



EDITION

6

The Human Body in Health and Illness

Herlihy



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The Human Body in Health and Illness

SIXTH EDITION

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Dedication

To all who live compassionately, seeing the divine in each other, our fur friends, and Mother Earth. We are all connected in life.

Love,

Barbara



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Last but certainly not least, many thanks to those who used previous editions and were kind enough to forward comments and suggestions. Your assistance is so appreciated. Keep the comments coming!

To the Instructor

Here she is...the sixth edition of *The Human Body in Health and Illness*...older, wiser, still smiling and eager to walk with you on your journey into the health professions. It's an exciting journey for all, and we wish you all the best.

The Human Body in Health and Illness tells the story of the human body with all its parts and the way these parts work together. It is a story that we have told many times in our classes. It is also a story that gets better with each telling as the body continues to reveal its mysteries and how marvelously it has been created. I hope that you enjoy telling the story as much as I do.

The Human Body in Health and Illness is a basic anatomy and physiology text addressed to the student preparing for a career in the health professions. It is written for students with minimal preparation in the sciences; no prior knowledge of biology, chemistry, or physics is required. The text provides all the background science information needed for an understanding of anatomy and physiology.

The basic principles of chemistry and biochemistry are presented in [Chapters 2 and 4](#), and they set the stage for an understanding of cellular function, fluid and electrolyte balance, endocrine function, and digestion. [Chapter 5](#), Microbiology Basics, presents clinically relevant microbiological topics. Check out the stories “Rick, Nick, and the Sick Tick” and “Dr. Semmelweis Screams: ‘Wash Those Mitts!’” The latter is an amusing presentation of a sad tale in the history of medicine and corresponds to the current emphasis on hand hygiene and health care–associated infection.

The anatomy and physiology content is presented in a traditional order, from simple to complex. The text begins with a description of a single cell and progresses through the various organ systems. There are two key themes that run throughout the text: (1) the relationship between structure and function—the student must understand that an organ is anatomically designed to perform a specific physiological function, and (2) homeostasis—the role that each organ system plays in sustaining life and what happens when that delicate balance is disturbed.

The text addresses two concerns about the selection of content. The first has to do with the amount of content. The field of anatomy and physiology is huge; therefore there must be a selection of content that can be mastered in the short period of time that a semester (or even two) allows. This text focuses on the physiology that is basic and most clinically relevant. Pathophysiology is introduced primarily to clarify physiological function. For instance, the different types of anemias illustrate the various steps in the making of the red blood cell. A second concern has to do with the recognition that we are not preparing physiologists; instead, we want the student to be able to use the physiology to understand clinically relevant content such as pathophysiology, physical assessment, diagnostics, and pharmacology. An understanding of physiology is crucial for advancement in the medically related sciences.

Textbook Strengths

- Anatomy and physiology are clearly and simply explained. A meticulously prepared set of **illustrations**—complete with amusing cartoons—supports the text. In fact, the story of the body is told as much through the art as through the written word.
- The text **truly integrates pathophysiology**; it is not merely boxed in or tacked on at the end. The integrated pathophysiology is used primarily to amplify the normal anatomy and physiology. The expanded **Medical Terminology and Disorders** tables and frequent references to common medical terminology allow the text to be used for an introductory course in pathophysiology and medical terminology.
- In addition to the pathophysiology, other topics are liberally integrated throughout the text. These include **common diagnostic procedures** such as blood count, lumbar puncture, urinalysis, and electrocardiography. **Pharmacological topics** are also introduced and, like the pathophysiology, are used to amplify the normal anatomy and physiology. For instance, the discussion of the neuromuscular junction is enhanced by a description of the effects of the neuromuscular blocking agents. Because of the effort of the text to make clinical correlations, it sets the stage for the more advanced health science courses, including pharmacology and medical-surgical nursing.
- **Re-Think** boxes are liberally distributed throughout each chapter and encourage students to master that content before progressing through the chapter. **Ramp It Up!** boxes develop selected clinically relevant topics that are simply too advanced to be included in the text as basic information. These boxed features contain new or advanced content commonly used in the clinical setting and allow instructors to scale their coverage in a manner appropriate to the course. They offer students the chance to make further connections between the text and their future careers. (*See the To the Student preface on page ix for descriptions and examples of each of the chapter features.*)
- **Medical terminology** is introduced, defined, and used throughout the text. Common clinical terms such as *hyperkalemia*, *vasodilation*, *hypertension*, and *diagnosis* are defined and reused so that the student gradually builds up a substantial medical vocabulary. The expanded **Medical Terminology and Disorders** tables were deliberately constructed to maximize the use of

common medical terms and disorders. To help foster a broader understanding of medical terminology, word parts and their meanings are included for nearly every term presented. Repetition of these helps students gain greater ground in understanding the very specific medical language they will be learning to use for a future in the health professions. A description is also provided, which gives the definition or other pertinent information on the topic.

- The **Review Your Knowledge** section has been expanded to include questions that require an analytical response. The **Go Figure** questions are based on the story told by the artwork. The questions can only be answered by analyzing the art and/or the information presented in the tables. This exercise encourages the student to see beyond the “pretty pictures” and realize that a picture is truly worth a thousand words. I would encourage you to assist your students to see that the art and the text are conveying the same message.
- The text is supported by many activities, exercises, puzzles, and games (e.g., Body Bingo) on **Evolve** (<http://evolve.elsevier.com/Herlihy>). These activities emphasize the focus of this text—clinically relevant anatomy and physiology.
- Last, the text incorporates many **amusing anecdotes** from the history of medicine. Although the human body is perfectly logical and predictable, we humans think, do, and say some strange things. Tales from the medical crypt provide some good laughs and much humility.

Classroom Resources

Materials from the **Study Guide** and **Evolve Instructor Learning Resources** can be used to:

1. Remediate students who are having difficulty in grasping the content.
2. Remediate students who have missed class(es).
3. Provide review for students engaged in pathophysiology and pharmacology whose memories need to be refreshed in the physiology.

Study Guide

The Study Guide for *The Human Body in Health and Illness* offers something for students at all levels of learning and is a ready-made resource for instructors looking for homework assignments. Each chapter includes two parts: Part I, Mastering the Basics, with matching, labeling, and coloring exercises; and Part II, Putting It All Together, containing multiple-choice questions, case studies, and word puzzles. Textbook page references are included with the questions, and the answer key is available on the Evolve website, only to instructors.

Evolve Instructor Learning Resources

The Evolve website for *The Human Body in Health and Illness* (<http://evolve.elsevier.com/Herlihy>) includes all of the Student Resources, as well as the following Instructor Resources:

- Answer Key for the Study Guide, Audience Response System questions, Image Collection, and ExamView Test Banks that include over 2300 questions!
- Instructor's Chapter Exams, Classroom Activities—including Bingo, Line 'Em Up, Sorting, and Word Puzzles—and the TEACH Instructor Resource.

TEACH Instructor Resource on Evolve

Instructors who adopt the textbook will also receive access to the TEACH Instructor Resource, which links all parts of the Herlihy educational package with customizable **Lesson Plans** based on objectives drawn from the text. The TEACH Lesson Plans are based on the chapter-by-chapter organization of *The Human Body in Health and Illness* and can be modified or combined to meet

your curriculum's scheduling and teaching needs.

TEACH has been completely updated and revised for this edition. The TEACH Lesson Plans help instructors prepare for class and make full use of the rich array of ancillaries and resources that come with the textbook. The content covered in each textbook chapter is divided across one or more lesson plans, each designed to occupy 50 minutes of class time. Lesson plans are organized into easily understandable sections that are each tied to the chapter learning objectives:

- **Instructor Preparation** This section provides a checklist of all the things you need to do to prepare for class, including a list of all the items you need to bring to class to perform any activity or demonstration included in the lesson plan.
- **Student Preparation** Textbook readings, study guide exercises, online activities, and other applicable homework assignments for each lesson are provided here, along with an overall estimated completion time.
- **The 50-Minute Lesson Plan** A lecture outline that reflects the chapter lecture slides that come as part of TEACH is included, as well as classroom activities and online activities, one or more critical thinking questions, and time estimates for the classroom lecture and activities.
- **Assessment Plan** To ensure that your students have mastered all the objectives, the TEACH Instructor Resource includes a separate Assessment Plan section. An easy-to-use table maps each assessment tool to the lesson plans and chapter objectives so that you can see all your assessment options—by chapter, by lesson, and by objective—and choose accordingly.

To the Student

This book will take you on an amazing journey through the human body. You will learn many body parts and, more importantly, how they work in an integrated manner to keep you going. You will use this information in your clinical practice when patients become ill with disorders of those structures. The following special features were created to help make learning enjoyable and fun.

Textbook Features

Key Terms

Key terms are listed at the beginning of each chapter, along with a page reference. Each is (1) presented in the text in blue print, (2) accompanied by a pronunciation guide, (3) thoroughly explained within the chapter, and (4) defined in the glossary.

Objectives

Numbered objectives identify the goals for each chapter.

Illustrations

Original illustrations and full-color cartoons help you make sense of anatomy and physiology using humor, clarity, and insight.

Do You Know...

Most of these boxed vignettes refer to clinical situations; others relate to interesting and amusing historical events related to anatomy and physiology.

Ramp It Up!

These features challenge you with more advanced anatomy and physiology topics.

Re-Think

These questions are liberally placed throughout the chapter to help reinforce important concepts.

As You Age

These boxed features contain numbered lists describing how the aging process affects human anatomy and physiology.

Sum It Up!

These features appear regularly throughout the chapters and help you synthesize key concepts.

Medical Terminology and Disorders Tables

These tables describe medical terms and specific disorders related to individual body systems, with a focus on developing a strong working medical vocabulary, which is necessary for a career in the health professions.

End-of-Chapter Features

Summary Outline

A detailed outline at the end of each chapter summarizes key concepts and serves as an excellent review of the chapter content. Use it as a study tool to review your reading and prepare for exams.

Review Your Knowledge

The matching and multiple-choice questions in this section cover the major points of the chapter and allow you to test your comprehension.

Go Figure

This review section asks you to interpret the figures in the chapter and reinforces the importance of the concepts presented.

Answers to Review Your Knowledge and Go Figure Questions

The **Appendix** contains answers to all Review Your Knowledge and Go Figure questions found in the textbook.

Glossary

The glossary includes a pronunciation guide and a brief definition of all key terms and many other words in the text.

Study Guide

Enhance your learning of the textbook content with the accompanying **Study Guide for *The Human Body in Health and Illness***. The Study Guide has something to offer students at all levels of learning, from labeling and coloring exercises to multiple-choice practice tests and case studies.

CHAPTER 1

Introduction to the Human Body

OBJECTIVES

1. Define the terms anatomy and physiology.
2. List the levels of organization of the human body.
3. Describe the 12 major organ systems.
4. Define homeostasis.
5. Describe the anatomical position.
6. List common terms used for relative positions of the body.
7. Describe the three major planes of the body.
8. List anatomical terms for quadrants and regions of the body.
9. Describe the major cavities of the body.

KEY TERMS

abdominopelvic cavity (p. 10)

anatomical position (p. 6)

anatomy (p. 1)

cranial cavity (p. 10)

dorsal cavity (p. 9)

frontal plane (p. 7)

homeostasis (p. 6)

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pleural cavities (p. 10)

quadrants (p. 10)

sagittal plane (p. 7)

spinal (vertebral) cavity (p. 10)

thoracic cavity (p. 10)

transverse plane (p. 7)

ventral cavity (p. 9)

viscera (p. 9)

<http://evolve.elsevier.com/Herlihy>

The human body is a wonderful creation. Millions of microscopic parts work together in a coordinated fashion to keep you going for about 75 years. Most of us are curious about our bodies—how they work, why they do not work, what makes us tick, and what makes us sick. As you learn more about the body, you will sometimes feel like this cartoon character: “What is this? Why do I need it? How does it work? Why don’t I have one?” As you study anatomy and physiology, you will learn the answers to these questions.



Anatomy and Physiology: What They Are

What's It Mean?

Anatomy (ah-NAT-o-mee) is the branch of science that studies the structure of the body. For example, anatomy describes what the heart looks like, how big it is, what it is made of, how it is organized, and where it is located. The word *anatomy* comes from the Greek word meaning to dissect. The science of anatomy arose from observations made by scientists centuries ago as they dissected bodies that were usually stolen from the local graveyard.

Physiology (fiz-ee-OL-o-jee) is the branch of science that describes how the body functions. For example, physiology describes how the heart pumps blood and why the pumping of blood is essential for life. Pathophysiology (path-o-fiz-ee-OL-o-jee) is the branch of science that describes the consequences of the improper functioning of the body—that is, how a body part functions when a person has a disease. Pathophysiology describes what happens during a heart attack and when the heart functions poorly or not at all.

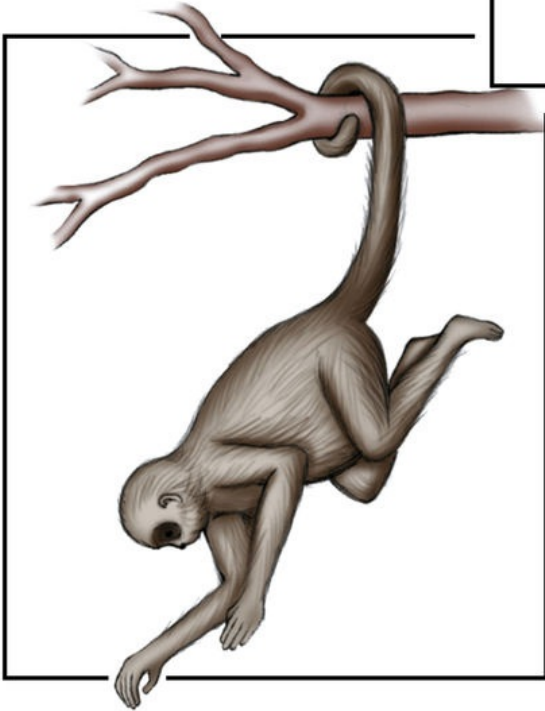
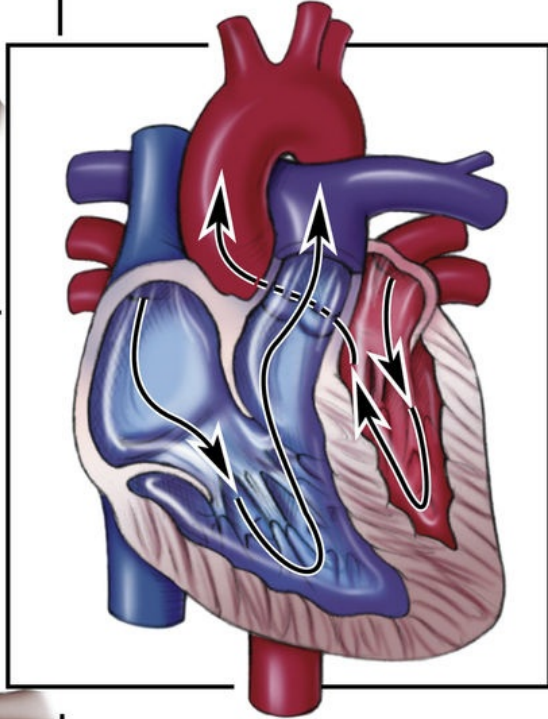


FIG. 1.1 Structure and function are closely related.

Why Do I Need to Know This?

Why study anatomy and physiology as part of your professional curriculum? Unless you gain a good understanding of normal anatomy and physiology, you cannot understand the diseases and disorders experienced by your patients, nor can you understand the basis for the various forms of treatment, such as drug therapy and surgical procedures. You want to give your patients the best possible care, so you must have a sound understanding of the human body.

Anatomy and physiology are closely related. Structure and function go together. When you examine the anatomy of a body part, ask yourself how its structure relates to its function. For example, the structure of the hand is related to its function: its ability to grasp an object (Fig. 1.1). The heart pumps blood, and the long, strong, flexible tail of the monkey allows it to hang from the tree. Structure and function are related.

Re-Think

1. What is the difference between anatomy and physiology?
2. Using any household item, explain what is meant by “structure and function are related.”

Do You Know...

Why This Grave Is Being Robbed, and Why the Grave Robber Is in Big, Big Trouble?

Dissection of the human body during medieval times was not allowed. Thus, the only way that early anatomists were able to obtain human bodies for dissection was to rob graves. Medieval scientists hired people to rob graves. Punishment for robbing graves was swift and severe. This lad will be in big, big trouble if he is caught, and it looks as if he will be. Surprisingly, grave robbing was common early in this century and in this country. Many a medical student who enrolled in the most prestigious medical schools had to “get” his own cadaver.



The Body's Levels of Organization

The body is organized from the very simple to the complex, from the microscopic atom to the complex human organism. Note the progression from simple to complex in [Fig. 1.2](#). Tiny atoms form molecules. These, in turn, form larger molecules. The larger molecules are eventually organized into *cells*, the basic unit of life. Specialized groups of cells form *tissues*. Tissues are then arranged into **organs**, such as the heart, stomach, and kidney. Groups of organs, in turn, create *organ systems*. Each organ system has a function, such as digestion, excretion, or reproduction. All the organ systems together form the human organism. From simple to complex, the body is built from the tiny atom to the human being.

Major Organ Systems

Twelve major organ systems make up the human body. Each performs specific functions that enable the human body to operate as a coordinated whole. Refer to [Fig. 1.3](#) and identify the location and distribution of the organs of each system.

- The integumentary (in-teg-yoo-MEN-tar-ee) system consists of the skin and related structures, such as hair and nails. The integumentary system forms a covering for the body, helps regulate body temperature, and contains some of the structures necessary for sensation.

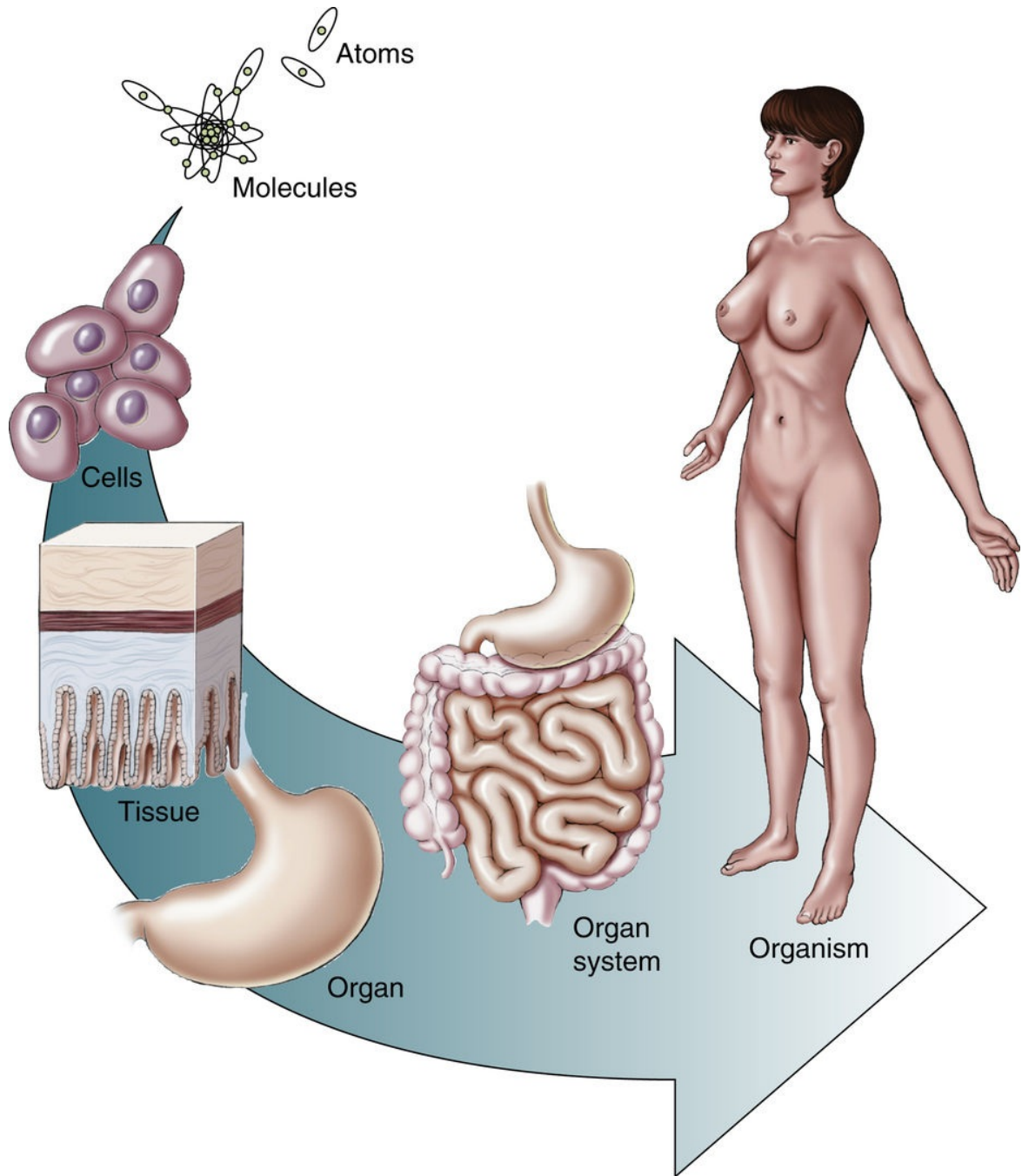
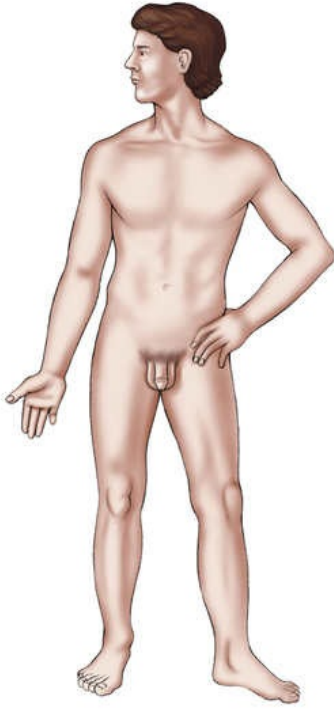


FIG. 1.2 Levels of organization, from atoms to human organism.

- The skeletal system forms the basic framework of the body. It consists primarily of bones, joints, and cartilage. The skeleton protects and supports body organs and enables us to move around.
- The muscular system has three types of muscles. *Skeletal muscles* attach to the bones and are responsible for movement of the skeleton and the maintenance

of body posture. *Smooth* and *cardiac muscles* are found in various organs and tubes; contraction and relaxation of these muscles help the organ systems carry out their functions.

- The nervous system is made up of the brain, spinal cord, nerves, and sense organs. Sensory nerves receive information from the environment and bring it to the spinal cord and brain, where it is interpreted. Decisions made by the brain and spinal cord are transmitted along motor nerves to various body structures.
- The endocrine (EN-doh-krin) system contains numerous glands that secrete hormones and chemical substances that regulate body activities such as growth, reproduction, metabolism, and water balance.
- The circulatory (SER-kyoo-lah-tor-ee) system consists of the blood, heart, and blood vessels. This system pumps (heart) and transports (blood vessels) blood throughout the body. Blood carries nutrients and oxygen to all the body's cells and also carries the waste away from the cells to the organs of excretion.
- The lymphatic (lim-FAT-ik) system is made up of the lymph nodes, lymphatic vessels, lymph, and other lymphatic organs. Lymph and lymphatic structures play an important role in fluid balance and in the defense of the body against pathogens and other foreign material.
- The immune system is an elaborate defense system that protects the body not only from pathogens, but also from allergens, such as pollens, bee venom, and some of our own cells that have gone awry (cancer cells). The immune system is widely distributed throughout the body (it is not shown in [Fig. 1.3](#)).
- The respiratory system contains the lungs and other structures that conduct air to and from the lungs. Oxygen-rich air moves into the lungs; the oxygen is picked up by the blood and distributed throughout the body. Carbon dioxide-rich air moves out of the lungs, thereby ridding the body of waste.
- The digestive system is comprised of organs designed to ingest food and break it down into substances that can be absorbed by the body. Food that is not absorbed is eliminated as waste.
- The urinary system contains the kidneys and other structures that help excrete waste products from the body through the urine. More importantly, the urinary system helps control water, electrolyte, and acid–base balance in the body.



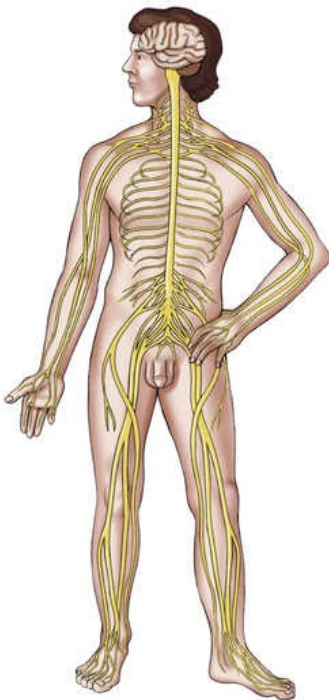
Integumentary system



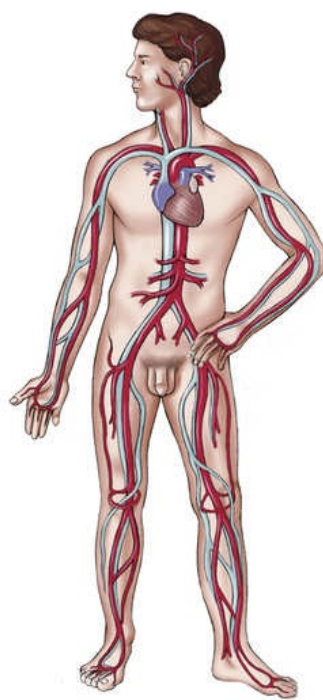
Skeletal system



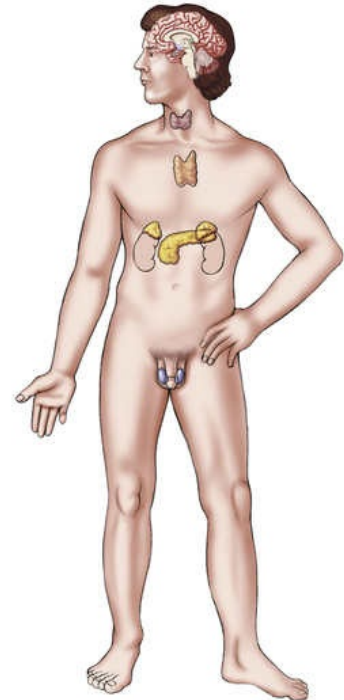
Muscular system



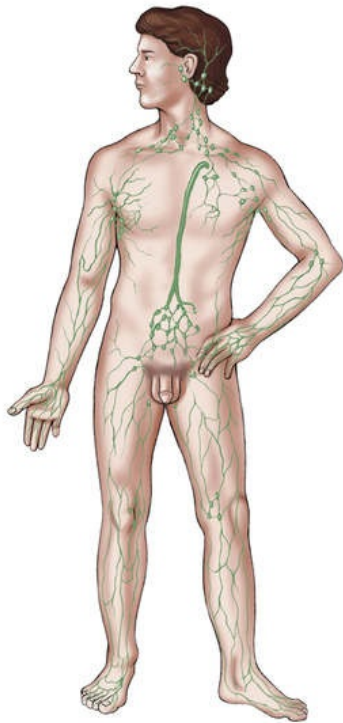
Nervous system



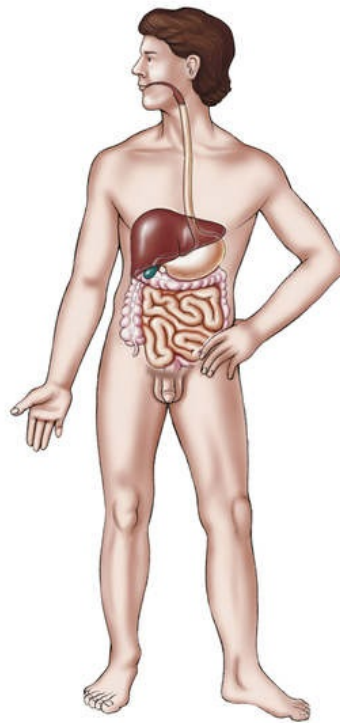
Circulatory system



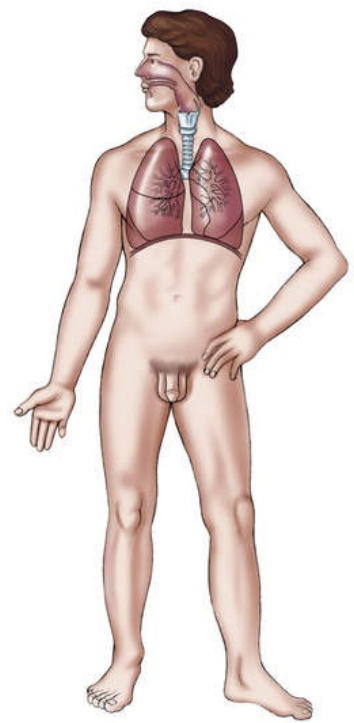
Endocrine system



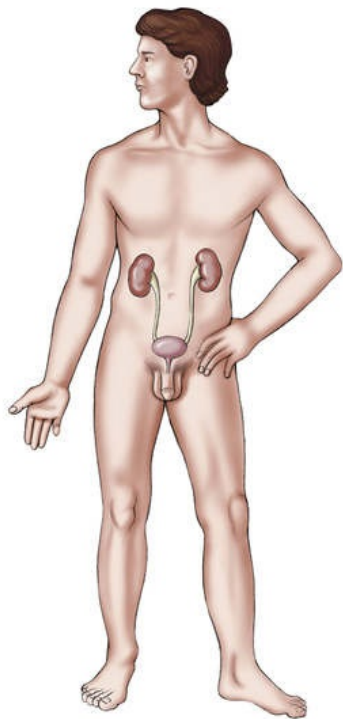
Lymphatic system



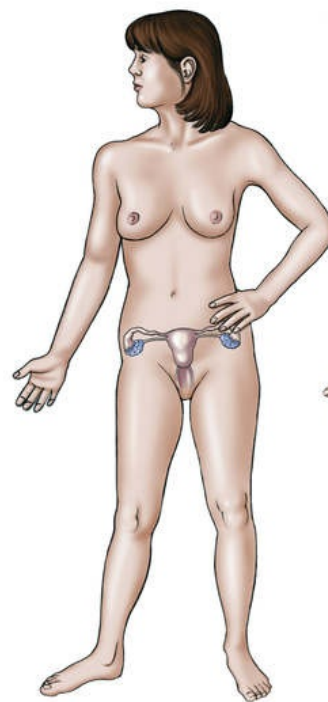
Digestive system



Respiratory system



Urinary system



Reproductive system

FIG. 1.3 Major organ systems of the body.

- The reproductive system is made up of organs and structures that enable humans to reproduce.

Homeostasis: Staying the Same

Homeostasis (ho-me-o-STAY-sis) literally means staying (*stasis*) the same (*homeo*). The term refers to the body's ability to maintain a stable internal environment in response to a changing environment. For example, in a healthy person, body temperature stays around 98.6°F (37°C), even when room temperature increases to 100°F or decreases to 60°F. The amount of water in your cells stays the same whether you drink 2, 3, or 4 liters (L) of water per day. Your blood sugar remains within normal limits whether you have just eaten a turkey dinner or have fasted for 6 hours. Mechanisms that help maintain homeostasis are called *homeostatic mechanisms*. Homeostatic imbalance results in disease or dysfunction.

Sum It Up!

Anatomy and physiology describe the structure and function of the body. The body is constructed from simple to complex (atoms to molecules to cells to tissues to organs to organ systems to the human organism). The 12 major organ systems are shown in [Fig. 1.3](#). Homeostatic mechanisms enable the body to “stay the same” despite changing internal and external environments.

Anatomical Terms: Talking About the Body

Special terms describe the location, position, and regions of body parts. Because these terms are used frequently, you should become familiar with them now. People in the medical field are often accused of speaking their own language. Indeed, we do! We always use these terms as if the body were standing in its anatomical position.

Anatomical Position

In its **anatomical position**, the body is standing erect, with the face forward, the arms at the sides, and the toes and palms of the hands directed forward ([Fig. 1.4](#)).

Relative Positions

Specific terms describe the position of one body part in relation to another body part. These are directional terms. They are like the more familiar directions of north, south, east, and west; however, whereas describing Canada as being located north of the United States would be correct, describing the head as “north of the chest” would sound strange. Therefore, in locating body parts, we use other terminology. The terms come in pairs. Note that the two terms in each pair are generally opposites. Remember, the references are valid only for the body in its anatomical position.

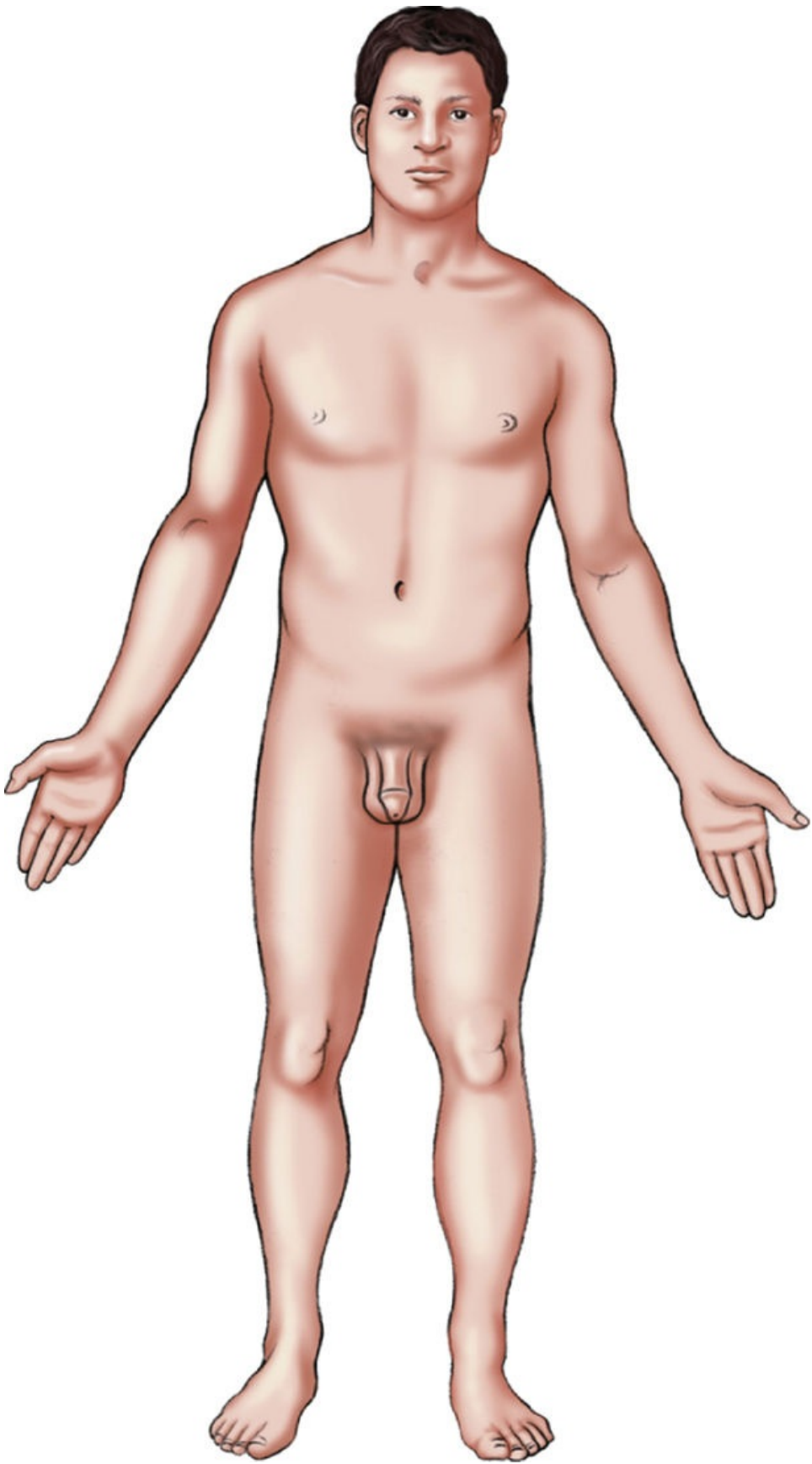


FIG. 1.4 Anatomical position.

- *Superior* and *inferior*. *Superior* means that a part is above another part or is closer to the head. For example, the head is superior to the chest. *Inferior* means that a part is located below another part or is closer to the feet. The chest, for example, is inferior to the head.
- *Anterior* and *posterior*. *Anterior* means toward the front surface (the belly surface). *Posterior* means toward the back surface. For example, the heart is anterior to the spinal cord, but the heart is posterior to the breastbone. Another word for anterior is *ventral*, and another word for posterior is *dorsal*. Consider the dorsal fin of a fish. It is the dorsal part of the shark that can be seen moving effortlessly and very quickly toward your surfboard!
- *Medial* and *lateral*. Imagine a line drawn through the middle of your body, dividing it into right and left halves. This is the midline. *Medial* means toward the midline of the body. The nose, for example, is medial to the ears. *Lateral* means away from the midline of the body. For example, the ears are lateral to the nose. In the anatomical position, the hand is closer to the lateral thigh than to the medial thigh.
- *Proximal* and *distal*. *Proximal* means that the structure is nearer to the point of attachment, often the trunk of the body. Because the elbow is closer to the point of attachment than is the wrist, the elbow is described as proximal to the wrist. The wrist is proximal to the fingers, meaning that the wrist is closer to the trunk than are the fingers. *Distal* means that a part is farther away from the point of attachment than another part. For example, the wrist is distal to the elbow, and the fingers are distal to the wrist.

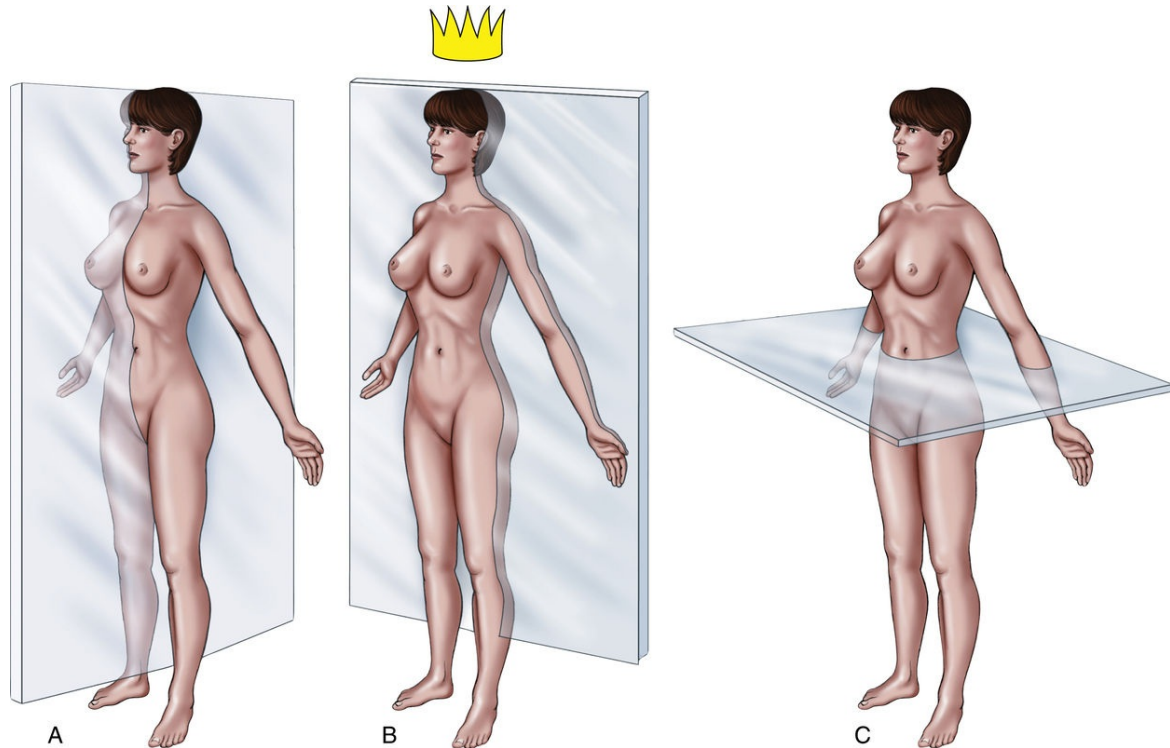


FIG. 1.5 Planes of the body. (A) Sagittal. (B) Frontal (coronal). (C) Transverse.

- *Superficial* and *deep*. *Superficial* means that a part is located on or near the surface of the body. The skin is superficial to the muscles. *Deep* means that the body part is away from the surface of the body. The bones, for example, are deep to the skin.
- *Central* and *peripheral*. *Central* means that the part is located in the center. *Peripheral* means away from the center. The heart, for example, is located centrally, whereas the blood vessels are located peripherally (away from the center and extending toward the limbs). The brain and spinal cord are called the central nervous system, and the nerves are called the peripheral nervous system.

? Re-Think

1. Use the terms *proximal* and *distal* to describe the relationship of the wrist to the elbow.
2. Use the terms *proximal* and *distal* to describe the relationship of the fingers to the wrist.
3. Use the terms *medial* and *lateral* to describe the parts of the thigh. Do the

same with the eye.

Planes of the Body

When we refer to the left side of the body, the top half of the body, or the front of the body, we are referring to the planes of the body. Each plane divides the body with an imaginary line in one direction. [Fig. 1.5](#) shows the following three important planes:

1. Sagittal plane (see [Fig. 1.5A](#)). The **sagittal plane** divides the body lengthwise into right and left portions. If the cut is made exactly down the midline of the body, the right and left halves of the body are equal. This division is a midsagittal section.
2. Frontal plane (see [Fig. 1.5B](#)). The **frontal plane** divides the body into anterior (ventral) and posterior (dorsal) portions. This plane creates the front part of the body and the back part of the body. The frontal plane is also called the *coronal plane*. Coronal means “crown,” so the imaginary line for the coronal plane is made across the part of the head where a crown would sit and then downward through the body.
3. Transverse plane (see [Fig. 1.5C](#)). The **transverse plane** divides the body horizontally, creating an upper (superior) and a lower (inferior) body. When the body or an organ is cut horizontally or transversely, it is called a cross section.

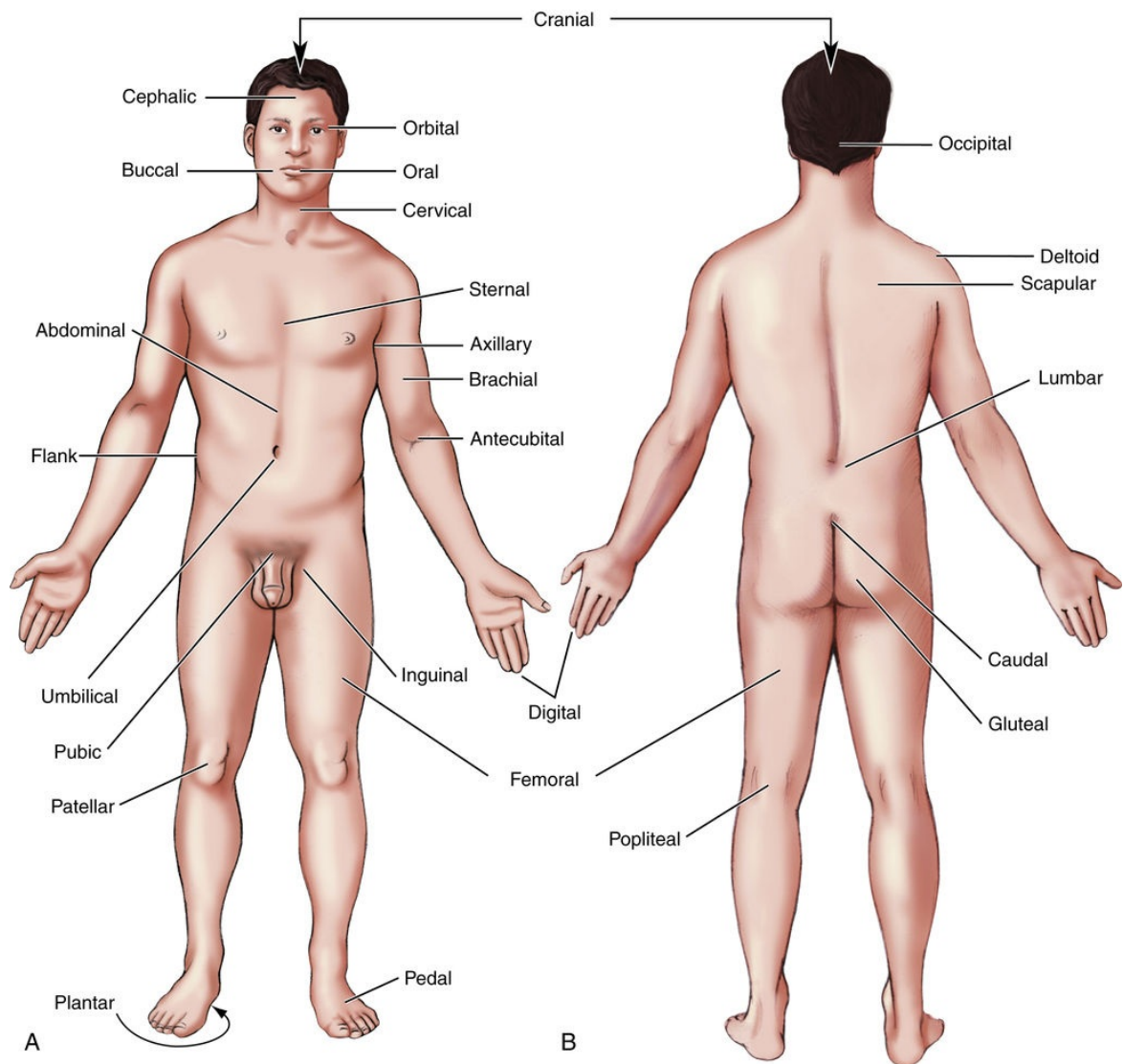


FIG. 1.6 Regional terms. (A) Anterior view. (B) Posterior view.

Regional Terms

Specific terms describe the different regions or areas of the body. [Fig. 1.6](#) illustrates the terms used to identify the regions on the anterior and posterior surfaces of the body.

On the anterior surface, identify the following regions:

Abdominal: anterior trunk just below the ribs

Antecubital: area in front of the elbow

Axillary: armpit

Brachial: arm

Buccal: cheek area; cavity between the gum and cheek

Cephalic: head

Cervical: neck region

Cranial: nearer to the head

Digital: fingers, toes

Femoral: thigh area

Flank: fleshy area along each side between the lower ribs and the top of the hip bones

Inguinal: area where the thigh meets the trunk of the body; often called the groin

Oral: mouth

Orbital: area around the eye

Patellar: front of the knee over the kneecap

Pedal: foot

Plantar: sole of the foot

Pubic: genital area

Sternal: middle of the chest (over the breastbone area)

Umbilical: navel

On the posterior surface, identify the following regions:

Caudal: near to the lower region of the spinal column (near the tailbone)

Deltoid: rounded area of the shoulder closest to the arm

Gluteal: buttocks

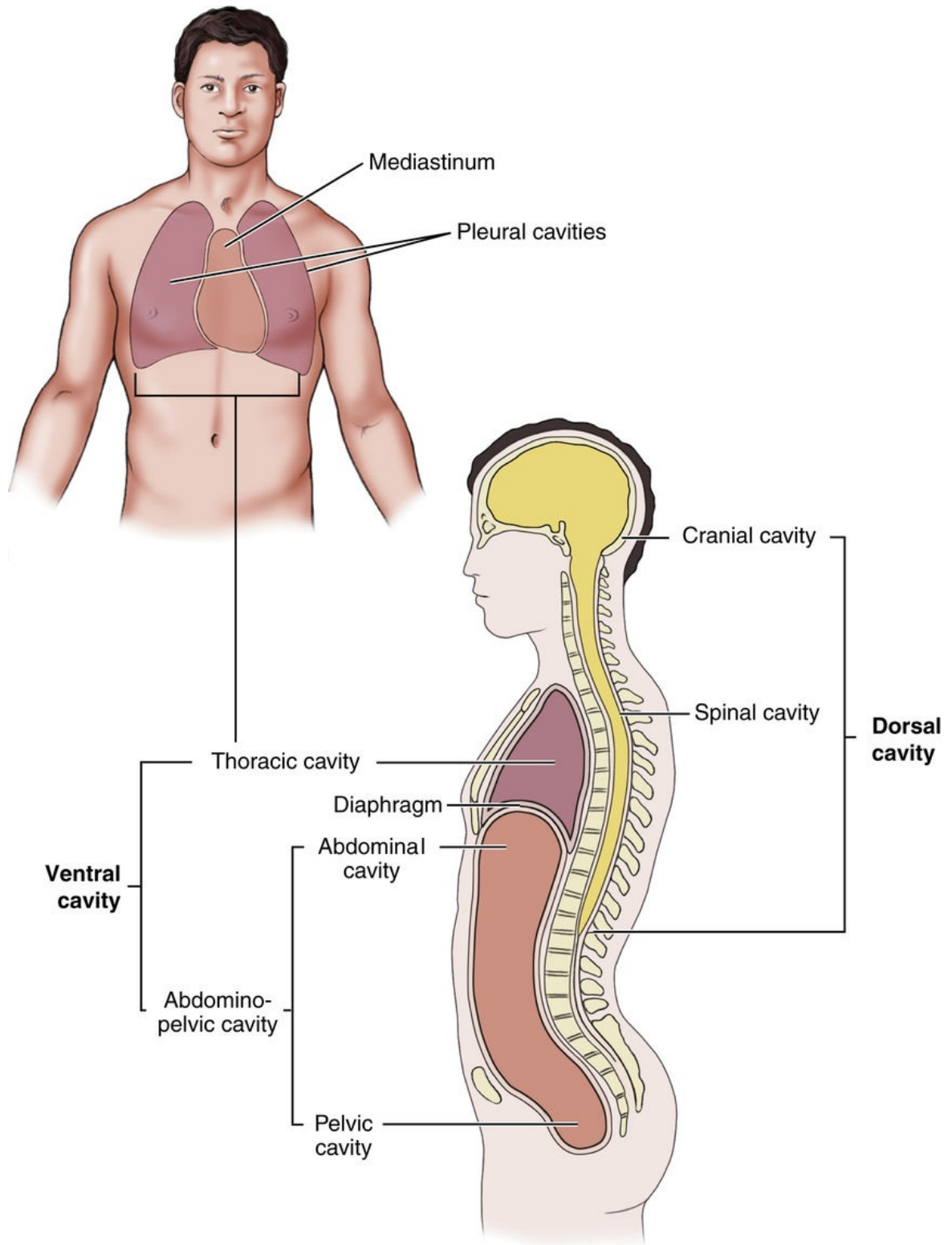


FIG. 1.7 Major body cavities.