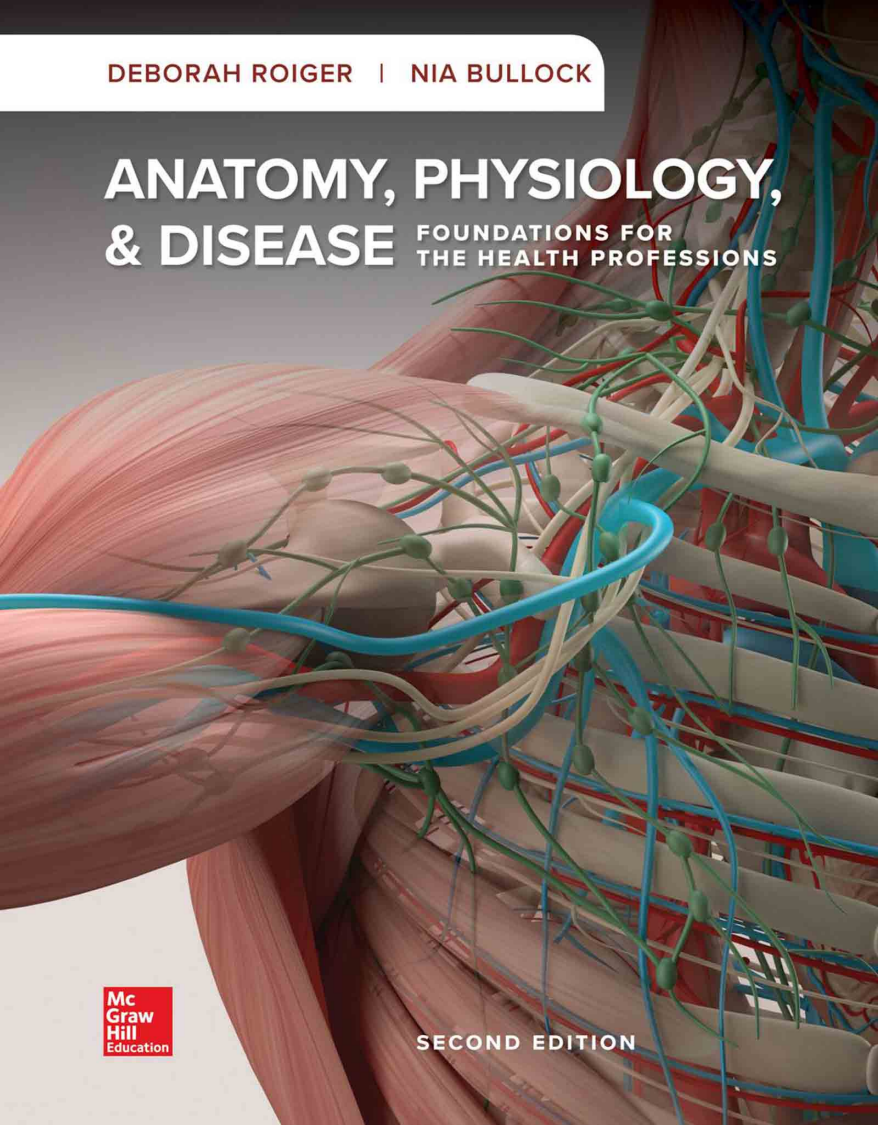
DEBORAH ROIGER | NIA BULLOCK

ANATOMY, PHYSIOLOGY, & DISEASE

FOUNDATIONS FOR THE HEALTH PROFESSIONS



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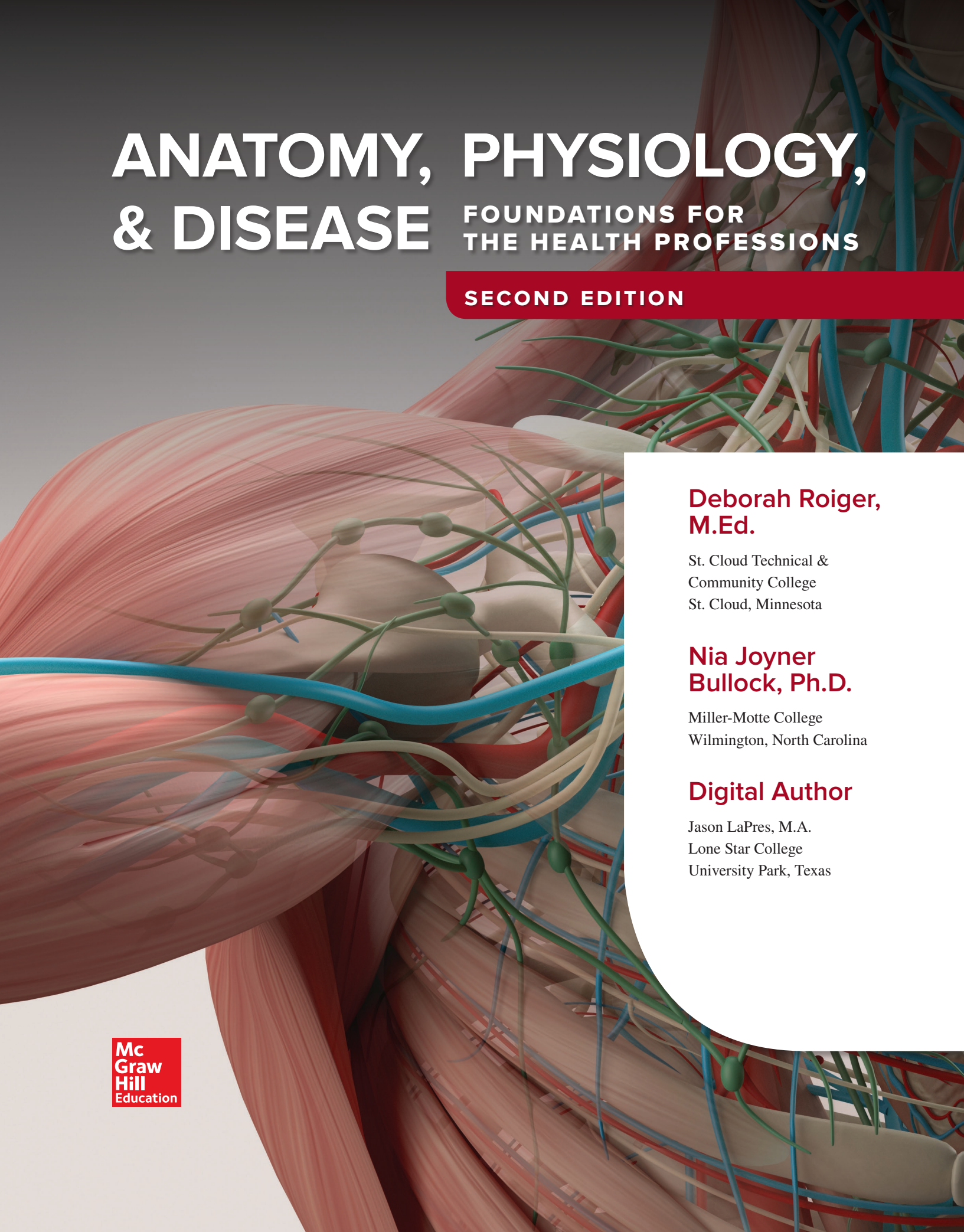

ANATOMY, PHYSIOLOGY, & DISEASE

FOUNDATIONS FOR THE HEALTH PROFESSIONS

SECOND EDITION

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Brief **Contents**

Dedication

I would like to dedicate this book to all of my anatomy and physiology students who have taught me so much.

~Deborah Roiger

I would like to dedicate this book to my family for all of their support and to my students, whose drive and dedication are awesome sources of inspiration.

~Nia Bullock

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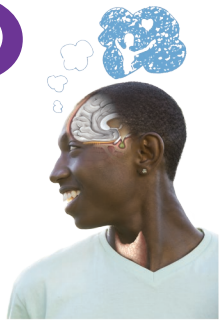

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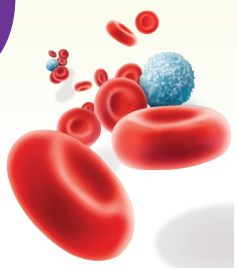

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About the **Authors**

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M.A. Education, St. Mary's University of Minnesota; B.S. Biology and Earth Science, St. Cloud State University

Deborah Roiger has 17 years of teaching experience, the last 12 of which were in the Minnesota State Colleges and University (MNSCU) system of 32 state-sponsored technical colleges, community colleges, and universities. She was voted instructor of the year in 2007 by the students at St. Cloud Technical College, received five awards for excellence by MNSCU for projects she developed, and was named educator of the year in 2009 by the MNSCU board of trustees. Deborah's development of digital resources for teaching anatomy and physiology online also earned an Innovation of the Year award in 2009 from the League for Innovation in the Community College. She has presented her work in the development of anatomy and physiology resources at four national conferences. Deborah is the author of *Anatomy & Physiology: Foundations for the Health Professions* and its accompanying workbook. She is a member of the Human Anatomy and Physiology Society (HAPS), American Academy for the Advancement of Science (AAAS), and National Science Teachers' Association.

Nia Joyner Bullock

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Dr. Nia Joyner Bullock has 18 years of teaching experience in private career colleges and universities. During her tenure at Miller-Motte College, she served in various professional capacities, including Academic Dean and Medical Assisting Program Director. She also teaches a variety of courses within the curriculum. Dr. Bullock has developed courses for the online division of the college and was instrumental in the implementation and use of various virtual training tools for allied health programs. She has made scholarly presentations at a number of scientific conferences and published articles and abstracts on maternal diabetes and its effects on embryonic heart development. She is a member of American Medical Technologists. Dr. Bullock lives in Wake Forest, North Carolina, with her husband and three sons.

Preface

The structure of the human body is fascinating. The study of human anatomy and physiology is vital knowledge for all students, and just as significant is an understanding of the abnormal functions of the body. Students seeking careers in the health care field can be doubly motivated when taking an anatomy, physiology, and pathology course, as the personally relevant content also prepares them for their chosen careers.

As instructors, we look for a text that is, first and foremost, accurate; is written at an appropriate level for our students—neither too high nor too low; can be customized to accommodate the organization of our individual courses; and will be interesting and appealing to our students.

This text has been designed specifically for college students taking an anatomy and physiology course or an anatomy, physiology, and pathology course.

- Reading-level assessments ensure the text is accessible to students.
- Thorough reviewing and meticulous checking of all text and illustrations ensure accuracy.
- All of the textbook and digital learning and assessment content has been mapped to specific learning outcomes, allowing instructors the option of building their course around specific outcomes and related content.
- The authors' illustration program has been expertly executed in full color and amazing detail by talented and precise medical illustrators.

Three Key Principles

The pedagogical approach of this text and its learning and assessment program is founded on three key principles:

1. **Tell students what we are going to teach them.** Each chapter in this text begins with a list of specific learning outcomes.
2. **Teach students what we outlined in the learning outcomes.** Everything in this text and all ancillary materials directly relates to the learning outcomes outlined in each chapter. Real-life situations, analogies, and a commonsense, direct approach are used to teach anatomy, physiology, and pathology concepts.
3. **Test students on what they have been taught.** All assignments, activities, discussion questions, review questions, and test questions in this text and in the *Workbook for Use with Anatomy, Physiology, and Disease* by Roiger/Bullock directly assess only the learning outcomes stated in each chapter.

This pedagogical approach warrants there will be no surprises for the student. If the learning outcomes are stressed through lecture and assignments, students quickly find comfort in having a guideline to follow in learning the content.

Changes to the Second Edition

This second edition features many macro-level changes that overlay each chapter of the book. The universal changes to the second edition include the following:

- A reorganization of chapters helps to better integrate pathology throughout the text. Chapter 1 (The Basics) and Chapter 3 (Introduction of Pathology) have merged and are now all incorporated into Chapter 1. Chapter 1 now introduces anatomy, physiology, and pathology to the student. All of the systems chapters follow Chapter 1, in the same sequence as in the first edition.
- The illustration program in the second edition has been completely revised to include more detailed, vibrant line art and many new photos. In addition, many figures have been revised to include content changes; those figures are included in the chapter-specific lists that follow, and the most significant new photos are noted as well.
- Learning outcomes now immediately follow relevant A or B heads.
- Twenty percent more Spot Check questions have been added throughout the text.
- Pronunciations now appear immediately after first use of the terms within text.
- The word "Homeostasis" is highlighted in bold, red lettering as important homeostasis concepts are introduced throughout the chapters.
- Chapter summaries have been expanded to include greater detail.
- Key terms lists are added to the end of each chapter.
- Warning boxes have been changed to "Common Misconception" boxes.
- Epidemiology Point boxes were removed from the chapters.

Chapter 1

- Merged Chapters 1 and 3 to cover introduction to anatomy, physiology, and pathology in the new Chapter 1
- Coverage added on communicable and noncommunicable disease, infectious and noninfectious disease, introduction to disease, predisposing factors, signs and symptoms of disease, classification of disease, diagnosing disease, treatment of diseases, and epidemiology
- Revised coverage included on the topics of hypersensitivities, cancer (shortened in Chapter 1, expanded in Chapter 2), and therapeutic treatment
- New Clinical Point boxes on pain scale and determining a diagnosis
- Updated Table 1.6 Most Prominent Chronic Diseases in the United States
- New photos in Figure 1.7(a)–(d) Anatomical planes

Chapter 2

- New section added: Modes of Tissue Growth, Change, Shrinkage, and Death (includes expanded coverage on cancer)
- Expanded coverage on hydrogen bonding
- Revised Figure 2.13 Generic cell cut to reveal its organelles
- Revised Figure 2.20 Protein synthesis: Transcription
- Revised Figure 2.21 Protein synthesis (continued): Translation
- Revised Figure 2.22 What happens after Translation
- Revised Figure 2.45(b): new cadaver heart photo

Chapter 3

- New Clinical Point on onychomycosis
- Updated Table 3.3 Skin Diseases and Disorders
- Eleven new photos throughout the chapter

Chapter 4

- Revised Figure 4.38(b) Histology of bone tissue
- Fourteen new photos throughout the chapter

Chapter 5

- Table 5.1 revised to include zygomaticus major
- Table 5.6 revised the function of tensor fasciae latae
- New Clinical Point on RICE acronym for muscle sprains
- Revised section on Effects of Aging on the Muscular System
- Revised text on Sprains and Muscle Strain in Disorders section
- Revised Figure 5.10 Muscles: full figure anterior view
- Revised Figure 5.11 Muscles: full figure posterior view
- Revised Figure 5.12(a) and (b) Muscles of the head and neck
- Revised Figure 5.26 Sliding filament theory of muscle contraction
- New photo in Figure 5.16(c) Muscles of the forearm, cadaver view
- New photo in Figure 5.17(c) Carpal tunnel syndrome, cadaver view

Chapter 6

- Overview is revised
- Expanded synapse and neurotransmitters coverage in Anatomy of a Neuron/Body section
- New Clinical Point on neurotransmitter imbalance and mental disorders
- Revised description of Wernicke's area, Huntington's disease, and Parkinson's disease
- Revised Figure 6.22(a) Resting membrane potential
- New Figure 6.22(b) Sodium/potassium pump
- Updated Table 6.6 Summary of Diseases and Disorders of the Nervous System

Chapter 7

- Revised text includes: anatomy of receptors for smell, cataract description, and physiology of taste
- Definition of proprioceptor was added to Chapter 7
- New Clinical Point box on age-related macular degeneration was added to Chapter 7
- Updated Table 7.3 Summary of Diseases and Disorders of the Senses in the Nervous System
- Revised Figure 7.8 The anatomy of the external ear, middle ear, and inner ear
- Revised Figure 7.10 Anatomy of the cochlea unwound
- Revised Figure 7.12 The effects of sound waves on the cochlea
- Revised Figure 7.13 Frequency response of the basilar membrane in the cochlea

Chapter 8

- Revised text on parathyroid glands
- New Clinical Point box on prediabetes

- New Clinical Point box on blood tests for hormone changes associated with menopause
- Revised Figure 8.4 Hypothalamus–anterior pituitary target-tissue relationship
- Revised Figure 8.5(a)–(c) Hypothalamus-pituitary relationship
- New photo in Figure 8.17 Acromegaly
- New photo in Figure 8.19 Endemic goiter resulting from an iodine deficiency
- New photo in Disease Point box on myxedema
- New photo in Figure 8.20(a) Cushing's syndrome

Chapter 9

- New Clinical Point box on carbon monoxide added
- Reorganized Blood Disorders section
- Updated Table 9.4 Summary of Diseases and Disorders of the Blood
- New photo in Figure 9.12(c) Agglutinated blood

Chapter 10

- Expanded section on Chambers and Valves to cover fossa ovalis
- Expanded section on Blood Flow through the Heart to include fetal heart blood flow
- Revised section on Heart Failure
- New Clinical Point box on defibrillation
- Coverage on fetal heart incorporated into chapter text (from Clinical Point box)
- Revised Figure 10.2 The position of the heart in the thorax (a, b, and c)
- Revised Figure 10.3 The pericardium and the heart wall
- New photo in Figure 10.5(c) External cadaver heart anterior view
- Revised Figure 10.9 General diagram of the pulmonary and systemic circuits
- New photo in Clinical Point box on defibrillators
- New photo in Figure 10.22(c) Polymer cast of coronary arteries
- New photo in Figure 10.31(b) Varicose veins

Chapter 11

- Revised section on Lymph and Lymph Vessels
- New Clinical Point box on organ transplantation and immunosuppressant drugs
- New Clinical Point box on biologic DMARDs
- Revised Figure 11.3(b) Valves in lymphatic vessels
- Revised Figure 11.14 Graph of a fever
- Revised Figure 11.18 Cellular immunity
- New photo for Disease Point box on elephantiasis
- New photo for Disease Point box on anaphylaxis
- New photo for Figure 11.24 Kaposi sarcoma

Chapter 12

- New photo in Figure 12.9 Lining of trachea
- New photo in Figure 12.13 Histology of the lung

- Revised Figure 12.15 A respiratory cycle of inspiration, expiration, and rest
- Revised Figure 12.17 Graphs of pulmonary volumes and capacities
- Revised Figure 12.22 Ventilation-perfusion coupling
- Revised Figure 12.23 Systemic gas exchange and transport
- Revised Figure 12.24 Alveolar gas exchange and transport
- New photo in Figure 12.28 Lung X-ray showing tuberculosis
- New photo in Figure 12.31 Lung cancer

Chapter 13

- Revised Figure 13.16 Gross anatomy of the small intestine showing the circular folds of the lining
- Revised Figure 13.17(b) Intestinal villi
- New photo in Disease Point box on gallstones

Chapter 14

- Angiotensinogen added to Aldosterone section
- New section added on Sources of Nitrogenous Wastes
- New photo added in Figure 14.5(b) Coronal section of cadaver kidney

Chapter 15

- New Clinical Point box added on anabolic steroids
- New photo in Figure 15.10(a) Mature spermatozoon
- New photo in Figure 15.14(a) Histology of a testis, seminiferous tubule
- Revised Figure 15.16 The male sexual response
- New photo in Figure 15.19 Hydrocele

Chapter 16

- New Clinical Point box added on birth control
- Revised Figure 16.13 The female sexual response
- Revised Figure 16.19 The process of fertilization
- Revised Figure 16.22 Initiating the birth process
- New photo in Figure 16.7(c) The female breast
- New photo in Figure 16.11 Ovulation in a human (endoscopic view)
- New photo in Figure 16.16 Removal of uterine fibroid

End matter

- Appendix B Nutrition table updated with the most current version (2015–2020)
- Appendix C updated to include answers to new Spot Check questions
- Appendix D: Prefixes, Suffixes, and Additional Word Roots is added to the Appendix section
- New terms added to the Glossary, and a number of terms and definitions are updated

Pedagogical Features

The following tools are built into this text to facilitate student learning.

Specific Learning Outcomes

Specific learning outcomes give clear expectations and direct student learning. Every piece of content, including the text, figures, and tables in each chapter, directly relates to specified learning outcomes.

Histology of the Skeletal System

Learning Outcomes

5. Describe the cells, fibers, and matrix of bone tissue.
6. Compare and contrast the histology of compact and cancellous bone.
7. Compare and contrast the histology of hyaline, elastic, and fibrocartilage connective tissues.

A **Chapter Summary** section, located at the end of each chapter, provides relevant bullet points to summarize each text section.

Summary

9.1 Word Roots and Combining Forms

- See the heading at the beginning of the chapter to learn the medical terminology that relates to the cardiovascular system.

9.2 Overview

- The cardiovascular system is composed of the heart, blood vessels, and blood.

9.3 Anatomy of Blood

- Blood is a connective tissue of formed elements in a matrix of plasma.

Plasma

- Plasma is 91% water; 7% protein; and 2% ions, nutrients, waste products, gases, and regulatory substances.
- Plasma is a solution, and its concentration is important for homeostasis.

Formed Elements

- The formed elements of the blood are erythrocytes, leukocytes, and thrombocytes.

Anatomy, Physiology, and Disease in Context

Physiology concepts are emphasized and put in context with real-world examples. The normal and abnormal functions of each system are explained in the context of a specific individual, and interconnections are made between new concepts and content in previous chapters.

Homeostasis, indicated throughout the text in red lettering, is discussed in context with relevant chapter topics and emphasizes the interdependent relationship between homeostasis and acid–base balance, fluid and electrolytes, and nutrition. These concepts are covered in the context of the body systems, not isolated in separate chapters.

Water moves between the two fluid compartments by osmosis, traveling easily across membranes to equalize the concentration of solutes on both sides and maintain **homeostasis.** Osmosis occurs very quickly to minimize the formation of concentration gradients of solutes in order to maintain homeostasis. Most of the solutes in the fluids are electrolytes, such as sodium in the extracellular fluids and potassium in the intracellular fluids. Fluid and electrolyte balance are therefore tied together. Figure 14.11 shows the movement of water between the major fluid compartments.

In Figure 14.11 you can see that water enters the body through the fluids you drink. This is the major source of water for the body, but not the only one. You may remember that water is also formed in the cells through cellular respiration ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy). This additional source is considered to be **metabolic water** because it is derived from a chemical process that occurs in the cells.

As you can see in Figure 14.12, the body's daily intake and output of water should be equal to maintain **homeostasis.** Although most of the water you take in is from drinks, food and metabolic water do make significant contributions to water balance. At the same time, urine output is the major way the body rids itself of water, while sweat, water evaporated from the skin, expired air, and feces also make significant

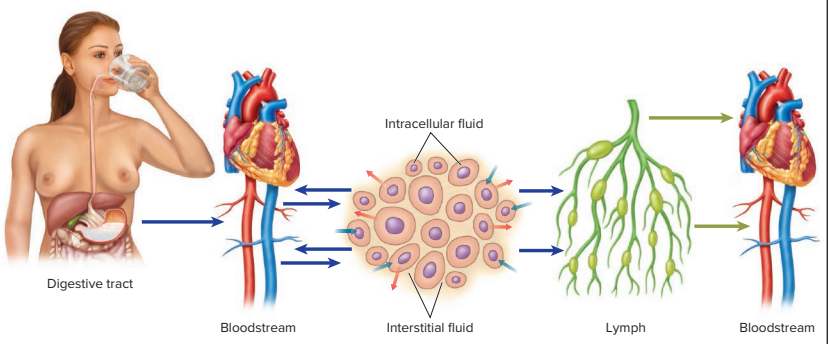

FIGURE 14.11 The movement of water between major fluid compartments.

Putting the Pieces Together, found at the end of each system chapter, ties the covered system to the other 10 systems of the human body.

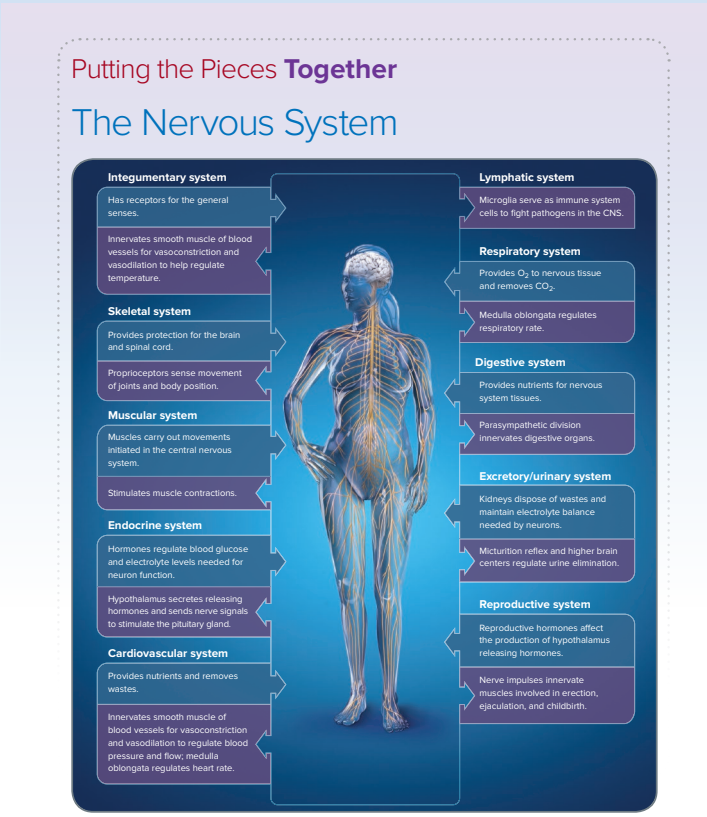

FIGURE 6.29 Putting the Pieces Together—The Nervous System: connections between the nervous system and the body's other systems.

Vibrant, accurate illustrations are frequently paired with striking cadaver photos. Students entering health sciences careers will ultimately be working with real bodies, and cadaver photos help to prepare students for later experiences in their careers.

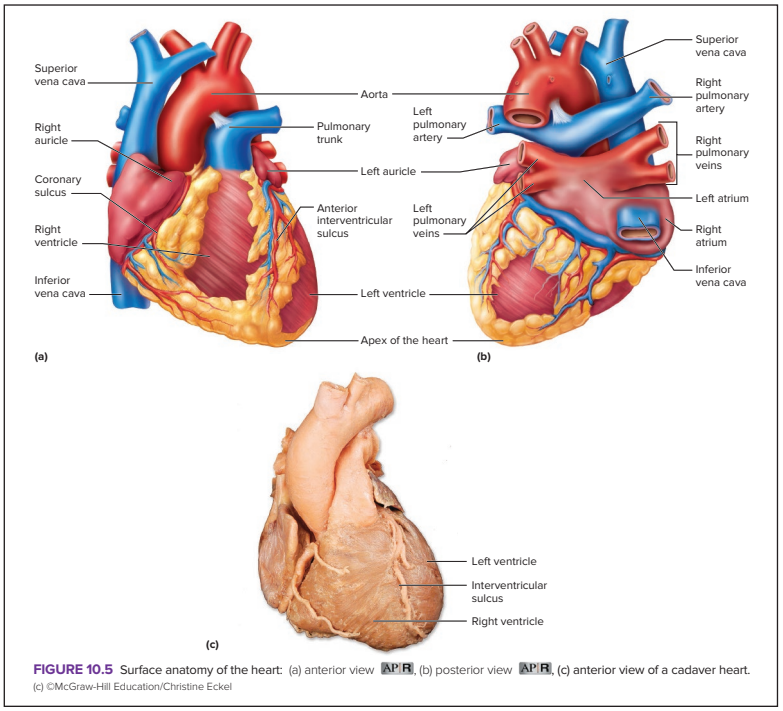

FIGURE 10.5 Surface anatomy of the heart: (a) anterior view AP R, (b) posterior view AP R, (c) anterior view of a cadaver heart.
(c) ©McGraw-Hill Education/Christine Eckel

Study Hint boxes contain useful tips and mnemonics for remembering structures and learning concepts.

Study Hint

When you are looking at a midsagittal view of the brain, such as **Figure 6.8e,** the diencephalon looks like the head of a duck. Upon closer inspection, seeing that the diencephalon has two components, imagine that the thalamus is the head of the duck and the hypothalamus is its beak.