1. Neuromuscular junction
 - a. The functional connection between a neuron and another cell is a synapse. The neuromuscular junction is a synapse.



CHAPTER ASSESSMENTS

9.1 Structure of a Skeletal Muscle

- 1 Describe the difference between a tendon and an aponeurosis. (p. 292)
- 2 Describe how connective tissue is part of the structure of a skeletal muscle. (p. 293)
- 3 Distinguish among deep fascia, subcutaneous fascia, and subserous fascia. (p. 293)
- 4 Identify the major parts of a skeletal muscle fiber and describe the functions of each. (pp. 293–296)

9.2 Skeletal Muscle Contraction

- 5 A neurotransmitter _____ (p. 297)
 - a. binds actin filaments, causing them to slide
 - b. diffuses across a synaptic cleft from a neuron to a

9.3 Muscular Responses

- 13 Define threshold stimulus. (p. 304)
- 14 Distinguish between a twitch and a sustained contraction. (p. 304)
- 15 Define motor unit and explain how the number of fibers in a unit affects muscular contractions. (p. 305)
- 16 Which of the following describes addition of muscle fibers to take part in a contraction? (p. 305)
 - a. summation
 - b. recruitment
 - c. tetany
 - d. twitch
- 17 Explain how a skeletal muscle can be stimulated to produce a sustained contraction. (p. 306)



INTEGRATIVE ASSESSMENTS/CRITICAL THINKING

Outcomes 7.10, 7.11, 9.7

1. Several important nerves and blood vessels course through the muscles of the gluteal region. To avoid the possibility of damaging such parts, intramuscular injections are usually made into the lateral, superior portion of the gluteus medius. What landmarks would help you locate this muscle in a patient?

Outcomes 9.1, 9.2

2. Millions of people take drugs called statins to lower serum cholesterol levels. In a small percentage of people taking these drugs, muscle pain, termed myopathy, is an adverse effect. In a small percentage of these individuals, the condition progresses to rhabdomyolysis, in which the sarcolemma breaks down.
 - a. Describe the structure and state the function of the sarcolemma.
 - b. Physicians can measure a patient’s levels of creatine

Outcome 9.2

4. As lactic acid 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 help relieve such soreness?

Outcomes 9.2, 9.3, 9.5

5. Why do you think athletes generally perform better if they warm up by exercising lightly before a competitive event?

Outcomes 9.2, 9.3, 9.6

6. Following an injury to a nerve, the muscles it supplies with motor nerve fibers may become paralyzed. How would you explain to a patient the importance of moving the disabled muscles passively or contracting them with electrical stimulation?

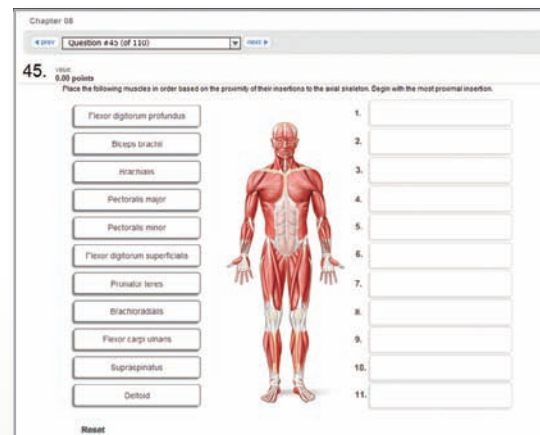


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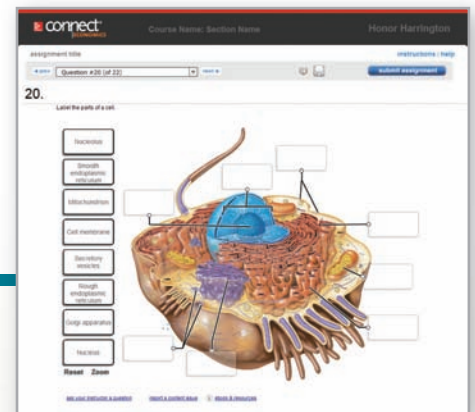


Hi. We are Leslie Day and Julie Pilcher. We've joined the author team as digital authors. We know it's frustrating when online homework questions don't match the textbook. That's where digital authors come in! We ensure that our online resources correlate directly with the information and learning tools found in the textbook. Here are some of the question types we've created for the 14th edition!



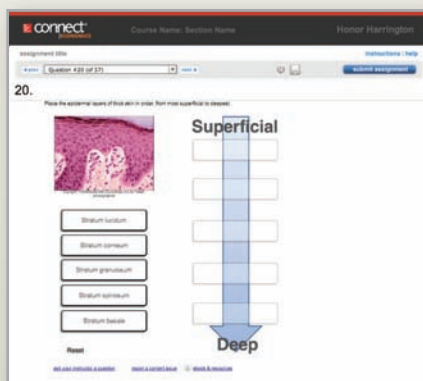
Integrated activities use a series of interactive questions to apply new knowledge and/or see how different processes are related. Some integrated questions also include animations to help the visual learner.

Labeling allows identification of structures using figures from the text. Also available are questions in which functions or descriptions are used as drag-and-drop labels.



Classification questions ask for placement of terms into appropriate categories, to recognize the difference and similarities in structures.

Concept Overview Interactives combine multiple concepts into one big-picture summary. These striking, visually dynamic presentations offer a review of previously covered material in a creatively designed environment to emphasize how individual parts fit together in the understanding of a larger mechanism or concept.



Sequence questions have been designed around ordering physiological processes or some anatomical topics, such as listing structures' locations from proximal to distal.

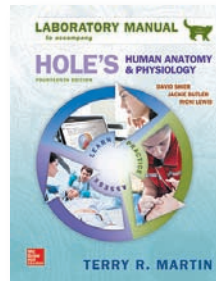
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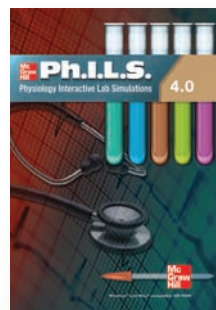
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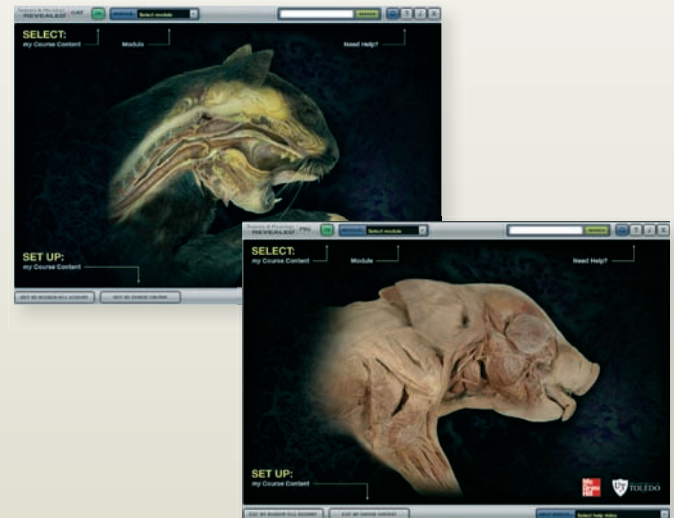
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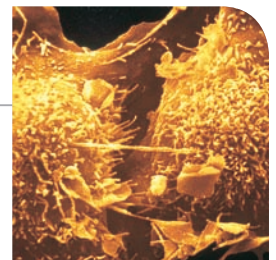
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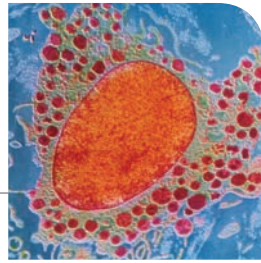


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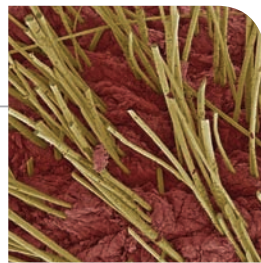
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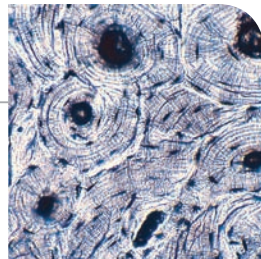
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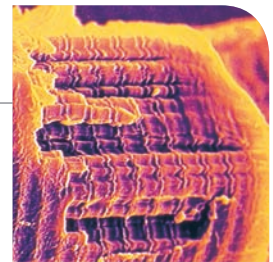
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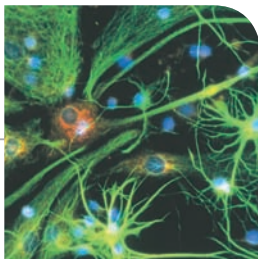
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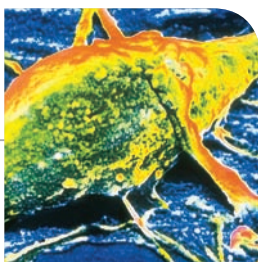
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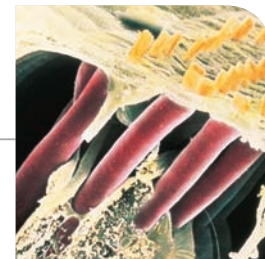
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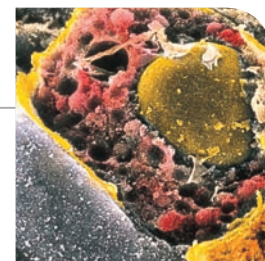
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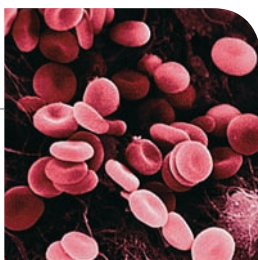


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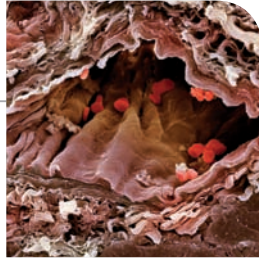
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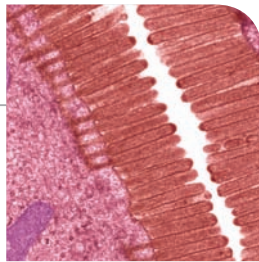
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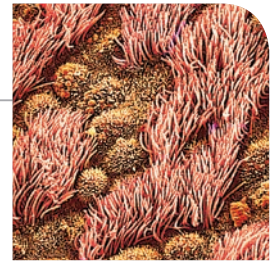
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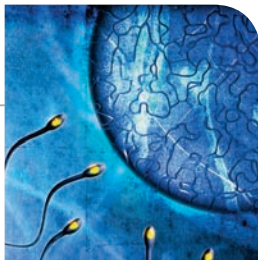
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A photo on the opening page for each chapter generates interest.

The Whole Picture presents a snapshot of the chapter content and explains how it relates to what new knowledge you will be adding to your knowledge base.

THE WHOLE PICTURE

Students often wonder why they are required to take anatomy and physiology in preparation for a career as a health-care professional. An understanding of homeostasis and normal anatomy and physiology helps the health-care professional recognize disease as it occurs in their patients.

Students should remember that among the reasons they are taking this course is to build a solid foundation for caring for their future patients.

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.



PREVIEW

Foundations for Success

The Preview Chapter 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.



LEARNING OUTCOMES

After you have studied this chapter, you should be able to:

P.1 Overview

- 1 Explain the importance of an individualized approach to learning (p. 2)

P.2 Strategies for Success

- 2 Summarize what you should do before attending class. (p. 2)
- 3 Identify student activities that enhance the classroom experience. (p. 6)
- 4 List and describe several study techniques that can facilitate learning new material. (p. 6)

Each chapter has a list of learning outcomes indicating the knowledge you should gain as you work through the chapter. (Note the blue learning arrow.) These outcomes are intended to help you master the similar outcomes set by your instructor. The outcomes will be tied directly to assessments of knowledge gained.

UNDERSTANDING WORDS

ana-, up: *anatomy*—the study of breaking up the body into its parts.

multi-, many: *multitasking*—performing several tasks simultaneously.

physio-, relationship to nature: *physiology*—the study of how body parts function.

This section 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. Inside the back cover and on the facing page is a comprehensive list of these prefixes, suffixes, and root words.

P.1 | Overview

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 while 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 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.

The first section of each chapter is an overview that tells you what to expect and why the subject is important.

After each major section, a question or series of questions tests your understanding of the material and enables you to practice using the new information. (Note the green practice arrow.) If you cannot answer the question(s) you should reread that section, being on the lookout for the answer(s).



PRACTICE

- 1 List some difficulties a student may experience when studying the human body.
- 2 Describe the ways that people learn.

Major divisions within a chapter are called “A-heads.” They are numbered sequentially, and are titled in very large turquoise type. A-heads identify major content areas.

P.2 | Strategies for Your Success

Many of the strategies for academic success are common sense, but it might help to review them. You may encounter new and helpful methods of learning.

The major divisions are subdivided into “B-heads,” which are identified by large, purple type. These will help you organize the concepts upon which the major divisions are built.

Before Class

Before attending class, prepare by reading and outlining or taking notes on the assigned pages of the text. If outlining, leave adequate space between entries to allow room for note-taking during lectures. Or, fold each page of notes taken before class

in half so that class notes can be written on the blank side of the paper across from the reading notes on the same topic. This strategy introduces the topics of the next class discussion, as well as new terms. Some students team a vocabulary list with each chapter's notes. Take the notes from the reading to class and expand them. At a minimum, the student should at least skim through the text, reading A-heads, B-heads, and the chapter summary to become acquainted with the topics and vocabulary before class.

Sometimes in your reading you will be directed back to a related concept, discussed in an earlier chapter, to help you better understand the new concept that is being explained.



RECONNECT

To Chapter 1, Homeostasis, pages 15–18.

Students using this book and taking various courses are often preparing for careers in health care. In some cases students may be undecided as to a specific area or specialty. The Career Corner presents a description of a particular career choice with each chapter. If it doesn't describe a career that you seek, perhaps it will give you a better sense of what some of your coworkers and colleagues do! You may even discover something exciting that you didn't know about!

In a "stroke," or *cerebrovascular accident (CVA)*, a sudden interruption in blood flow in a vessel supplying brain tissues damages the cerebrum. The affected blood vessel may rupture, bleeding into the brain, or be blocked by a clot. In either case, brain tissues downstream from the vascular accident die and some loss of function may occur. Temporary interruption in cerebral blood flow, perhaps by a clot that quickly breaks apart, produces a much less serious *transient ischemic attack (TIA)*, sometimes called a ministroke.

As you read, you may feel the need for a "study break." Sometimes you may just need to "chill out." Other times, you may just need to shift gears. Try the following! Throughout the book are shaded boxes within the flow of the text, Clinical Application boxes, and From Science to Technology boxes that present sidelights to the main focus of the text. Indeed, some of these may cover topics that your instructor chooses to highlight. Read them! They are interesting, informative, and a change of pace.

The opposite of looking back and reconnecting is looking ahead. A Glimpse Ahead applies concepts being discussed in the particular section of the text to future learning. This feature tells how the information learned here will carry over and be incorporated into understanding the functioning of other body systems.



A GLIMPSE AHEAD | To Chapters 9 and 10

The energy we must expend just to stay alive is called the basal metabolic energy. The body uses close to 40% of the basal metabolic energy to actively transport sodium and potassium ions across cell membranes. Imagine learning that 40% of your household budget went for one item—it had better be important! In this case it is. The concentration gradients for sodium and potassium ions that the sodium/potassium pumps establish throughout the body are essential for muscle and nerve cells to function. Chapters 9 and 10 further discuss the functioning of these important cell types.



CAREER CORNER

Radiologic Technologist

At age fifty-two the woman is younger than most of the others having their bone mineral density measured. The gynecologist advised a baseline test to assess the health of the patient's skeleton because her parents had osteoporosis.

A radiology technologist conducts the test. She explains the procedure to the patient, then positions her on her back on a padded table, fully clothed. The scanner passes painlessly over the patient's hip and lower spine, emitting low-dose X rays that form images of the bones. Spaces on the scan indicate osteopenia, the low bone mineral density that may be a prelude to osteoporosis.

Radiology technologists administer medical imaging tests, such as ultrasound and magnetic resonance imaging (MRI), as well as mammography and the three-dimensional X-ray cross sections of computerized tomography (CT). The technologists protect patients from radiation with drapes and positioning, and operate scanning devices to produce the highest-quality images from which a radiologist can accurately diagnose an illness or injury.

A registered radiologic technologist completes two years of training at a hospital or a two- or four-year program at a college or university, and must pass a national certification exam.



CLINICAL APPLICATION 9.3

TMJ Syndrome

Temporomandibular joint (TMJ) syndrome causes facial pain, headache, ringing in the ears, a clicking jaw, insomnia, teeth sensitive to heat or cold, backache, dizziness, and pain in front of the ears. A misaligned jaw or grinding or clenching the teeth can cause TMJ by stressing the temporomandibular joint, which is the articulation between the mandibular condyle of the mandible and the mandibular fossa of the temporal bone. Loss of coordination of these structures affects the nerves that pass through the neck and jaw region, causing the symptoms.

Getting enough sleep and drinking enough water can help prevent symptoms of TMJ, and eating soft foods, applying ice packs, using relaxation techniques, and massaging affected muscles can alleviate symptoms. A physical therapist can recommend exercises that stretch and relax the jaw, which may help some people. Sitting for long hours in one position can cause or worsen TMJ.

Doctors diagnose TMJ syndrome using an electromyograph, in which electrodes record muscle activity in four pairs of head and neck muscle groups. Several treatments are available. The National Institute of Dental and Craniofacial Research recommends that treatments not permanently alter the teeth or jaw. Low doses of certain antidepressants, or injections of botulinum toxin or corticosteroids, may help. Using a procedure called arthrocentesis, a physician might remove fluid accumulating in the affected joint. Another treatment is an oral appliance fitted by a dentist that fine-tunes the action of jaw muscles to form a more comfortable bite. An oral appliance, also known as a bite guard or stabilization splint, is a piece of plastic that fits over the top or bottom teeth. Very rarely, surgery may be required to repair or replace a joint.



FROM SCIENCE TO TECHNOLOGY 4.1

The Human Metabolome

A generation ago, prehealth profession students had to memorize a complex chart of biochemical pathways that represent all of the energy reactions in a cell. The cellular respiration pathways ran down the center, with branches radiating outward and in some places interconnecting into a giant web. Today, several technologies as well as the ability to store massive amounts of data have made possible the Human Metabolome Database.

"Metabolome" refers to all of the small molecules that are part of metabolism in a cell, tissue, organ, or an entire organism. The database is a vast, annotated catalog of those molecules, "metabolites." The government of Canada is supporting the effort to search all published papers and books that describe metabolites and link that information with experimental data. The techniques of electrophoresis and chromatography are used to separate metabolites, and mass spectrometry (MS) and

nuclear magnetic resonance (NMR) spectroscopy describe their chemical characteristics.

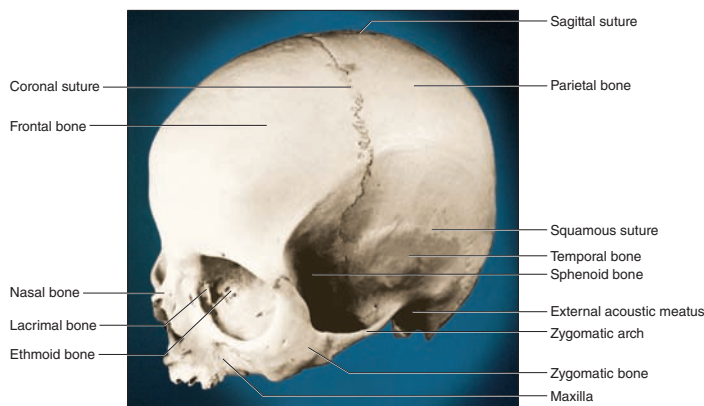
Biochemists estimate that human cells have at least 2,500 different metabolites, but fewer than half have been identified. Far fewer have been analyzed for their concentrations in different cell types under different conditions. In the Human Metabolome Database, each entry has an electronic "MetaboCard" that includes 90 data fields, half with clinical data (such as associated diseases and drug interactions) and half with biochemical data (such as pathways and enzymes that interact with the metabolite). Each entry is also hyperlinked to other databases, interfacing with 1,500 drugs and 3,600 foods and food additives. The information in the Human Metabolome Database is being used in drug discovery, toxicology, transplant monitoring, clinical chemistry, disease diagnosis, and screening of newborns for metabolic disorders.

Remember when you were very young and presented with a substantial book for the first time? You were likely intimidated by its length, but were reassured that there were "a lot of pictures." There are a lot of illustrations in this book as well, all designed to help you master the material.

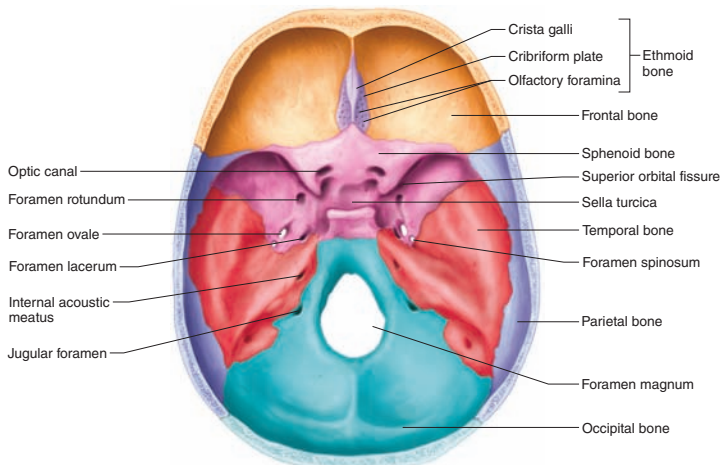
Photographs and Line Art

Sometimes subdivisions have so many parts that the book goes to a third level, the "C-head." This division is identified in a slightly smaller, bold, black font.

Photographs provide a realistic view of anatomy.

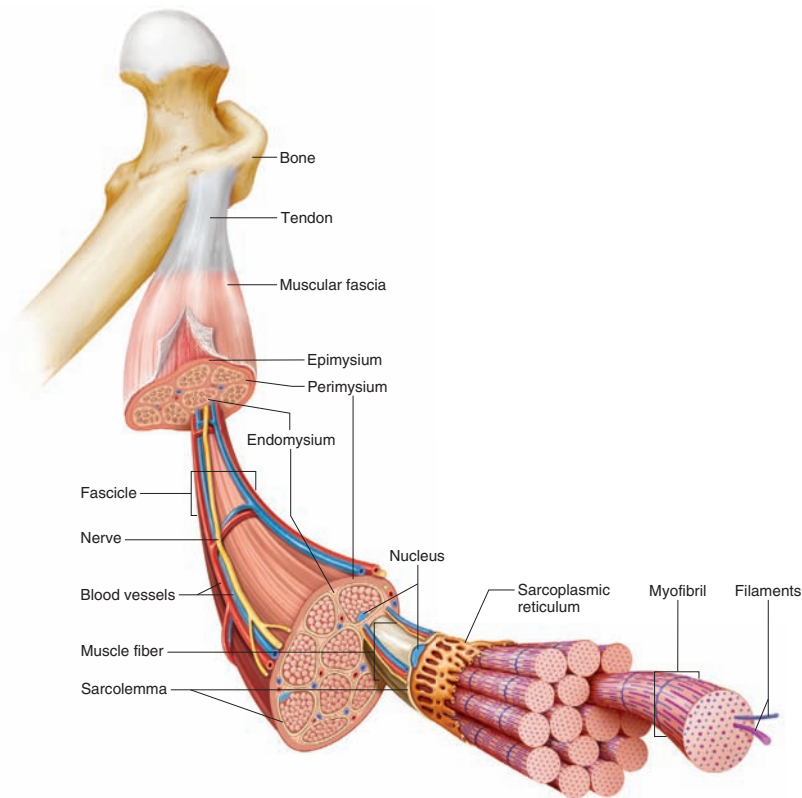


Line art can present different positions, layers, or perspectives.



Macroscopic to Microscopic

Many figures show anatomical structures in a manner that is macroscopic to microscopic (or vice versa).



Flow Charts

Flow charts depict sequences of related events, steps of pathways, and complex concepts, easing comprehension. Other figures may show physiological processes.

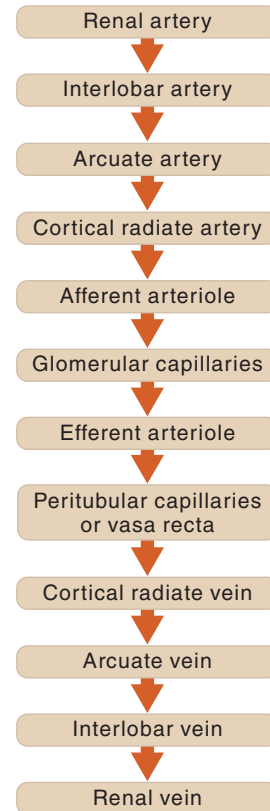


FIGURE 20.8 Pathway of blood through the blood vessels of the kidney and nephron.

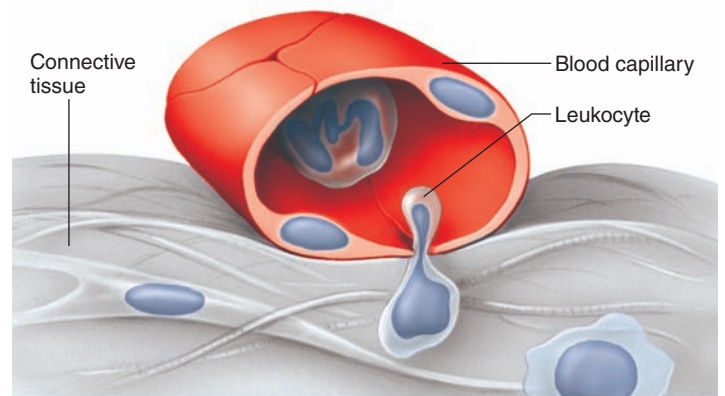


FIGURE 14.15 In a type of movement called diapedesis, leukocytes squeeze between the endothelial cells of a capillary wall and enter the tissue space outside the blood vessel.

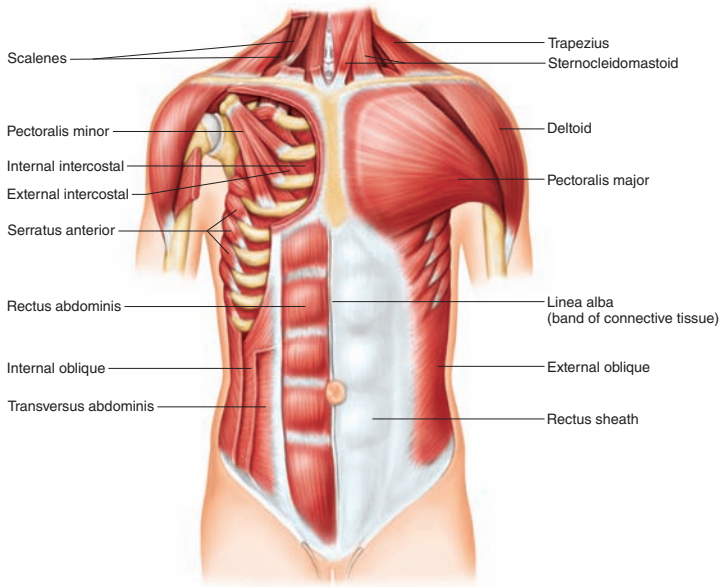
Q What is a monocyte called once it has left the bloodstream and entered the tissues?

Answer can be found in Appendix G.

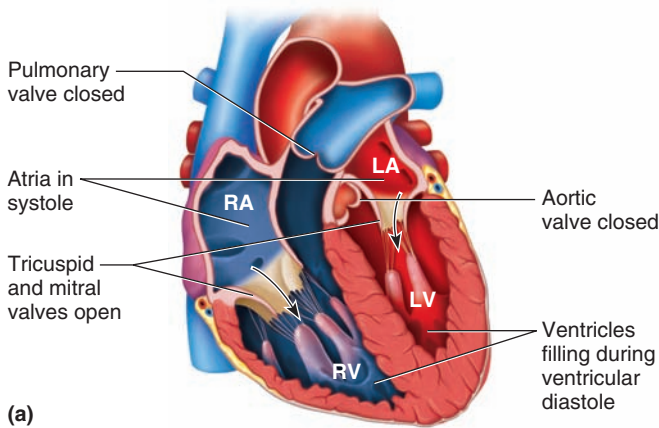
Figure questions encourage you to think about what you are seeing and make connections between the visual representation and the words in the text.

Anatomical Structures

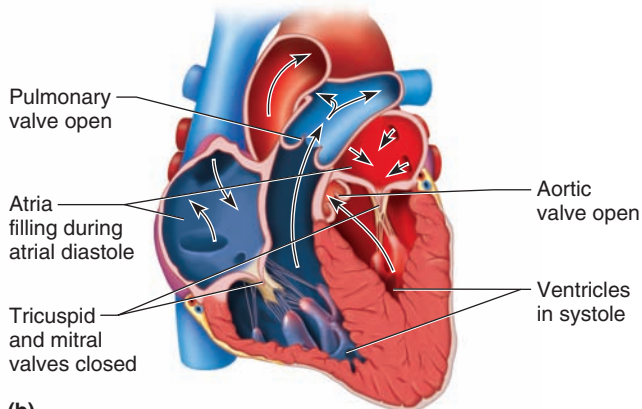
Some figures illustrate the locations of anatomical structures.



Other figures illustrate the functional relationships of anatomical structures.



(a)



(b)

TABLE 5.4 Exocrine Glandular Secretions

Type	Description of Secretion	Example
Merocrine glands	A fluid product released through the cell membrane by exocytosis	Salivary glands, pancreatic glands, sweat glands of the skin
Apocrine glands	Cellular product and portions of the free ends of glandular cells pinch off during secretion	Mammary glands, ceruminous glands lining the external acoustic meatus
Holocrine glands	Disintegrated entire cells filled with secretory products	Sebaceous glands of the skin

Organizational Tables

Organizational tables can help “put it all together,” but are not a substitute for reading the text or having good notes.

It is critical that you attend class regularly, and be on time—even if the instructor’s notes are posted online, and the information is in the textbook. For many learners, hearing and writing new information is a better way to retain facts than just scanning notes on a computer screen. Attending lectures and discussion sections also provides more detailed and applied analysis of the subject matter, as well as a chance to ask questions.

During Class

Be alert and attentive in class. Take notes by adding either to the outline or notes taken while reading. Auditory learners benefit from recording the lectures and listening to them while driving or doing chores. This is called **multitasking**—doing more than one activity at a time.

Participate in class discussions, asking questions of the instructor and answering questions he or she poses. All of the students are in the class to learn, and many will be glad someone asked a question others would not be comfortable asking. Such student response can alert the instructor to topics that are misunderstood or not understood at all. However, respect class policy. Due to time constraints and class size, asking questions may be more appropriate after a large lecture class or during tutorial (small group) sessions.

After Class

In learning complex material, expediency is critical. Organize, edit, and review notes as soon after class as possible, fleshing out sections where the lecturer got ahead of the listener. Highlighting or underlining (in color, for visual learners) the key terms, lists, important points and major topics make them stand out, which eases both daily reviews and studying for exams.

Lists

Organizing information into lists or categories can minimize information overload, breaking it into manageable chunks. For example, when studying the muscles of the thigh it is easier to learn the insertion, origin, action, and nerve supply of the four muscles

making up the *quadriceps femoris* as a group, because they all have the same insertion, action at the knee, and nerve supply . . . they differ only in their origins.

Mnemonic Devices

Another method for remembering information is the **mnemonic device**. One type of mnemonic device is a list of words, forming a phrase, in which the first letter of each word corresponds to the first letter of each word that must be remembered. For example, ***Frequent parade often tests soldiers' endurance*** stands for the skull bones *frontal*, *parietal*, *occipital*, *temporal*, *sphenoid*, and *ethmoid*. Another type of mnemonic device is a word formed by the first letters of the items to be remembered. For example, ***ipmat*** represents the stages in the cell cycle: *interphase*, *prophase*, *metaphase*, *anaphase*, and *telophase*.

Study Groups

Forming small study groups helps some students. Together the students review course material and compare notes. Working as a team and alternating leaders allows students to verbalize the information. Individual students can study and master one part of the assigned material, and then explain it to the others in the group, which incorporates the information into the memory of the speaker. Hearing the material spoken aloud also helps the auditory learner. Be sure to use anatomical and physiological terms, in explanations and everyday conversation, until they become part of your working vocabulary, rather than intimidating jargon. Most important of all—the group must stay on task, and not become a vehicle for social interaction. Your instructor may have suggestions or guidelines for setting up study groups.

Flash Cards

Flash cards may seem archaic in this computer age, but they are still a great way to organize and master complex and abundant information. The act of writing or drawing on a note card helps the

tactile learner. Master a few new cards each day, and review cards from previous days, and use them all again at the end of the semester to prepare for the comprehensive final exam. They may even come in handy later, such as in studying for exams for admission to medical school or graduate school. Divide your deck in half and flip half of the cards so that the answer rather than the question is showing. Mix them together and shuffle them. Get used to identifying a structure or process from a description as well as giving a description when provided with a process or structure. This is more like what will be expected of you in the real world of the health-care professional.

Manage Your Time

Many of you have important obligations outside of class, such as jobs and family responsibilities. As important as these are, you still need to master this material on your path to becoming a health-care professional. Good time management skills are therefore essential in your study of human anatomy and physiology. In addition to class, lab, and study time, multitask. Spend time waiting for a ride, or waiting in a doctor's office, reviewing notes or reading the text.

Daily repetition is helpful, so scheduling several short study periods each day can replace a last-minute crunch to cram for an exam. This does not take the place of time to prepare for the next class. Thinking about these suggestions for learning now can maximize study time throughout the semester, and, hopefully, lead to academic success. A working knowledge of the structure and function of the human body provides the foundation for all careers in the health sciences.



PRACTICE

- 3 Why is it important to prepare before attending class?
- 4 Name two ways to participate in class discussions.
- 5 List several aids for remembering information.

Chapter Summary

A summary of the chapter provides an outline to review major ideas and is a tool for organizing thoughts.

P.1 Overview (page 2)

Try a variety of methods to study the human body.

P.2 Strategies for Success (page 2)

While strategies for academic success seem to be common sense, you might benefit from reminders of study methods.

1. Before class

Read the assigned text material prior to the corresponding class meeting.

- a. Reconnects refer back to helpful, previously discussed concepts.
- b. A Glimpse Ahead applies current learning to future topics.
- c. Shaded boxes present sidelights to the main focus of the text.
- d. Photographs, line art, flow charts, and organizational tables help in mastery of the materials.

2. During class

Take notes and participate in class discussions.

3. After class

- a. Organize, edit, and review class notes.
- b. Mnemonic devices aid learning.
 - (1) The first letters of the words to remember begin words of an easily recalled phrase.
 - (2) The first letters of the items to be remembered form a word.
- c. Small study groups reviewing and vocalizing material can divide and conquer the learning task.
- d. Flash cards help the tactile learner.
- e. Time management skills encourage scheduled studying, including daily repetition instead of cramming for exams.

CHAPTER ASSESSMENTS

Chapter assessments that are tied directly to the learning outcomes allow you to self assess your mastery of the material. (Note the purple assess arrow.)

P.1 Overview

- 1 Explain how students learn in different ways. (p. 2)

P.2 Strategies for Success

- 2 Methods to prepare for class include _____. (p. 2)
 - a. reading the chapter
 - b. outlining the chapter
 - c. taking notes on the assigned reading
 - d. making a vocabulary list
 - e. all of the above

- 3 Describe how you can participate in class discussions. (p. 6)
- 4 Forming the phrase "I passed my anatomy test." To remember the cell cycle (interphase, prophase, metaphase, anaphase, telophase) is an example of a _____. (p. 7)
- 5 Name a benefit and a drawback of small study groups. (p. 7)
- 6 Explain the value of repetition in learning and preparation for exams. (p. 7)

A textbook is inherently linear. This text begins with chapter 1 and ends with chapter 24. Understanding physiology and the significance of anatomy, however, requires you to be able to recall previous concepts. Critical thinking is all about linking previous concepts with current concepts under novel circumstances, in new ways. Toward this end, we have included in the Integrative Assessment/Critical Thinking section references to sections from earlier chapters. Making connections is what it is all about!

INTEGRATIVE ASSESSMENTS/CRITICAL THINKING

Outcomes P.1, P.2

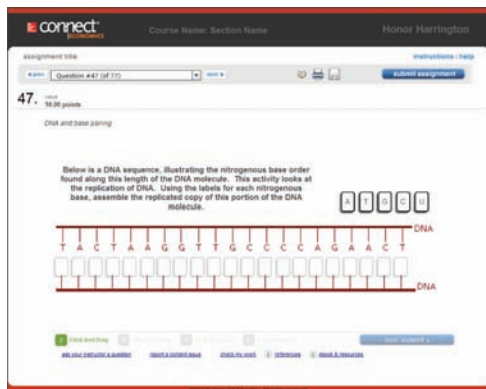
1. Which study methods are most successful for you?

Outcome P.2

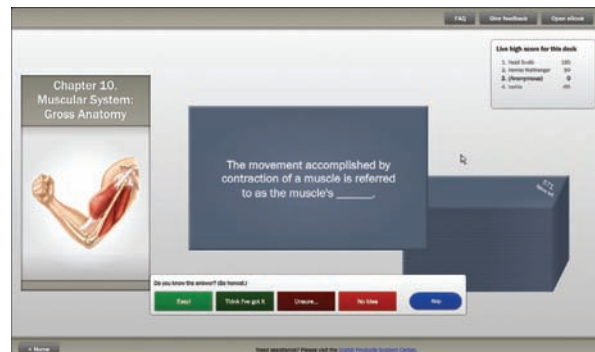
2. Design a personalized study schedule.

Check out McGraw-Hill online resources that can help you practice and assess your learning.

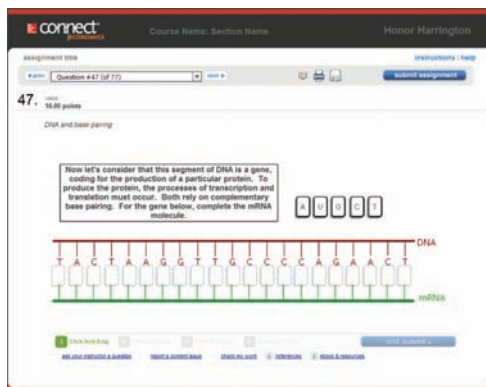
McGraw-Hill Connect® Interactive Questions Reinforce your knowledge using assigned interactive questions.



McGraw-Hill LearnSmart® Discover which concepts you have mastered and which require more attention with this personalized, adaptive learning tool.



Connect Integrated Activity Practice your understanding.



McGraw-Hill Anatomy & Physiology | REVEALED®
Go more in depth using virtual dissection of a cadaver.



Your brain enables you to learn, to practice, and to assess your understanding—whether of a textbook, or how to handle a medical emergency.

THE WHOLE PICTURE

Human anatomy and physiology are the studies of the human body and how it works. Our bodies are communities of cells, which are the microscopic units of living organisms. Cells are specialized to take on specific and necessary responsibilities, and together they maintain an environment within the body in which they can all live.

Learning anatomy and physiology requires familiarity with the language used to describe structures and functions. Cells aggregate and interact to form tissues, which in turn layer and fold and intertwine to form organs, which in turn connect into organ systems.

Mastering the principles of anatomy and physiology not only will give you a new appreciation for your day-to-day activities, talents, strengths, and health, but will provide a foundation for you to help your future patients, for those of you going into health care.



Module 1: Body Orientation



Introduction to Human Anatomy and Physiology



LEARNING OUTCOMES

After you have studied this chapter, you should be able to:

1.1 Origins of Medical Science

- 1 Identify some of the early discoveries that lead to our current understanding of the human body. (p. 10)

1.2 Anatomy and Physiology

- 2 Explain how anatomy and physiology are related. (p. 11)

1.3 Levels of Organization

- 3 List the levels of organization in the human body and the characteristics of each. (p. 12)

1.4 Characteristics of Life

- 4 List and describe the major characteristics of life. (p. 14)
- 5 Give examples of *metabolism*. (p. 14)

1.5 Maintenance of Life

- 6 List and describe the major requirements of organisms. (p. 14)
- 7 Explain the importance of homeostasis to survival. (p. 15)
- 8 Describe the parts of a homeostatic mechanism and explain how they function together. (p. 16)

1.6 Organization of the Human Body

- 9 Identify the locations of the major body cavities. (p. 18)
- 10 List the organs located in each major body cavity. (p. 18)
- 11 Name and identify the locations of the membranes associated with the thoracic and abdominopelvic cavities. (p. 20)
- 12 Name the major organ systems, and list the organs associated with each. (p. 22)
- 13 Describe the general function of each organ system. (p. 22)

1.7 Life-Span Changes

- 14 Identify changes related to aging, from the microscopic to the whole-body level. (p. 27)

1.8 Anatomical Terminology

- 15 Properly use the terms that describe relative positions, body sections, and body regions. (p. 27)

