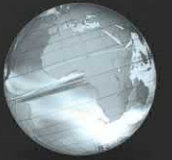


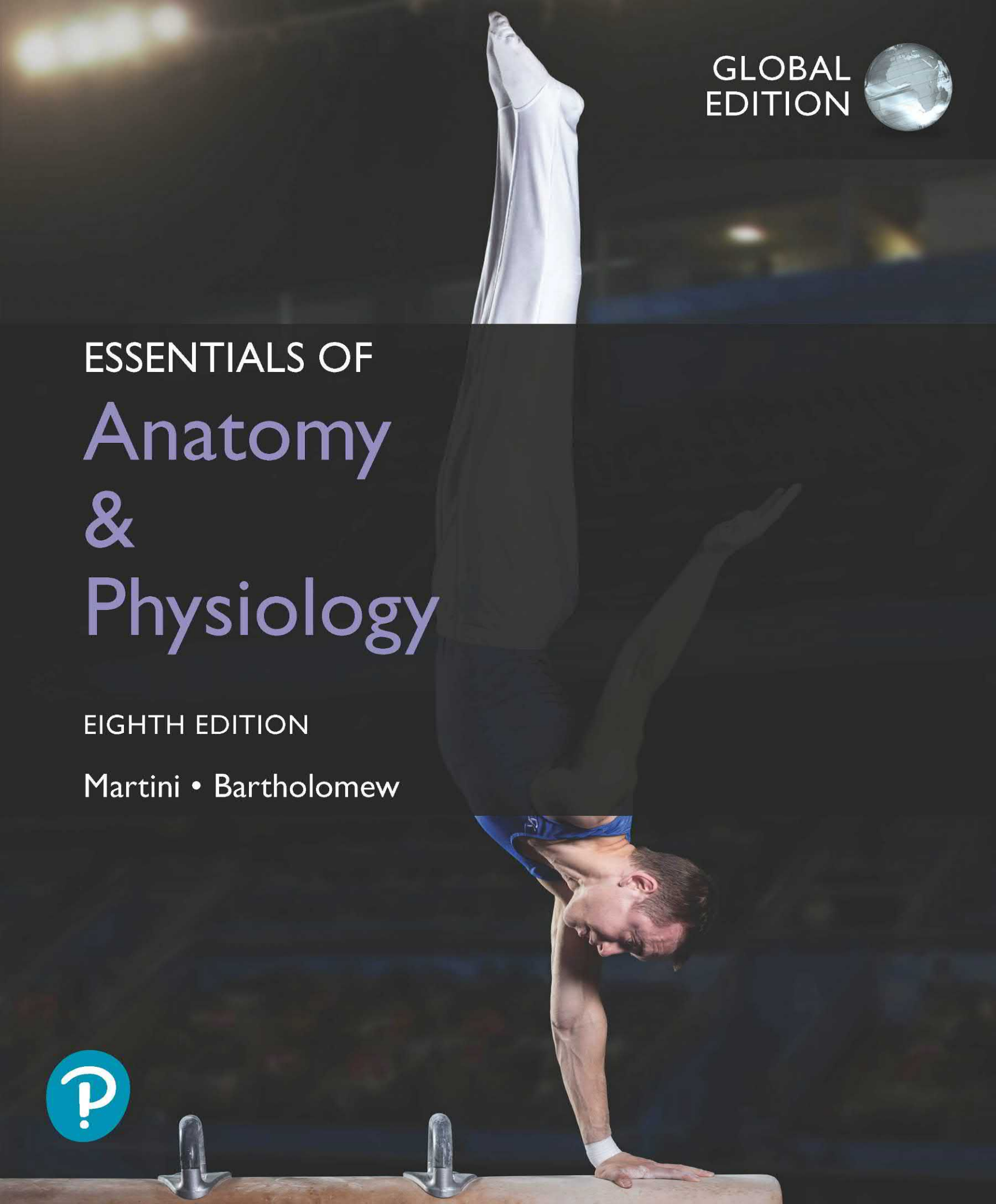
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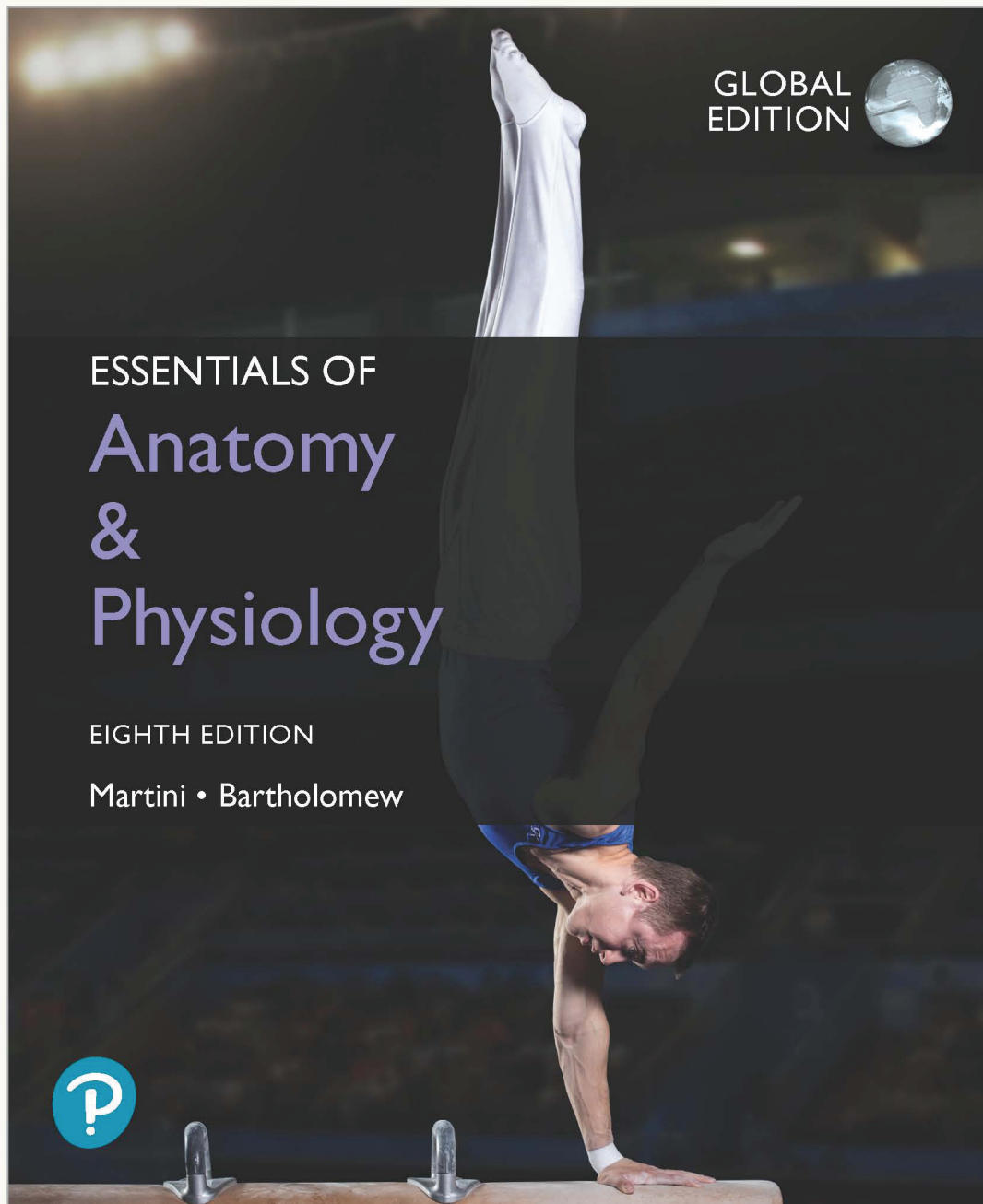
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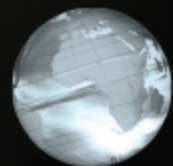


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DEDICATION

To Kitty, P.K., Ivy, and Kate: We couldn't have done this without you.

Thank you for your encouragement, patience, and understanding

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Spotlight Figures Visually Summarize Difficult Physiological Processes, Making Them Easier to Understand

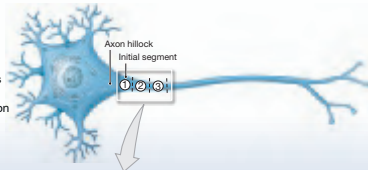
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SPOTLIGHT

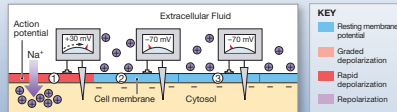
Figure 8-9
PROPAGATION OF AN ACTION POTENTIAL

Continuous Propagation along an Unmyelinated Axon

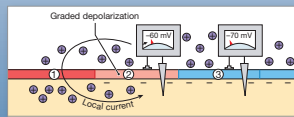
In an unmyelinated axon, an action potential moves along by continuous propagation. The action potential spreads by depolarizing the adjacent region of the axon membrane. This process continues to spread as a chain reaction down the axon.



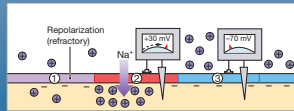
1 As an action potential develops at the initial segment (1), the membrane potential at this site depolarizes to +30 mV.



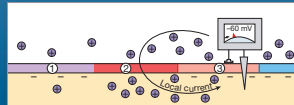
2 As the sodium ions entering at (1) spread away from the open voltage-gated channels, a graded depolarization quickly brings the membrane in segment (2) to threshold.



3 An action potential now occurs in segment (2) while segment (1) begins repolarization.

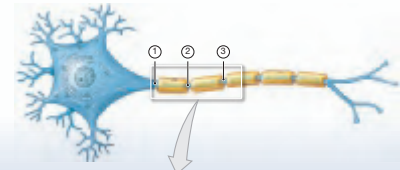


4 As the sodium ions entering at segment (2) spread laterally, a graded depolarization quickly brings the membrane in segment (3) to threshold.

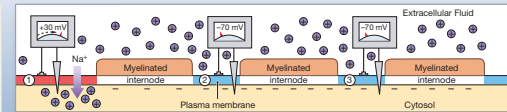


Saltatory Propagation along a Myelinated Axon

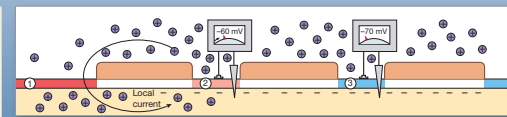
Because myelin limits the movement of ions across the axon membrane, the action potential must "jump" from node to node during propagation. This results in much faster propagation along the axon.



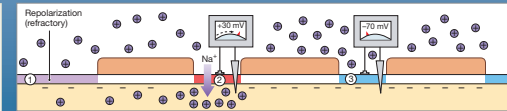
1 An action potential develops at the initial segment (1).



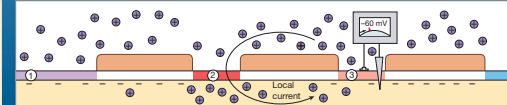
2 A local current produces a graded depolarization that brings the axon membrane at the next node to threshold.



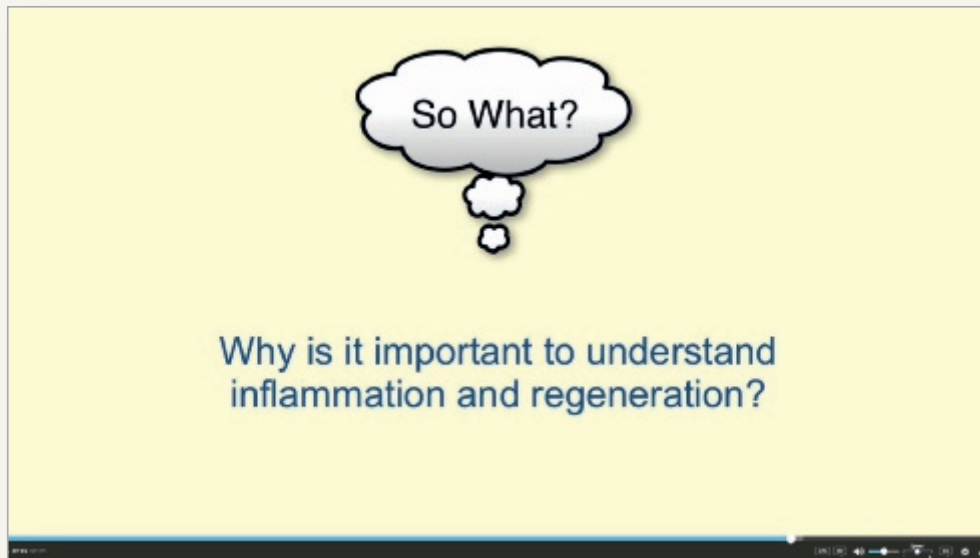
3 An action potential develops at node (2).



4 A local current produces a graded depolarization that brings the axon membrane at node (3) to threshold.



NEW Spotlight Figure Videos Bring This Effective Text Feature to Life

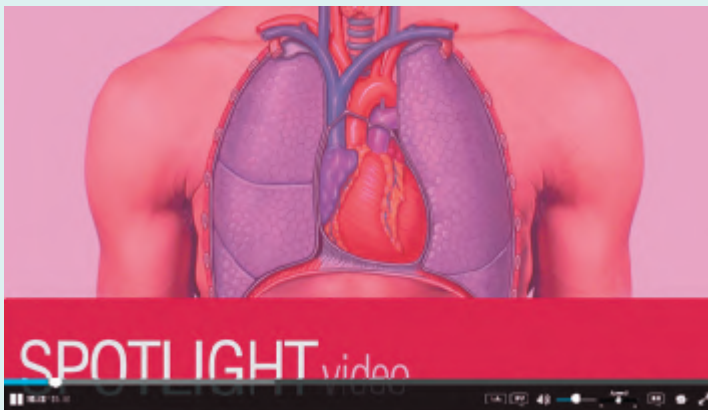


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SmartArt Video: Endochondral Ossification

Watch the [SmartArt Video for chapter 6](#), and then complete the question at right.



▼ Part A

A hard ossified bone in an adult actually begins within the embryo as a miniature version composed of _____.

- elastic cartilage
- hyaline cartilage
- dense regular connective tissue
- dense irregular connective tissue
- fibrocartilage


Submit

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Coaching Activities in Mastering A&P™ allow instructors to assign the videos to ensure students view them.

Build Your Knowledge Integration Figures Emphasize That the Body Systems Work Together, Not in Isolation

Build Your Knowledge Integration features show students how body systems affect each other and work together to maintain homeostasis.



Build Your Knowledge

How the **URINARY SYSTEM** integrates with the other body systems presented so far

Integumentary System

- The Integumentary System prevents excessive fluid loss through skin surface; produces vitamin D₃, important for the renal production of calcitriol; sweat glands assist in elimination of water and solutes
- The urinary system eliminates nitrogenous wastes; maintains fluid, electrolyte, and acid-base balance of blood that nourishes the skin

Respiratory System

- The Respiratory System assists in the regulation of pH by eliminating carbon dioxide
- The urinary system assists in the elimination of carbon dioxide; provides bicarbonate buffers that assist in pH regulation

Cardiovascular System

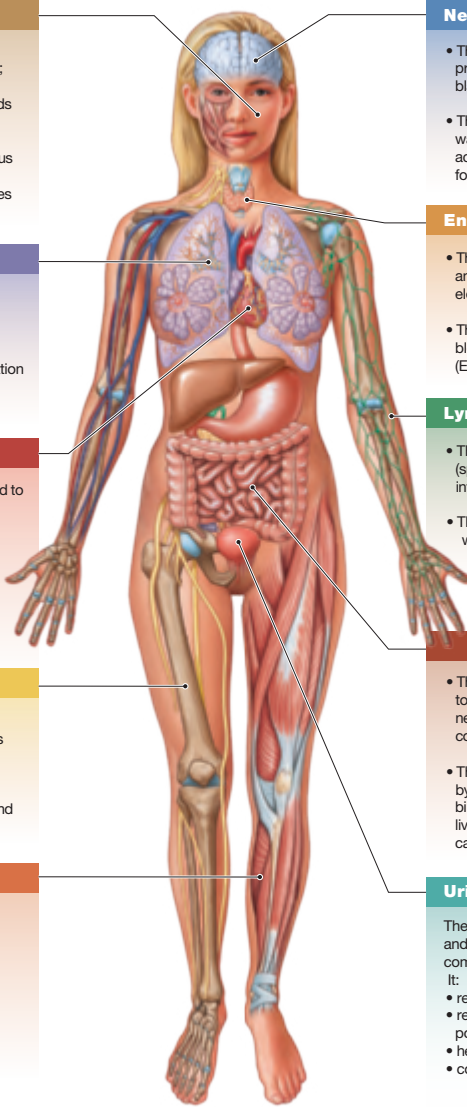
- The Cardiovascular System delivers blood to glomerular capillaries, where filtration occurs; accepts fluids and solutes reabsorbed during urine production
- The urinary system releases renin to elevate blood pressure and erythropoietin (EPO) to accelerate red blood cell production

Skeletal System

- The Skeletal System provides some protection for kidneys and ureters with its axial division; pelvis protects urinary bladder and proximal portion of urethra
- The urinary system conserves calcium and phosphate needed for bone growth

Muscular System

- The Muscular System controls urination by closing urethral sphincters. Muscle layers of trunk provide some protection for urinary organs
- The urinary system excretes waste products of muscle and protein metabolism; assists in regulation of calcium and phosphate concentrations



Nervous System

- The Nervous System adjusts renal blood pressure; monitors distension of urinary bladder and controls urination
- The urinary system eliminates nitrogenous wastes; maintains fluid, electrolyte, and acid-base balance of blood, which is critical for neural function

Endocrine System

- The Endocrine System produces aldosterone and ADH, which adjust rates of fluid and electrolyte reabsorption by kidneys
- The urinary system releases renin when local blood pressure drops and erythropoietin (EPO) when renal oxygen levels fall

Lymphatic System

- The Lymphatic System provides adaptive (specific) defense against urinary tract infections
- The urinary system eliminates toxins and wastes generated by cellular activities; acid pH of urine provides innate (nonspecific) defense against urinary tract infections

Digestive System

- The Digestive System absorbs water needed to excrete wastes at kidneys; absorbs ions needed to maintain normal body fluid concentrations; liver removes bilirubin
- The urinary system excretes toxins absorbed by the digestive epithelium; excretes bilirubin and nitrogenous wastes from the liver; calcitriol production by kidneys aids calcium and phosphate absorption

Urinary System

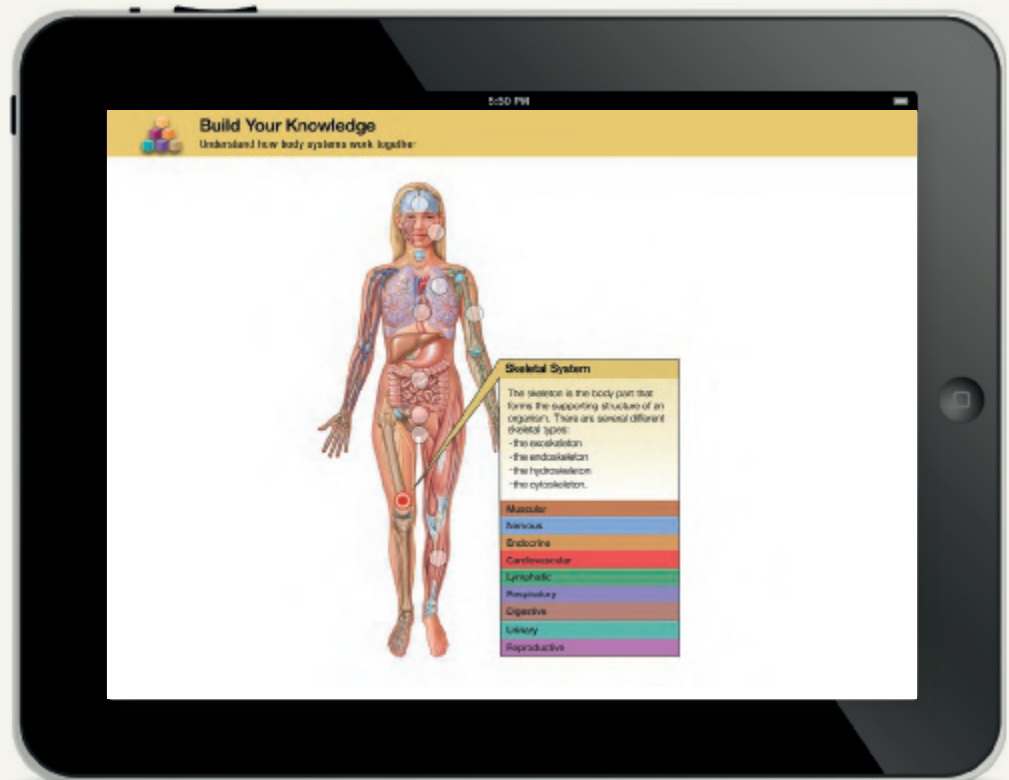
The urinary system excretes metabolic waste and maintains normal body fluid pH and ion composition.

It:

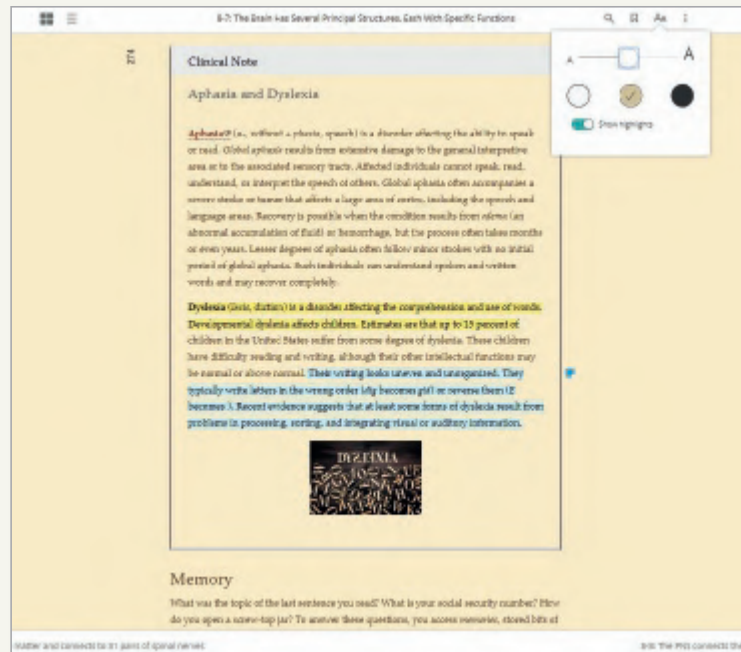
- regulates blood volume and blood pressure
- regulates plasma concentrations of sodium, potassium, chloride, and other ions
- helps to stabilize blood pH
- conserves valuable nutrients

NEW Interactive Versions of These Figures Allow Students to Explore at Their Own Pace

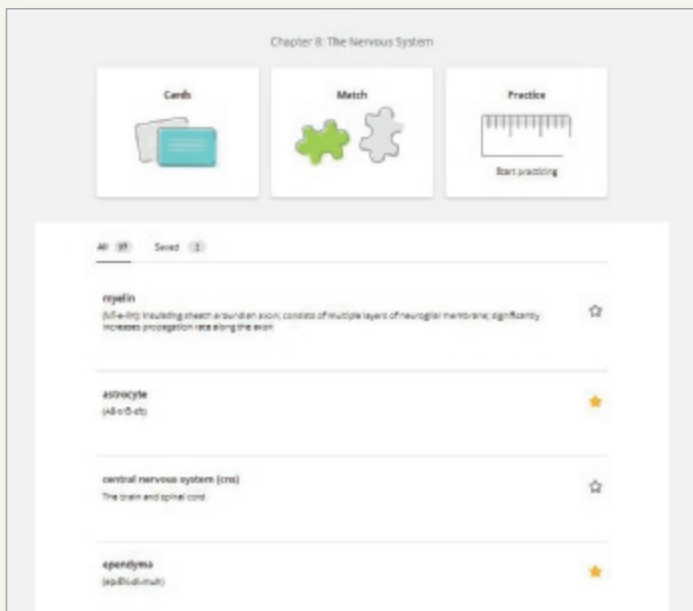
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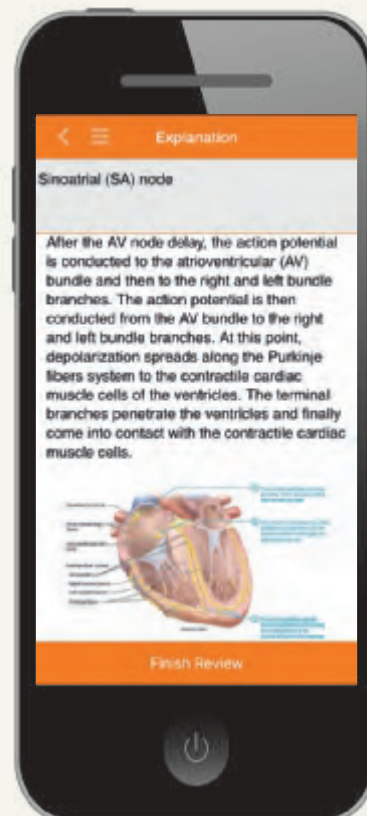
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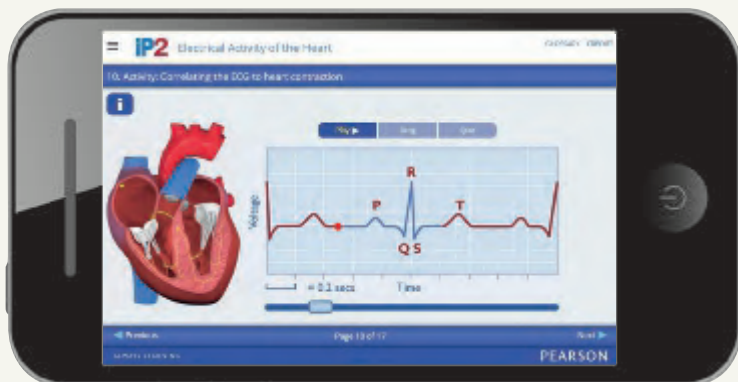


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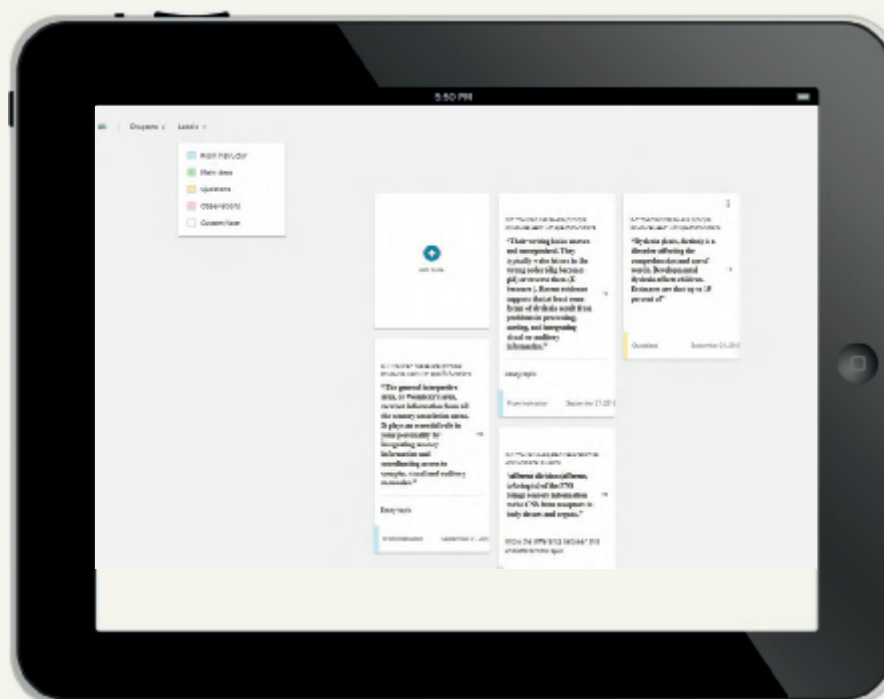


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KATHLEEN WELCH, M.D. (clinical consultant) received her



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KEVIN PETTI, Ph.D. (contributor) Dr. Petti is a professor at San Diego State Miramar College, where he teaches courses in human anatomy and physiology, human dissection, and health education. He is President Emeritus of the Human Anatomy and Physiology Society (HAPS)

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Preface

Welcome to the Eighth Edition of *Essentials of Anatomy & Physiology*! This textbook introduces the essential concepts needed for an understanding of the human body and helps students place information in a meaningful context, develop their problem-solving skills, and prepare for a career in a medical or allied health field. In this edition, we continue to build on this text's hallmark quality: a clear, effective visual and narrative presentation of anatomy and physiology. During the revision process, the author and illustrator team drew upon their combined content knowledge, research skills, artistic talents, and 50-plus years of classroom experience to make this the best edition yet.

The broad changes to this edition are presented in the **New to the Eighth Edition** section below. Also below are the sections **Learning Outcomes** and **Chapter-by-Chapter Changes in the Eighth Edition**.

New to the Eighth Edition

In addition to the technical changes in this edition, such as updated statistics and anatomy and physiology descriptions, we have simplified the presentations to make the narrative easier to read. We have also focused on improving the integration of illustrations with the narrative. These are the key changes in this new edition:

- **Improved readability** uses simpler, shorter, more active sentences to make reading and studying easier for students. In all chapters, the Flesch/Kincaid reading levels have been decreased.
- **Improved text-art integration** throughout the illustration program enhances the readability of figures. Tabular information is now integrated into the figures so that the relevant text is located immediately next to each part of a figure. Increased color saturation was also applied to the art throughout the text.
- **Terminology** has been updated based on *Terminologia Anatomica* and *Terminologia Histologica*, our references for anatomical and tissue terms. We continue to use possessive forms of diseases when the proposed alternative has not been widely accepted, e.g., Parkinson's disease and Huntington's disease.
- **Mastering A&P®**, Pearson's online learning and assessment system, contains new assignable activities tied to features in the book, including 10 narrated, annotated Spotlight

Videos that walk students through these popular features to explain core concepts, and a Build Your Knowledge interactive widget that allows them to see how body systems work together to maintain homeostasis. In addition, many Spotlight figures have Coaching Activities in Mastering, and the Body System figures correspond to Concept Map Coaching Activities that will bring home the concept of body system integration. Instructors can assign homework from proven media programs such as Practice Anatomy Lab™ (PAL™) 3.1 and Interactive Physiology®—all organized by chapter—and have assignments automatically graded. Mobile friendly Dynamic Study Module questions help students study effectively and efficiently by allowing them to quiz themselves anytime, anywhere. In the Mastering A&P Study Area, students can access a full suite of self-study tools, including Bone and Dissection videos and A&P Flix.

Learning Outcomes

The chapters of the Eighth Edition are organized around specific Learning Outcomes that indicate what students should be able to do after studying the chapter.

- **Learning Outcomes** appear in chapter-opening numbered lists, as well as directly below each relevant chapter section heading.
- **Full-sentence chapter headings** do more than introduce new topics; they state the core fact or concept that will be presented in the section. There is a one-to-one correspondence between the Learning Outcomes and the full-sentence section headings in every chapter.
- **Checkpoints** are located at the close of each section and ask students to pause and check their understanding of facts and concepts. The Checkpoints reinforce the Learning Outcomes presented on the chapter-opening page and below chapter section headings, resulting in a systematic integration of the Learning Outcomes over the course of the chapter. Answers are located in the blue Answers tab at the back of the book. All the Checkpoints have been reviewed, and questions were added or revised to reflect our improved readability.

All assessments in Mastering A&P are organized by the Learning Outcomes, making it easy for instructors to organize their courses and demonstrate results against goals for student achievement.

Chapter-by-Chapter Changes in the Eighth Edition

This annotated Table of Contents provides select examples of revision highlights in each chapter of the Eighth Edition.

Chapter 1 An Introduction to Anatomy and Physiology

- Section 1-1 revised (*cellular differentiation* replaces *differentiation*; *the same kind of organisms* replaces *similar, but not identical, organisms*; *Organisms exhibit movement* replaces *Organisms can move*.)
- Figure 1-4 Negative Feedback: Control of Body Temperature revised (new title)
- Figure 1-10 Relationships among the Subdivisions of the Body Cavities of the Trunk revised (*visceral layer of serous pericardium* replaces *visceral pericardium*, *parietal layer of serous pericardium* replaces *parietal pericardium*)
- Related Clinical Terms revised (*acute* and *chronic* terms added; *injury* added to definition of *radiology*)

Chapter 2 The Chemical Level of Organization

- Section 2-1 revised (clarified definition of *radiation*)
- Spotlight Figure 2-7 Chemical Notation revised (simplified introduction and replaced spelled out numbers with numerals to better integrate the Visual Representation and Chemical Notation columns)
- Section 2-8 revised (clarified that, in physiology, the term *electrolyte* applies to both the ionizable substance and its ions)
- New Clinical Note (*Too Sweet on Sugar* replaces *Fatty Acids and Health*)

Chapter 3 Cell Structure and Function

- Section 3-7 Learning Outcome revised (sequence of interphase and mitosis now correlates with section discussion)
- Table 3-1 revised (*propagation of nerve impulses* replaces *conduction of nerve impulses*)
- Figure 3-5 Diffusion Across the Plasma Membrane revised (color of water molecules now matches those in Chapter 2 figures)
- Figure 3-9 The Sodium-Potassium Exchange Pump revised (corrected relative sizes of sodium and potassium ions)
- Spotlight Figure 3-7 Protein Synthesis, Processing, and Packaging revised (added magnification of TEM illustrating exocytosis)
- Section 3-10 revised (*cellular differentiation* replaces *differentiation*)

Chapter 4 The Tissue Level of Organization

- Figure 4-1 An Orientation to the Body's Tissues revised (*nervous tissue* replaces *neural tissue*)
- Figure 4-2 Cell Junctions revised (*basal lamina* replaces *clear layer* and *reticular lamina* replaces *dense layer*)
- Figure 4-3 The Surfaces of Epithelial Cells (added *Lateral surfaces* and *Basal surface* labels)
- Figure 4-4 Simple Epithelia revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-5 Stratified Epithelia revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-6 Methods of Glandular Secretion revised (*Modes* changed to *Methods* in figure title and letters added to different parts of the figure to enhance text-art integration)
- Table 4-2 revised (*Method of Secretion* replaces *Mode of Secretion*)
- Clinical Note Marfan's Syndrome revised (*Marfan* replaces *Marfan's*)
- Figure 4-9 Loose Connective Tissue revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-10 Dense Connective Tissue revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-11 Types of Cartilage revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-14 Muscle Tissue revised (moved part letters to highlight tissue types and enhance text-art integration)
- Figure 4-15 Nervous Tissue revised (new title *Nervous Tissue* replaces *Neural Tissue*)

Chapter 5 The Integumentary System

- The text now uses *subcutaneous layer* as the primary term and *hypodermis* as the secondary term.
- Figure 5-1 The General Structure of the Integumentary System revised (*Subcutaneous layer* replaces *Hypodermis*)
- Spotlight Figure 5-2 revised (part labels added to better align text and art)
- Section 5-2 heading revised (shortened to *Epidermal pigmentation and dermal circulation influence skin color*)
- Figure 5-5 Hair Follicles and Hairs revised (*Subcutaneous layer* replaces *Hypodermis* in part b)
- Figure 5-6 Sebaceous Glands and Their Relationship to Hair Follicles revised (*Subcutaneous layer* replaces *Hypodermis*)
- Figure 5-7 Sweat Glands revised (*Eccrine sweat gland* replaces *Merocrine sweat gland* as primary term, *Subcutaneous layer* replaces *Hypodermis*)

- Build Your Knowledge revised (added *in females, specialized integumentary glands secrete milk* to Integumentary System functions)

Chapter 6 The Skeletal System

- Figure 6-1 A Classification of Bones by Shape revised (bone art enlarged, added *Sectional view* label to part c)
- Clinical Note: Types of Fractures and Steps in Repair revised (replaced x-rays of *Displaced fracture* and *Spiral fracture*)
- Figure 6-8 The Skeleton revised (enlarged figure and increased color and contrast; added *Sternum* label)
- Figure 6-9 The Axial and Appendicular Divisions of the Skeleton revised (*Rib cage* replaced *Thoracic cage* to correlate with the *Axial Skeleton* bone count; *coxal bone* deleted from *Hip bone* box)
- Figure 6-10 The Adult Skull, Part I revised (added leader dots to leader lines of *Coronal suture*, *Squamous suture*, and *Lambdoid suture*)
- Figure 6-12 Sectional Anatomy of the Skull revised (added forked leader to *Frontal sinuses* label)
- Figure 6-13 The Paranasal Sinuses revised (*Ethmoidal cells* replaces *Ethmoidal sinuses*)
- Figure 6-16 The Vertebral Column revised (color coded Vertebral regions to match art in later chapters)
- Figure 6-17 Typical Vertebrae of the Cervical, Thoracic, and Lumbar Regions revised (changed color in icon art to match Figure 6-18 icon art)
- Figure 6-19 The Sacrum and Coccyx revised (adjusted position of *Lateral sacral crest* leader line in part b)
- Figure 6-20 The Thoracic Cage revised (added thoracic cage definition)
- Figure 6-24 The Right Radius and Ulna revised (*RADIUS* and *ULNA* labels changed to *Radius* and *Ulna* to match use in other figures in chapter)
- Figure 6-25 The Bones of the Wrist and Hand revised (rearranged terms in *Proximal Carpals* box to match sequence as discussed in the text)
- Section 6-10 revised (*Plane* movement replaces *Gliding* movement)
- Figure 6-26 The Hip Bones and the Pelvis revised (*Sacroiliac joint* replaces *Sacroiliac joint*)
- Figure 6-33 Rotational Movements revised (added a red dot to mark the location of the joint involved in rotational movements of the head)
- Section 6-11 heading and Learning Outcome revised (*joints* replaces *articulations*)
- Spotlight Figure 6-35 Synovial Joints revised (*Plane joint* replaces *Gliding joint*; *gliding* inserted into *Plane joint Movement* text)

- Figure 6-40 The Knee Joint revised (added *PCL* abbreviation after *Posterior cruciate ligament* and *ACL* abbreviation after *Anterior cruciate ligament* labels)

Chapter 7 The Muscular System

- Figure 7-1 The Organization of Skeletal Muscles revised (added part letters to enhance text–art integration)
- Figure 7-2 The Organization of a Skeletal Muscle Fiber revised (enhanced art)
- Figure 7-3 Changes in the Appearance of a Sarcomere during Contraction of a Skeletal Muscle Fiber (added *Relaxed myofibril* label in part a and *Relaxed myofibril* label in part b)
- Spotlight Figure 7-4 Events at the Neuromuscular Junction revised (updated ACh receptor membrane channel art and added text to step 5)
- Figure 7-6 Steps Involved in Skeletal Muscle Contraction and Relaxation revised (updated ACh receptor membrane channel and T tubule/Sarcoplasmic reticulum art)
- Figure 7-10 Muscle Metabolism revised (in part c, *the hydrolysis of ATP* replaces *pyruvate* as the source of hydrogen ions at peak activity)
- Table 7-12 Muscle Terminology revised (*Terms Indicating Specific Regions of the Body* moved to left column to better correlate with anatomical terminology introduced in Chapter 1)
- Figure 7-17 Muscles of the Pelvic Floor revised (in part b, *transverse perineal* replaces *transverse perineus*)

Chapter 8 The Nervous System

- Section 8-1 revised (recognized the *enteric nervous system (ENS)* as a third division of the *peripheral nervous system*)
- Figure 8-5 Schwann Cells and Peripheral Axons revised (added *neurolemmocytes* as a secondary term for Schwann cells; *neurolemma* replaces *neurilemma*)
- Figure 8-14 Gross Anatomy of the Spinal Cord revised (*lumbosacral enlargement* replaces *lumbar enlargement*; *ventral roots* replaces *anterior roots*; *dorsal roots* replaces *posterior roots*; *spinal ganglion* replaces *dorsal root ganglion*)
- Figure 8-15 Sectional Anatomy of the Spinal Cord revised (*spinal ganglion* replaces *dorsal root ganglion*)
- Figure 8-16c The Brain revised (*Medial view* replaces *Sagittal section*, *Brainstem* replaces *Brain stem*)
- Section 8-8 The PNS connects the CNS with the body's external and internal environments, Cranial Nerves revision (added sentence: *If the full name of the cranial nerve is*

given, then only the Roman numeral is needed, such as optic nerve (II)). This addition affects cranial nerves figure labels and text narrative.

- Figure 8-22 The Basal Nuclei revised (removed *amygdaloid body* from *Basal Nuclei* box since it is considered a component of the limbic system)
- Figure 8-25 The Cranial Nerves, parts a and b revised (*N* preceding Roman numeral of named optic nerves is deleted)
- Figure 8-26 Peripheral Nerves and Nerve Plexuses revised (leader line from *Femoral nerve* corrected)
- Figure 8-27 Dermatomes revised (*CN V* replaces *N V*)
- Figure 8-29 A Stretch Reflex revised (*quadriceps muscles* replaces *muscles* in second line of caption)
- Figure 8-31 The Posterior Column Pathway revised (*Primary Sensory Cortex* changed to *Primary Somatosensory Cortex*; *Dorsal root ganglion* changed to *Spinal ganglion*)
- Figure 8-32 The Corticospinal Pathway revised (*brainstem* replaces *brain stem*)
- Figure 8-35 The Parasympathetic Division revised (*N* changed to *CN*; added postganglionic neuron on rectum art)
- Table 8-2 The Effects of the Sympathetic and Parasympathetic Divisions of the ANS on Various Body Structures revised (EYE: Sympathetic Effects - *Focusing for distance vision* replaces *Focusing for near vision*; Parasympathetic Effects - *Focusing for close vision* replaces *Focusing for distance vision*)

Chapter 9 The General and Special Senses

- Figure 9-3 Tactile Receptors in the Skin revised (added myelin sheath to afferent nerve fiber in Tactile Discs box; *bulbous corpuscle* replaces *Ruffini corpuscle*; *lamellar [pacinian] corpuscle* replaces *lamellated [pacinian] corpuscle*)
- Figure 9-4 Baroreceptors and the Regulation of Autonomic Functions revised (changed *carotid sinus* to *carotid sinuses* and added a second leader; *aortic arch* replaces *aortic sinus* and corrected position of leader line)
- Figure 9-6 The Olfactory Organs revised (in part a, changed Olfactory nerve fibers (*N I*) to Olfactory nerve fibers (*I*); in part b, *dendritic bulb* replaces *knob*)
- Figure 9-7 Taste Buds and Gustatory Epithelial Cells revised (new title; in part a, eliminated line spacing between the four primary taste sensations to indicate that all portions of the tongue provide sweet, salty, sour, and bitter sensations; in part b, *gustatory epithelial cell* replaces *gustatory cell*)
- Figure 9-8 The Accessory Structures of the Eye revised (*lateral angle* replaces *lateral canthus* and *medial angle* replaces *medial canthus*)

- Figure 9-10 The Sectional Anatomy of the Eye revised (in parts a and c, *fovea centralis* replaces *fovea*; in part b, *neural layer* replaces *neural part* and *pigmented layer* replaces *pigmented part*; part c caption revised [*Superior view of dissection of the right eye* replaces *Horizontal dissection of the right eye*])
- Figure 9-11 Retinal Organization revised (*pigmented layer of retina* replaces *pigmented part of retina* and *neural layer of retina* replaces *neural part of retina*; *fovea centralis* replaces *fovea*)
- Figure 9-14 Focal Point, Focal Distance, and Visual Accommodation revised (in part a, text in art changed to "*Light rays from a distant source (object) are parallel*", and caption revised by adding "*the greater the angle of arriving light rays and*"; art in parts d and e exchanged to better match art in parts a, b, and c)
- Spotlight Figure 9-16 Refractive Problems revised (added "*a process called accommodation*" to the end of introductory paragraph)
- Figure 9-18 The Structure of Rods and Cones revised (*pigmented epithelium* replaces *pigment epithelium*)
- Figure 9-20 The Visual Pathways revised (*Optic nerves [III]* replaces *Optic nerves [N II]*)
- Figure 9-21 The Anatomy of the Ear revised (*Facial nerve [VII]* replaces *Facial nerve [N VII]* and *Vestibulocochlear nerve [N VIII]* replaces *Vestibulocochlear nerve [N VIII]*)
- Figure 9-23 The Internal Ear revised (*ampullary crests* replaces *cristae*)
- Figure 9-24 The Semicircular Ducts revised (*ampullary crest* replaces *crista ampullaris*; *ampullary cupula* replaces *cupula*; *Vestibular nerve* replaces *Vestibular branch*)
- Figure 9-25 The Utricle and Sacculae revised (*macula of utricle* replaces *macula*)
- Figure 9-27 Sound and Hearing revised (*Cochlear nerve* replaces *Cochlear branch of cranial nerve VIII*)
- Figure 9-28 Pathways for Auditory Sensations revised (*Vestibular nerve* replaces *Vestibular branch*; *Vestibulocochlear nerve [VIII]* replaces *Vestibulocochlear nerve [N VIII]*; in step 5, *auditory* replaces *acoustic*)

Chapter 10 The Endocrine System

- Figure 10-1 Organs and Tissues of the Endocrine System revised (deleted *Secretes* from the examples of Organs with Secondary Endocrine Functions)
- Figure 10-2 The Role of Target Cell Receptors in Hormone Action revised (*neurons* replaces *neural tissue*; *skeletal muscle fiber* replaces *skeletal muscle tissue*)
- Figure 10-4 Hypothalamic Control over Endocrine Function revised (added color coding to boxed text to enhance links between hypothalamic structures and functions)

- Figure 10-8 Pituitary Hormones and Their Targets revised (changed color of adrenal gland secretion oval to enhance link with revised boxed text color in Figure 10-4)
- Section 10-4 Title revised (*The thyroid gland synthesizes thyroid hormones that affect the rate of metabolism* replaces *The thyroid gland lies inferior to the larynx and requires iodine for hormone synthesis*)
- Table 10-1 The Pituitary Hormones revised (under Target column, *Interstitial endocrine cells of testes* replaces *Interstitial cells of testes*)
- Figure 10-10 The Homeostatic Regulation of the Blood Calcium Ion Concentration revised (clarified that figure discusses calcium ion concentration in *blood* and calcitonin's limited role in bone deposition)
- Table 10-2 Hormones of the Thyroid Gland and Parathyroid Glands revised (*principal cells* replaces *chief cells*)
- Figure 10-13 The Endocrine Pancreas revised (*bile duct* replaces *common bile duct*)
- Figure 10-14 The Homeostatic Regulation of the Blood Glucose Concentration revised (added Homeostatic to figure title and clarified normal blood glucose levels is a range)
- Clinical Note Diabetes Mellitus revised (updated estimated number of people in the U.S. with some form of diabetes)
- Clinical Note Endocrine Disorders revised (*congenital hypothyroidism* replaces *cretinism* and *infantile hypothyroidism*)
- Build Your Knowledge revised (clarified that vitamin D₃ is a *precursor to calcitriol production* in the Integumentary System box)

Chapter 11 The Cardiovascular System: Blood

- Spotlight Figure 11-1 The Composition of Whole Blood revised (clarified definition of hematocrit; updated *normal hematocrit range for adult males and adult females*)
- Section 11-3 Abundance of Red Blood Cells section revised (described the composition of the three layers observed after centrifugation of whole blood)
- Section 11-3 Structure of RBCs section revised (clarified that a *flexible cell membrane* accounts for ability of RBCs bend and squeeze through capillaries)
- Section 11-3 Sex and Iron Reserves revised (*Sex and Iron Reserves* replaces *Gender and Iron Reserves*)
- Figure 11-3 Recycling of Hemoglobin revised (clarified that Fe^{2+} is an *iron ion*; added label to large intestine)
- Clinical Note Abnormal Hemoglobin revised (*sickle cell disease [SCD]* replaces *sickle cell anemia [SCA]*)
- Figure 11-6 Blood Types and Cross-Reactions revised (corrected shapes of anti-A and anti-B antibodies)
- Figure 11-7 Blood Typing Testing revised (added “clumping” or “no clumping” under test results for clarification)

- Figure 11-9 The Vascular, Platelet, and Coagulation Phases of Hemostasis revised (added *Endothelium* label for clarification)

Chapter 12 The Cardiovascular System: The Heart

- Section 12-1 revised (clarified that *pericardium* includes an outer *fibrous pericardium* and an inner *serous pericardium*)
- Figure 12-1 The Location of the Heart in Thoracic Cavity revised (*parietal layer of serous pericardium* replaces *parietal pericardium*, *visceral layer of serous pericardium* replaces *visceral pericardium*)
- Figure 12-3 The Position and Anatomy of the Heart revised (parts are rearranged; part a art now shows the position of the heart)
- Figure 12-4 The Heart Wall and Cardiac Muscle Tissue revised (*parietal layer of serous pericardium* replaces *parietal pericardium*, *visceral layer of serous pericardium* replaces *visceral pericardium*)
- Spotlight Figure 12-5 The Heart: Internal Anatomy and Blood Flow revised (*tricuspid valve* replaces *right atrioventricular valve*, *mitral valve* replaces *left atrioventricular valve*)
- Figure 12-6 The Valves of the Heart revised (*tricuspid* replaces *right AV [tricuspid] valve*, *mitral valve* replaces *left AV [bicuspid] valve*)
- Figure 12-8 Action Potentials in Cardiac Contractile Cells and Skeletal Muscle Fibers revised (new figure title; *cardiac contractile cell* replaces *cardiac muscle cell*, *skeletal muscle fiber* replaces *skeletal muscle*)
- Figure 12-11 The Cardiac Cycle revised (Changed color of central *Cardiac cycle* to enhance text and art)
- Figure 12-12 Heart Sounds revised (new part a art avoids crossing of leader lines)
- Figure 12-13 Autonomic Innervation of the Heart revised (*Vagus nerve [X]* replaces *Vagus [NX]*)

Chapter 13 The Cardiovascular System: Blood Vessels and Circulation

- Figure 13-2 The Structure of the Various Types of Blood Vessels revised (clarified internal, or *lumen*, diameters of blood vessels)
- Figure 13-8 The Baroreceptor Reflexes of the Carotid Sinuses and Aortic Arch revised (new Figure title; *Baroreceptors in carotid sinuses and aortic arch* replaces *Baroreceptors in aortic and carotid sinuses*)
- Figure 13-18 The Venous Drainage of the Abdomen and Chest revised (*hemi-azygos* replaces *hemiazzygos*)
- Figure 13-19 A Flowchart of the Tributaries of the Superior and Inferior Venae Cavae revised (*Hemi-azygos* replaces *Hemiazzygos*)

- Figure 13-20 The Hepatic Portal System revised (clarified drainage of *left and right gastroepiploic veins*)
- BYK Integrator (*lactate* replaces *lactic acid*)

Chapter 14 The Lymphatic System and Immunity

- Definition of the term “immune response” revised from “a defense against specific antigens” to “the body’s reaction to infectious agents and abnormal substances”)
- Figure 14-1 The Components of the Lymphatic System revised (added CNS lymphatic vessels to the art; Other Lymphoid Tissues and Organs heading replaces Lymphoid Tissues and Organs heading because lymph nodes are organs)
- Spotlight Figure 14-4 Origin and Distribution of Lymphocytes revised (*hemocytoblasts* replaces *hematopoietic stem cells*)
- Figure 14-6 The Structure of a Lymph Node revised (*cortex* replaces *outer cortex*; *paracortex* replaces *deep cortex*)
- Figure 14-9 The Body’s Innate Defenses revised (clarifies the roles of *complement*)
- Figure 14-11 Forms of Immunity revised (*artificially acquired* replaces *artificially induced*)
- Figure 14-12 An Overview of Adaptive Immunity revised (former title “An Overview of the Immune Response”; new title emphasizes that adaptive immunity is part of the “immune response”)
- Figure 14-17 An Integrated Summary of the Immune Response (new title corresponds with broadened definition of the term “immune response”; *regulatory T cells* replaces *suppressor T cells*)

Chapter 15 The Respiratory System

- Figure 15-1 The Structures of the Respiratory System revised (*Respiratory bronchioles* replaces *Smallest bronchioles*)
- Figure 15-2 The Respiratory Mucosa revised (*mucus* replaces *mucus layer*)
- Figure 15-3 The Nose, Nasal Cavity, and Pharynx revised (*posterior internal apertures* replaces *internal nares*, and *nostrils* replaces *external nares*)
- Clinical Note Cystic Fibrosis revised (added text to clarify that cystic fibrosis affects not only the respiratory system, but also the digestive and reproductive systems)
- Figure 15-4 The Anatomy of the Larynx and Vocal Cords revised (*glottis in the open position* art and photomicrograph now positioned next to each other)
- Figure 15-5 The Anatomy of the Trachea revised (*main bronchi* replaces *primary bronchi* and *lobar bronchi* replaces *secondary bronchi*)
- Figure 15-6 Bronchial Branching and a Lobule of the Lung revised (new figure title; *segmental bronchi* replaces *tertiary bronchi*)

- Figure 15-7 Alveolar Organization revised (*pneumocyte type I* replaces *type I pneumocyte*, and *pneumocyte type II* replaces *type II pneumocyte*; *blood air barrier* replaces *respiratory membrane*)
- Figure 15-8 The Gross Anatomy of the Lungs revised (added caption “*The lobes are shown as though transparent to make the main branching of the bronchial tree visible*”)
- Spotlight Figure 15-10 Pulmonary Ventilation revised (clarified *rib cage* structures and that *accessory respiratory muscles* are only active in *forced breathing*)
- Figure 15-11 Pulmonary Volumes and Capacities revised (TV replaces V_T as abbreviation for tidal volume; clarified table describing sex differences)
- Spotlight Figure 15-16 The Control of Respiration revised (CN replaces N)
- BYK Integrator revised (deleted *nourish* from Integumentary System description)

Chapter 16 The Digestive System

- Section 16-1 revised under *Secretion*, added *salts* to the substances released into the digestive tract
- Section 16-1 revised (clarified that the *enteric nervous system [ENS]* consists of the *myenteric plexus* and *submucosal plexus*)
- Figure 16-1 The Components of the Digestive System revised (*mechanical digestion* replaces *mechanical processing*, *chemical digestion* replaces *chemical breakdown*)
- Figure 16-2 The Structure of the Digestive Tract revised (included *muscularis mucosae* within the Mucosa box, *muscular layer* replaces *muscularis externa*)
- Figure 16-4 The Oral Cavity revised (*frenulum of tongue* replaces *lingual frenulum*)
- Figure 16-6 Teeth: Structural Components and Dental Succession revised (*cement* replaces *cementum*, *alveolar process* replaces *bone of alveolus*, *deciduous teeth* replaces *primary teeth*, *permanent teeth* replaces *adult teeth*)
- Figure 16-8 The Anatomy of the Stomach revised (*muscular layer* replaces *muscularis externa*; added *gastrin-producing G cells* to part d caption)
- Spotlight Figure 16-9 Regulation of Gastric Activity revised (*muscular layer* replaces *muscularis externa*; *neural inhibition* and *hormonal inhibition* added to *Intestinal Phase KEY*)
- Figure 16-11 The Intestinal Wall revised (*muscular layer* replaces *muscularis externa*; *Goblet cells [intestinal mucous cells]* replaces *Mucous cells*)
- Figure 16-13 The Pancreas revised (*bile duct* replaces *common bile duct*)
- Figure 16-14 The Surface Anatomy of the Liver revised (*bile duct* replaces *common bile duct*)
- Figure 16-15 Liver Histology revised (*portal triad* replaces *portal area*; *interlobular bile duct* replaces *bile duct*, *interlobular artery* replaces *branch of the hepatic artery proper*,

interlobular vein replaces *branch of hepatic portal vein*; *stellate macrophages* replaces *Kupffer cells*)

- Figure 16-16 The Gallbladder revised (*bile duct* replaces *common bile duct*)
- Figure 16-17 The Large Intestine revised (*teniae coli* replaces *tenia coli* because there is no singular form to refer to one of the longitudinal smooth muscle bands)
- Spotlight Figure 16-18 Chemical Events in Digestion (clarified large organic molecules are *chemically* broken down before absorption)
- BYK Integrator revised (clarified mechanical and chemical digestion functions in Digestive System box)

Chapter 17 Metabolism and Energetics

- Figure 17-2 Nutrient Use in Cellular Metabolism revised (*electron transport chain* replaces *electron transport system*)
- Figure 17-4 The Citric Acid Cycle revised (*electron transport chain* replaces *electron transport system*)
- Spotlight Figure 17-5 Electron Transport Chain and ATP Formation revised (new figure title and clarified the role of *chemiosmosis* in ATP formation)
- Figure 17-6 A Summary of the Energy Yield of Aerobic Metabolism revised (*electron transport chain* replaces *electron transport system*)
- Figure 17-7 Carbohydrate Metabolism revised (clarified that gluconeogenesis only involves noncarbohydrates; deleted *Other carbohydrates* box from art)

Chapter 18 The Urinary System

- Section 18-1 revised (*metabolic wastes* replaces *organic wastes*)
- Figure 18-2 The Position of the Kidneys revised (clarified locations of *last thoracic* and *third lumbar vertebrae* to better correlate with text)
- Figure 18-4 The Blood Supply to the Kidneys revised (part a, added *segmental artery* label; part b, *renal pyramid* replaces *medulla*, and added *interlobar artery* and *interlobar vein* labels to better correlate with part a)
- Figure 18-5 A Representative Nephron and the Collecting System revised (highlighted general functions of *descending limb* and *ascending limb* in the Nephron Loop box with bullet points; *descending thin limb* replaces *thin descending limb*)
- Figure 18-6 The Renal Corpuscle revised (in part a, *capsular outer layer* replaces *parietal epithelium*, *visceral layer* replaces *visceral epithelium*; in part b, *fenestrated capillary endothelium* replaces *capillary epithelium*, *foot processes of podocytes* replaces *filtration slits*; in part c, *foot processes* replaces *pedicels*)
- Figure 18-10 The Renin-Angiotensin-Aldosterone System and Regulation of GFR revised (new figure title; *systemic veins* replaces *venous reservoirs*)

- Figure 18-11 Organs for Conducting and Storing Urine revised (new figure title; *ureteral orifices* replaces *ureteral openings*)
- NEW Figure 18-12 The Control of Urination
- Figure 18-14 Ions in Body Fluids revised (caption revised to emphasize electrical neutrality within each fluid compartment)
- BYK Integrator Urinary System revised (*excretes* replaces *removes*)

Chapter 19 The Reproductive System

- Section 19-1 revised (*sperm* replaces *spermatozoa/spermatozoon* as the primary term)
- Figure 19-2 The Scrotum, Testes, and Seminiferous Tubules revised (*sperm* replaces *spermatozoa*)
- Section 19-2 revised (*dartos muscle* replaces *dartos*; *sustenocytes* replaces *sustentacular cells*; *prostate* replaces *prostate gland*)
- Figure 19-3 Spermatogenesis revised (*sperm* replaces *spermatozoa/spermatozoon*)
- Figure 19-6 The Penis revised (*foreskin* replaces *prepuce*)
- Spotlight Figure 19-7 Regulation of Male Reproduction revised (*interstitial endocrine cells* replaces *interstitial cells*; *sperm* replaces *spermatozoa*)
- Figure 19-10 Ovarian Follicle Development and the Ovarian Cycle revised (*ovarian follicle* replaces *follicle*; in caption, clarified that ovarian follicles enter *the 28-day* ovarian cycle as tertiary ovarian follicles)
- Section 19-3 revised (*functional layer* of endometrium replaces *functional zone* of endometrium, and *basal layer* of endometrium replaces *basilar layer* of endometrium)
- Figure 19-12 The Female External Genitalia revised (*bulb of vestibule* replaces *vestibular bulb*)
- Spotlight Figure 19-14 Regulation of Female Reproduction revised (*ovarian follicle* replaces *follicle*; temperature ranges added for both Celsius and Fahrenheit scales; and Menses label changed to Menstrual Phase)
- BYK Integrator Reproductive System revised (kidneys *excrete* replaces *kidneys remove* in Urinary System box)

Chapter 20 Development and Inheritance

- Figure 20-1 Fertilization revised (in part b, changed step 2 title and text in steps 3 and 4; clarified when DNA synthesis occurs, *sperm* replaces *spermatozoon*)
- Figure 20-3 Events in Implantation revised (*cytotrophoblast* replaces *cellular trophoblast*, *syncytiotrophoblast* replaces *syncytial trophoblast*)
- Figure 20-4 The Inner Cell Mass revised (*extra-embryonic* replaces *extraembryonic*, changed *Gastrulation* from *day 12* to *day 15*)
- Spotlight Figure 20-5 Extra-Embryonic Membranes and Placenta Formation revised (added *mucus plug* to week 10/step 5 art)

- Figure 20-6 The Placenta and Placental Circulation revised (*Mucus plug* replaces *Cervical (mucous) plug*)
- Figure 20-7 Development during the First Trimester revised (new part a Week 3 art and new Week 4, 8, and fiberoptic photographs)
- Figure 20-8 Fetal Development in the Second and Third Trimesters revised (new photograph of 6-month-old fetus)
- Figure 20-16 The Milk Ejection Reflex (new title replaces *The Milk Let-Down Reflex*)
- Figure 20-16 A Map of Human Chromosomes revised (*Down Syndrome* replaces *Down's Syndrome*; *Marfan's Syndrome* replaces *Marfan Syndrome*; *Sickle Cell Disease* replaces *Sickle Cell Anemia*)
- Section 20-8 The Human Genome revised (new title; added description of gene-editing technique *CRISPR/Cas9*)

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No two people could expect to produce a flawless textbook of this scope and complexity. Any errors or oversights are strictly our own rather than those of the reviewers, artists, or editors. In an effort to improve future editions, we ask that readers with pertinent information, suggestions, or comments concerning the organization or content of this textbook e-mail us directly at the e-mail address below. Any and all comments and suggestions will be deeply appreciated and carefully considered in the preparation of the next edition.

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Chapters

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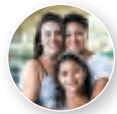
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