Anatomy & Physiology for Health Professions

An Interactive Journey

Fourth Edition

Bruce J. Colbert • Jeff Ankney • Karen T. Lee

BRIEF CONTENTS

Anatomy & Physiology for Health Professions

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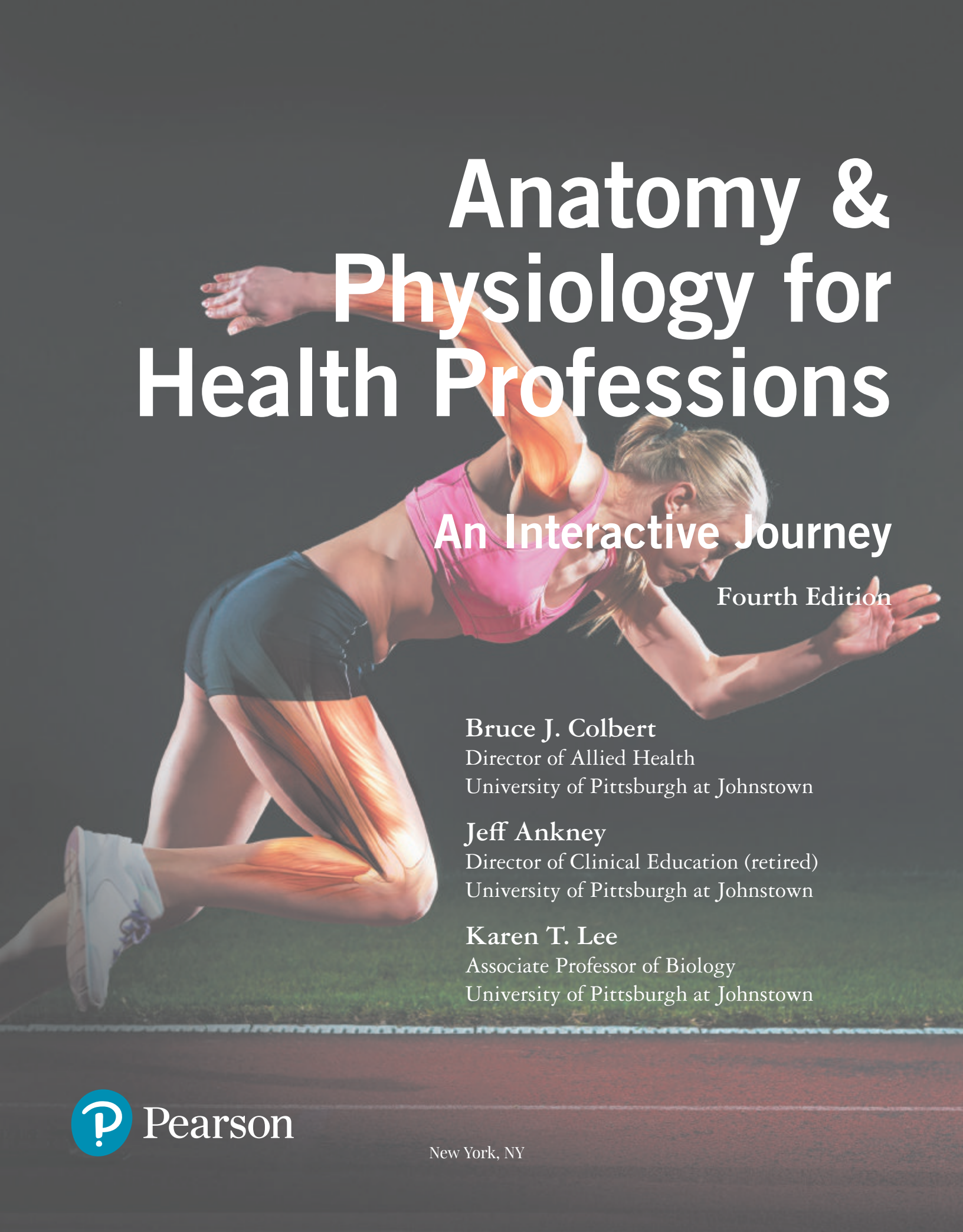

Anatomy & Physiology for Health Professions

An Interactive Journey

Fourth Edition

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DEDICATIONS

To all the future health care professionals learning anatomy and physiology: May your chosen professions be as personally rewarding as ours have been.

—Your Travel Guides Bruce, Jeff, and Karen

I dedicate this book to those closest to me who share this wonderful journey through life: my wife Patty, my sons Joshua and Jeremy, my daughter-in-law Ali, granddaughter Lenyx, and my three brothers and sister. Also a special thanks to the many teachers who encouraged me to develop my writing skills. Finally, a special dedication to the memory of my Mom and Dad, who taught me the importance of education.

—Bruce

A special thanks to all my family for their support and understanding through this long process. Mom and Dad, thank you both for always being there no matter where my journey took me.

A sincere thank you to Mr. James McCall, who inspired me to become a teacher those many years ago. And to my past teachers and professors—here's proof that underachievers sometimes do hit their stride!

—Jeff

I dedicate this book to my family, who have always supported me, no matter where life has taken me: not only my "real" family—my late father Ed, my mother Pat, brother Eddie, sister-in-law Sheila, and assorted aunts, uncles, and cousins, who really had no choice but to be part of my life—but also those members of my extended family who have inexplicably chosen to be part of my life, giving me the gift of their friendship. I couldn't have done it without them.

—Karen

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Bruce Colbert is the Director of the Allied Health Department at the University of Pittsburgh at Johnstown, where he teaches Cardiopulmonary Anatomy and Physiology along with several other courses. He holds a master's degree in health education and administration, has authored ten books and several articles, and has given more than 300 invited lectures and workshops at both the regional and national levels. Many of his workshops provide teacher training involving techniques to make the health sciences engaging and relevant to today's students. In addition, Bruce has presented workshops on developing effective critical and creative thinking, stress and time management, and study skills. He is an avid basketball player, even after three knee surgeries.

Jeff Ankney was the Director of Clinical Education for the University of Pittsburgh at Johnstown's Respiratory Care program, where he was responsible for the development and evaluation of hospital clinical sites as well as directing and all other aspects of clinical education. Jeff has served as a public school teacher, Assistant Director of Cardiopulmonary Services, Program Coordinator of Pulmonary Rehabilitation, and a member of hospital utilization review, hospital policy, and patient safety committees. He is a consultant on hospital management and currently serves on patient safety and hospital quality committees. Jeff was also the recipient of the American Cancer Society Public Education Award.

Karen Lee is the Assistant Director of the Office of Student Scholarship, Creative Activities, and Research at George Mason University, where she coordinates student programming. For 20 years before moving to George Mason she was a faculty member in the Biology Department at the University of Pittsburgh at Johnstown, where she taught anatomy and physiology for nursing and allied health majors and was also the Undergraduate Research Coordinator. She is a marine biologist by training and is active in the Council on Undergraduate Research. For 25 years she has sung bass in women's barbershop choruses and quartets.

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Special thanks to Zack Ankney, MD, for his review and comments and for teaching dad a thing or two.

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Anatomy and physiology is a critical academic course one must master to succeed in the health professions. This fourth edition of *Anatomy and Physiology for Health Professions: An Interactive Journey* is still written in the conversational manner that we pioneered in the first edition. We continue with the journey theme, richly interwoven with relatable analogies and current clinical applications to make the material engaging and relevant.

Too often students adopt the strategy of memorizing massive amounts of information and simply store it in their short-term memories to pass the test. We continue to strive to have a text that students actually enjoy reading and that truly engages them with the content in order to make the lasting connections that will help them *thrive* as health care practitioners.

New to This Edition

- Significantly enhanced select drawings with side-by-side micrographs helping learners to connect illustrative concepts to real life
- New and updated Clinical Applications present the most current research on specific anatomy and physiology topics related to chapter content. One prime example is the new American Heart Association blood pressure classifications and guidelines released in late 2017
- New cellular and tissue tables complete with actual micrographs to provide visual representations to table text
- Updated body system disorder content to provide learners with the most recent information and connect common diseases to changes in anatomy and physiology
- Revised learning outcomes to connect learners with key chapter concepts and serve as a review and study tool
- Reorganized content and headings as appropriate to improve the flow of information
- Updated Test Your Knowledge and end-of-chapter review questions to provide learners with a chance to check their understanding of new concepts.
- Retained the "Successful" Student Success Companion Guide.

What Is NOT New to This Edition

- We haven't changed the user-friendly, conversational writing style—rich with analogies with appropriate humor sprinkled in—that encourages relevant learning and that has made the previous editions so popular.

So what else have we done to facilitate learning the material? First, we have placed study skills and stress management tips in a *Study Success Companion* in the back of your book to help you along your journey through this class and beyond.

Second, we have provided useful appendices on medical terminology, abbreviations, lab reference values, and nutritional information.

Third, we have strived to make anatomy and physiology "come alive" by using an engaging writing style that makes it seem as if we are sitting next to you talking about the concepts. We have made every effort to put together an anatomy and physiology book that you will actually enjoy reading. We hope you consider us as assistants to the most important guide through this journey: your teacher.

Humor, where appropriate, and analogies to compare the human body to everyday things to which you can relate have been interwoven throughout the text. Finally, we have added special features in a unique fashion tailored to the visual learning styles and relevant learning that today's students require.

We have worked hard to create an even more exciting and visually appealing fourth edition and sincerely hope these features will help make studying anatomy and physiology a positive experience. Have a safe and happy journey!

Resources

- Textbook
- Student Workbook
- MyLab Health Professions with Pearson eText

The Instructor Package:

- Instructor's Resource Manual
- PowerPoint slides
- Image Library
- TestGen Computerized Test Bank
- MyLab Health Professions with Pearson eText

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We gratefully thank Jill Rembetski, who acted as an invaluable guide through the development and completion of both the first, second, and third editions as well as this new edition of *Anatomy and Physiology for Health Professions*. We value all her hard work and attention to detail that added so much to this project. She really should be listed as a contributing author and given an award for her patience with us. To all those at Pearson who were so helpful and friendly in this monumental process, especially Derril Trakalo, Faye Gemmellaro, and Marlene Pratt, thank you! A special thank-you to Mark Cohen for his original belief in this project. Also, we gratefully acknowledge a great group of reviewers who helped shape this project with their thoughtful insights. Finally, special thanks to Jan Snyder for putting up with quirky authors and helping in so many ways.

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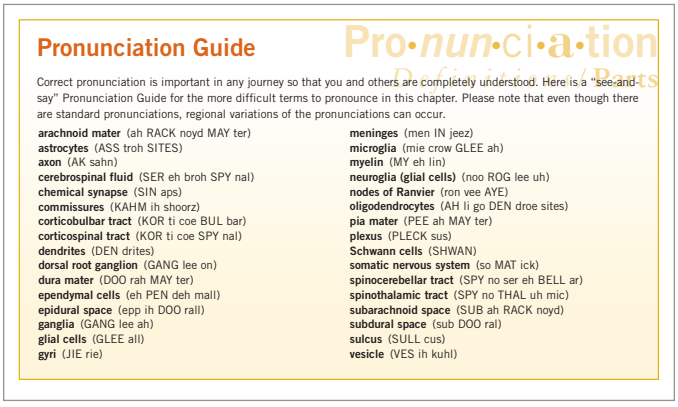
A USER'S GUIDE TO THE FEATURES OF THE BOOK

We have designed this textbook to be fun, interesting, and rich in features to aid your understanding of this challenging topic. Here is a quick guide to what makes this text different from others. We hope that the special highlights of this book enhance your learning experience as the journey of your health care career unfolds.

SPECIAL FEATURES MAKE LEARNING FUN

Pronunciation Guides

Although this is not a medical terminology book, understanding and pronouncing medical words is critical to your success. The "see-and-say" pronunciations will help you practice terms that are more challenging to say.

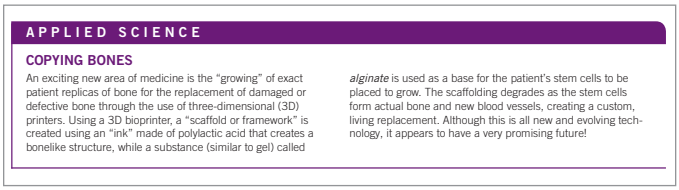


Pronunciation Guide

Pro•*nun*•ci•a•tion
Definitions/Parts

Correct pronunciation is important in any journey so that you and others are completely understood. Here is a "see-and-say" Pronunciation Guide for the more difficult terms to pronounce in this chapter. Please note that even though there are standard pronunciations, regional variations of the pronunciations can occur.

arachnoid mater (ah RACK noyd MAY ter)
astrocytes (ASS troh SITES)
axon (AK sahn)
cerebrospinal fluid (SER eh broh SPY nal)
chemical synapse (SIN aps)
commissures (KAHM ih shoorz)
corticobulbar tract (KOR ti coe BUL bar)
corticospinal tract (KOR ti coe SPY nal)
dendrites (DEN drites)
dorsal root ganglion (GANG lee on)
dura mater (DOO rah MAY ter)
ependymal cells (eh PEN deh mall)
epidural space (epp ih DOO rall)
ganglia (GANG lee ah)
glial cells (GLEE all)
gyri (JIE rie)
meninges (men IN jeez)
microglia (mie crow GLEE ah)
myelin (MY eh lin)
neuroglia (glial cells) (noo ROG lee uh)
nodes of Ranvier (ron vee AYE)
oligodendrocytes (AH li go DEN droe sites)
pia mater (PEE ah MAY ter)
plexus (PLECK sus)
Schwann cells (SHWAN)
somatic nervous system (so MAT ick)
spinocerebellar tract (SPY no ser eh BELL ar)
spinothalamic tract (SPY no THAL uh mic)
subarachnoid space (SUB ah RACK noyd)
subdural space (sub DOO ral)
sulcus (SULL cus)
vesicle (VES ih kuhl)



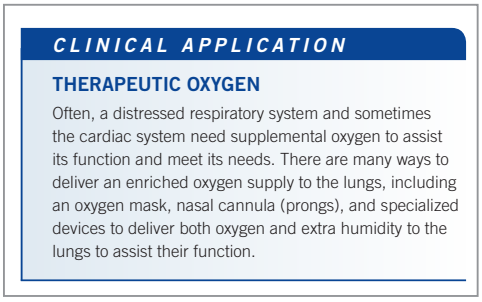
APPLIED SCIENCE

COPYING BONES

An exciting new area of medicine is the "growing" of exact patient replicas of bone for the replacement of damaged or defective bone through the use of three-dimensional (3D) printers. Using a 3D bioprinter, a "scaffold or framework" is created using an "ink" made of polylactic acid that creates a bonelike structure, while a substance (similar to gel) called *alginate* is used as a base for the patient's stem cells to be placed to grow. The scaffolding degrades as the stem cells form actual bone and new blood vessels, creating a custom, living replacement. Although this is all new and evolving technology, it appears to have a very promising future!

Amazing Facts

These "that's awesome" facts will help you appreciate the wonder of the human design. For example, our bodies create 2 million new red blood cells every second, and the total surface area of all the red blood cells in our bodies is greater than the surface of a football field!



CLINICAL APPLICATION

THERAPEUTIC OXYGEN

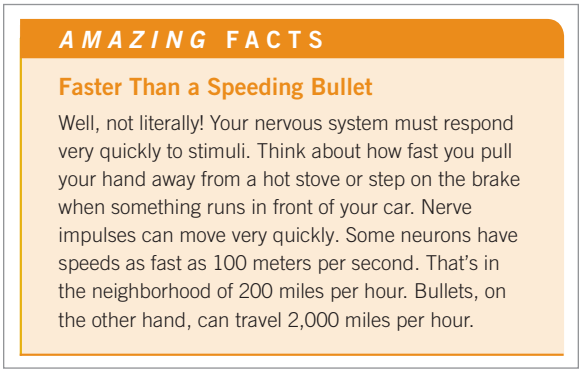
Often, a distressed respiratory system and sometimes the cardiac system need supplemental oxygen to assist its function and meet its needs. There are many ways to deliver an enriched oxygen supply to the lungs, including an oxygen mask, nasal cannula (prongs), and specialized devices to deliver both oxygen and extra humidity to the lungs to assist their function.

Clinical Applications

These highlight boxes show the relevance of what you are learning and how that knowledge is needed in clinical practice. This feature includes topics such as aging, major diagnostic studies, and therapeutics.

Applied Science

These boxes present scientific concepts in context as they relate to chapter content.



***AMAZING* FACTS**

Faster Than a Speeding Bullet

Well, not literally! Your nervous system must respond very quickly to stimuli. Think about how fast you pull your hand away from a hot stove or step on the brake when something runs in front of your car. Nerve impulses can move very quickly. Some neurons have speeds as fast as 100 meters per second. That's in the neighborhood of 200 miles per hour. Bullets, on the other hand, can travel 2,000 miles per hour.

Test Your Knowledge

After a concept is fully developed within a chapter, a "Test Your Knowledge" section will ensure you understand what was just covered before moving on and reducing the risk of getting lost on your journey.

TEST YOUR KNOWLEDGE 9–3

Choose the best answer.

1. The molecules used to send signals across synapses are called:
   a. hormones.
   b. ions.
   c. neurotransmitters.
   d. messengers.

2. Which axons are fastest?
   a. Small, myelinated
   b. Small, unmyelinated
   c. Large, unmyelinated
   d. Large, myelinated

3. What is another name for myelinated axons?
   a. Gray matter
   b. Dura mater
   c. White matter
   d. Duzitmater

4. After a neurotransmitter is released from the presynaptic neuron, what happens next?
   a. Nothing
   b. The postsynaptic cell engulfs the neurotransmitter
   c. The neurotransmitter binds to the postsynaptic cell
   d. The neurotransmitter is cleaned up

5. If an illness could be treated by increasing the activity of chemical synapses, which treatment would work?
   a. Decreasing the amount of neurotransmitter
   b. Inhibiting the "cleanup" enzyme
   c. Blocking the receptors on the receiving cell
   d. Blocking action potentials

6. An AChE inhibitor would:
   a. increase levels of ACh.
   b. decrease levels of ACh.
   c. no change of ACh.
   d. increase levels of AChE.

LEARNING HINT

ARTERIES OR VEINS?

Remembering what arteries and veins do can be confusing. One easy way to remember is that arteries take blood *away* from the heart. Both words start with *a*. Obviously, then, veins have to bring blood *back* to the heart.

Chapter Summary, Case Study, and Review Questions

These elements provide you every opportunity to review and master the key concepts of every chapter.

FOCUS ON PROFESSIONS

An orthopedic technologist is an allied healthcare professional who assists orthopedic surgeons. These practitioners are expert in the skillful application and removal of plaster and synthetic casts. They prepare equipment and devices for orthopedic surgical procedures and create and adjust simple braces and prosthetic devices, as well as adjust canes, crutches and walkers. Orthopedic technologists prepare traction setups and also provide a wealth of related educational information for patients. For more information, contact the National Association of Orthopaedic Technologists at *www.naot.org*.

(Source: Chanpen Supagoson/Shutterstock)

Focus on Professions

These job descriptions present a brief overview of the tasks performed by various health care professionals. They appear strategically within the chapters to help you visualize how what you are learning relates to a particular job. We hope this feature will open the door to the many career possibilities that await if you continue your studies in health care.

Learning Hints

These tips are sprinkled throughout the chapters to facilitate your understanding of difficult concepts. Some hints are in the form of amusing stories or mnemonic aids.

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SUMMARY

Points of Interest

- The nervous system is the body's control system. It has a sensory (input) system, an integration center, the CNS, and a motor (output) system. The input and output nerves are in the PNS, and the brain and spinal cord are the CNS.
- The tissue of the nervous system is made up of two types of cells: neurons, which send, receive, and process information, and neuroglia, which support the neurons.
- Neurons are excitable cells. They do their jobs by carrying tiny electrical currents caused by changes in cell permeability to certain ions. These tiny electrical currents can be all-or-none responses (action potentials), can change depending on the size of the stimulus (graded potentials), can travel down axons (impulse conduction), or can be used to transmit information from one cell to another (synaptic transmission).
- Your CNS is surrounded by a three-layered membrane system: dura mater, arachnoid mater, and pia mater, collectively known as the meninges. Cerebrospinal fluid is also contained in the space between the arachnoid and pia maters.
- The spinal cord has 31 segments, each with a pair of spinal nerves. The spinal nerves are a part of the peripheral nervous system.
- The spinal nerves are made of a pair of spinal roots. The ventral root is integral to motor function, and the dorsal root is integral to sensory function. Spinal nerves are mixed; they carry both sensory and motor information.
- A series of tracts run up and down the spinal cord to and from the brain. The tracts going toward the brain carry sensory information to the brain. The tracts coming from the brain toward the spinal cord carry motor information from the brain.

CASE STUDY

During the biggest game of his high school football career, Dylan, the best wide receiver in the league, leaps high into the air in the end zone to score the game-winning touchdown. A player for the other teams hits him hard, knocking him into the goalpost. Dylan crumples to the ground, unmoving. When the EMTs get to him, Dylan is paralyzed on both sides of his body and in respiratory arrest.

Given your knowledge of the nervous system, can you pinpoint the location of Dylan's spinal injury? Explain how you arrived at your conclusion.

REVIEW QUESTIONS

Multiple Choice

1. The input side of your nervous system is known as:
   a. motor.
   b. sensory.
   c. association.
   d. all of the above.

2. The ascending spinal tracts carry _____ information to the brain.
   a. hormonal
   b. motor
   c. sensory
   d. sensory and motor

3. During depolarization, _____ ions move _____ a neuron.
   a. K^+, out of
   b. K^+, into
   c. Na^+, out of
   d. Na^+, into

4. The ventral root of the spinal cord is:
   a. sensory.
   b. motor.
   c. association.
   d. none of the above.

5. Spinal nerves carry what kind of information?
   a. Sensory
   b. Motor
   c. Mixed
   d. Vertebral

6. A spinal cord injury at T_5 would cause:
   a. paralysis in all four limbs.
   b. paralysis from the chest down.
   c. paralysis in all four limbs and respiratory arrest.
   d. paralysis of the arms.

Drawings with Micrographs

Side-by-side comparisons of select drawings and micrographs will help you connect illustrative concepts to real life.

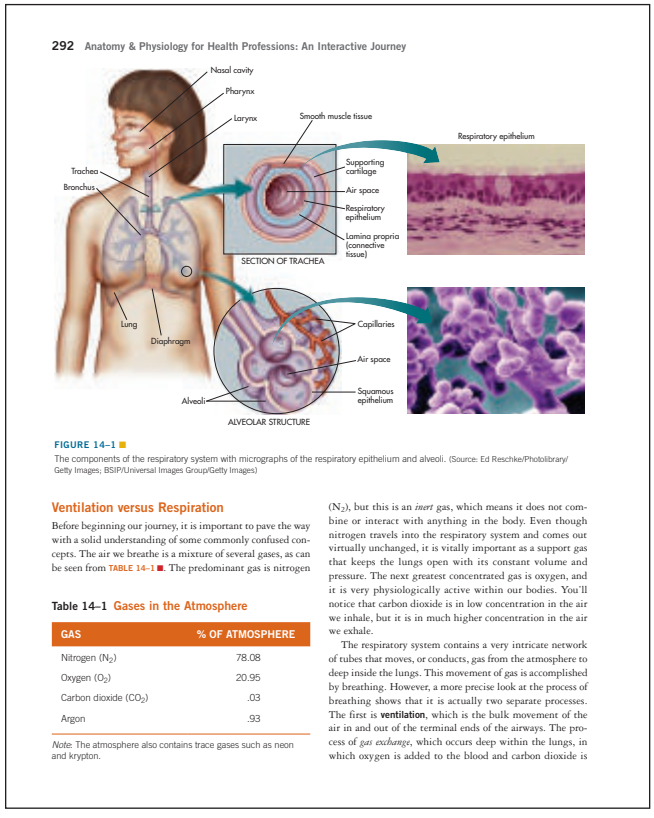

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FIGURE 14–1 ■
The components of the respiratory system with micrographs of the respiratory epithelium and alveoli. (Source: Ed Reschke/Photolibrary/Getty Images; BSIP/Universal Images Group/Getty Images)

Ventilation versus Respiration

Before beginning our journey, it is important to pave the way with a solid understanding of some commonly confused concepts. The air we breathe is a mixture of several gases, as can be seen from TABLE 14–1 ■. The predominant gas is nitrogen (N_2), but this is an *inert* gas, which means it does not combine or interact with anything in the body. Even though nitrogen travels into the respiratory system and comes out virtually unchanged, it is vitally important as a support gas that keeps the lungs open with its constant volume and pressure. The next greatest concentrated gas is oxygen, and it is very physiologically active within our bodies. You'll notice that carbon dioxide is in low concentration in the air we inhale, but it is in much higher concentration in the air we exhale.

The respiratory system contains a very intricate network of tubes that moves, or conducts, gas from the atmosphere to deep inside the lungs. This movement of gas is accomplished by breathing. However, a more precise look at the process of breathing shows that it is actually two separate processes. The first is **ventilation**, which is the bulk movement of the air in and out of the terminal ends of the airways. The process of *gas exchange*, which occurs deep within the lungs, in which oxygen is added to the blood and carbon dioxide is

Table 14–1 Gases in the Atmosphere

GAS	% OF ATMOSPHERE
Nitrogen (N_2)	78.08
Oxygen (O_2)	20.95
Carbon dioxide (CO_2)	.03
Argon	.93

Note: The atmosphere also contains trace gases such as neon and krypton.

Cellular and Tissue Tables

Micrographs provide visual representation to table text for greater understanding and comprehension.

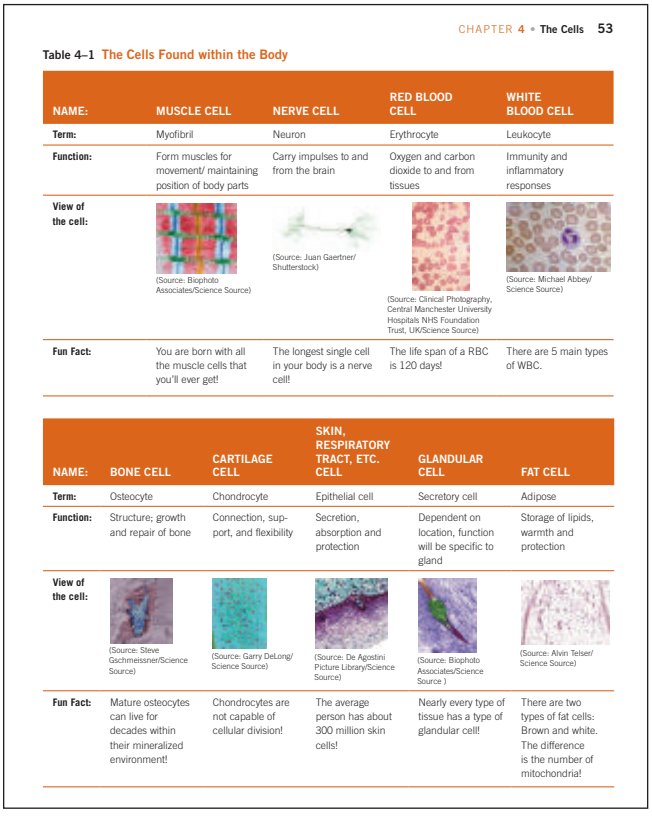

Table 4–1 The Cells Found within the Body

NAME:	MUSCLE CELL	NERVE CELL	RED BLOOD CELL	WHITE BLOOD CELL
Term:	Myofibril	Neuron	Erythrocyte	Leukocyte
Function:	Form muscles for movement/ maintaining position of body parts	Carry impulses to and from the brain	Oxygen and carbon dioxide to and from tissues	Immunity and inflammatory responses
View of the cell:	(Source: Biophoto Associates/Science Source)	(Source: Juan Gaertner/ Shutterstock)	(Source: Clinical Photography, Central Manchester University Hospitals NHS Foundation Trust, UK/Science Source)	(Source: Michael Abbey/ Science Source)
Fun Fact:	You are born with all the muscle cells that you'll ever get!	The longest single cell in your body is a nerve cell!	The life span of a RBC is 120 days!	There are 5 main types of WBC.

NAME:	BONE CELL	CARTILAGE CELL	SKIN, RESPIRATORY TRACT, ETC. CELL	GLANDULAR CELL	FAT CELL
Term:	Osteocyte	Chondrocyte	Epithelial cell	Secretory cell	Adipose
Function:	Structure; growth and repair of bone	Connection, support, and flexibility	Secretion, absorption and protection	Dependent on location, function will be specific to gland	Storage of lipids, warmth and protection
View of the cell:	(Source: Steve Gschmeissner/Science Source)	(Source: Garry DeLong/ Science Source)	(Source: De Agostini Picture Library/Science Source)	(Source: Biophoto Associates/Science Source)	(Source: Alvin Telser/ Science Source)
Fun Fact:	Mature osteocytes can live for decades within their mineralized environment!	Chondrocytes are not capable of cellular division!	The average person has about 300 million skin cells!	Nearly every type of tissue has a type of glandular cell!	There are two types of fat cells: Brown and white. The difference is the number of mitochondria!

ANCILLARIES GUIDE YOUR JOURNEY

Study Success Companion

Your Study Success Companion will help you establish a good foundation for your trip. This appendix includes study skills and stress management techniques to help you as you journey through Anatomy, Physiology, & Disease. It also contains topics such as the Metric System in case you do not have this background and need a self-taught mini-refresher.

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What Is MyLab Health Professions with Pearson eText ?

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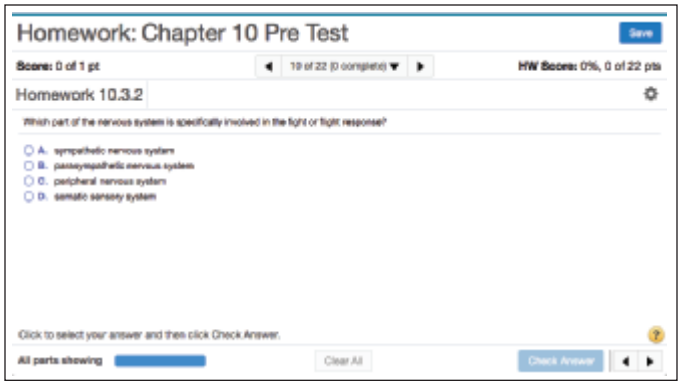
With *MyLab Health Professions for Anatomy & Physiology for Health Professions*, you can track your own progress through your entire Anatomy & Physiology course.



Homework pre-test question

How Do Students Benefit?

Here's how *MyLab Health Professions for Anatomy & Physiology for Health Professions* helps you:

- Keep up and get unstuck by providing immediate feedback on quizzes, case studies, interactive exercises, and more
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- Increase understanding of difficult concepts with a vast variety of study material for different learning styles
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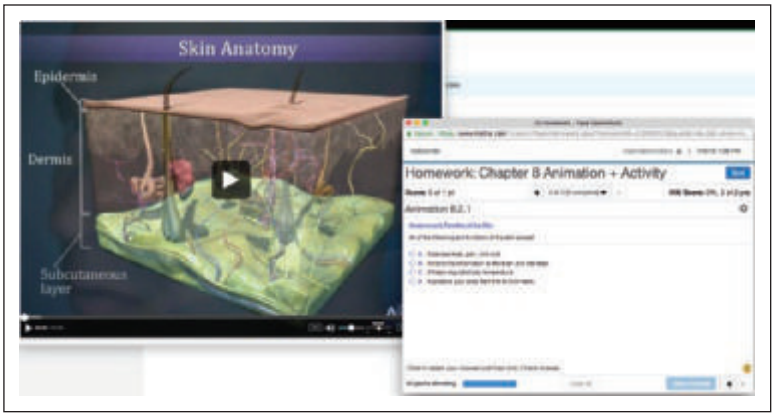

Animation with associated activity

Key Features of *MyLab Health Professions for Anatomy & Physiology for Health Professions, 4th Edition:*

- **Pre-Tests and Post-Tests**—Using questions aligned to the learning outcomes in *Anatomy & Physiology for Health Professions: An Interactive Journey*, 4th Edition, multiple tests measure your understanding of topics.
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- **Animations and Video Clips** with associated activities assist with deeper understanding of difficult concepts.
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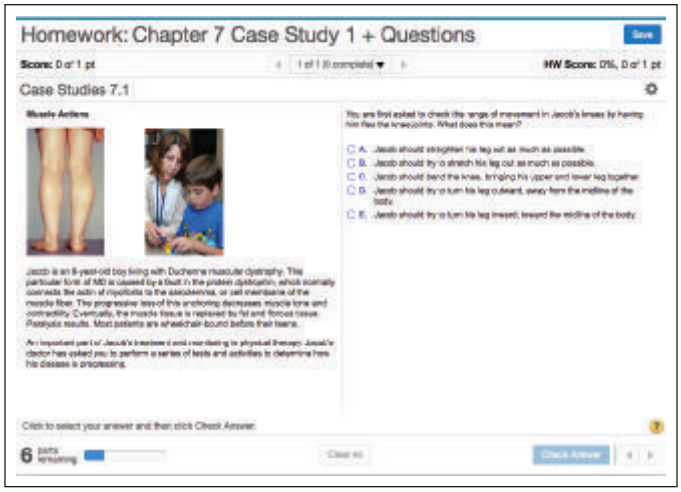
- **NEW: Dynamic Study Modules** guide your study effectively by focusing your time on the things you don't know. They continuously assess your activity and performance in real time. Here's how it works: First you complete a set of questions with a unique answer format that also asks you to indicate your confidence level. Questions



Case Study (Source: Clinical Photography, Central Manchester University Hospitals NHS Foundation Trust, UK/Science Source; Fotosearch/SuperStock)

repeat until you can answer all questions correctly and confidently. After the question set is completed, Dynamic Study Modules explain the concept using materials from the text. Dynamic Study Modules are accessible on smartphones, tablets, and computers.

- **NEW! Pearson Prep**—Designed by learning scientists, Pearson Prep auto-creates flashcards from notes and other course materials that you upload. You can also create cards on the fly or purchase expert decks aligned to the chapters of the text.

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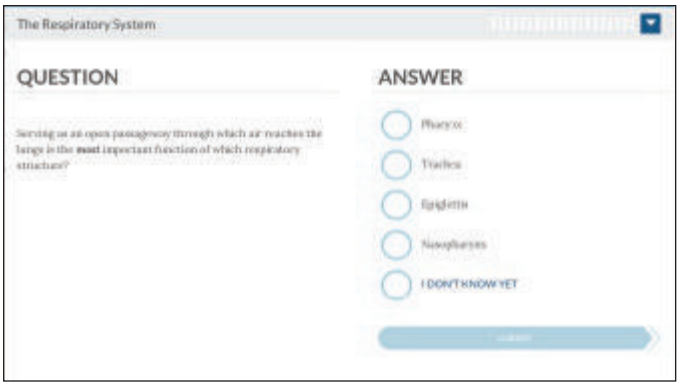
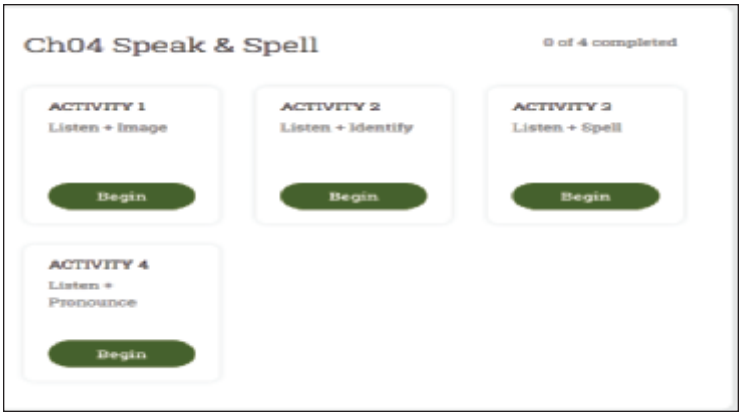
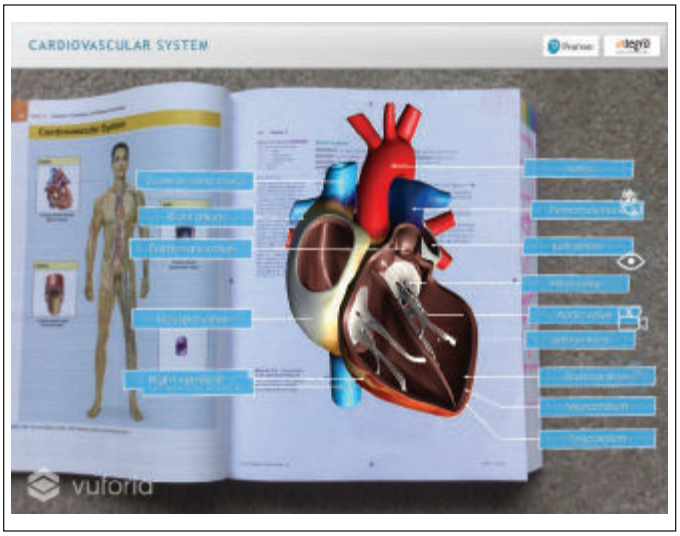
- **NEW! Augmented Reality**—This app-based study tool brings anatomy and physiology to life through the use of Augmented Reality anatomical figures enhanced with 3D, physiology videos, and labeling exercises.



Dynamic Study Module



Speak & Spell



Augmented reality

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- Audio Insights
- Video Lecture Captures
- Animations
- Anatomy Labeling
- X-rays with "hot spots" that highlight important information
- Self-study review questions interspersed throughout
- Chapter "Test Your Knowledge" questions in interactive format

How Do Instructors Benefit?

Instructors can push notes and highlights directly to students so they provide embellishment or focus on key concepts within the text.

Introduction to Anatomy and Physiology

1

LEARNING THE LANGUAGE AND CUSTOMS

Imagine getting ready to travel to a foreign country where you do not speak the language. Think of the potential problems you would encounter if you don't prepare properly for your journey. To maximize the success of your journey, one of the most important preparatory steps is to develop a basic understanding of the native language and customs. Every profession has a specialized "native" language all of its own along with numerous abbreviations. Medical terminology is the professional language of medicine that one needs to master for success. This chapter lays the foundation for learning medical terminology, and future chapters will build on this foundation so that at our journey's end, not only will you understand anatomy and physiology but you will also be fluent in medical terminology.

LEARNING OUTCOMES

At the end of your journey through this chapter, you will be able to:

- Explain the terms *anatomy* and *physiology* and how they are interrelated.
- Construct and define medical terms using word roots, prefixes, and suffixes.
- Identify commonly used medical abbreviations.
- Contrast the metric and English systems of measures.
- Describe various signs and symptoms of disease along with associated disease terminology.
- Explain the concepts and importance of homeostasis and metabolism.

Pronunciation Guide

Pro•*nun*•ci•a•tion
Definitions/Parts

Correct pronunciation is important in any journey so that you and others are completely understood. Here is a "see-and-say" Pronunciation Guide for the more difficult terms to pronounce in this chapter. Please note that even though there are standard pronunciations, regional variations of the pronunciations can occur.

anabolism (ah NAB oh lizm)
anatomy (ah NA tom ee)
catabolism (ka TAB oh lizm)
diagnosis (DYE ahg NOH sis)
etiology (EE tee ALL oh jee)
homeostasis (HOH mee oh STAY sis)
macroscopic anatomy (MAK roh SCOP ic)
metabolism (meh TAB oh lizm)
microscopic anatomy (MY kroh SCOP ic)
pathology (path ALL oh jee)
physiology (fiz ee ALL oh jee)
prognosis (prog NOH sis)
rhinoplasty (RYE noh PLASS tee)
syndrome (SIN drohm)

WHAT IS ANATOMY AND PHYSIOLOGY?

You're probably so accustomed to hearing the words *anatomy* and *physiology* used together that you may not have given much thought to what each one means and how they differ. They each have unique meanings. Let's take a closer look.

Anatomy

Anatomy is the study of the internal and external *structures* of plants, animals, or, for our focus, the human body. The human body is an amazing and complex machine that can perform an almost limitless number of tasks. To truly understand how something works, it is important to know how it is put together. The word *anatomy* is from the Greek language and literally means "to cut apart," which is exactly what you must do to see how something is put together. For example, the study of the arrangement of the bones that comprise the human skeleton, which is the anatomical framework for our bodies, is considered *skeletal anatomy*. Leonardo da Vinci, in the 1400s, correctly drew the human skeleton and could be considered one of the earliest *anatomists* (one who studies anatomy).

Just as we can subdivide biology into more specific concentrations, such as cell biology, plant biology, and animal biology, we can also broadly divide anatomy into microscopic anatomy and macroscopic anatomy. **Microscopic anatomy** is the study of structures that can be seen and examined only with magnification aids, such as a microscope. The study of cellular structures (cytology) and tissue samples (histology) are examples of microscopic anatomy.

Macroscopic anatomy, sometimes called **gross anatomy**, represents the study of the structures visible to the unaided or naked eye. For example, the study of the various bones that make up the human body is skeletal anatomy. Viewing an x-ray of the arm to determine the type and location of a broken bone is considered an examination of gross anatomy.

Physiology

Physiology focuses on the *functions* and processes of the various structures that make up the human body. Physiologic processes include, for example, muscle contraction, our senses of smell and sight, and how we breathe. We focus on each of these processes in their respective chapters. Physiology is closely related to anatomy because physiology is the study of how a structure (anatomy) such as a cell or bone actually functions (physiology). Physiology includes all the vital processes of life; it is complex, and therefore has many subspecialties. Human physiology, animal physiology, cellular physiology, and neurophysiology are just some of the specific branches of physiology.

Putting It All Together

In summary, anatomy focuses on *structure* and how something is put together, whereas physiology is the study of how those different structures work together to make the body *function* as a whole. For example, anatomy would be the study of the structure of the red blood cells (RBCs), and physiology would be the study of how the RBCs carry vital oxygen throughout the body. **FIGURE 1–1** ■ shows deformed RBCs (sickle or curved in shape) that are present in the disease sickle cell anemia. Because of the anatomical deformity, the physiological process of carrying oxygen is adversely affected, and blockages in blood flow can result due to their distorted shape.

You will notice on your journey that the design of a structure is often related to its function. For example, joint anatomy is dictated by the functions of those bones forming the joint. Hinge joints are located at the knees, where back-and-forth bending movement is required, whereas the ball-and-socket joint of the hip provides for a greater range of motion.

Therefore, it makes sense to combine these two sciences into anatomy and physiology (A&P). Human anatomy and physiology forms the foundation for all medical practice. Anything that negatively changes the normal structure or function can be called *disease*, and the study of disease is *pathophysiology*.

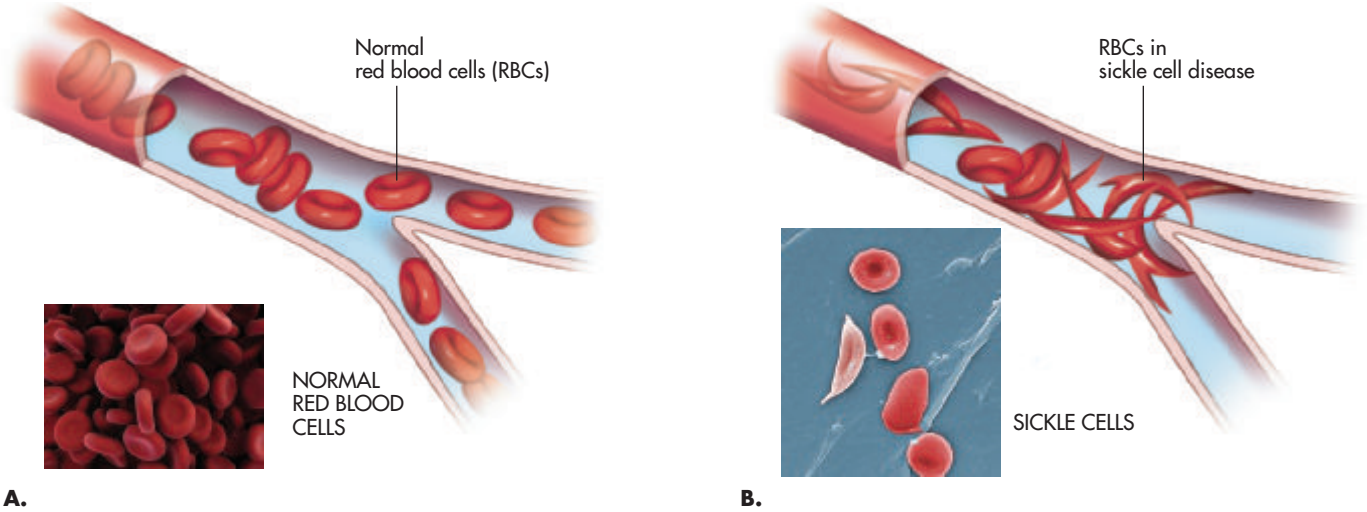

FIGURE 1–1

A. Normal red blood cells (RBCs) are flexible and donut-shaped and move with ease through blood vessels. (Source: Sebastian Kaulitzki/Shutterstock) **B.** The anatomical distortion of the structure of RBCs in sickle cell anemia affects their normal function to carry oxygen. In addition, the sickle cells lose their ability to bend and pass through the small blood vessels, thereby causing blockages to blood flow. (Source: Janice Haney Carr/CDC)

TEST YOUR KNOWLEDGE 1–1

Indicate whether the following examples are gross anatomy or microscopic anatomy by putting a G or an M in the space provided.

1. _____ Viewing an x-ray to determine the type of bone break
2. _____ Classifying a tumor to be cancerous by cell type
3. _____ Viewing bacteria to determine what disease is present
4. _____ Examining the chest for any obvious deformities
5. _____ Viewing samples as a histotechnologist or cytotechnologist

THE LANGUAGE

Even if you're traveling to another city within your home country, you will most likely need to learn a few things about the language its citizens speak. For example, think of the many different names people use to identify a sandwich made on a long skinny roll. Your "sub" might be someone else's "grinder," "hoagie," or "hero."

Anatomy and physiology also has its own unique language that you must learn before you can converse comfortably. Some words, such as *cardiac*, *respiratory*, and *hypertension*, are already familiar to you. Others will seem strange and foreign. Let's take a closer look.

Medical Terminology

As stated earlier, the language of anatomy and physiology is primarily based on medical terminology. Understanding medical terminology may seem like an overwhelming task because, on the surface, there appears to be *so* many terms. In reality, there are only a relatively few word roots, prefixes, and suffixes, but they can be put together in a host of ways to form numerous terms.

Most of the medical terms are derived from the Greek and Latin languages because much of the science of medicine originated in ancient Greek- and Latin-speaking societies that came from the Mediterranean region.

Each medical term has a basic structure on which to build, called the *word root*. For example, *cardi* is the word root for terms pertaining to the heart. Rarely is the word root used alone. Instead, it is combined with prefixes and suffixes that can change its meaning. Prefixes come before the word root, whereas suffixes come after the word root. The suffix *ology* means "study of" and, therefore, we can combine *cardi* and *ology* to form **cardiology**, which is the study of the heart. The prefix *tachy* means "fast" and can be placed in front of the word root to form **tachycardia**, which means "fast heart rate."

Often you will be given a **combining form**, which is the word root and a connecting vowel (usually *o*), to make it easier to pronounce and combine with possible suffixes. For example, the combining form for heart is cardi/o. FIGURE 1–2 ■ shows the components of a medical term.

FOCUS ON PROFESSIONS

There are many medical specialties ("ologists"), and just by searching online or skimming the Yellow Pages of a phone book (some of us still remember those) you can see firsthand the vast array that exists—from anesthesiologists to urologists.

Listed in TABLE 1–1 ■ are some common combining forms to get you started.

Now let's add some common prefixes that can be placed before the word roots to alter their meaning (see TABLE 1–2 ■) and some common suffixes (TABLE 1–3 ■) and see what kinds of words we can form with just these few parts.

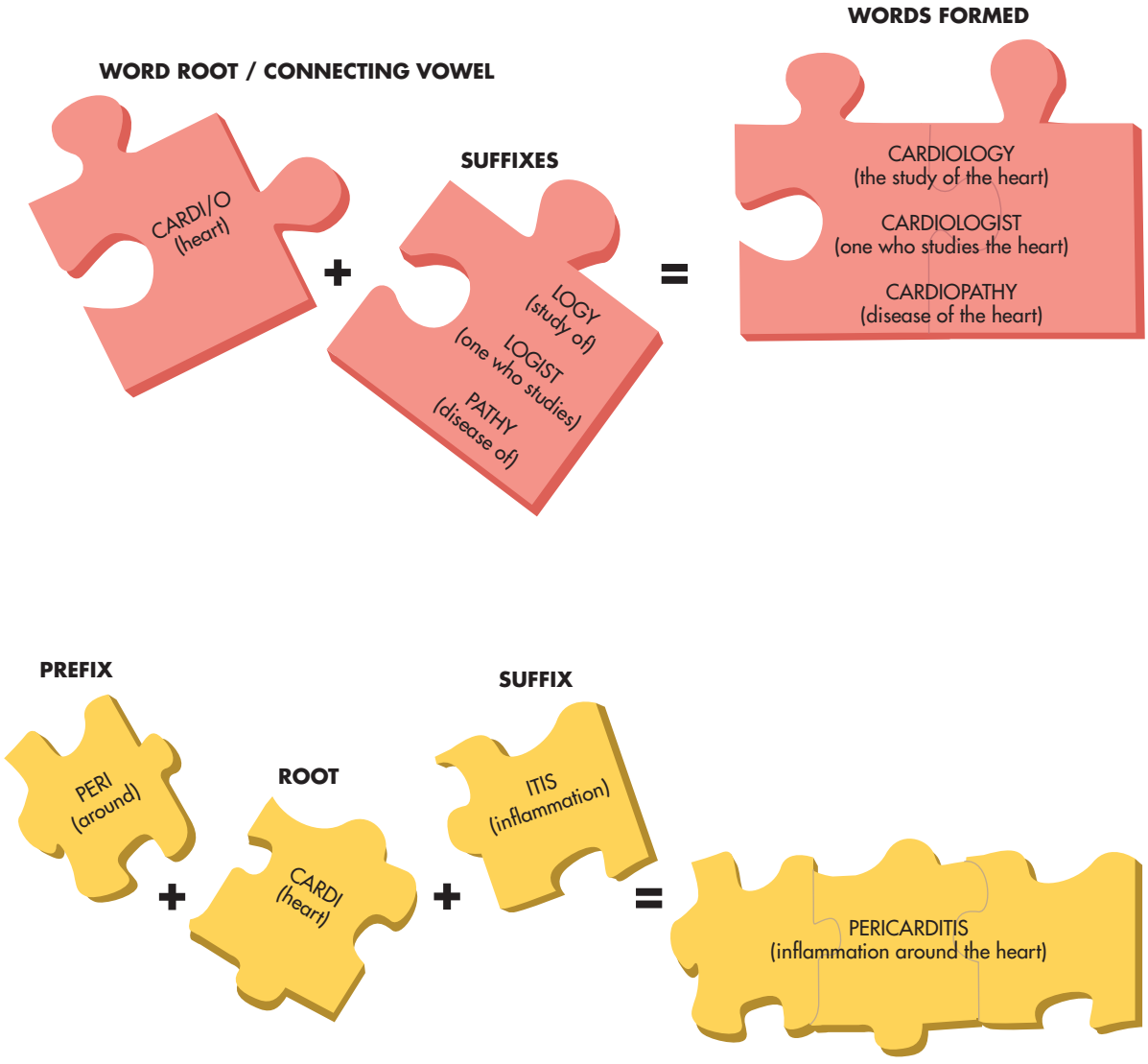

FIGURE 1–2 ■
How prefixes and suffixes can be combined with a word root to form many medical terms.

Table 1–1 Common Combining Terms

WORD ROOT/ COMBINING FORM	MEANING
abdomin/o	abdomen
aden/o	gland
angi/o	vessel
arthr/o	joint
cardi/o	heart
col/o	colon
cyan/o	blue
cyt/o	cell
derm/o	skin
erythr/o	red
gastr/o	stomach
glyc/o	sugar
hemat/o, hem/o	blood
hepat/o	liver
hist/o	tissue
leuk/o	white
mamm/o	breast
nephr/o	kidney
neur/o	nerve
oste/o	bone
path/o	disease
phag/o	to swallow
pneum/o, pneumon/o	air or lung
rhin/o	nose

Table 1–2 Common Prefixes

PREFIX	MEANING
a, an	without
acro	extremities
brady	slow
dia	through
dys	difficult
electro	electric
endo	within
epi	upon or over
hyper	above normal
hypo	below normal
macro	large
micro	small
peri	around
sub	under, below
tachy	fast

Using Tables 1–1, 1–2, and 1–3, look at all the terms you can make from just the one word root, cardi/o. *Cardiology* is the study of the heart, and a *cardiologist* is one who studies the heart. *Bradycardia* is a slow heart rate, *tachycardia* is a fast heart rate, and an *electrocardiogram* is an electrical recording of the heart. If your heart was enlarged due to inflammation (*carditis*), you would have *cardiomegaly*, which would mean you have heart disease (*cardiopathy*). The Tin Man from *The Wizard of Oz* thought he had no heart (*acardia*), but realized that he had *cardiomegaly* all along. (*Disclaimer:* Although having an enlarged heart, or cardiomegaly, was good for the Tin Man, it is an abnormal and serious medical condition.)

LEARNING HINT

GENERAL HINTS ON FORMING MEDICAL TERMS

Although you can learn the various word roots, prefixes, and suffixes, it gets confusing trying to put them correctly together. In most instances, the medical definition indicates the last part of the term first, especially when suffixes are used. For example, an inflammation of the stomach is *gastritis*, not *itisgastro*, and one who studies the stomach is a *gastrologist*, not an *ologistgastro*. When using prefixes, you usually put the parts together in the order you say the definition. For example, slow heart rate is *bradycardia*, not *cardiabrady*. As with all general rules, there are exceptions, but with practice, using medical terminology will become familiar to you.

Table 1–3 Common Suffixes

SUFFIX	MEANING
-al, -ic	pertaining to or related to
-algia	pain
-cyte	cell
-ectomy	surgical removal of
-gram	a recording
-graphy	the process of recording
-ist	one who specializes
-itis	inflammation of
-megaly	enlargement of
-ologist or -logist	one who studies
-ology or -logy	study of
-oma	tumor
-osis	disease or condition of
-ostomy	surgically forming an opening
-otomy	cutting into
-pathy	disease
-penia	decrease or lack of
-phobia	fear of
-plasty	surgical repair
-scope	instrument to view or examine

LEARNING HINT

COMBINING AND FORMING MEDICAL TERMS

If a suffix begins with a vowel, drop the vowel in the combining form. For example, the combining form for stomach is gastr/o, and if we add the suffix for inflammation, *itis*, the medical term becomes *gastritis*. The suffixes *ology* and *logy* are both acceptable for "the study of." If you use *ology* and a combining form such as cardi/o, an *o* would be dropped to form *cardiology*. A general rule is that when a suffix begins with a vowel, drop the vowel in the combining form.

Abbreviations

Abbreviations are used extensively in the medical profession. They are useful in simplifying long, complicated terms for diseases, diagnostic procedures, and therapies that require extensive documentation. For now, review TABLE 1–4 ■ for some common abbreviations you may have heard in a healthcare setting or on television.

Of course, you will learn many more medical terms and abbreviations as we explore the upcoming chapters and become fluent in conversational medical language. This will help you avoid using lay terms (common, everyday terms) to describe medical and anatomical concepts. For example, now you know that the correct term for "getting a nose job" is **rhinoplasty**.

Table 1–4 Common Medical Abbreviations

ABBREVIATION	MEANING
A&P	anatomy and physiology
ACLS	advanced cardiac life support
b.i.d.	give twice a day
BP	blood pressure
CA	cancer
CAD	coronary artery disease
CBC	complete blood count
CPR	cardiopulmonary resuscitation
CXR	chest X-ray
*ED/ER	emergency department/emergency room
GI	gastrointestinal
ICU	intensive care unit
IV	intravenous
NPO, npo	Latin *nil per os*, which means "nothing by mouth"
prn	whenever needed
q.i.d.	give four times a day
SOB	shortness of breath
STAT	Latin *statim*, which means "immediately"
t.i.d.	give three times a day

**Note*: Traditionally, the hospital emergency areas were called *emergency rooms (ERs)*, but those areas have expanded to where they are considered a whole department. Both abbreviations are acceptable, but many healthcare professionals now prefer the term *emergency department (ED)*.

TEST YOUR KNOWLEDGE 1–2

Define the medical terms.

1. acrocyanosis

_____

2. nephrologist

_____

3. cytomegaly

_____

4. dermatitis

_____

5. appendectomy

_____

Give the correct medical term.

6. removal of the stomach _____
7. disease of the bones _____
8. electrical recording of the heart _____
9. inflammation of the joints _____
10. one who studies the nervous system _____
11. abbreviation for patient not allowed to eat or drink _____
12. abbreviation for giving a drug or treatment as needed _____
13. abbreviation for imaging of thoracic area _____
14. abbreviation that infers urgency of action _____

The Metric System

Whereas medical terminology represents the written and spoken language for understanding anatomy and physiology, the metric system is the "mathematical language" of anatomy and physiology to measure weight, volume, and length. For example, blood pressure is measured in millimeters of mercury (mm Hg), and organ size is usually measured in centimeters (cm). Medications and fluids are given in milliliters (mL) or cubic centimeters (cc), and weight is often measured in kilograms (kg). What exactly does it mean when you are taught that normal cardiac output is 6 liters per minute? You can now see why you must be familiar with the metric system to truly understand anatomy and physiology and medicine. Although the metric system may seem complicated if you are not familiar with it, it really isn't if you have a basic understanding of math. In fact, once you have enough practice, using the metric system is actually easier than the measurements you are used to using.

FOCUS ON PROFESSIONS

Medical assistants must become familiar with medical terminology in their workplace. Additionally, **coders**, **transcriptionists**, and **health information technicians**, all of whom deal extensively with medical charts and patient records, must master this language.

(Source: Goodluz/Shutterstock)

AMAZING FACTS

The Longest Medical Term

The longest medical term is *pneumonoultramicroscopicsilicovolcanoconiosis* composed of 45 letters, which is a form of pneumoconiosis (condition of the lung) caused by very fine (ultramicro) silicate or quartz dust.

Two major systems of measurement are in use today. The U.S. Customary System (USCS) is used in the United States, and the International System of Units or SI (Systéme International) is used everywhere else, and especially in health care, science, and the pharmaceutical industry. The SI system is also known as the international or **metric system** and is based on the power (or multiples) of 10.

The USCS system is based on the British Imperial System and uses several different designations for the basic units of length, weight, and volume. We commonly call this the **English system**. For example, in the English system, volumes can be expressed as ounces, pints, quarts, gallons, pecks, bushels, or cubic feet. Distance can be expressed in inches, feet, yards, and miles. Weights are measured in ounces, pounds, and tons. This may be the system you are most familiar with, but it is not the system of choice used throughout the world and within the medical profession because the English system has no common base and is therefore very cumbersome to use. It is difficult to know the relationships between each unit of measure because they are not based in an orderly fashion according to the powers of 10 as in the metric system. For example, how many pecks are in a bushel? Just what is a peck? How many inches are in a mile? These all require extensive calculations and memorization of certain equivalent values, whereas in the metric system, you simply move the decimal point the appropriate power of 10.

This has been a brief overview of the two types of measurement systems that you will encounter in your everyday activities as a healthcare professional. If you want to learn more about the metric system, please refer to the Study Success Companion at the end of this text, where a simplified explanation is given on how to easily use the metric system in the healthcare setting. In addition, the Study Success Companion will show you a simplified method for conversions both within and between the metric and English systems. See Table 3 in the Study Success Companion section, which gives common prefixes of the metric system and compares the metric and English systems. Since we introduced the Study Success Companion here, please take some time to read this early on as it will greatly enhance your success in this course. It also includes powerful yet simple hints on study skills and stress management.

AMAZING FACTS

Metric Emergency

In 1989, an Air Canada passenger jet ran out of fuel and the pilot had to glide the jetliner onto a runway for, thankfully, a safe emergency landing. The near disaster occurred because the fuel had been erroneously measured in pounds instead of kilograms at a time when Canada was converting to the metric system!

THE LANGUAGE OF DISEASE

This chapter is about planning for a smooth trip by learning the language used at our destination. However, even with the most careful planning, things can still go wrong. Flat tires, airport delays, and loss of money or credit cards can ruin a trip. Similarly, problems can happen to the human body. Ideally, the body works to make things function smoothly and in balance. Sometimes things happen to alter those functions. Eating habits, smoking, inherited traits, trauma, environmental factors, and even aging can alter the body's balance and lead to **disease**. Disease, which literally means "not [dis] at ease," is a condition in which the body fails to function normally.

Although this is an A&P course that focuses on *normal* function and structure, it is often helpful to reinforce the concepts with some elaboration of what can go wrong. Therefore, at the end of each system chapter, a *brief* discussion on some of the major and more common diseases associated with that system is provided. For example, a future physical therapist or massage therapist may want to spend more time exploring in-depth disease information on the muscular system, a dental hygienist may wish to learn more about the function of teeth in the digestive system, and a radiologic technologist may want to focus on the skeletal system. For now, a brief discussion of some of the unique language of disease is needed to lay the foundation for future discussions.

Signs and Symptoms of Disease

Think back to a time when you were sick. You may have had a fever, cough, nausea, dizziness, joint aches, or a generalized weakness. These are examples of **signs** and **symptoms** of disease. Although the terms *signs* and *symptoms* are often used interchangeably, each has its own specific definition. Signs are more definitive, *objective* (measurable), obvious indicators of an illness. They can actually be measured and expressed as numbers. Fever or monitoring the change in the size of a mole are good examples of signs. **Vital signs** are common, measurable indicators that help us assess the health of our patients. Vital signs are the signs essential to life and include pulse (heart rate), blood pressure, body temperature, and respiratory rate. The vital sign normal values can change according to the patient's age and sex.

CLINICAL APPLICATION

THE VITAL SIGN OF PULSE

Although there are several body locations where a pulse can be taken, the pulse is commonly taken by applying slight finger pressure over the radial artery located in each wrist (on the thumb side) and counting the number of beats in a 60-second period (see **FIGURE 1–3** ■). The normal heart rate for an adult is 60–100 beats per minute, a child's rate is approximately 70–120, and a newborn's rate is 90–170 beats per minute. If an adult has a heart rate of 165 beats per minute, what medical term would you use to describe that condition?

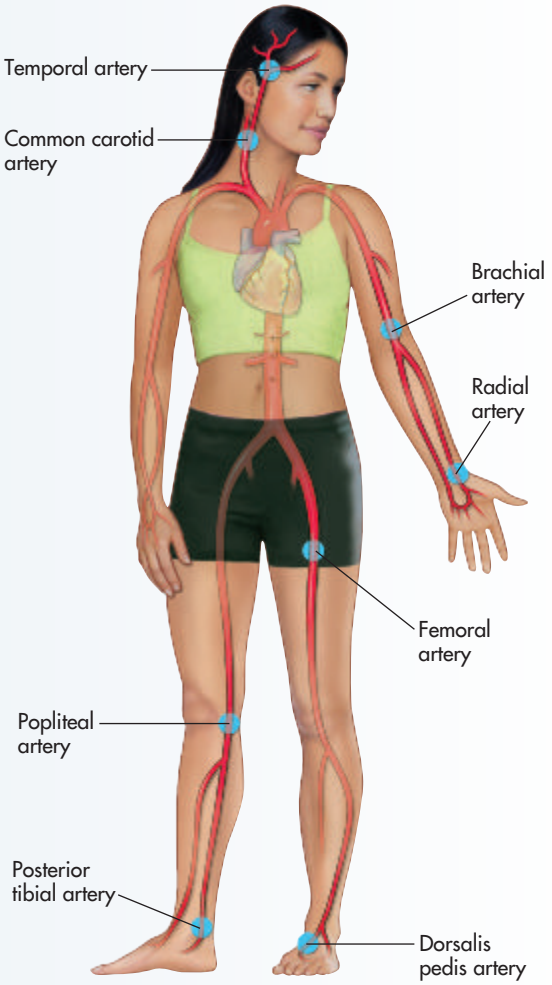

FIGURE 1–3 ■

A healthcare professional taking a radial pulse and common pulse points.

Symptoms, on the other hand, are more *subjective*, based on the individual's perception and therefore more difficult to measure consistently. Although pain has been under consideration as a fifth vital sign, it is still a subjective evaluation very much like a symptom. For example, tolerance to pain varies among individuals, so an equal amount of pain (as in a needlestick) applied to a number of people could be perceived as a light, moderate, or intense level of pain, depending on each individual's perception. Symptoms are hard to measure. They are, however, still very important in the diagnosis of disease. Sometimes a disease exhibits a set group of signs and symptoms that may occur at about the same time. This specific grouping of signs and symptoms is known as a **syndrome**. Signs, symptoms, and syndromes are further explained throughout the textbook as they relate to the anatomy and physiology of the various body systems.

CLINICAL APPLICATION

METABOLIC SYNDROME, OR SYNDROME X

A disturbing syndrome that affects nearly one-quarter of the U.S. adult population is known as *metabolic syndrome*, or *syndrome X*. A patient with this syndrome exhibits at least three of the following five common conditions: high blood sugar levels (hyperglycemia), high blood pressure (hypertension), abdominal obesity, high triglycerides (a lipid substance in the blood), and low blood level of high density lipoprotein or HDL (a good form of blood cholesterol). Individuals who exhibit this syndrome are at increased risk for diabetes, heart attack, and/or stroke. Poor diet and a lack of exercise clearly contribute to the development of this syndrome.

Discovering as many signs and symptoms as possible can help to **diagnose** a disease. A *diagnosis* is an identification of a disease determined by studying the patient's signs, symptoms, history, and results of diagnostic tests. The diagnostic procedure is done by first obtaining a patient history and determining their **chief complaint/concern (CC)**. Although the individual may have many medical problems, the chief complaint is what brought them *now* to seek medical help. Obtaining a complete medical history can help in determining the **etiology**, or cause, of the disease.

It is also helpful to determine if the chief complaint was gradual or of a sudden onset. Quite often, symptoms gradually develop from a disease process that may have been there for some time. These often are **chronic conditions** as opposed to **acute conditions** that exhibit a rapid onset of signs and symptoms. One of the problems with chronic conditions is that due to their usually gradual onset, older patients often attribute them to "just getting older" and often ignore them as an indicator of disease. As the conditions worsen, these people can no longer ignore them, and they seek help. By that time, treating the disease may be more complicated or difficult due to its severity.

The signs and symptoms of a chronic disease may disappear at times; this period is known as **remission** of the disease. **Relapses** are recurrences of the signs and symptoms of disease. If the signs and symptoms acutely "flare up," this is known as an **exacerbation** of the disease. **Mortality** is the measure of the number of deaths attributed to a specific disease in a given population over a period of time. **Morbidity** is the measure of the disabilities and extent of problems caused by an illness. For example, although polio has a low mortality rate (few deaths associated with the disease), it does have a high morbidity rate due to the paralysis, limb deformities, and difficulty breathing later in life.

The Centers for Disease Control and Prevention (CDC) tracks disease worldwide. If a disease is continually present within a specific population or region, it is called **endemic**. If the disease occurs suddenly in large numbers over a specific region, it is called an **epidemic**. If the disease spreads country or worldwide, it is called a **pandemic**.

Diseases that have a prognosis of death are referred to as **terminal** diseases. The **prognosis** is the prediction of the outcome of a disease. Hopefully, your *prognosis* for doing well in this anatomy and physiology course is excellent.

LEARNING HINT

WHAT'S IN A WORD?

The word *gnosis* is Greek for "knowledge." *Dia* means "through or complete"; therefore, *diagnosis* literally means "know through or completely." *Pro* is a prefix meaning "before or in front of." Perhaps you can figure out that *prognosis* literally means "the foreknowledge or predicting of the outcome of a disease."

TEST YOUR KNOWLEDGE 1–3

Answer the following questions.

1. Use a checkmark to indicate which of the following are vital signs:
   _____ a. pulse
   _____ b. cough
   _____ c. blood pressure
   _____ d. age
   _____ e. indigestion
   _____ f. respiratory rate
   _____ g. body temperature

2. Which of the following is the medical term for the cause of a disease?
   a. Prognosis
   b. Diagnosis
   c. Etiology
   d. Syndrome

3. Which of the following is the medical term for the outcome of a disease?
   a. Prognosis
   b. Diagnosis
   c. Etiology
   d. Syndrome

4. If you describe a disease as "terminal," you are describing the:
   a. diagnosis.
   b. prognosis.
   c. etiology.
   d. treatment.

5. A disease that is not deadly but has a lot of disabling characteristics that impact a person's quality of life would be said to have:
   a. high mortality and low morbidity.
   b. low mortality and low morbidity.
   c. high mortality and high morbidity.
   d. low mortality and high morbidity.

6. If an outbreak of a disease such as avian flu occurs worldwide, it would be said to be:
   a. pandemic.
   b. endemic.
   c. epidemic.
   d. chronic.

ANATOMY AND PHYSIOLOGY CONCEPTS YOU WILL ENCOUNTER ON YOUR JOURNEY

In this section, we take a closer look at some additional concepts related to the study of anatomy and physiology that you will learn more about as you travel through the chapters in this text. Let's begin with one of the most important concepts in maintaining normal health.

Homeostasis

For the body to function normally, it must constantly monitor both its internal and external environment and make the appropriate adjustments. For cells to thrive, they must be maintained in an environment that provides a proper temperature range, balanced oxygen levels, and adequate nutrients. Heart rate and blood pressure must also be monitored and maintained within a certain range, or **set point**, for optimal functioning. **Homeostasis** is the physiological process in which your body monitors and maintains a stable internal environment or equilibrium. Survival depends on the body's ability to maintain homeostasis. *Homeostatic regulation* refers to the adjustments made in the human organism to maintain this stable internal environment. Although the ending *stasis* literally means "standing still," as you will soon see, *homeostasis* is actually a dynamic state of equilibrium.

The thermostat in your house functions like a homeostatic mechanism. A temperature is set and then maintained by a sensor that monitors the internal environmental temperature and either heats the house if the sensor registers too cold or cools the house if the sensor registers too hot. A continuous feedback loop from the sensor to the thermostat determines what action is needed. Because the feedback loop opposes the stimulus (cools down if too hot, heats up if too cold), it is referred to as a **negative feedback loop**.

The body also relies on negative feedback loops that continually sense the internal and external environment and make adjustments to maintain homeostasis (see **FIGURE 1–4** ■). The hypothalamus in the brain represents the body's temperature control. If the hypothalamus senses a very cold environment,

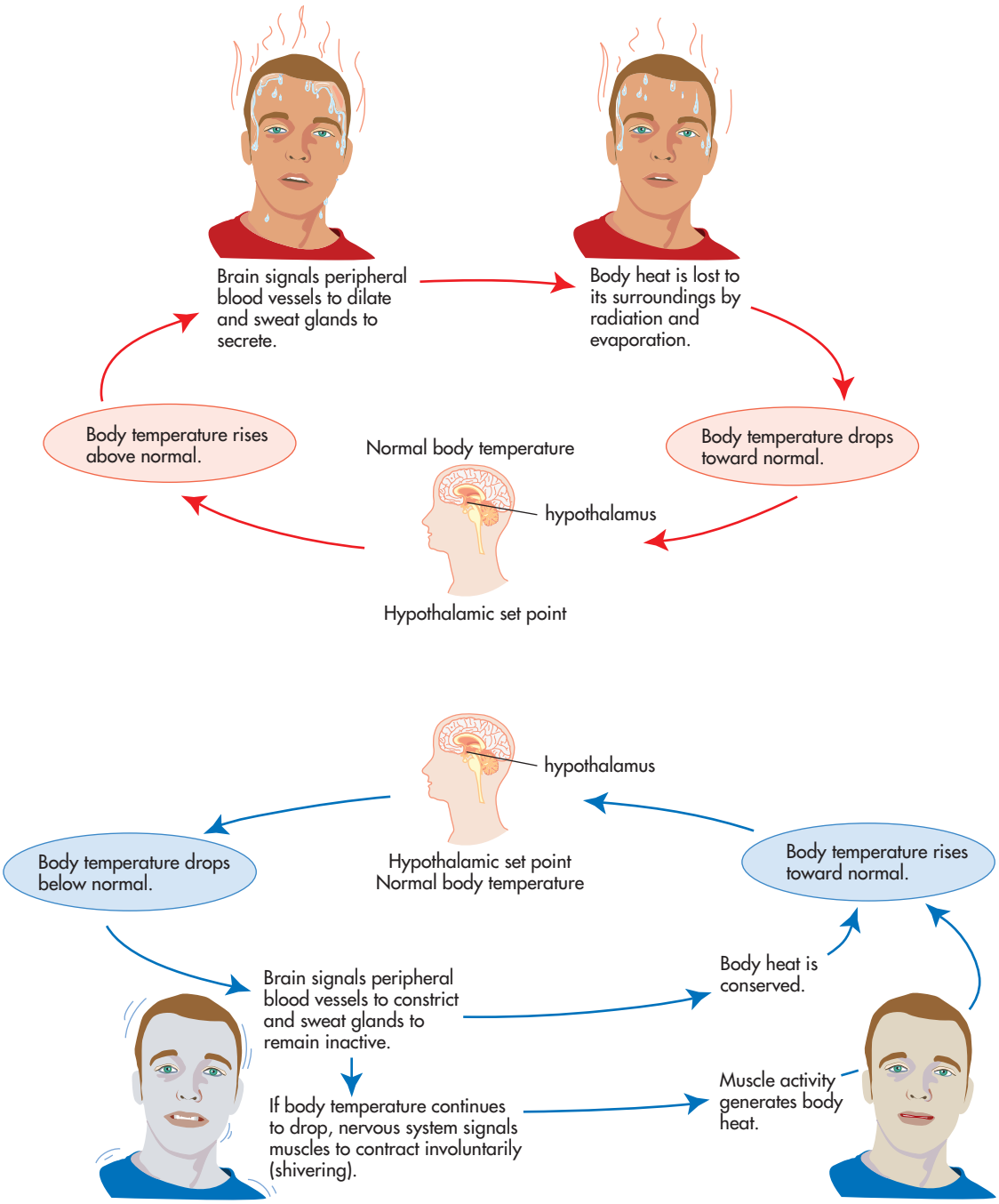

FIGURE 1–4 ■
The homeostatic control of normal body temperature (98.6°F or 37°C).

it opposes this cold stimulus (negative feedback loop) and performs physiological processes to gain heat within the body to maintain an internal temperature near 98.6°F (37°C). The body begins to shiver, and this increased muscular activity generates heat. In addition, because most heat loss is through peripheral areas (head, arms, and legs), the body decreases the size or diameter of the peripheral blood vessels (vasoconstriction), causing the blood to be deeper from the skin surface where the heat would be lost to the cold environment. This keeps the blood closer to the core of the body, where it is warmer. Of course, we can assist the body by wearing a heavy coat and hat, which would remove much of the stress of the cold environment, or by simply getting out of the cold to a warmer environment.

Conversely, if you are in the desert and the temperature is 120°F (48.9°C), the body senses this as too hot and

stimulates physiological processes to cool you down. These processes include sweating (evaporation is a cooling process) and enlarging the peripheral vessels (peripheral vasodilation) to dissipate the body heat into the external environment. In healthcare practice, if a patient presents with a very high temperature, the person may need to be rapidly cooled with ice packs or baths to reduce his or her temperature toward the normal range. Much of healthcare practice is just that—assisting the body through therapy and treatments in returning it to homeostasis.

Your body is also capable of **positive feedback**, which increases the magnitude of a change. This process is also known as a *vicious cycle*. Positive feedback is not a way to regulate your body because it increases a change away from the ideal set point. Often, positive feedback is harmful if the vicious cycle cannot be broken, but sometimes positive feedback is necessary for a process to run to completion.

A good example of necessary positive feedback is the continued contraction of the uterus during childbirth. When a baby is ready to be born, a signal, not well understood at this time, tells the hypothalamus to release the hormone oxytocin from the posterior pituitary. Oxytocin increases the intensity of uterine contractions. As the uterus contracts, the pressure inside the uterus caused by the baby moving down the birth canal increases the signal to the hypothalamus. More oxytocin is released, and the uterus contracts harder. Pressure becomes higher inside the uterus, the hypothalamus is signaled to release more oxytocin, and the uterus contracts yet harder. This cycle of ever-increasing uterine contractions due to ever-increasing release of oxytocin from the hypothalamus continues until the pressure inside the uterus decreases—that is, until the baby is born.

CLINICAL APPLICATION

"BREAKING" A FEVER (MEDICALLY KNOWN AS PYREXIA)

It is believed that most fevers are the body's way of making an inhospitable environment for a pathogen. Why is it that when someone begins sweating after a prolonged fever, the fever is said to be "breaking"? A fever sets the hypothalamus to a higher set temperature. The body increases metabolism to generate more heat to reach this now higher set temperature (just like when you turn up the thermostat in your house). Once whatever is causing the fever is gone, the temperature set by the hypothalamus is turned back down to the true normal. The body must now rapidly get rid of the excess heat by the cooling process of evaporation through sweating.

AMAZING FACTS

Bizarre Signs and Symptoms!

Here are some strange signs and symptoms that have been indications of diseases. Please note that there are other signs, symptoms, and tests to determine specific diseases. Please do not use this list of oddities as a sole diagnostic tool!

1. Generalized itching skin of unknown origin can be an indication of Hodgkin's disease.
2. Sweating at night may indicate tuberculosis.
3. A desire to eat clay or starchy paste may indicate an iron deficiency in the body.
4. Breath that smells like fruit-flavored chewing gum or nail polish remover may be an indication of diabetes.
5. A magenta-colored tongue may be indicative of a riboflavin deficiency.
6. A patient with profound kidney disease often doesn't have moons (lunula) on the fingernails.
7. A "hairy" tongue may mean that a patient's normal mouth flora has died from improper use of antibiotics and a yeast infection is now present.
8. Spoon-shaped fingernails may point to an iron deficiency in the body.
9. Brown linear streaks on the fingernails of fair-skinned people may indicate melanoma (skin cancer).
10. Having trouble smelling peanut butter from a distance? Recent studies show difficulty in smelling peanut butter from a foot away can indicate early stages of Alzheimer's disease, Parkinson's disease, or even multiple sclerosis.
11. If you have a stabbing pain in your heel and haven't stepped on a sharp object, you could have a herniated disc. This is because the sciatic nerve runs from your back to your heel.
12. Hiccups lasting more than 48 hours could be a sign of lung or esophageal cancer.
13. A newfound urge to steal may be one of the early signs of a specific type of dementia. (Please do not use this as a defense in a court of law!)

Metabolism

If you travel to other countries, you will see many different cultures and customs. Even though each culture is unique, they all share certain similarities. The same can be said for all of us, who are unique but share certain functions in order to maintain life. All humans, for example, need food and water to produce complex chemical reactions needed for growth,

reproduction, movement, and so on. On the cellular level, all humans require the process of **metabolism** in order to survive. *Metabolism* refers to all the energy and material transformations that occur within living cells.

Metabolism is further subdivided into two opposite processes. **Anabolism** is the process by which simpler compounds are built up and used to manufacture materials for growth, repair, and reproduction, such as the assembly of simple amino acids to form complex proteins. This is the building phase of metabolism. **Catabolism** is the process by which complex substances are broken down into simpler substances. This is the tearing-down phase of metabolism. For example, the breakdown of food into simpler chemical building blocks such as blood sugar or glucose for energy use is a catabolic process. An abnormal and extreme example of catabolism is a starvation victim whose body "feeds upon itself," actually consuming the body's own tissues.

SUMMARY

Points of Interest

- Anatomy is the study of the actual internal and external structures of the body, and physiology is the study of how these structures normally function. Pathology is the study of the disease processes by which abnormal structures and abnormal body functions can occur.
- Medical terminology is the language of medicine and combines word roots, prefixes, and suffixes to construct numerous medical terms to describe conditions, locations, diagnostic tools, and so on.
- The metric system is the mathematical language of medicine based on powers of 10. If you require more practice with this system, please go to your student Study Success Companion at the end of this text for a simplified review.
- A change in objective measurable values such as temperature (signs) and subjective patient perceptions (symptoms) can indicate a disease is present. Vital signs are pulse, respirations, temperature, and blood pressure.
- Patients will present with a chief complaint/concern and signs and symptoms that will aid in the identification, better known as the diagnosis, of the disease or condition. Patient history and results of diagnostic tests will also aid in diagnosis. Other related terms include determining the cause or etiology of the disease. In addition, it is helpful to determine if the condition had a rapid onset (acute condition) or if it was a gradual process (chronic condition).
- The body tries to maintain a balanced or stable environment called homeostasis. It must constantly monitor the environment and make changes to maintain this balance. It often accomplishes homeostasis through negative feedback loops.
- Metabolism refers to all of the chemical operations going on within the body and can be broken down into two opposite processes. The building phase of metabolism is anabolism, in which simpler compounds are built up and used to manufacture materials for growth, reproduction, and repairs. The tearing-down phase is catabolism, in which complex substances are broken down into simpler substances, such as food broken down for energy use.

CASE STUDY

A 45-year-old male involved in a vehicular accident is transferred to the ICU with SOB and abdominal pain. He has acrocyanosis, tachycardia, and a past medical history of cardiopathy and coronary artery disease (CAD). He weighs 150 pounds and is 5 feet 6 inches tall. His chest x-ray shows an enlarged heart. Blood pressure shows hypertension at 155/95 mmHg. His facial injuries will require future rhinoplastic surgery. An electrocardiogram and lower GI series is ordered.

a. What is his CC(s) and etiology?

_____

_____

b. Where exactly in the hospital was the patient taken?

_____

_____

c. Describe the patient's color, heart rate, and breathing.

_____

_____

d. What is the medical term for what the x-ray showed?

_____

_____

e. What future facial surgery will he need?

_____

_____

REVIEW QUESTIONS

Multiple Choice

1. Which of the following is an example of microscopic anatomy?
   a. Viewing an x-ray
   b. Examining the shape of an organ during an autopsy
   c. Classifying a type of bacterial cell
   d. Watching how the pupils in the eyes react to light

2. Acromegaly means which of the following?
   a. A large stomach
   b. Enlarged extremities
   c. An inflamed stomach lining
   d. A large acrobat

3. The process that prevents movement away from a normal set point is called:
   a. positive feedback.
   b. negative feedback.
   c. vicious cycle.
   d. control center.

4. In the medical field, science, engineering, and pharmaceutical industries, volume is measured in:
   a. kilograms.
   b. liters.
   c. meters.
   d. gallons.

5. The cause of a disease is referred to as the:
   a. prognosis.
   b. diagnosis.
   c. pathology.
   d. etiology.

6. Which of the following is a sign?
   a. Nausea
   b. Fever
   c. Dizziness
   d. Fatigue

7. A man reports to the emergency department with nausea and vomiting. He has a fever and his pulse and blood pressure are elevated. After some tests, it is determined that he has a stomach virus. Which of the following is his prognosis?
   a. Rest and drink plenty of fluids
   b. A viral infection
   c. You'll be fine in a few days
   d. Nausea and vomiting and fever

8. Which of the following is not a vital sign?
   a. Heart rate of 76
   b. Blood pressure of 135/70 mmHg
   c. Temperature of 97.4°F
   d. Vital capacity of 6 liters

Fill in the Blank

1. Ted injured his knee at last night's football game. Today his doctor wants to make a small incision and use a device to "look around the joint" to assess the damage. What is the term for this device?
   _____

2. _____ is the study of the structures of the body, and _____ is the study of the functions of these structures.

3. Bob has just been told he has hepatomegaly. This means his _____ is _____.

4. Pulse and temperature represent two _____ signs of the body.

5. Jill is injured badly in a car accident. She is bleeding excessively. Her blood pressure is dropping rapidly. Her heart beats faster to try to raise her blood pressure, yet it keeps dropping due to blood loss. This is an example of _____ feedback.

Short Answer

1. Explain the difference between *diagnosis* and *prognosis*.

_____

_____

_____

_____

2. Knowing that difficulty swallowing is called dysphagia, what is the function of a phagocyte?

_____

_____

_____

_____

3. Contrast negative and positive feedback loops.

4. Describe one example of homeostasis in your body.

5. After saving for 10 years for a ski trip to the Alps, Jose experienced a spectacular wipeout on the first run down the mountain. A broken leg is the diagnosis. List his symptoms, prognosis, etiology, and treatment.

6. Contrast the terms *endemic*, *epidemic*, and *pandemic*.

7. Contrast *catabolism* and *anabolism*.

The Human Body

2

READING THE MAP

Now that we have a basic understanding of the native language and some basic concepts, how will we successfully navigate through an unfamiliar city or country? We must, of course, study maps or program our GPS so we can plan our visit and know where we are going. The same effort is required to learn the "terrain" of the human body. This chapter provides the major external map of the human body that serves as a guide for future chapters, which will map the internal regions in detail. Medical directional terms and body locations are the foundations we will need as we journey together through this wondrous creation called the human body. Isn't it ironic that if there is one thing we should know better than anything else, it should be our own bodies? To borrow from an old saying, by the end of our journey through this text, you will know your entire body like the "back of your hand."

LEARNING OUTCOMES

At the end of your journey through this chapter, you will be able to:

- List and describe the various body positions.
- List and describe the various body directional terms.
- Define the body planes.
- Locate and describe the body cavities and their respective organs.
- List and describe the anatomical divisions of the abdominal region.
- Identify and locate the various body regions.

Pronunciation Guide

Pro•nun•ci•a•tion
Definitions/Parts

Correct pronunciation is important in any journey so that you and others are completely understood. Here is a "see-and-say" Pronunciation Guide for the more difficult terms to pronounce in this chapter. Please note that even though there are standard pronunciations, regional variations of the pronunciations can occur.

abdominopelvic cavity (ab DOM ih noh PELL vik)
antecubital (an tee CUE bi tal)
buccal (BUCK al)
caudal (KAWD al)
cephalic (seh FAL ik)
coronal plane (koh ROH nal)
cranial (KRAY nee al)
distal (DISS tal)
dorsal (DOR sal)
gluteal (GLOO tee al)
mediastinum (ME dee ah STY num)
midsagittal plane (mid SAJ ih tal)
pleural cavities (PLOO ral)
superficial (SOO per FISH al)
thoracic cavity (tho RASS ik)
transverse (tranz VERS)
Trendelenburg (tren DELL in berg)

THE MAP OF THE HUMAN BODY

When reading a map, you need certain universal directional terms, such as *north*, *south*, *east*, and *west*, to help you understand and use the map. A map is often made to represent a specific region so that more details can be included about that particular area, making it easier to explore. Likewise, scientists have created standardized body directional terms and divide the body into distinct regions, sections, and cavities so that we can more clearly and rapidly locate and discuss anatomical features. Having certain anatomical landmarks on the body also provides needed points of reference for surgery, diagnostic procedures, and clinical discussions related to patient care. The spinal column is a major anatomical landmark for many structures in the center of our bodies and the specific vertebrae are often referenced for certain anatomical structure locations. For example, the bifurcation of the lung (where the main airways divide into the left and right lung) occurs at the fifth or sixth thoracic vertebrae on a chest x-ray.

If a patient states, "I have pain in my stomach," does that really tell you a lot of information? Often, patients use the word *stomach* when actually referring to the abdominal region. A more specific localization and description of the pain can help in determining what is wrong with a patient. It is helpful to know the type of pain (dull, sharp, or stabbing) and *exactly* where in that region the pain is located to help determine its cause. For example, pain in the general abdominal region can indicate a variety of problems, including ulcers, heart attack, appendicitis, indigestion, or liver problems. Knowing the exact body region can help a clinician better determine the precise problem.

Body Positions

The body can assume many positions and therefore has different orientations. To standardize the orientation for the study of anatomy, scientists developed the **anatomical position**. The anatomical position, as shown in FIGURE 2–1 ■,

FIGURE 2–1 ■
The anatomical position.

is a human standing erect, face forward, with feet parallel and arms hanging at the side, with palms facing forward.

Other body positions that are important to discuss because of clinical assessments and treatments in health care are the supine, prone, Trendelenburg, and Fowler's positions. In the **supine position**, the patient is laying face *upward* (think sUPine = face UP). In the **prone position**, the patient is laying face *downward*, on the stomach (think prONe = ON stomach). When a patient is in the **Trendelenburg position**, the head of the bed is lower than the patient's feet. This position is used to help move secretions from various regions of the patient's lungs. Although this is therapeutic, certain precautions must be taken. Because the patient's head is lower than the heart, gravity increases the blood flow to the head, and therefore intracranial pressure increases. This position is contraindicated in patients with recent eye surgery or cerebral injuries or bleeding. In the **Fowler's position**, the patient is sitting in bed with the head of the bed elevated. This position is often used in the hospital to facilitate breathing and for comfort of bedridden patients while eating or talking. See **FIGURE 2–2** ■ for these body positions.

Directional Terms

Superior (**cranial** or **cephalic**) means toward the head or upper body. **Inferior** (**caudal**) means away from the head or toward the lower part of the body. **Anterior** (**ventral**) refers to body parts toward or on the front of the body, and **posterior** (**dorsal**) refers to body parts toward or on the back of the body. Remember, if during your trip you stop at the beach, you will know it is not safe to swim if you see a shark's *dorsal* fin sticking out of the water. **Medial** refers to body parts located near the middle or midline of the body. **Lateral** refers to body parts located away from midline (or on the side).

One more analogy that relates to a map is the concept of a *reference point*. If you were traveling from Colorado to Florida, for example, you would have to travel in a southeasterly direction. Colorado is your starting point and serves as your reference. However, if you were traveling from Florida to Colorado, you would travel in a northwesterly direction because Florida is now your point of reference. Any body part can either be superior or inferior depending on your reference point. For example, the knee is superior to the ankle if the ankle is the reference point. Turning this around, the ankle is inferior to the knee if the knee is the reference point.

CLINICAL APPLICATION

ADDITIONAL BODY POSITIONS

Other specific positions of the human body are used in medicine to facilitate diagnosis and treatment. For example, the **lithotomy** position is a common position for surgical procedures and medical examination of the pelvis, lower abdomen, and reproductive organs. In the lithotomy position, patients are placed on their back with feet elevated (usually in stirrups). This is also the traditional position for childbirth in Western nations.

The **dorsal recumbent** position has the patients lying on their back with their knees flexed and feet flat on the table or bed. This position is used for some surgical procedures and examinations of the vagina and rectum.

A. **B.**

A. Lithotomy and **B.** dorsal recumbent positions.