CHAPTER

1



Masterfile

Jaime's Story

Jaime is nervous as he walks up to the front desk of the radiology department. He clears his throat and says, "Hi. My name's Jaime. I'm the new transporter."

"Hi. I'm Ellen. Nice to meet you – just a minute," replies Ellen without looking up from what she is doing. She finishes typing something on the computer and dials the phone. "Jan, we've got a 9 o'clock C-spine and a 10 o'clock cranial series coming your way. Thanks." After she hangs up the phone Ellen turns back toward Jaime. "Sorry about that. We have a couple of CT scans coming in and I didn't want to forget."

"Not a problem. C-spine. . . . That's the cervical spine, right? I just started an A&P class and we were just learning about that." Ellen nods as she stands up and hands him some folders. She waves for him to follow her as she heads down the hall.

"That's right. You're going to get a lot of chances to put your learning into practice here. You won't just be transporting patients. You'll get a chance to help the x-ray techs, develop x-ray films, and do scheduling, too. You can follow me around until you're comfortable with everything. Right now, we're going to take an x-ray of a little girl's broken arm. Here's the chart. Write down the name, time, and procedure here. All of this is inputted into the computer, but we always keep a backup on paper. Let's go."

After taking the x-rays, Jaime helps Ellen at the desk, scheduling a lower-right ultrasound for a gentleman with back pain. "I didn't know ultrasound was used for anything other than pregnancy." Ellen laughs and explains that ultrasonography can be used for most hollow spaces in the body. She explains that the doctor wants an ultrasound image of the patient's kidneys to determine if a CT scan is necessary.

A basic understanding of the human body is necessary not only for the health-care provider, as we will find following Jaime's story, but also for anyone concerned about their own health and well-being.

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An Introduction to the Human Body

INTRODUCTION

In recent years the explosion of information in science and medicine has led to dramatic advances in the improvement of human health. To understand how your body maintains a healthy balance in all of its systems, you must learn about its structures and how they function. Our exploration of the human body begins with an introduction to the meanings of anatomy (structure) and physiology (function). We will then consider how living things are organized and explore the properties that we share with animals, plants, and even bacteria. The study of human anatomy and physiology will provide you with basic information about the human body and a common vocabulary that will help you speak about the body in a way that is understood by scientists and health-care professionals alike.

The sciences of anatomy and physiology are the foundations for understanding the structure and function of the human body. **Anatomy** (a-NAT-ō-mē; *ana-* = up; *-tomy* = process of cutting) is the science of body structures and the relationships among structures. **Physiology** (fiz′-ē-OL-ō-jē; *physio-* = nature; *-logy* = study of) is the science of body functions—how the body parts work. Because function can never be separated completely from structure, we can understand the human body best by studying anatomy and physiology together. In this book we will look at how each part of the body is designed to carry out particular functions and how the structure of a part often reflects its functions. For example, the bones of the skull join tightly to form a rigid case that protects the brain. The bones of the fingers, by contrast, are more loosely joined to allow a variety of movements.

CONCEPTS

1.1 The human body is composed of six levels of structural organization and contains eleven systems.

1.2 The human body carries on basic life processes that distinguish it from nonliving objects.

1.3 Homeostasis is controlled through feedback systems.

1.4 The human body is described using the anatomical position and specific terms.

1.5 Body cavities are spaces within the body that help protect, separate, and support internal organs.

1.6 Serous membranes line the walls of body cavities and cover the organs within them.

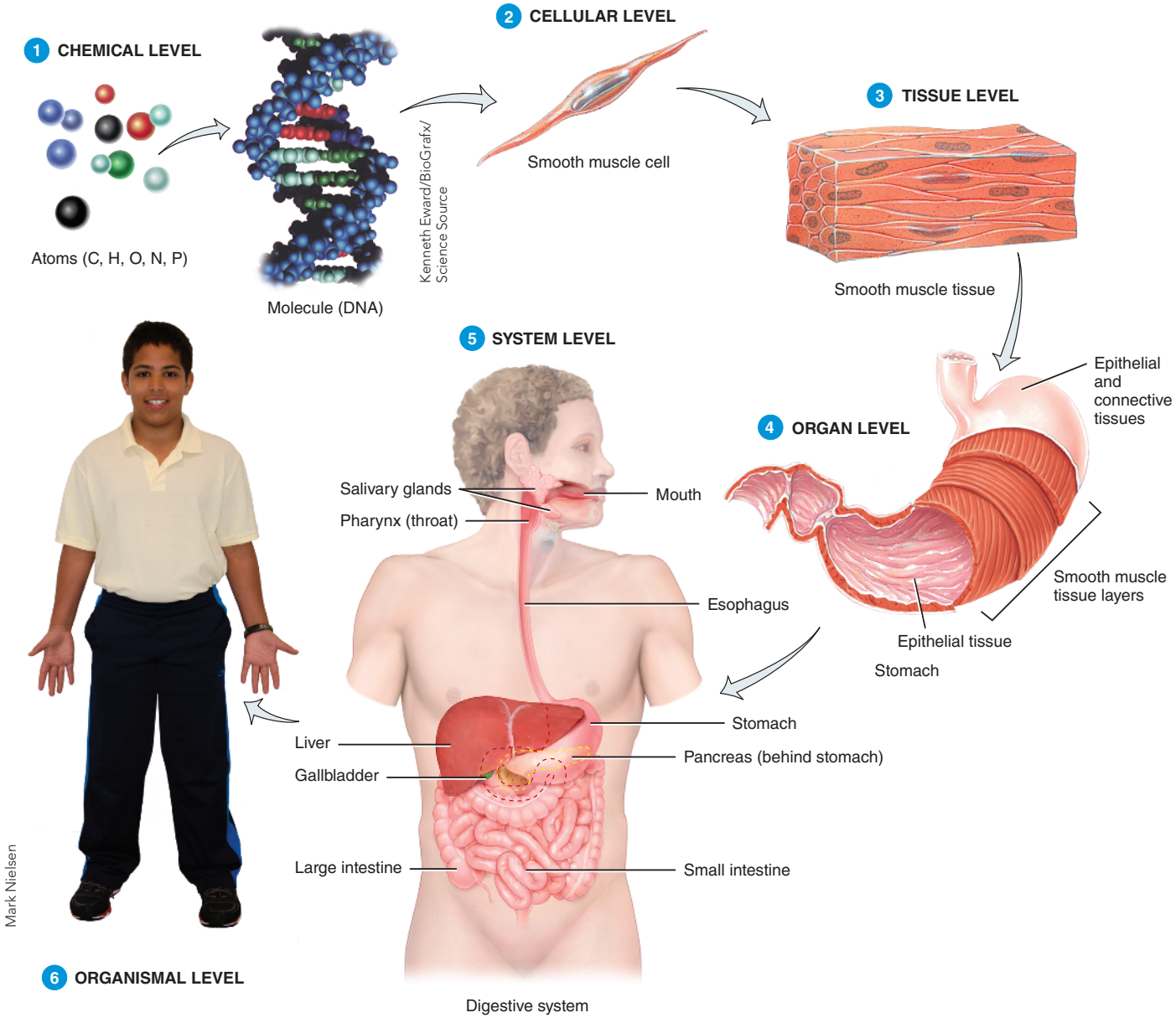
1.7 The abdominopelvic cavity is divided into regions or quadrants.

1.1 The human body is composed of six levels of structural organization and contains eleven systems.

The structures of the human body are organized on several levels. Our exploration of the human body will extend from some of the smallest body structures and their functions to the largest structure—an entire person. From the smallest to the largest, six levels of organization will help you to understand anatomy and physiology: the chemical, cellular, tissue, organ, system, and organismal levels (Figure 1.1).

1 ***Chemical level***. This very basic level includes **atoms**, the smallest components of a chemical element that retain the properties of the element, and **molecules**, two or more atoms joined together. Certain atoms, such as carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), calcium (Ca), and sulfur (S), are essential for life. Two familiar examples of molecules found in the body are

FIGURE 1.1 Levels of structural organization in the human body.



The levels of structural organization are chemical, cellular, tissue, organ, system, and organismal.

deoxyribonucleic acid (DNA), the genetic material passed from one generation to the next, and glucose, a sugar readily used by the body. Chapter 2 focuses on the chemical level of organization.

2. ***Cellular level***. Molecules combine to form **cells**, the basic structural and functional units of an organism that are composed of chemicals. Cells are the smallest living units in the human body. Among the many types of cells in your body are muscle cells, nerve cells, and blood cells. The cellular level of organization is the focus of Chapter 3.

3. ***Tissue level***. **Tissues** are groups of cells and the materials surrounding them that work together to perform a particular function. There are just four basic types of tissue in your body: *epithelial tissue, connective tissue, muscle tissue,* and *nervous tissue*. Note in Figure 1.1 that smooth muscle tissue consists of tightly packed smooth muscle cells. Chapter 4 describes the tissue level of organization in greater detail.

4. ***Organ level***. At the organ level different types of tissues join together to form body structures. **Organs** usually have a recognizable shape, are composed of two or more different types of tissues, and have specific functions. Examples of organs include the skin, bones, stomach, heart, liver, lungs, and brain. Figure 1.1 shows how several tissues make up the stomach. The stomach's outer covering is a layer of epithelial tissue and connective tissue that reduces friction when the stomach moves and rubs against other organs. Underneath are three muscle tissue layers, which contract to churn and mix food and push it into the next digestive organ, the small intestine. The innermost lining of the stomach is an epithelial tissue layer that produces fluid and chemicals responsible for digestion in the stomach.

5. ***System level***. A **system** consists of related organs that have a common function. One example of the system level, also called the organ system level, is the digestive system, which breaks down and absorbs food. Its organs include the mouth, salivary glands, pharynx (throat), esophagus, stomach, small intestine, large intestine, liver, gallbladder, and pancreas. Sometimes an organ is part of more than one system. For example, the pancreas is part of both the digestive system and the hormone-producing endocrine system.

6. ***Organismal level***. An **organism** (OR-ga-nizm) is any living individual. All parts of the human body functioning together constitute the total organism—a single living person.

In the chapters that follow, you will study the anatomy and physiology of the major body systems. Table 1.1 introduces the components and functions of these systems in the order they are discussed in this book. As you study the body systems, you will discover how they work together to maintain health, protect you from disease, and allow for reproduction of the human species. You will also discover that all body systems influence one another.

As an example, consider how just two body systems—the integumentary system and skeletal system—cooperate to function at the organismal level. The integumentary system, which includes the skin, hair, and nails, protects all other systems, including the skeletal system, which includes all of the bones and joints of the body. The skin serves as a barrier between the outside environment and internal tissues and organs, such as those that make up the skeletal system. The skin also participates in the production of vitamin D, which the body needs to absorb the calcium in foods such as milk. Calcium is used to build bones and teeth. The skeletal system, in turn, provides support for the integumentary system, serves as a reservoir for calcium by storing it in times of plenty and releasing it in times of need, and houses the cells that produce white blood cells, which help the skin resist invasion by disease-causing microbes such as bacteria and viruses.



CLINICAL CONNECTION | *Noninvasive Diagnostic Techniques*

Health-care professionals and students of anatomy and physiology commonly use several noninvasive diagnostic techniques to assess certain aspects of body structure and function. A **noninvasive diagnostic technique** is one that does not involve insertion of an instrument or device through the skin or a body opening. In **inspection**, the examiner observes the body for any changes that deviate from normal. For example, a physician may examine the mouth cavity for evidence of disease. Following inspection, one or more additional techniques may be employed. In **palpation** (pal-PĀ-shun; *palp-* = gently touching) the examiner feels body surfaces with the hands. An example is palpating the abdomen to detect enlarged or tender internal organs or abnormal masses. In **auscultation** (aws-kul-TĀ-shun; *auscult-* = listening) the examiner listens to body sounds to evaluate the functioning of certain organs, often using a stethoscope to amplify the sounds. An example is auscultation of the lungs during breathing to check for crackling sounds associated with abnormal fluid accumulation. In **percussion** (pur-KUSH-un; *percus-* = beat through) the examiner taps on the body surface with the fingertips and listens to the resulting echo. For example, percussion may reveal the abnormal presence of fluid in the lungs or air in the intestines. It may also provide information about the size, consistency, and position of an underlying structure. An understanding of anatomy is important for the effective application of most of these diagnostic techniques.

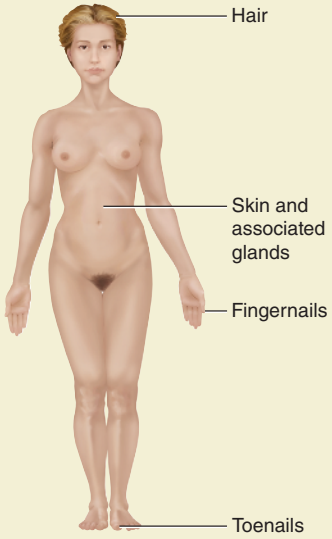
TABLE 1.1

The Eleven Systems of the Human Body

INTEGUMENTARY SYSTEM (CHAPTER 5)

Components: **Skin** and associated structures, such as **hair**, **fingernails** and **toenails**, **sweat glands**, and **oil glands**.

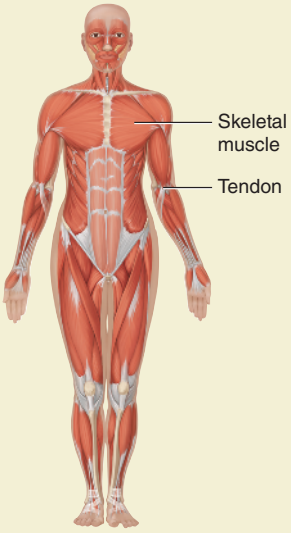
Functions: Protects body; helps regulate body temperature; eliminates some wastes; helps make vitamin D; detects sensations such as touch, pain, warmth, and cold.



MUSCULAR SYSTEM (CHAPTERS 10, 11)

Components: **Skeletal muscles**—voluntarily controlled muscles usually attached to bones (smooth and cardiac muscles are components of other body systems).

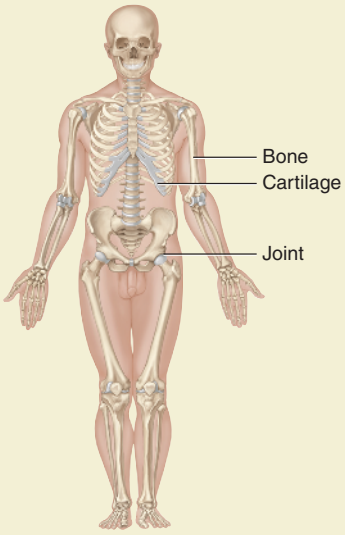
Functions: Participates in body movements, such as walking; maintains posture; produces heat.



SKELETAL SYSTEM (CHAPTERS 6–9)

Components: **Bones** and **joints** of the body and their associated **cartilages**.

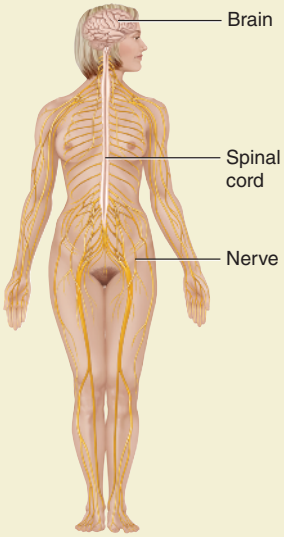
Functions: Supports and protects body; provides surface area for muscle attachments; aids body movements; houses cells that produce blood cells; stores minerals and lipids (fats).



NERVOUS SYSTEM (CHAPTERS 12–16)

Components: **Brain**, **spinal cord**, **nerves**, and special sense organs, such as **eyes** and **ears**.

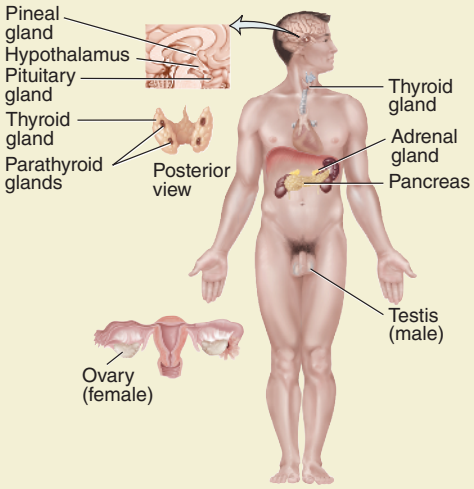
Functions: Generates action potentials (nerve impulses) to regulate body activities; detects changes in body's internal and external environments, interprets changes, and responds by causing muscular contractions or glandular secretions.



ENDOCRINE SYSTEM (CHAPTER 17)

Components: Hormone-producing glands (**pineal gland**, **hypothalamus**, **pituitary gland**, **thymus**, **thyroid gland**, **parathyroid glands**, **adrenal glands**, **pancreas**, **ovaries**, and **testes**) and hormone-producing cells in several other organs.

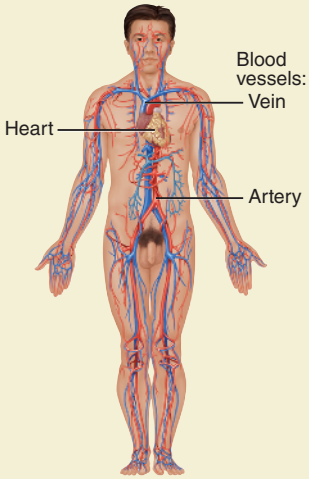
Functions: Regulates body activities by releasing hormones (chemical messengers transported in blood from endocrine gland or tissue to target organ).



CARDIOVASCULAR SYSTEM (CHAPTERS 18–20)

Components: **Blood**, **heart**, and **blood vessels**.

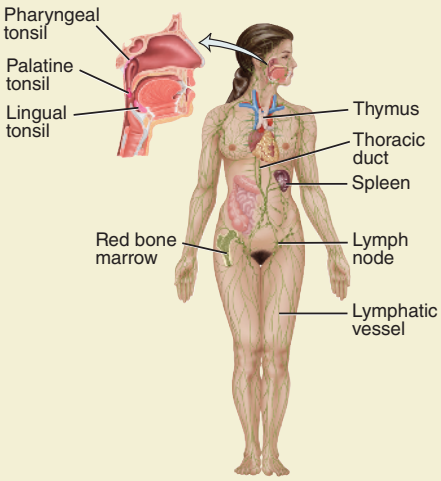
Functions: Heart pumps blood through blood vessels; blood carries oxygen and nutrients to cells and carbon dioxide and wastes away from cells and helps regulate acid–base balance, temperature, and water content of body fluids; blood components help defend against disease and repair damaged blood vessels.



LYMPHATIC SYSTEM AND IMMUNITY (CHAPTER 21)

Components: **Lymphatic fluid** and **lymphatic vessels**; **spleen**, **thymus**, **lymph nodes**, and **tonsils**; cells that carry out immune responses (**B cells**, **T cells**, and others).

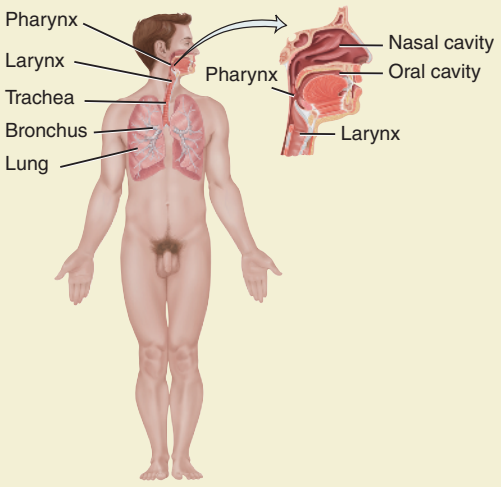
Functions: Returns proteins and fluid to blood; carries lipids from gastrointestinal tract to blood; contains sites of maturation and proliferation of B cells and T cells that protect against disease-causing microbes.



RESPIRATORY SYSTEM (CHAPTER 22)

Components: **Lungs** and air passageways such as the **pharynx** (throat), **larynx** (voice box), **trachea** (windpipe), and **bronchial tubes** leading into and out of lungs.

Functions: Transfers oxygen from inhaled air to blood and carbon dioxide from blood to exhaled air; helps regulate acid–base balance of body fluids; air flowing out of lungs through vocal cords produces sounds.



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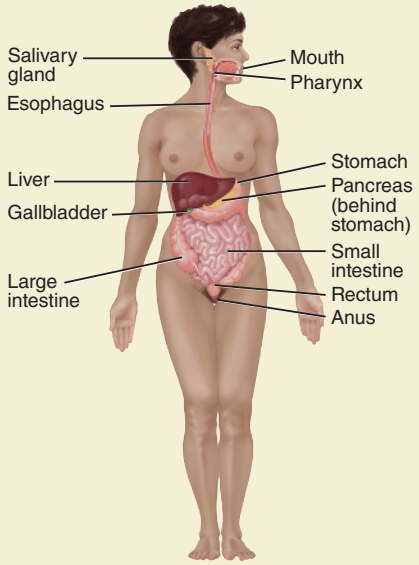
TABLE 1.1 CONTINUED

The Eleven Systems of the Human Body

DIGESTIVE SYSTEM (CHAPTER 23)

Components: Organs of gastrointestinal tract, a long tube that includes the **mouth**, **pharynx** (throat), **esophagus** (food tube), **stomach**, **small** and **large intestines**, and **anus**; also includes accessory organs that assist in digestive processes, such as **salivary glands**, **liver**, **gallbladder**, and **pancreas**.

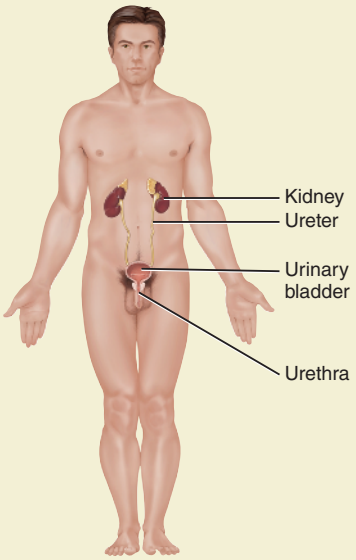
Functions: Achieves physical and chemical breakdown of food; absorbs nutrients; eliminates solid wastes.



URINARY SYSTEM (CHAPTER 24)

Components: **Kidneys**, **ureters**, **urinary bladder**, and **urethra**.

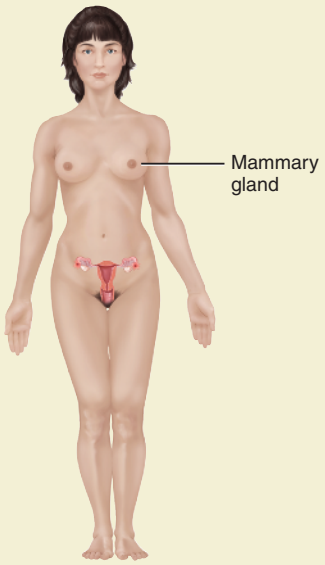
Functions: Produces, stores, and eliminates urine; eliminates wastes and regulates volume and chemical composition of blood; helps maintain the acid–base balance of body fluids; maintains body's mineral balance; helps regulate production of red blood cells.

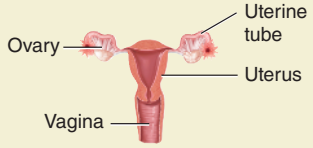


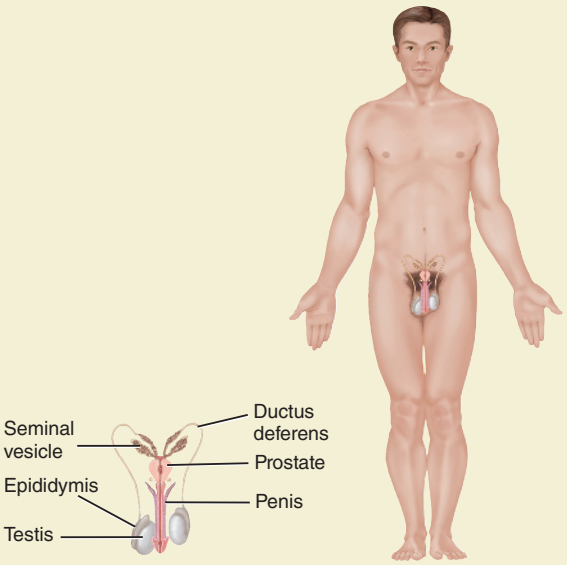
REPRODUCTIVE SYSTEMS (CHAPTER 25)

Components: **Gonads** (**testes** in males and **ovaries** in females) and associated organs (**uterine tubes**, **uterus**, **vagina**, and **mammary glands** in females and **epididymides**, **ductus deferens**, **seminal vesicles**, **prostate**, and **penis** in males).

Functions: Gonads produce gametes (sperm or oocytes) that unite to form a new organism; gonads also release hormones that regulate reproduction and other body processes; associated organs transport and store gametes; mammary glands produce milk.









✓ CHECKPOINT

1. Two or more atoms join together to form what? To which level of organization does this belong?
2. Which levels of structural organization are you unable to see with your naked eye?
3. Which level of organization is composed of two or more different types of tissues that work together to perform a specific function?
4. How are organs and tissues different?

1.2 The human body carries on basic life processes that distinguish it from nonliving objects.

Basic Life Processes

All living organisms have certain characteristics that distinguish them from nonliving things. The following are the six most important life processes of the human body:

Metabolism (me-TAB-ō-lizm) is the sum of all chemical processes that occur in the body. One phase of metabolism is **catabolism** (ka-TAB-ō-lizm; *catabol-* = throwing down; *-ism* = a condition), the breaking down of complex chemical substances into simpler ones. The other phase of metabolism is **anabolism** (a-NAB-ō-lizm; *anabol-* = a raising up), the building up of complex chemical substances from smaller, simpler ones. For example, catabolism splits proteins in food into amino acids, which can be used during anabolism as the building blocks for new proteins that make up muscles and bones. In metabolic processes, oxygen taken in by the respiratory system and nutrients broken down in the digestive system provide the chemical energy to power cellular activities.

Responsiveness is the body's ability to detect and respond to changes in its internal or external environment. An increase in body temperature during a fever would be an example of a change in the internal environment (inside your body). Turning your head toward the sound of squealing brakes is an example of responsiveness to a change in the external environment (outside your body) to prepare for a potential threat. Different cells in the body respond to environmental changes in characteristic ways. Nerve cells respond by generating electrical signals known as nerve impulses. Muscle cells respond to nerve impulses by contracting, which generates force to move body parts.

Movement includes motion of the whole body, individual organs, single cells, and even tiny organelles inside cells. For example, the coordinated action of several muscles enables you to move your body from one place to another by walking or running. After you eat a meal that contains fats, your gallbladder contracts and releases bile into the gastrointestinal tract to help in the digestion of fats. When a body tissue is damaged or infected, certain white blood cells move from the bloodstream into the affected tissue to help clean up and repair the area. Even inside individual cells, various cellular parts move from one position to another to carry out their functions.

Growth is an increase in body size. It may be due to an increase in (1) the size of existing cells, (2) the number of cells, or (3) the amount of material surrounding cells. In a growing bone, for example, mineral deposits accumulate between bone cells, causing the bone to grow in length and width.

Differentiation (dif′-er-en-shē-Ā-shun) is the process in which unspecialized cells become specialized cells. Such unspecialized cells, which can divide and give rise to cells that undergo differentiation, are known as **stem cells**. Each type of cell in the body has a specialized structure and function. Specialized cells differ in structure and function from the unspecialized cells that gave rise to them. For example, red blood cells and several types of white blood cells differentiate from the same unspecialized cells in red bone marrow. Similarly, a single fertilized human egg (ovum) undergoes tremendous differentiation to develop into an embryo, and then into a fetus, an infant, a child, and finally an adult.

Reproduction refers to either (1) the formation of new cells for tissue growth, repair, or replacement or (2) the production of a new individual. Cell formation occurs continuously throughout life; life continues from one generation to the next through the production of a new individual through the fertilization of an ovum by a sperm cell.

Although not all of these processes occur all of the time in every cell of the body, when they cease to occur properly, cell death may occur. When cell death is extensive and leads to organ failure, without intervention the result is death of the organism. Clinically, loss of the heartbeat, absence of spontaneous breathing, and loss of brain functions indicate death in the human body.

Homeostasis

The French physiologist Claude Bernard (1813–1878) first proposed that the cells of many-celled organisms flourish because they live in the relative constancy of *le milieu interieur*—the environment of the interior of the body—despite continual changes in the organisms' external environment. The American physiologist Walter B. Cannon (1871–1945) coined the term *homeostasis* to describe this dynamic constancy. **Homeostasis** (hō′-mē-ō-STĀ-sis; *homeo-* = sameness; *-stasis* = standing still) is the maintenance of relatively stable conditions in the body's internal environment. Through the constant interaction of the body's many regulatory processes, homeostasis ensures that the body's internal environment remains stable despite changes inside and outside the body. Each body structure, from the chemical level to the system level, contributes in some way to keeping the internal environment of the body within normal limits.

Homeostasis is a dynamic process. As conditions change, the body makes adjustments within a narrow range that is compatible with maintaining life. For example, the pancreas normally helps maintain the level of glucose in blood between 70 and 110 milligrams of glucose per 100 milliliters of blood. When blood glucose levels begin to fall, the pancreas secretes the hormone glucagon, which stimulates cells to release glucose into the blood. As blood glucose level starts to rise, the pancreas releases another hormone, insulin, which stimulates cells to remove glucose from the blood.

Body Fluids

An important aspect of homeostasis is maintaining the volume and composition of **body fluids**, dilute, watery solutions containing dissolved chemicals that are found inside cells and surrounding them. The fluid within cells is **intracellular fluid** (*intra-* = inside). The fluid outside body cells is **extracellular fluid** (*extra-* = outside). Dissolved in the water of intracellular and extracellular fluids are oxygen, nutrients, proteins, and a variety of *ions* (electrically charged chemical particles). All of these substances are needed to maintain life. The extracellular fluid that fills the narrow spaces between cells of tissues is known as **interstitial fluid** (in′-ter-STISH-al; *inter-* = between). As you progress with your studies, you will learn that the extracellular fluid within blood vessels is termed **blood plasma**, that within lymphatic vessels is called **lymph**, that in and around the brain and spinal cord is called **cerebrospinal fluid**, and that in joints is called **synovial fluid**.

As Bernard predicted, the proper functioning of body cells depends on precise regulation of the composition of the interstitial fluid surrounding them. Because interstitial fluid surrounds all body cells, it is often called the body's *internal environment*. The composition of interstitial fluid changes as substances move back and forth between it and blood plasma. Such exchange of materials occurs across the thin walls of the smallest blood vessels in the body, the *blood capillaries*. This movement in both directions across capillary walls provides needed materials, such as glucose, oxygen, ions, and so on, to tissue cells. It also removes wastes, such as carbon dioxide, from interstitial fluid.

✓ CHECKPOINT

5. What are some examples of movements that occur inside the human body?
6. Shivering when a cold wind blows over you is an example of what basic life process?
7. Where would you find intracellular fluid, extracellular fluid, and interstitial fluid?
8. A spinal tap is a procedure in which fluid is drawn from the space between the membranes that surround the spinal cord. What type of body fluid is being extracted?

RETURN TO Jaime's Story



Jaime can't believe how quickly the day has flown by. He thinks about his first day at work as he hurries to his evening anatomy and physiology class. Jaime had helped with several x-rays of different parts of the body, including the chest of a suspected tuberculosis case, a sprained ankle of an elderly woman, and the abdomen of a child who had swallowed a coin. Ellen had shown him how to process the x-ray film, and he had tagged along as she transported patients. She had explained most of the terms that she was using and quizzed him to see which he knew and which he didn't.

Jaime finds Amy and Lindsey waiting for him outside the lecture hall. "So, save any lives today?" Amy asks as they settle into their seats in the classroom.

"No, not exactly. But, it's amazing. I think I'm really going to like working there. The x-ray techs are all nice, and Dr. Sebbo, the radiologist, bought everyone lunch today. He was happy to answer a bunch of questions for me while he took some x-rays and pointed out a lot of amazing stuff. He even showed me some films from last week, including a gallbladder packed with stones and an inflamed kidney full of urine."

Lindsey makes a face and says, "Ugh, nasty. Did they figure out what was wrong with the patient?"

"He had an enlarged prostate gland that was blocking release of the urine in his urinary bladder. It was backing up into the kidney and causing a lot of inflammation and swelling. Dr. Sebbo showed me the healthy kidney versus the inflamed one and explained how the increased pressure and concentration of the urine could damage the kidney if they didn't do something about it. They used a catheter to relieve pressure from the urinary bladder. It was incredible. I can't wait to go back tomorrow."

A. *Jaime is helping move patients and develop x-rays. What levels of structural organization are involved in these activities?*
B. *The gallbladder and kidney described by Jaime are found in which organ system(s)?*
C. *Would the urine in the patient's inflamed kidney be considered an intracellular or extracellular fluid?*
D. *The prostate patient suffered from decreased fluid movement through the kidney. Which basic life processes would be affected by this condition?*

1.3 Homeostasis is controlled through feedback systems.

Homeostasis in the human body is continually being disturbed. Some disruptions come from the external environment in the form of physical insults such as the intense heat of a Texas summer or a lack of enough oxygen for that two-mile run. Other disruptions originate in the internal environment, such as a blood glucose level that falls too low when you skip breakfast. Homeostatic imbalances may also occur due to psychological stresses in your social environment—the demands of work and school, for example. In most cases the disruption of homeostasis is mild and temporary, and the body responds quickly to restore balance in the internal environment. In some cases the disruption of homeostasis may be intense and prolonged, as in poisoning, overexposure to temperature extremes, severe infection, or major surgery. Under these circumstances, regulation of homeostasis may fail.

Fortunately, the body has many regulating systems that can usually bring the internal environment back into balance. Most often, the nervous system and the endocrine system, working together or independently, provide the needed corrective measures. The nervous system regulates homeostasis by sending electrical signals known as *nerve impulses* to organs that can counteract changes from the balanced state. The endocrine system includes many glands that secrete messenger molecules called *hormones* into the blood. Nerve impulses typically cause rapid changes, but hormones usually work more slowly. However, both means of regulation work toward the maintenance of homeostasis using processes you will learn about next.

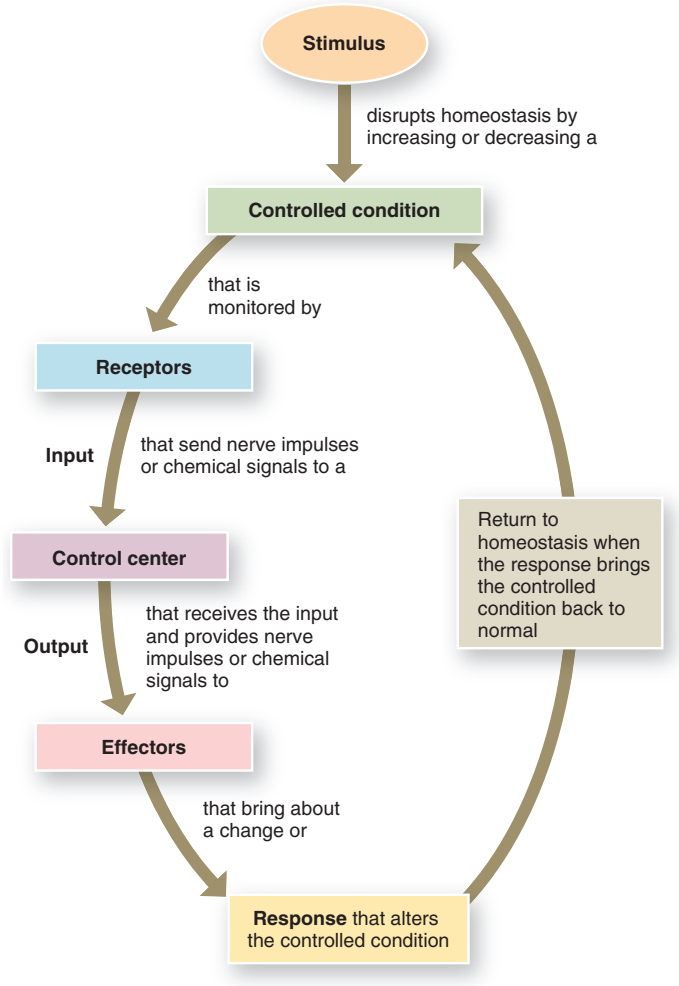
Feedback Systems

The body can regulate its internal environment through many feedback systems. A **feedback system** is a cycle of events in which the status of a body condition is monitored, evaluated, changed, remonitored, reevaluated, and so on. Each monitored variable, such as body temperature, blood pressure, or blood glucose level, is termed a *controlled condition*. Any disruption that changes a controlled condition is called a *stimulus*. Three basic components make up a feedback system—a receptor, a control center, and an effector (Figure 1.2):

1. A **receptor** is a body structure that monitors changes in a controlled condition and sends input to a control center. Typically, the input is in the form of nerve impulses or chemical signals. Nerve endings in the skin that sense temperature are one of hundreds of different kinds of receptors in the body.
2. A **control center** in the body sets the range of values within which a controlled condition should be maintained, evaluates the input it receives from receptors, and generates output commands when they are needed. Output typically occurs as nerve impulses or chemical signals. In our skin temperature example, the brain acts as the control center, receiving nerve impulses from the skin receptors and generating nerve impulses as output.
3. An **effector** is a body structure that receives output from the control center and produces a *response* or effect that changes the controlled condition. Nearly every organ or tissue in the body can behave as an effector. When your body temperature drops sharply, your brain (control center) sends nerve impulses to your skeletal muscles (effectors) that cause you to shiver, which generates heat and raises your body temperature.

A group of receptors and effectors communicating with their control center forms a feedback system that can regulate a controlled condition in the body's internal environment. In a feedback system, the response of the system "feeds back" information to change the controlled condition in some way, either inhibiting it (negative feedback) or enhancing it (positive feedback).

FIGURE 1.2 Operation of a feedback system.



The three basic components of a feedback system are the receptors, a control center, and effectors.

Negative Feedback Systems

A **negative feedback system** *reverses* a change in a controlled condition (negates the change). First, a stimulus disrupts homeostasis by altering the controlled condition. The receptors that are part of the feedback system detect the change and send input to a control center. The control center evaluates the input and, if necessary, issues output commands to an effector. The effector produces a physiological response that is able to return the controlled condition to its normal state.

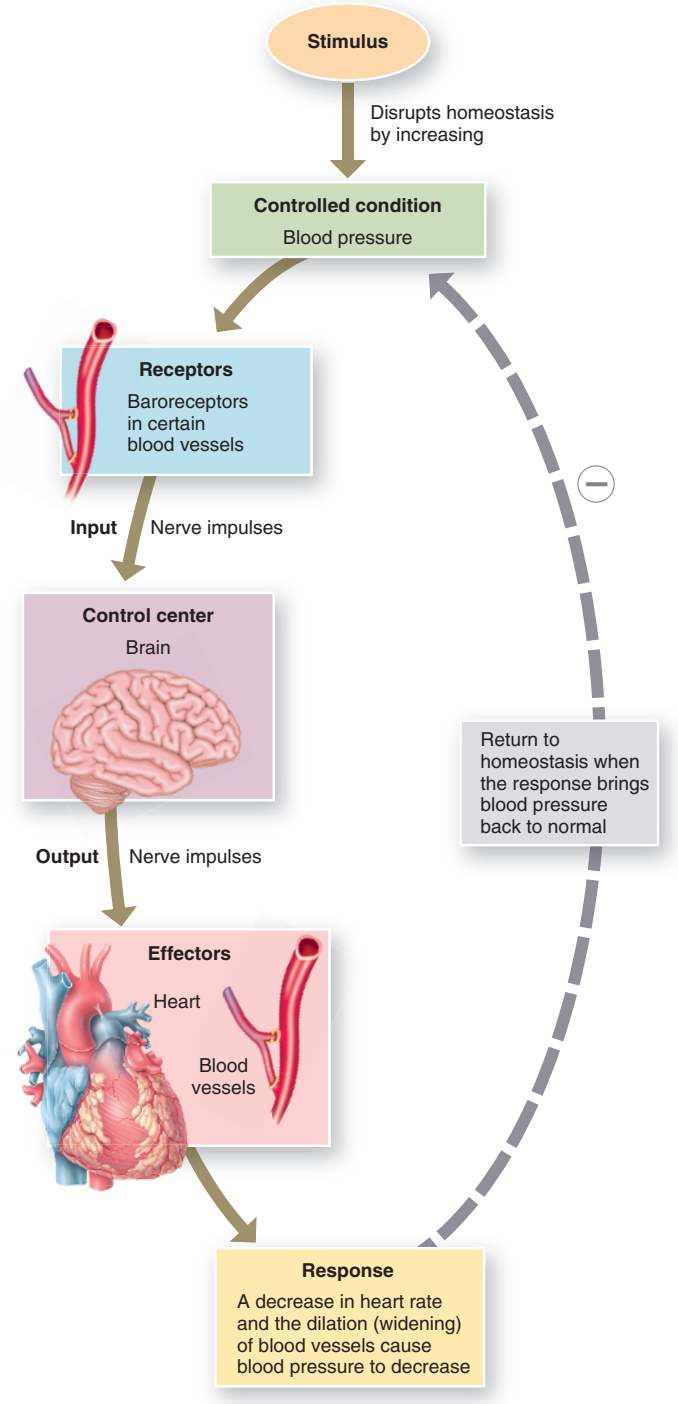
Consider one negative feedback system that helps regulate blood pressure. *Blood pressure* is the force exerted by *blood* as it presses against the walls of blood vessels. When the heart beats faster or harder, blood pressure increases. If a stimulus causes blood pressure (controlled condition) to rise, the following sequence of events occurs (Figure 1.3). *Baroreceptors* (the receptors), pressure-sensitive nerve cells located in the walls of certain blood vessels, detect the higher pressure. The baroreceptors send nerve impulses (input) to the brain (control center). The brain interprets the impulses and responds by sending nerve impulses (output) to the heart and blood vessels (the effectors). Heart rate decreases and blood vessels dilate (widen), both of which cause blood pressure to decrease (response). This sequence of events quickly returns the controlled condition—blood pressure—to normal, and homeostasis is restored. Notice that the activity of the effector produces a result (a drop in blood pressure) that is opposite to the original stimulus (an increase in blood pressure). This is why it is called a negative feedback system.

Positive Feedback Systems

Unlike a negative feedback system, a **positive feedback system** tends to *strengthen* or *reinforce* a change in one of the body's controlled conditions, making the magnitude of the change larger or, in mathematical terms, more positive. In a positive feedback system, the control center still provides commands to an effector, but the effector produces a response that adds to or *reinforces* the initial change in the controlled condition. The action of a positive feedback system continues until it is interrupted by some mechanism that restores homeostasis.

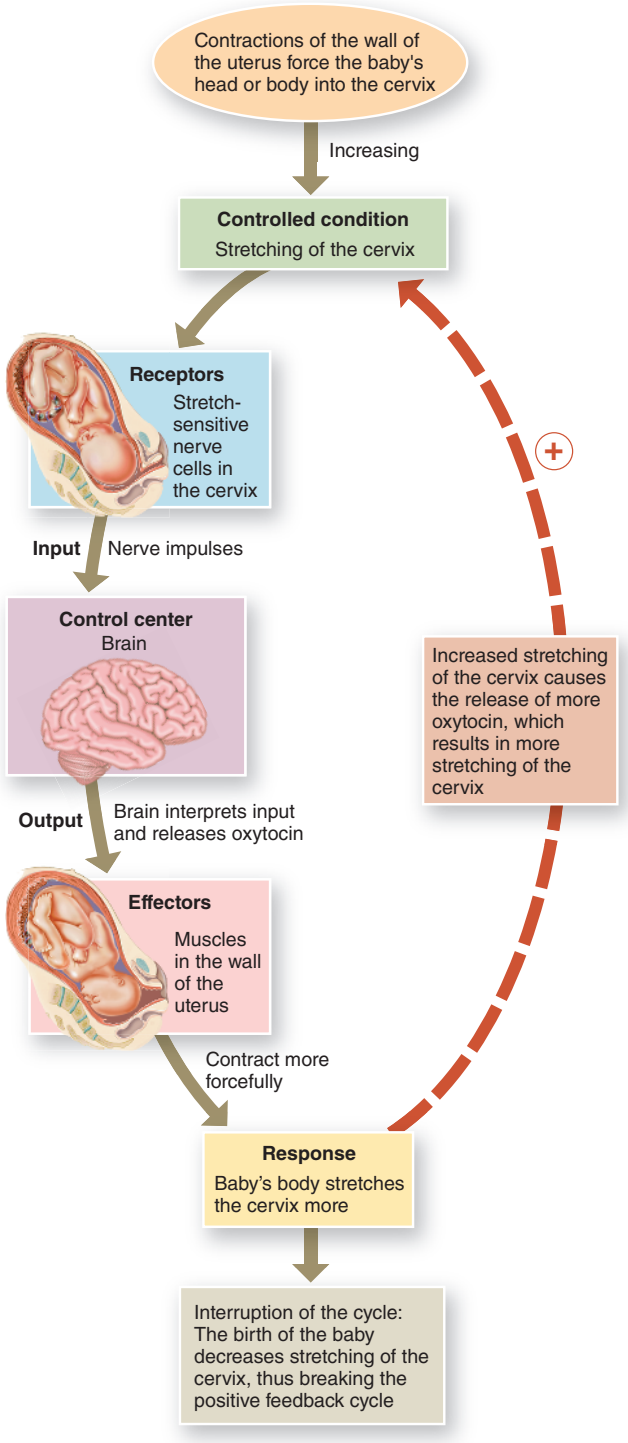
Normal childbirth provides a good example of a positive feedback system (Figure 1.4). The first contractions of labor (stimulus) push part of the fetus into the cervix, the lowest part of the uterus, which opens into the vagina. Stretch-sensitive nerve cells (receptors) monitor the amount of stretching of the cervix (controlled condition). As stretching increases, they send more nerve impulses (input) to the brain (control center), which in turn releases the hormone oxytocin (output) into the blood. Oxytocin causes muscles in the wall of the uterus (effector) to contract even more forcefully. The contractions push the fetus farther down the uterus, which stretches the cervix even more. The cycle of stretching, hormone release, and ever-stronger contractions is interrupted only by the birth of the baby. Then stretching of the cervix ceases and oxytocin is no longer released.

FIGURE 1.3 Homeostatic regulation of blood pressure by a negative feedback system. Note that the response is fed back into the system, and the system continues to lower blood pressure until there is a return to normal blood pressure (homeostasis). The broken return arrow with a negative sign surrounded by a circle symbolizes negative feedback.



If the response reverses the stimulus, a system is operating by negative feedback.

FIGURE 1.4 Positive feedback control of labor contractions during birth of a baby. The broken return arrow with a positive sign surrounded by a circle symbolizes positive feedback.



If the response enhances or intensifies the stimulus, a system is operating by positive feedback.

Because a positive feedback system continually reinforces a change in a controlled condition, some event outside the system must shut it off. If the action of a positive feedback system is not stopped, it can "run away," and may even produce life-threatening conditions in the body. The action of a negative feedback system, by contrast, slows and then stops as the controlled condition returns to its normal state. Usually, positive feedback systems reinforce conditions that do not happen very often, and negative feedback systems regulate conditions in the body that remain fairly stable over long periods.

Homeostatic Imbalances

As long as all of the body's controlled conditions remain within certain narrow limits, body cells function efficiently, negative feedback systems maintain homeostasis, and the body stays healthy. Should one or more components of the body lose their ability to contribute to homeostasis, however, the normal balance among all of the body's processes may be disturbed. If the homeostatic imbalance is moderate, a disorder or disease may occur; if it is severe, death may result.

A **disorder** is any abnormality of structure or function. **Disease** is a more specific term for an illness characterized by a recognizable set of signs and symptoms. A *local disease* affects one part or a limited region of the body (for example, a sinus infection); a *systemic disease* affects either the entire body or several of its systems (for example, influenza). Diseases alter body structures and functions in characteristic ways, usually producing a recognizable cluster of signs and symptoms. **Signs** are objective changes that a clinician can observe and measure. Signs of disease can be either anatomical, such as swelling or a rash, or physiological, such as fever, high blood pressure, or paralysis. **Symptoms** are subjective changes in body functions that are not apparent to an observer, such as headache, nausea, and anxiety.

✓ CHECKPOINT

9. Which two body systems are largely responsible for maintaining homeostasis?

10. What is the name for the body structure that responds to the control center signal in a feedback system?

11. The response to a stimulus in either a negative or positive feedback system is initiated by what body systems?

12. How are negative and positive feedback systems similar? How are they different? Which one bears primary responsibility for maintaining homeostasis?

13. Why do positive feedback systems that are part of a normal physiological response include a mechanism to stop them?

CLINICAL CONNECTION | *Diagnosis of Disease*

Diagnosis (dī′-ag-NŌ-sis; *dia-* = *through;* -gnosis = knowledge) is the science and skill of distinguishing one disorder or disease from another. The patient's symptoms and signs, his or her medical history, a physical exam, and laboratory tests provide the basis for making a diagnosis. Taking a *medical history* consists of collecting information about events that might be related to a patient's illness. These include the chief complaint (primary reason for seeking medical attention), history of present illness, past medical problems, family medical problems, social history, and review of symptoms. A *physical examination* is an orderly evaluation of the body and its functions. This process includes the noninvasive techniques of inspection, palpation, auscultation, and percussion that you learned about earlier, along with measurement of vital signs (temperature, pulse, respiratory rate, and blood pressure), and sometimes laboratory tests.

1.4 The human body is described using the anatomical position and specific terms.

Scientists and health-care professionals use a common language of special terms when referring to body structures and their functions. The language of anatomy they use has precisely defined terms that allow us to communicate clearly. For example, is it correct to say, "The wrist is above the fingers"? This might be true if your upper limbs (described shortly) are at your sides. But if you hold your hands up above your head, your fingers would be above your wrists. To prevent this kind of confusion, anatomists use a standard anatomical position and a specific vocabulary for relating body parts to one another.

Body Positions

Descriptions of any part of the human body assume that the body is in a standard position of reference called the **anatomical position** (an′-a-TOM-i-kul). In the anatomical position, the subject stands erect facing the observer, with the head level and the eyes facing forward. The feet are flat on the floor and directed forward, and the upper limbs are at the sides with the palms turned forward (Figure 1.5). In the anatomical position, the body is upright. Two terms describe a reclining body: face down, it is in the **prone** position; face up, it is in the **supine** position.

Regional Names

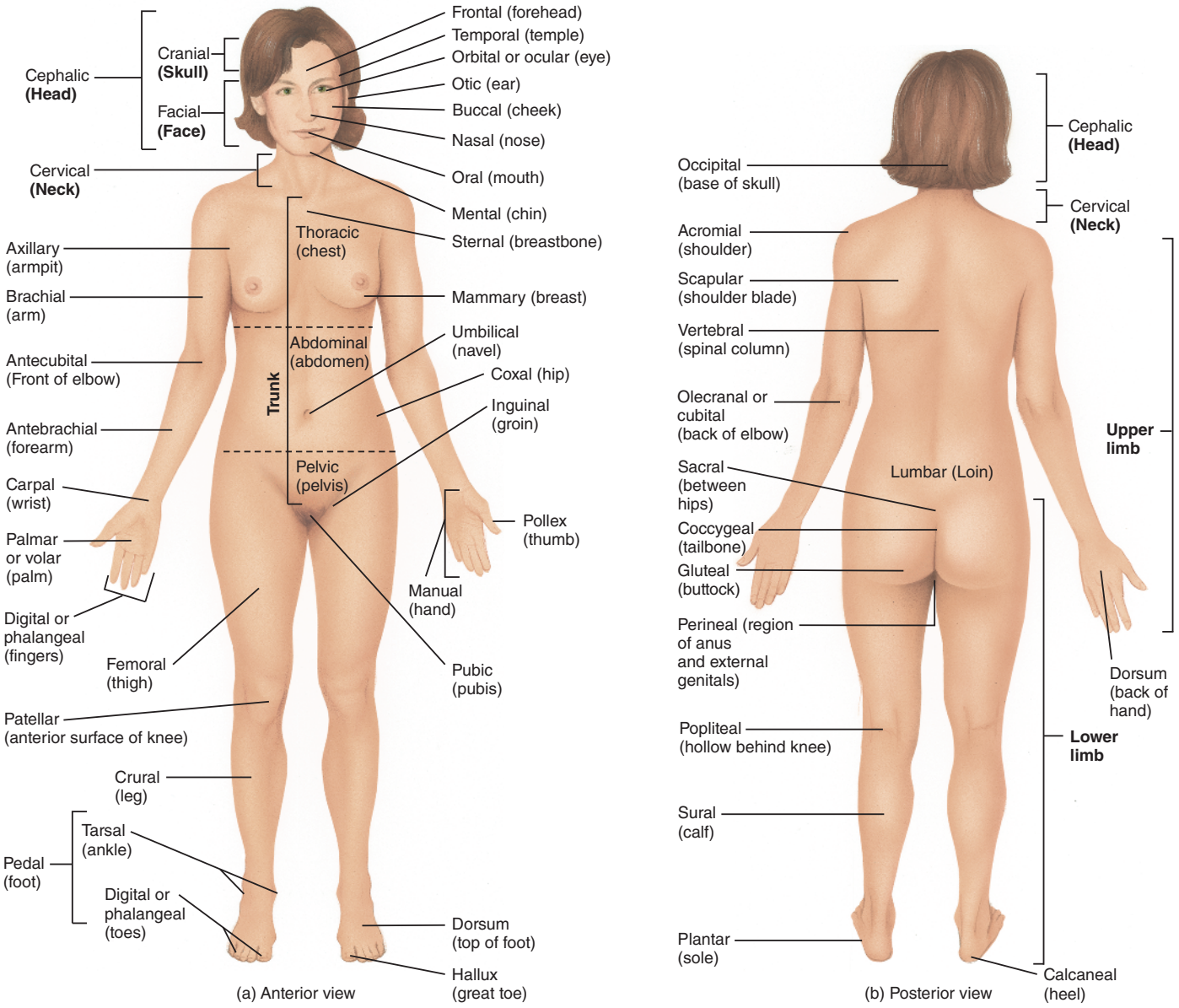
The human body is divided into several major regions that can be identified externally. These are the head, neck, trunk, upper limbs, and lower limbs (Figure 1.5). The **head** consists of the skull and face. The **skull** encloses and protects the brain, and the **face** is the front portion of the head that includes the eyes, nose, mouth, forehead, cheeks, and chin. The **neck** supports the head and attaches it to the trunk. The **trunk** consists of the chest, abdomen, and pelvis. Each **upper limb** is attached to the trunk and consists of the shoulder, armpit, arm (portion of the limb from the shoulder to the elbow), forearm (portion of the limb from the elbow to the wrist), wrist, and hand. Each **lower limb** is also attached to the trunk and consists of the buttock, thigh (portion of the limb from the buttock to the knee), leg (portion of the limb from the knee to the ankle), ankle, and foot. The *groin* is the area on the front surface of the body marked by a crease on each side, where the trunk attaches to the thighs.

Figure 1.5 shows the anatomical and common names of major parts of the body. The anatomical term for each part appears first and is followed in parentheses by the corresponding common name. For example, if you receive a tetanus shot in your *gluteal region*, it is an injection in your *buttock*. Because the anatomical term for a body part usually is based on a Greek or Latin word, it may look different from the common name for the same part or area. For example, the Latin word *axilla* (ak-SIL-a) is the anatomical name for armpit. Thus, the axillary nerve is one of the nerves passing within the armpit. You will learn more about the Greek and Latin word roots of anatomical and physiological terms as you read this book.

Directional Terms

To locate various body structures, anatomists use specific **directional terms**, words that describe the position of one body part relative to another. Several directional terms are grouped in pairs that have opposite meanings, such as anterior (front) and posterior (back). It is important to understand that directional terms have relative meanings; they only make sense when used to describe the position of one structure in relation to another. For example, your knee is superior to your ankle, even though both are located in the inferior half of the body.

FIGURE 1.5 The anatomical position. The anatomical names and corresponding common terms (in parentheses) are indicated for specific body regions. For example, the cephalic region is the head.



In the anatomical position, the subject stands erect facing the observer with the head level and the eyes facing forward. The feet are flat on the floor and directed forward, and the upper limbs are at the sides with the palms facing forward.

TABLE 1.2

Directional Terms

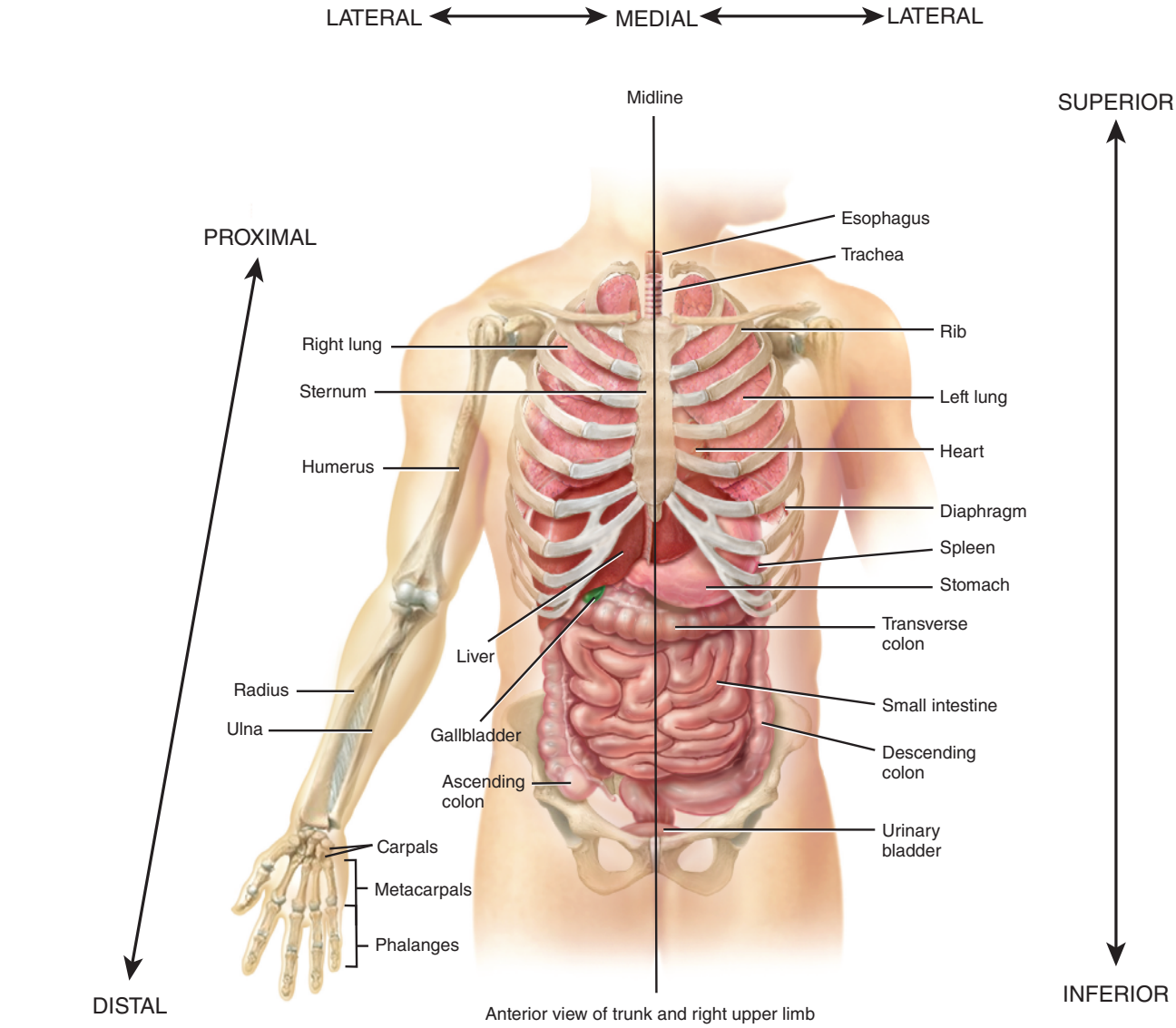
DIRECTIONAL TERM	DEFINITION	EXAMPLE OF USE
Superior (soo′-PĒR-ē-or) **(cephalic or cranial)**	Toward the head, or the upper part of a structure	The heart is superior to the liver.
Inferior (in′-FĒR-ē-or) **(caudal)**	Away from the head, or the lower part of a structure	The stomach is inferior to the lungs.
Anterior (an′-TĒR-ē-or) **(ventral)***	Nearer to or at the front of the body	The sternum (breastbone) is anterior to the heart.
Posterior (pos′-TĒR-ē-or) **(dorsal)**	Nearer to or at the back of the body	The esophagus is posterior to the trachea (windpipe).
Medial (MĒ-dē-al)	Nearer to the midline†	The ulna is medial to the radius.
Lateral (LAT-er-al)	Farther from the midline	The lungs are lateral to the heart.
Intermediate (in′-ter-MĒ-dē-at)	Between two structures	The transverse colon is intermediate to the ascending and descending colons.
Ipsilateral (ip-si-LAT-er-al)	On the same side of the body as another structure	The gallbladder and ascending colon are ipsilateral.
Contralateral (CON-tra-lat-er-al)	On the opposite side of the body from another structure	The ascending and descending colons are contralateral.
Proximal (PROK-si-mal)	Nearer to the attachment of a limb to the trunk; nearer to the origination of a structure	The humerus is proximal to the radius.
Distal (DIS-tal)	Farther from the attachment of a limb to the trunk; farther from the origination of a structure	The phalanges are distal to the carpals.
Superficial (soo′-per-FISH-al) **(external)**	Toward or on the surface of the body	The ribs are superficial to the lungs.
Deep (internal)	Away from the surface of the body	The ribs are deep to the skin of the chest and back.

*The terms *anterior* and *ventral* mean the same thing in humans. However, in four-legged animals *ventral* refers to the belly side and is therefore *inferior*. Similarly, the terms *posterior* and *dorsal* mean the same thing in humans, but in four-legged animals *dorsal* refers to the back side and is therefore *superior*.

†The **midline** is an imaginary vertical line that divides the body into equal right and left sides.

Table 1.2 and Figure 1.6 present the main directional terms. Study the directional terms in Table 1.2 and the example of how each is used. As you read the examples, look at Figure 1.6 to see the location of each structure.

FIGURE 1.6 Directional terms.

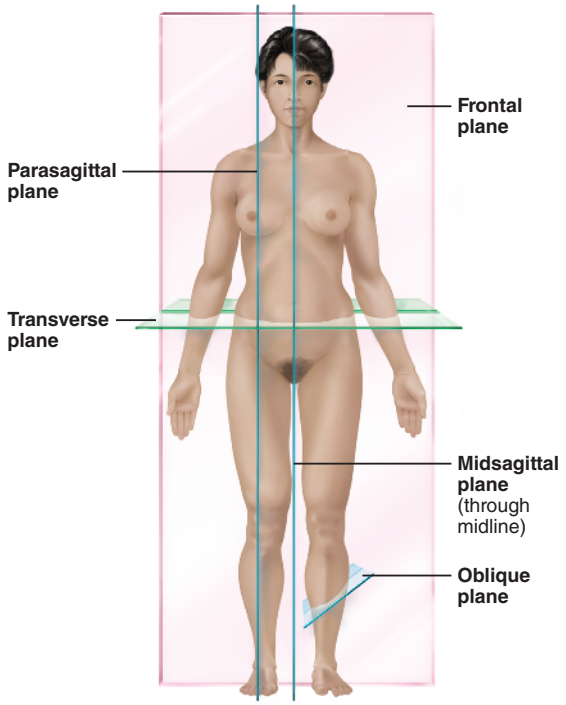


Directional terms precisely locate various parts of the body relative to one another.

Planes and Sections

You will also study parts of the body relative to **planes**—imaginary flat surfaces that pass through body parts (Figure 1.7). A **sagittal plane** (SAJ-i-tal; *sagitt-* = arrow) is a vertical plane that divides the body or organ into right and left sides. More specifically, when such a plane passes through the midline of the body or an organ and divides it into *equal* right and left sides, it is called a **midsagittal (median) plane**. The *midline* is an imaginary vertical line that divides the body into equal left and right sides. If the sagittal plane does not pass through the midline but instead divides the body or an organ into *unequal* right and left sides, it is called a **parasagittal plane** (*para-* = near). A **frontal (coronal) plane** (kō-RŌ-nal; *corona* = crown) divides the body or organ into anterior and posterior portions. A **transverse (horizontal) plane** divides the body or organ into superior and inferior portions. Sagittal, frontal, and transverse planes are all at right angles to one another. An **oblique plane**, by contrast, passes through the body or an organ at an oblique angle (any angle other than a 90° angle).

FIGURE 1.7 Planes through the human body.



Frontal, transverse, sagittal, and oblique planes divide the body in specific ways.

When you study a body region, you often view it in section. A **section** is a cut of the body or one of its organs made along one of the planes just described. It is important to know the plane of the section so you can understand the anatomical relationship of one part to another. Figure 1.8 indicates how three different sections—*transverse, frontal*, and *midsagittal*—provide different views of the brain.

CHECKPOINT

14. Describe the anatomical position in your own words.

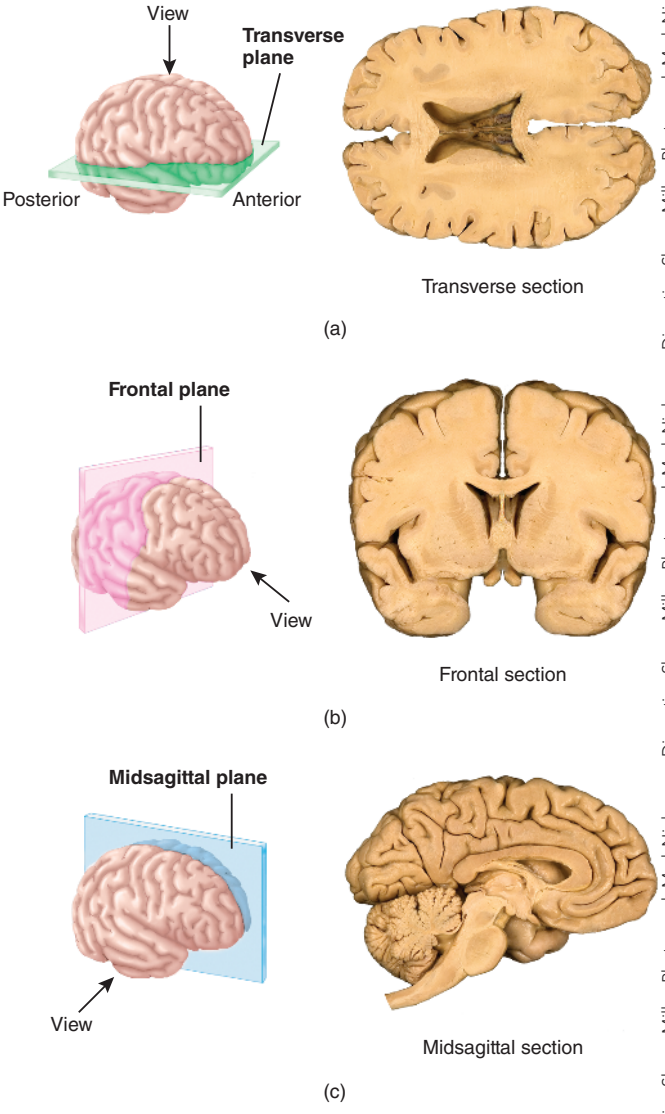
15. Blood is typically drawn from the antecubital space. Where is this?

16. Is the urinary bladder medial or lateral to the ascending colon? Is the radius proximal or distal to the humerus? Are the ribs superficial or deep to the lungs?

17. Which directional terms can be used to specify the relationships between (1) the elbow and the shoulder, (2) the left and right shoulders, (3) the sternum and the humerus, and (4) the heart and the diaphragm?

18. What is the difference between a plane and a section?

FIGURE 1.8 Planes and sections through different parts of the brain. The diagrams (left) show the planes, and the photographs (right) show the resulting sections. Note: The arrows in the diagrams indicate the direction from which each section is viewed. This aid is used throughout the book to indicate viewing perspectives.



Dissection Shawn Miller; Photograph Mark Nielsen.

Dissection Shawn Miller; Photograph Mark Nielsen.

Dissection Shawn Miller; Photograph Mark Nielsen.

Planes divide the body in various ways to produce sections.

1.5 Body cavities are spaces within the body that help protect, separate, and support internal organs.

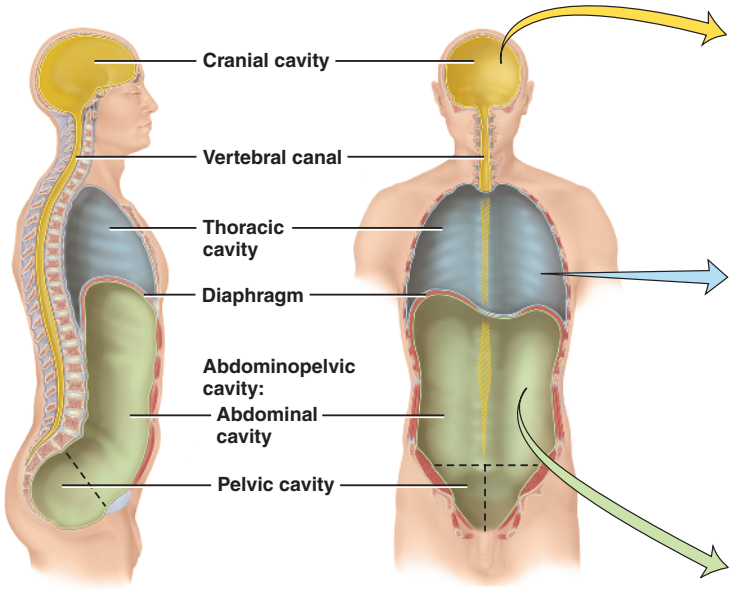
You have spaces within your body called **body cavities** that protect and support internal organs and isolate them from one another. Bones, muscles, and ligaments separate the various body cavities. Here we discuss several of the larger body cavities (Figure 1.9).

The **cranial cavity** (KRĀ-nē-al) is formed by the cranial bones and contains the brain. The **vertebral canal** (VERT-te-bral) is formed by the bones of the vertebral column (backbone), which contains the spinal cord. The cranial cavity and vertebral canal are continuous with one another.

The major body cavities of the trunk are the thoracic and abdominopelvic cavities. The **thoracic cavity** (thor-AS-ik; *thorac-* = chest), or chest cavity, is encircled by the ribs, the muscles of the chest, the sternum (breastbone), and the thoracic portion of the vertebral column (Figure 1.10). Within the thoracic cavity are the **pericardial cavity** (per′-i-KAR-dē-al; *peri-* = around; *-cardial* = heart) containing the heart and two **pleural cavities** (PLOOR-al; *pleur-* = rib or side), each containing one lung. The central portion of the thoracic cavity is an anatomical region called the **mediastinum** (mē′-dē-as-TĪ-num; *media-* = middle; *-stinum* = partition). It is located between the lungs and extends from the sternum to the vertebral column, and from the first rib to the diaphragm. The mediastinum contains all thoracic organs except the lungs themselves. Among the structures in the mediastinum are the heart, esophagus, trachea, thymus, and several large blood vessels that enter and exit the heart. The **diaphragm** (DĪ-a-fram = partition or wall) is a dome-shaped muscle that separates the thoracic cavity from the abdominopelvic cavity.

The **abdominopelvic cavity** (ab-dom′-i-nō-PEL-vik) extends from the diaphragm to the pelvic floor and is enclosed by the abdominal wall and the bones and muscles of the pelvis (Figure 1.11).

FIGURE 1.9 Body cavities. The dashed black lines indicate the border between the abdominal and pelvic cavities.



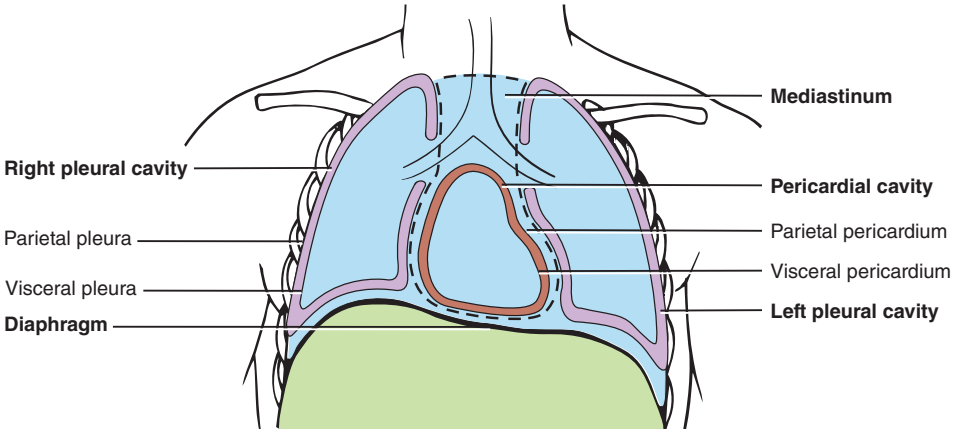
(a) Right lateral view (b) Anterior view

CAVITY	COMMENTS
Cranial cavity	Formed by cranial bones and contains brain.
Vertebral canal	Formed by vertebral column and contains spinal cord and the beginnings of spinal nerves.
Thoracic cavity*	Chest cavity; contains pleural and pericardial cavities and the mediastinum.
Pleural cavity	A potential space between the layers of the pleura that surrounds a lung.
Pericardial cavity	A potential space between the layers of the pericardium that surrounds the heart.
Mediastinum	Central portion of thoracic cavity between the lungs; extends from sternum to vertebral column and from first rib to diaphragm; contains heart, thymus, esophagus, trachea, and several large blood vessels.
Abdominopelvic cavity	Subdivided into abdominal and pelvic cavities.
Abdominal cavity	Contains stomach, spleen, liver, gallbladder, small intestine, and most of large intestine; the serous membrane of the abdominal cavity is the peritoneum.
Pelvic cavity	Contains urinary bladder, portions of large intestine, and internal organs of reproduction.

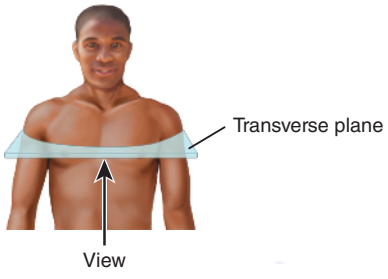
* See Figure 1.10 for details of the thoracic cavity.

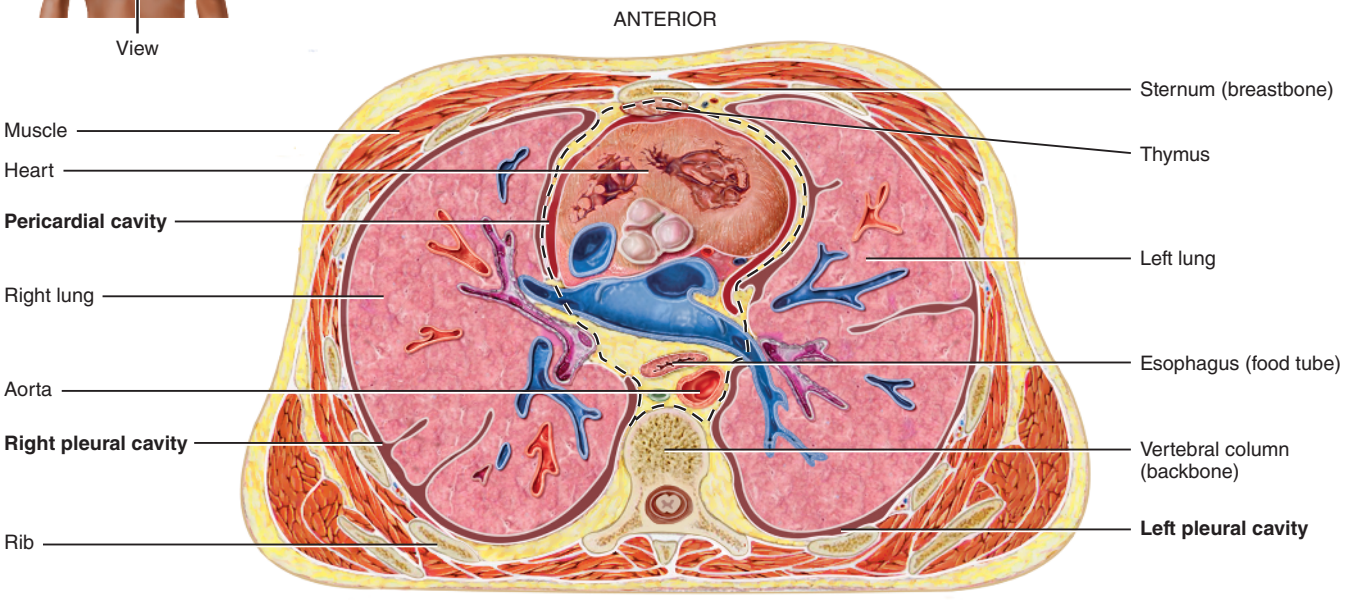
The major cavities of the trunk are the thoracic and abdominopelvic cavities.

FIGURE 1.10 The thoracic cavity. The dashed lines indicate the borders of the mediastinum. Note: When transverse sections are viewed inferiorly (from below), the anterior aspect of the body appears on top and the left side of the body appears on the right side of the illustration.



(a) Anterior view of thoracic cavity





(b) Inferior view of transverse section of thoracic cavity

The thoracic cavity contains three smaller cavities and the mediastinum.

As the name suggests, the abdominopelvic cavity is divided into two portions, even though no wall separates them. The superior portion, the **abdominal cavity** (*abdomin-* = belly), contains the stomach, spleen, liver, gallbladder, small intestine, and most of the large intestine. The inferior portion, the **pelvic cavity** (PEL-vik; *pelv-* = basin), contains the urinary bladder, portions of the large intestine, and internal organs of the reproductive system. Organs inside the thoracic and abdominopelvic cavities are called **viscera** (VIS-er-a).

✓ CHECKPOINT

19. The diaphragm separates what two cavities?

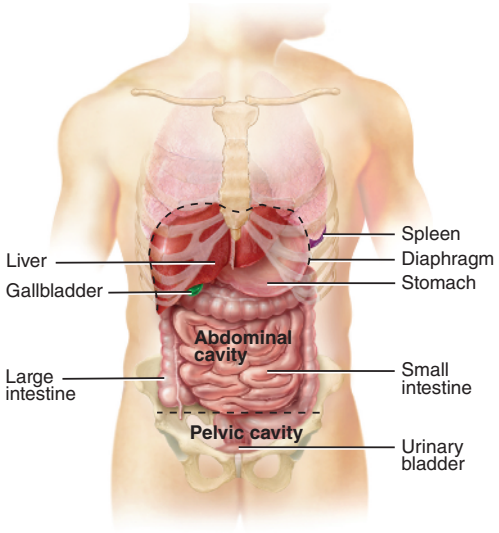
20. In which cavities are the following organs located: urinary bladder, stomach, heart, small intestine, lungs, thymus, and liver? Use the following symbols for your responses: T = thoracic cavity, A = abdominal cavity, or P = pelvic cavity.

21. Which of the following structures are contained in the mediastinum: right lung, heart, esophagus, spinal cord, trachea, ribs, thymus, left pleural cavity?

22. What is the name of the cavity that surrounds the heart? Which cavities surround the lungs?

23. What organ lies distinctly in both the abdominal and pelvic cavities?

FIGURE 1.11 The abdominopelvic cavity. The upper dashed line indicates the position of the diaphragm. The lower dashed line shows the approximate boundary between the abdominal and pelvic cavities.



Anterior view

The abdominopelvic cavity extends from the diaphragm to the groin.

RETURN TO Jaime's Story



The next day, Jaime shows up at work and finds Terry, one of the x-ray technicians he had met the previous day, sitting at the desk. "Morning, Terry. What have you got for me?"

"Good morning, Jaime. I'm going to need your help with a 9 o'clock patient. Doc wants a bunch of new films on him. Motorcycle versus truck accident!" Jaime glances at the x-ray films lying on the desk. "Those his films?" Jaime asks.

"Yeah, check this out. He broke his neck in several places. Doc wants a lateral view and an anterior view. He also broke his collarbone and humerus, and shattered his elbow. We'll need an acromial series, an olecranal series, and an oblique view. You'll need to help position him. It's going to hurt . . . a lot. Why don't you see if this guy is ready now." Jaime heads off to check on the patient.

After lunch, Jaime helps take a series of x-rays of an elderly man with suspected pneumonia. The patient coughs repeatedly whenever he moves, which appears to induce more coughing. When Jaime is finally able to get a few clear x-rays taken and developed, he returns the patient to his room. The patient complains of back pain and the chills, so Jaime checks with a nurse and finds a blanket and an extra pillow for him. On his way back to the desk, Jaime is called to bring an ultrasound device to admitting for a victim in a car accident who may have internal bleeding in her spleen. As he watches the doctor quickly scan the patient's abdomen with the ultrasound, Jaime tries to keep up as she rattles off the organs found medial and inferior to the spleen, commenting on which appear intact and which look suspicious. After that, Jaime returns to the radiology department with the equipment and helps Terry with more patients.

That evening, Jaime describes his experiences to classmates in his study group at the library. "It was unbelievable. Her spleen appeared intact, but her stomach might have been punctured by a broken rib. I tell you, it's incredible how much of this stuff you see on the job."

E. *If Terry and Jaime need to obtain a lateral view of the motorcycle rider's neck, from what direction would they take the x-ray picture?*

F. *Where are the acromial and olecranal structures found on the motorcyclist's body?*

G. *The coughing patient's movements appeared to prompt more coughing. Is this a type of feedback mechanism? Explain your answer.*

H. *What are the elderly patient's signs and symptoms?*

I. *Using anatomical directions, describe the relationship between the car accident victim's stomach and her spleen.*

1.6 Serous membranes line the walls of body cavities and cover the organs within them.

A **membrane** is a thin, pliable tissue that covers, lines, partitions, or connects structures. One example is a slippery, double-layered membrane called a **serous membrane**, a thin epithelium that lines the walls of the thoracic and abdominal cavities and covers the viscera within those cavities. The parts of a serous membrane are (1) the *parietal layer* (pa-RĪ-e-tal) that lines the walls of the cavities, and (2) the *visceral layer* (VIS-er-al) that covers and adheres to the organs within the cavities. Serous membranes secrete a small amount of lubricating fluid (serous fluid) into the space between the two layers. Serous fluid reduces friction, allowing the viscera to slide somewhat during movements—as when the lungs inflate and deflate during breathing.

The serous membrane of the pleural cavities is called the **pleura** (PLOO-ra) (see Figure 1.10a). The *visceral pleura* clings to the surface of the lungs, the *parietal pleura* lines the chest wall, and the space between them is the *pleural cavity*. The serous membrane of the pericardial cavity is the **pericardium** (per′-i-KAR-dē-um) (see Figure 1.10a). The *visceral pericardium* covers the surface of the heart, the *parietal pericardium* lines the chest wall, and the *pericardial cavity* is in between them. The **peritoneum** (per-i-tō-NĒ-um) is the serous membrane of the abdominal cavity. The *visceral peritoneum* covers the abdominal viscera, and the *parietal peritoneum* lines the abdominal wall. Between them is the *peritoneal cavity*. Most abdominal organs are located in the peritoneal cavity. Some are located between the parietal peritoneum and the posterior abdominal wall. Such organs are said to be *retroperitoneal* (re′-trō-per-i-tō-NĒ-al; *retro* = behind). Examples of retroperitoneal organs include the kidneys, pancreas, and duodenum of the small intestine.

A summary of body cavities and their membranes is presented in the table included in Figure 1.9.

✓ CHECKPOINT

24. What is the function of serous membranes?

25. What is the meaning of the term "retroperitoneal"?

1.7 The abdominopelvic cavity is divided into regions or quadrants.

To describe the location of the many abdominal and pelvic organs more easily, anatomists and clinicians use two methods of dividing the abdominopelvic cavity into smaller areas (Figure 1.12). In the first method, two horizontal lines and two vertical lines, aligned like a tic-tac-toe grid, partition this cavity into nine **abdominopelvic regions** (Figure 1.12a). The top horizontal line is drawn just inferior to the rib cage, across the stomach; the bottom horizontal line is drawn just inferior to the tops of the hip bones. Two vertical lines are drawn through the midpoints of the clavicles (collar bones). The four lines divide the abdominopelvic cavity into nine regions: the **right hypochondriac**, **epigastric**, **left hypochondriac**, **right lumbar**, **umbilical**, **left lumbar**, **right inguinal**, **hypogastric**, and **left inguinal**.

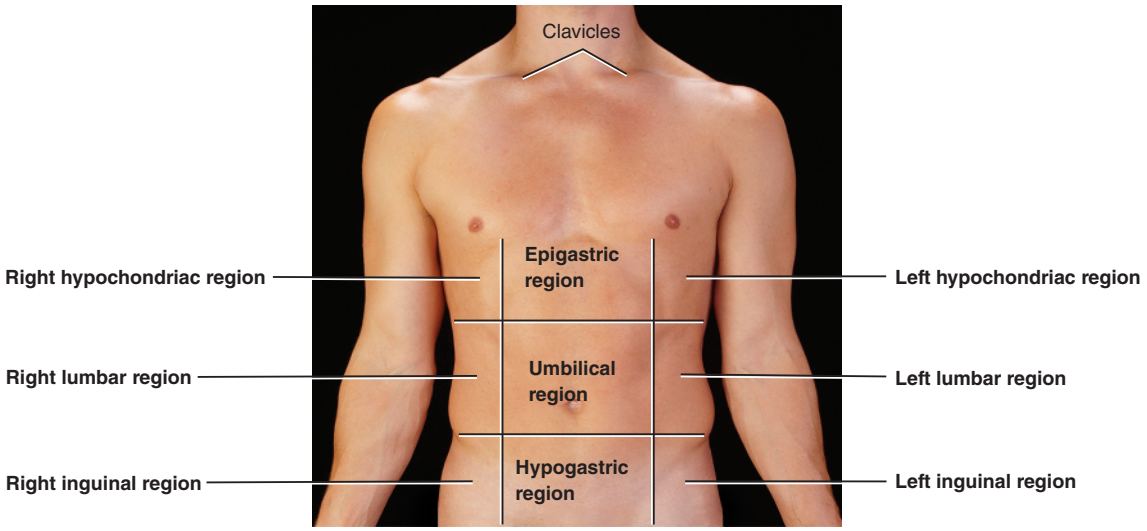
In the second, simpler method a midsagittal line and a transverse line are passed through the **umbilicus** (um-bi-LĪ-kus; *umbilic-* = navel) or *belly button*, to divide the abdominopelvic cavity into **quadrants** (KWOD-rantz; *quad-* = one-fourth), as shown in Figure 1.12b. The abdominopelvic quadrants are the **right upper quadrant**, **left upper quadrant**, **right lower quadrant**, and **left lower quadrant**. The nine-region division is more widely used for anatomical studies, and quadrants are more commonly used by clinicians for describing the site of abdominopelvic pain, a tumor, or other abnormality.

✓ CHECKPOINT

26. In which abdominopelvic region is each of the following found: most of the liver, most of the small intestines, urinary bladder?

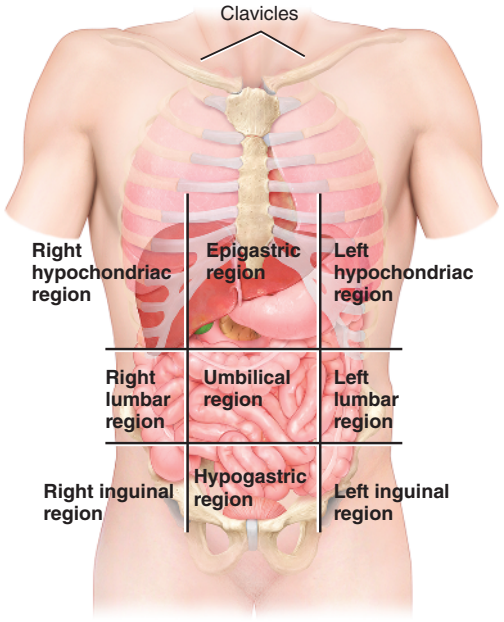
27. When anatomical terms refer to right and left, do we mean your right and left or those of the person you are facing? (*Hint: See Figure 1.12.*)

FIGURE 1.12 Regions and quadrants of the abdominopelvic cavity.

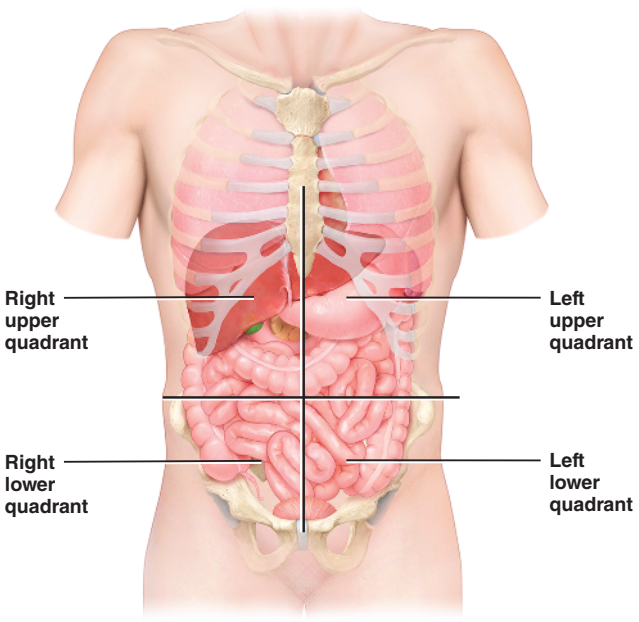


Andy Washnik

(a) Anterior view showing abdominopelvic regions



(b) Anterior view showing location of abdominopelvic regions



(c) Anterior view showing location of abdominopelvic quadrants

The nine-region designation is used for anatomical studies; the quadrant designation is used by clinicians to locate the site of pain, a tumor, or some other abnormality.

Jaime's Story



At the end of the week, Jaime spends an hour with Dr. Sebbo, reviewing the structures of the mediastinum in a series of x-rays to better read the x-rays and understand the instructions for positioning the x-ray equipment. They use a recent CT scan of a patient with appendicitis to review the quadrants and regions of the abdominopelvic cavities. "As you can see," Dr. Sebbo say, "the appendix is located here inferior to the junction between the small and large intestines. In a normal individual, it would be hidden posterior to the junction, but in this poor fellow, it was so swollen that it was starting to tear through the surrounding membrane." When Jaime is able to correctly identify the various structures in the CT scan, Dr. Sebbo compliments him on picking up on the terminology and techniques so quickly. Jaime grins and says, "I admit that it's all coming faster than I expected, but everyone's been really helpful with this."

Jaime has found that his study of anatomy and physiology has direct application to his new job. Gaining knowledge about anatomy and physiology allows us to understand the relationship of body structures to their functions. As you read through this book keep in mind that, like Jaime's experience, what you are learning will have meaning to you in both your professional life and your personal life. So far, you have learned how the body is organized, what characteristics determine life, and some basic anatomical terminology that names body parts and describes their locations.

In each chapter, we will explore a new story designed to illustrate the application of anatomical and physiological principles in your everyday life. Although the case stories themselves are fictional, the situations, illnesses, and characters are based on the experiences of real people just like you.

EPILOGUE AND DISCUSSION

J. *Name the structures found within the mediastinum seen on the x-ray.*
K. *Describe the quadrant and regions in which you would expect to find the CT patient's and a normal person's appendix.*
L. *What membrane was the inflamed appendix tearing through?*