chapter 1

Introduction to Human Anatomy and Physiology

THE TALE OF THE MUMMY'S TOE. No one knows her name, but she lived sometime between 1550 and 1300 B.C. in Thebes, a city in ancient Egypt. All that remains are pieces of her skeleton, bound with linen to preserve the general shape of her body in life. Yet, the telltale bones reveal a little of what her life was like.

The shape of the pelvic bones indicate that the person immortalized as the mummy was female. She was 50 to 60 years old when she died, according to the way the bony plates of her skull fit together and the lines of mineral deposition of a particularly well-preserved tooth. Among the preserved bones from the skull, pelvis, upper limbs, and right lower limbs, the part that easily commands the most attention is the right big toe, for it ends in a prosthesis, a man-made replacement for a skeletal part. It was crucial for her balance and locomotion.

The mummy's toe tip is made of wood and painted a dark brown, perhaps to blend in with her skin color. It consists of a long part and two smaller parts that anchor the structure to the rest of the digit. Seven leather strings once attached it to the foot, and it even bears a fake nail. The fact that connective tissue and skin have grown over the prosthesis reveals that her body had accepted the unnatural replacement part. Most amazing, however, is the shape of the prosthesis, which is remarkably like the body part it was intended to replace. Signs of wear indicate that it served its owner well. Unlike other prostheses found with mummies that were placed after death to provide a complete skeleton for burial, this one was clearly used during the person's lifetime.

The old woman with the fake toe is evidence of quite sophisticated medical technology. Modern-day medical sleuths from the departments of pathology and diagnostic radiology at Ludwig-Maximillians University in Munich evaluated the ancient evidence using computerized tomography (CT) scans of the remnants of the natural toe. The researchers detected poor mineral content of the toe, plus calcium deposits in the largest blood vessel, the aorta, suggesting impaired circulation to the feet. Perhaps the mummy in life suffered from type II diabetes mellitus, which can cause poor circulation to the toes. If gangrene had set in, long-ago healers might have amputated the affected portion of the toe, replacing it with a very reasonable facsimile.

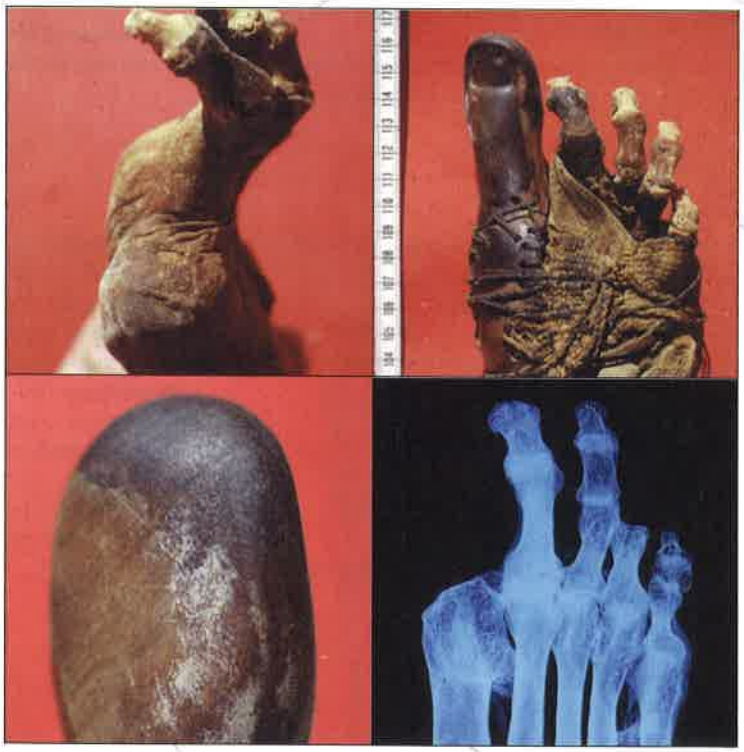


Photo:
A wooden toe on an ancient Egyptian mummy reveals sophisticated knowledge of human anatomy and physiology from long ago.

Chapter Objectives

After studying this chapter, you should be able to do the following:

1.1 Introduction

1. Describe the early studies into the workings of the body. (p. 3)

1.2 Anatomy and Physiology

2. Define *anatomy* and *physiology,* and explain how they are related. (p. 3)

1.3 Characteristics of Life

3. List and describe the major characteristics of life. (p. 4)

1.4 Maintenance of Life

4. List and describe the major requirements of organisms. (p. 4)
5. Define *homeostasis,* and explain its importance to survival. (p. 5)
6. Describe a homeostatic mechanism. (p. 5)

1.5 Levels of Organization

7. Explain biological levels of organization. (p. 7)

1.6 Organization of the Human Body

8. Describe the locations of the major body cavities. (p. 8)
9. List the organs located in each major body cavity. (p. 8)
10. Name the membranes associated with the thoracic and abdominopelvic cavities. (p. 10)
11. Name the major organ systems, and list the organs associated with each. (p. 12)
12. Describe the general functions of each organ system. (p. 12)

1.7 Anatomical Terminology

13. Properly use the terms that describe relative positions, body sections, and body regions. (p. 13)

Aids to Understanding Words

append- [to hang something] *append*icular: Pertaining to the limbs.

cardi- [heart] peri*cardi*um: Membrane that surrounds the heart.

cran- [helmet] *cran*ial: Pertaining to the portion of the skull that surrounds the brain.

dors- [back] *dors*al: Position toward the back.

homeo- [same] *homeo*stasis: Maintenance of a stable internal environment.

-logy [study of] physio*logy*: Study of body functions.

meta- [change] *meta*bolism: Chemical changes that occur within the body.

pariet- [wall] *pariet*al membrane: Membrane that lines the wall of a cavity.

pelv- [basin] *pelv*ic cavity: Basin-shaped cavity enclosed by the pelvic bones.

peri- [around] *peri*cardial membrane: Membrane that surrounds the heart.

pleur- [rib] *pleur*al membrane: Membrane that encloses the lungs and lines the thoracic cavity.

-stasis [standing still] homeo*stasis*: Maintenance of a stable internal environment.

-tomy [cutting] ana*tomy*: Study of structure, which often involves cutting or removing body parts.

Key Terms

abdominopelvic (ab-dom´´ĭ-no-pel´vik)
absorption (ab-sorp´shun)
anatomy (ah-nat´o-me)
appendicular (ap´´en-dik´u-lar)
assimilation (ah-sim´´ĭ-la´shun)
axial (ak´se-al)
circulation (ser-ku-la´shun)
digestion (di-jest´yun)
excretion (ek-skre´shun)
homeostasis (ho´´me-ō-sta´sis)
metabolism (mĕ-tab´o-lizm)
negative feedback (neg´ah-tiv fēd´bak)
organelle (or´´gah-nel´)
organism (or´gah-nizm)
parietal (pah-ri´ĕ-tal)
pericardial (per´´ĭ-kar´de-al)
peritoneal (per´´ĭ-to-ne´al)
physiology (fiz´´e-ol´o-je)
pleural (ploo´ral)
reproduction (re´´pro-duk´shun)
respiration (res´´ pĭ-ra´shun)
thoracic (tho-ras´ik)
visceral (vis´er-al)

The accent marks used in the pronunciation guides are derived from a simplified system of phonetics that is standard in medical usage. The single accent (´) denotes the major stress and identifies the most heavily pronounced syllable in the word. The double accent (´´) indicates the secondary stress. A syllable marked with a double accent receives less emphasis than the syllable that carries the main stress, but more emphasis than neighboring unstressed syllables.

1.1 Introduction

Modern medicine began with long-ago observations on the function, and malfunction, of the human body. The study of the human body probably began with our earliest ancestors, who must have been curious about how their bodies worked, as we are today. At first, their interests most likely concerned injuries and illnesses because healthy bodies demand little attention from their owners. Their healers relied heavily on superstitions and notions about magic. However, as healers tried to help the sick, they began to discover useful ways of examining and treating the human body. They observed the effects of injuries, noticed how wounds healed, and examined dead bodies to determine causes of death. They also found that certain herbs and potions could sometimes be used to treat coughs, headaches, and other common problems.

Over time, people began to believe that humans could understand forces that caused natural events. They began observing the world around them more closely, asking questions and seeking answers. This set the stage for the development of modern science.

As techniques for making accurate observations and performing careful experiments evolved, knowledge of the human body expanded rapidly (fig. 1.1). At the same time, early medical providers coined many new terms to name body parts, describe their locations, and explain their functions. These terms, most of which originated from Greek and Latin words, formed the basis for the language of anatomy and physiology. (The names of some modern medical and applied sciences are listed on page 17.)

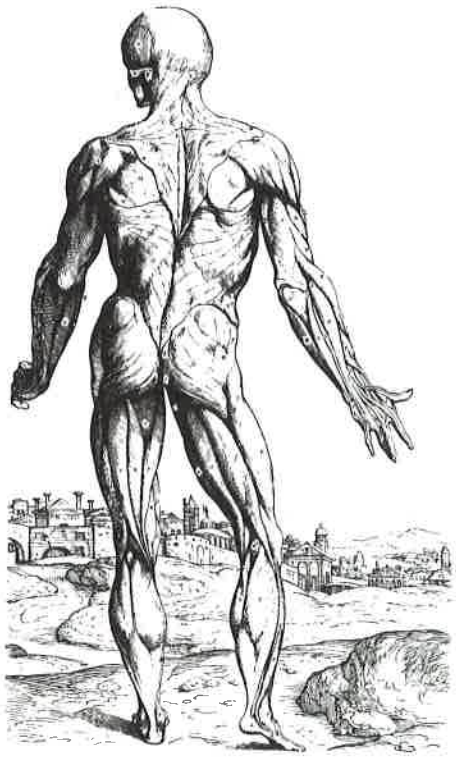


Figure 1.1
The study of the human body has a long history, as this illustration from the second book of *De Humani Corporis Fabrica* by Andreas Vesalius, issued in 1543, illustrates. (Note the similarity to the anatomical position, described later in this chapter.)

CHECK YOUR RECALL

1. What factors probably stimulated an early interest in the human body?
2. What kinds of activities helped promote the development of modern science?

1.2 Anatomy and Physiology

Anatomy (ah-nat´o-me) is the branch of science that deals with the structure (morphology) of body parts—their forms and how they are organized. **Physiology** (fiz´´e-ol´o-je), on the other hand, concerns the functions of body parts—what they do and how they do it.

The topics of anatomy and physiology are difficult to separate because the structures of body parts are so closely associated with their functions. Body parts form a well-organized unit—the human organism—and each part functions in the unit's operation. A particular body part's function depends on the way the part is constructed—that is, how its subparts are organized. For example, the organization of parts in the human hand with its long, jointed fingers makes it easy to grasp objects; the hollow chambers of the heart are adapted to pump blood through tubular blood vessels; the shape of the mouth enables it to receive food; and teeth are shaped to break solid foods into small pieces (fig. 1.2).

Anatomy and physiology are ongoing as well as ancient fields. Researchers frequently discover new information about physiology, particularly at the molecular level. Although unusual, new parts of human anatomy are discovered today too. Recently, researchers identified a small piece of connective tissue between the upper part of the spinal cord and a muscle at the back of the head. This connective tissue bridge may be the trigger for pain impulses in certain types of tension headaches.

In 2000, a team of international researchers and a private company deciphered the human genome—that is, the biochemical instructions that run the human body. Discovering the activities of our 35,000 or so genes is revealing many new details of physiology.

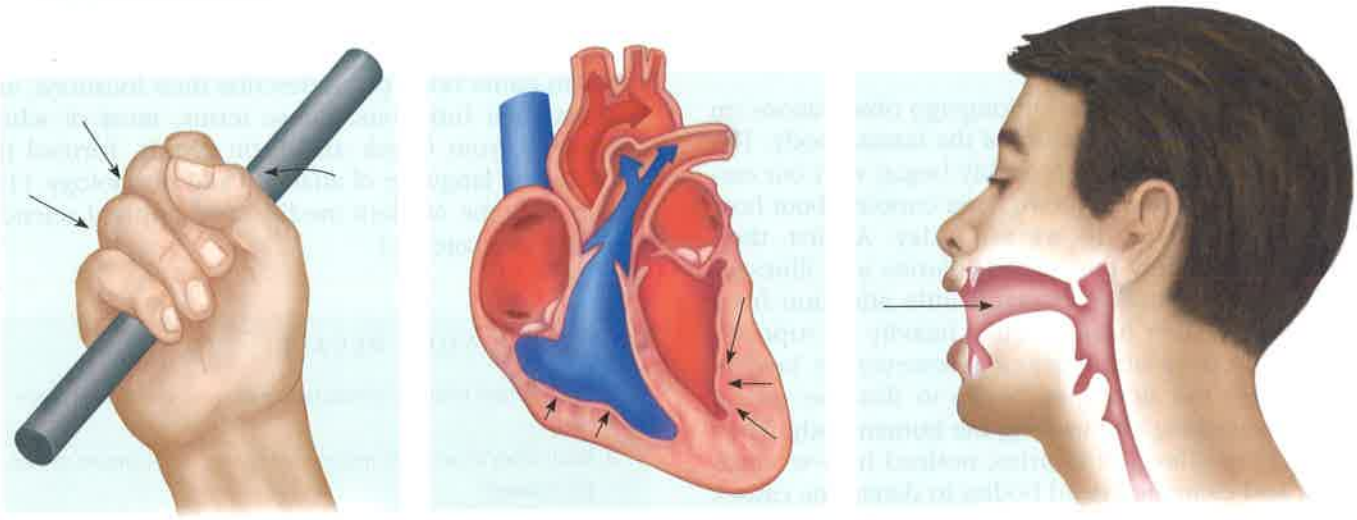


Figure 1.2
The structures of body parts make possible their functions: (*A*) The hand is adapted for grasping, (*B*) the heart for pumping blood, and (*C*) the mouth for receiving food. (Arrows indicate movements associated with these functions.)

CHECK YOUR RECALL

1. Why is it difficult to separate the topics of anatomy and physiology?
2. List several examples that illustrate how the structure of a body part makes possible its function.

1.3 Characteristics of Life

Before beginning a more detailed study of anatomy and physiology, it is helpful to consider some of the traits humans share with other organisms, particularly with other animals. As living organisms, we can move and respond to our surroundings. We start out as small individuals and then grow, eventually able to reproduce. We gain energy by taking in or ingesting food, by breaking it down or digesting it, and by absorbing and assimilating it. The absorbed substances circulate throughout the internal environment of our bodies. We can then, by the process of respiration, use the energy in these nutrients for such vital functions as growth and repair of body parts. Finally, we excrete wastes from the body. The acquisition of food and utilization of its energy, plus excretion, constitute **metabolism** (mĕ-tab´o-lizm). Table 1.1 summarizes the characteristics of life.

CHECK YOUR RECALL

1. What are the characteristics of life?
2. How are the characteristics of life dependent on metabolism?

TABLE 1.1 CHARACTERISTICS OF LIFE

PROCESS	EXAMPLES
Movement	Change in position of the body or of a body part; motion of an internal organ
Responsiveness	Reaction to a change taking place inside or outside the body
Growth	Increase in body size without change in shape
Reproduction	Production of new organisms and new cells
Respiration	Obtaining oxygen, removing carbon dioxide, and releasing energy from foods (Some forms of life do not use oxygen in respiration.)
Digestion	Breakdown of food substances into simpler forms that can be absorbed and used
Absorption	Passage of substances through membranes and into body fluids
Circulation	Movement of substances from place to place in body fluids
Assimilation	Changing of absorbed substances into chemically different forms
Excretion	Removal of wastes produced by metabolic reactions

1.4 Maintenance of Life

The structures and functions of almost all body parts help maintain the life of the organism. The only exceptions are an organism's reproductive structures, which ensure that its species will continue into the future.

Requirements of Organisms

Life requires certain environmental factors, including the following:

1. **Water** is the most abundant chemical in the body. It is required for many metabolic processes and

provides the environment in which most of them take place. Water also transports substances within the organism and is important in regulating body temperature.

2. **Foods** are substances that provide the body with necessary chemicals (nutrients) in addition to water. Some of these chemicals are used as energy sources, others supply raw materials for building new living matter, and still others help regulate vital chemical reactions.
3. **Oxygen** is a gas that makes up about one-fifth of ordinary air. It is used to release energy from food substances. This energy, in turn, drives metabolic processes.
4. **Heat** is a form of energy. It is a product of metabolic reactions, and the degree of heat present partly determines the rate at which these reactions occur. Generally, the more heat, the more rapidly chemical reactions take place. (*Temperature* is a measure of the degree of heat.)
5. **Pressure** is an application of force to something. For example, the force on the outside of the body due to the weight of air above it is called *atmospheric pressure*. In humans, this pressure is important in breathing. Similarly, organisms living under water are subjected to *hydrostatic pressure*—a pressure a liquid exerts—due to the weight of water above them. In humans, heart action produces blood pressure (another form of hydrostatic pressure), which forces blood through blood vessels.

Health-care workers repeatedly monitor patients' *vital signs*—observable body functions that reflect essential metabolic activities. Vital signs indicate that a person is alive. Assessment of vital signs includes measuring body temperature and blood pressure and monitoring rates and types of pulse and breathing movements. Absence of vital signs signifies death. A person who has died displays no spontaneous muscular movements, including those of the breathing muscles and beating heart. A dead person does not respond to stimuli, and has no reflexes, such as the knee-jerk reflex and the pupillary reflexes of the eye. Brain waves cease with death, demonstrated by a flat electroencephalogram (EEG), signifying a lack of metabolic activity in the brain.

Although organisms require water, food, oxygen, heat, and pressure, these factors alone are not enough to ensure survival. Both the quantities and the qualities of such factors are also important. For example, the volume of water entering and leaving an organism must be regulated, as must the concentration of oxygen in body fluids. Similarly, survival depends on the quality as well as the quantity of food available—that is, food must supply the correct nutrients in adequate amounts.

Homeostasis

Factors in the external environment may change. If an organism is to survive, however, conditions within the fluid surrounding its body cells, which comprise its **internal environment,** must remain relatively stable. In other words, body parts function only when the concentrations of water, nutrients, and oxygen and the conditions of heat and pressure remain within certain narrow limits. This condition of a stable internal environment is called **homeostasis** (ho´´me-ō-sta´sis).

The body maintains homeostasis through a number of self-regulating control systems, or **homeostatic mechanisms,** that have the following three components in common (fig. 1.3):

Receptors, which provide information about specific conditions (stimuli) in the internal environment.

A **set point,** which tells what a particular value should be (such as body temperature at 98.6°F).

Effectors, which cause responses that alter conditions in the internal environment.

A homeostatic mechanism works as follows. If the receptors measure deviations from the set point, effectors are activated that can return conditions toward normal. As conditions return toward normal, the deviation from the set point progressively lessens, and the effectors are gradually shut down. Such a response is called a **negative feedback** (neg´ah-tiv fēd´bak) mechanism, both because the deviation from the set point is corrected (moves in the opposite or negative direction) and because the correction reduces the action of the effectors. This latter aspect is important because it prevents a correction from going too far.

To better understand this idea of negative feedback, imagine a room equipped with a furnace and an air

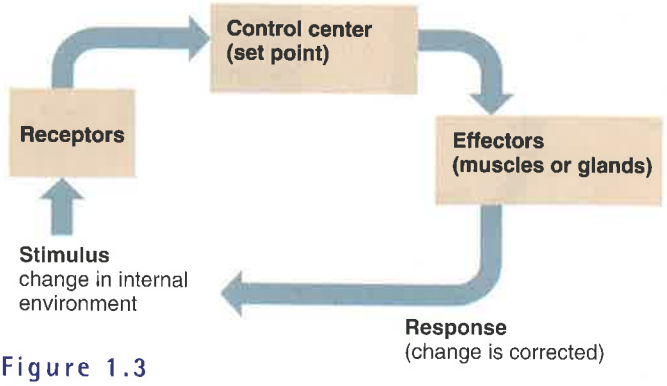


Figure 1.3
A homeostatic mechanism monitors an aspect of the internal environment and corrects any changes.

conditioner (fig. 1.4). Suppose the room temperature is to remain near 20°C (68°F), so the thermostat is adjusted to an operating level, or set point, of 20°C. Because a thermostat senses temperature changes, it will signal the furnace to start and the air conditioner to stop whenever the room temperature drops below the set point. If the temperature rises above the set point, the thermostat will stop the furnace and start the air conditioner. As a result, the room will maintain a relatively constant temperature.

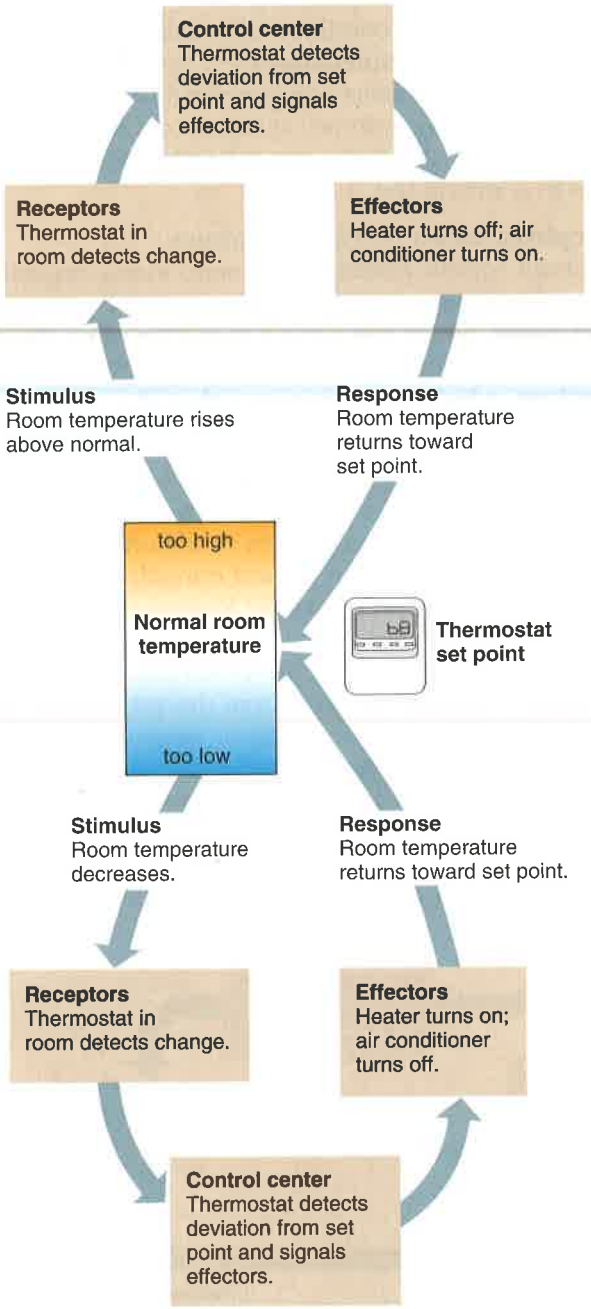


Figure 1.4
A thermostat signals an air conditioner and a furnace to turn on or off to maintain a relatively stable room temperature. This system is an example of a homeostatic mechanism.

A similar homeostatic mechanism regulates body temperature in humans. Temperature receptors are scattered throughout the body. The "thermostat" is a temperature-sensitive region in a temperature control center of the brain. In healthy persons, the set point of the brain's thermostat is at or near 37°C (98.6°F).

If a person is exposed to a cold environment and body temperature begins to drop, the temperature receptors sense this change and the temperature control center triggers heat-generating and heat-conserving activities. For example, small groups of muscles are stimulated to contract involuntarily, an action called *shivering*. Such muscular contractions produce heat, which helps warm the body. At the same time, blood vessels in the skin are signaled to constrict so that less warm blood flows through them. In this way, deeper tissues retain heat that might otherwise be lost.

If a person is becoming overheated, the brain's temperature control center triggers a series of changes that promote loss of body heat. Sweat glands in the skin secrete perspiration, and as this fluid evaporates from the surface, heat is carried away and the skin is cooled. At the same time, the brain center dilates blood vessels in the skin. This action allows the blood carrying heat from deeper tissues to reach the surface, where heat is lost to the outside (fig. 1.5). The brain stimulates an increase in heart rate, which sends a greater volume of blood into surface vessels, and an increase in breathing rate, which allows more heat-carrying air to be expelled from the lungs. Body temperature regulation is discussed further in chapter 6 (p. 120).

Another homeostatic mechanism regulates the blood pressure in the blood vessels (arteries) leading away from the heart. In this instance, pressure-sensitive receptors in the walls of these vessels sense changes in blood pressure and signal a pressure control center of the brain. If blood pressure is above the set point, the brain signals the heart chambers to contract more slowly and with less force. This decreased heart action sends less blood into the blood vessels, decreasing the pressure inside them. If blood pressure falls below the set point, the brain center signals the heart to contract more rapidly and with greater force so that the pressure in the vessels increases. Chapter 13 (p. 348) discusses regulation of blood pressure in more detail.

There are many other examples of homeostatic mechanisms in human physiology. One is the increased respiratory activity that maintains blood levels of oxygen in the internal environment during strenuous exercise. Another is the sensation of thirst created by the nervous system, stimulating water intake when the internal environment has become too concentrated. Negative feedback mechanisms also control hormone secretion (see chapter 11, p. 285).

Homeostatic mechanisms maintain a relatively constant internal environment, yet physiological values may vary slightly in a person from time to time or from

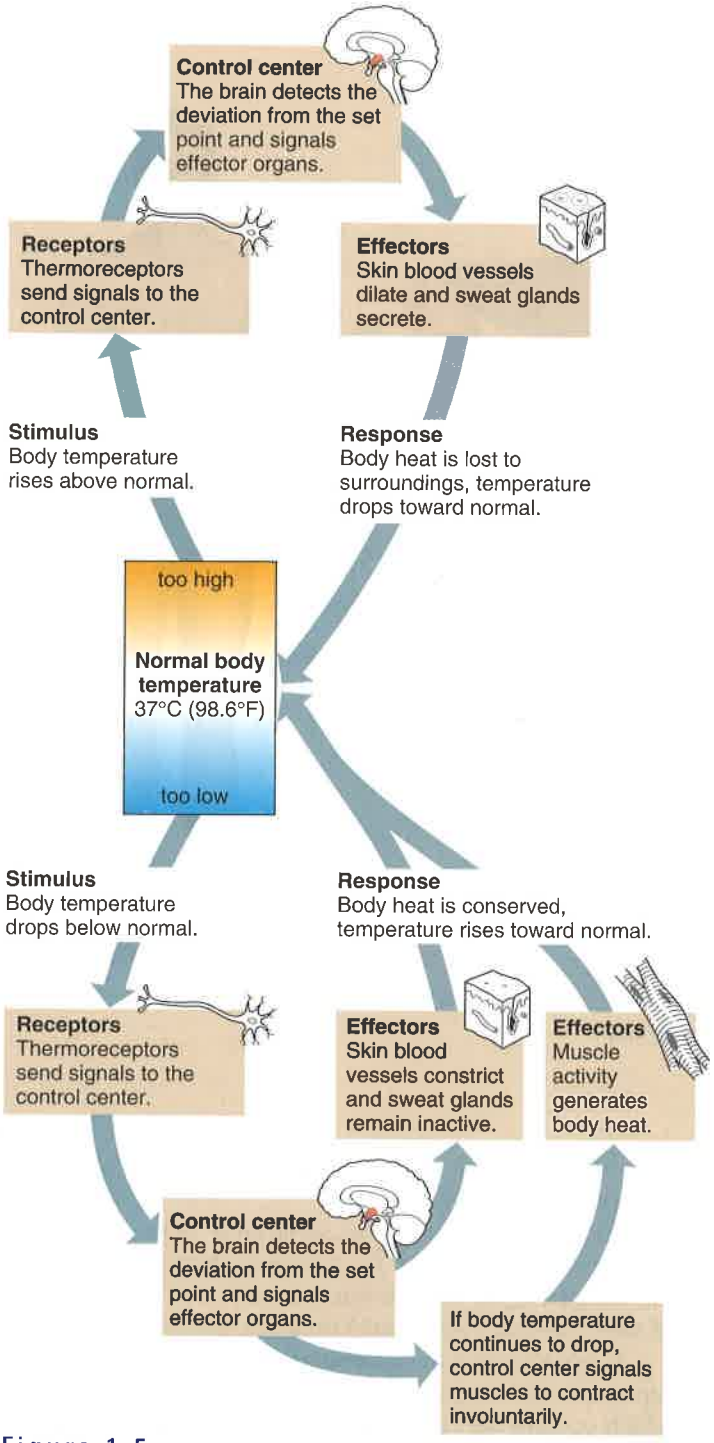


Figure 1.5
A homeostatic mechanism regulates body temperature.

one individual to the next. Therefore, both normal values for an individual and the **normal range** for the general population are clinically important.

CHECK YOUR RECALL

1. What requirements of organisms does the external environment provide?
2. Why is homeostasis important to survival?
3. Describe two homeostatic mechanisms.

1.5 Levels of Organization

Until the invention of magnifying lenses and microscopes about 400 years ago, anatomists were limited in their studies to what they could see with the unaided eye—large parts. With these tools, investigators discovered that larger body structures were made up of smaller parts, which in turn were composed of even smaller ones (fig. 1.6).

Today, scientists recognize that all materials, including those that make up the human body, are composed of chemicals. Chemicals consist of invisible particles called **atoms,** which join to form **molecules.** Small molecules can combine in complex ways to form larger molecules called **macromolecules.**

Within the human and other organisms, the basic unit of structure and function is a **cell,** which is microscopic. Although cells vary in size, shape, and specialized functions, all have certain characteristics in common. For instance, all cells of humans and other complex organisms contain structures called **organelles** (or´´gan-elz´) that carry out specific activities. Organelles are composed of aggregates of macromolecules, such as proteins, carbohydrates, lipids, and nucleic acids.

Cells may be organized into layers or masses that have common functions. Such a group of cells forms a **tissue.** Groups of different tissues that interact form **organs**—complex structures with specialized functions—and groups of organs that function closely together comprise **organ systems.** Organ systems make up an **organism** (or´gah-nizm).

Body parts can be thought of as having different levels of organization, such as the *atomic level, molecular level,* or *cellular level.* Furthermore, body parts vary in complexity from one level to the next. That is, atoms are less complex than molecules, molecules are less complex than organelles, tissues are less complex than organs, and so forth.

Chapters 2–6 discuss these levels of organization in more detail. Chapter 2 (pp. 31–44) describes the atomic and molecular levels. Chapter 3 (pp. 49–58) deals with organelles and cellular structures and functions, and chapter 4 explores cellular metabolism. Chapter 5 describes tissues. Chapter 6 (p. 113) presents membranes (linings) as examples of organs, and the skin and its accessory organs as an example of an organ system. Beginning with chapter 6, the structures and functions of each of the organ systems are described in detail.

CHECK YOUR RECALL

1. How does the human body illustrate levels of organization?
2. What is an organism?
3. How do body parts at different levels of organization vary in complexity?

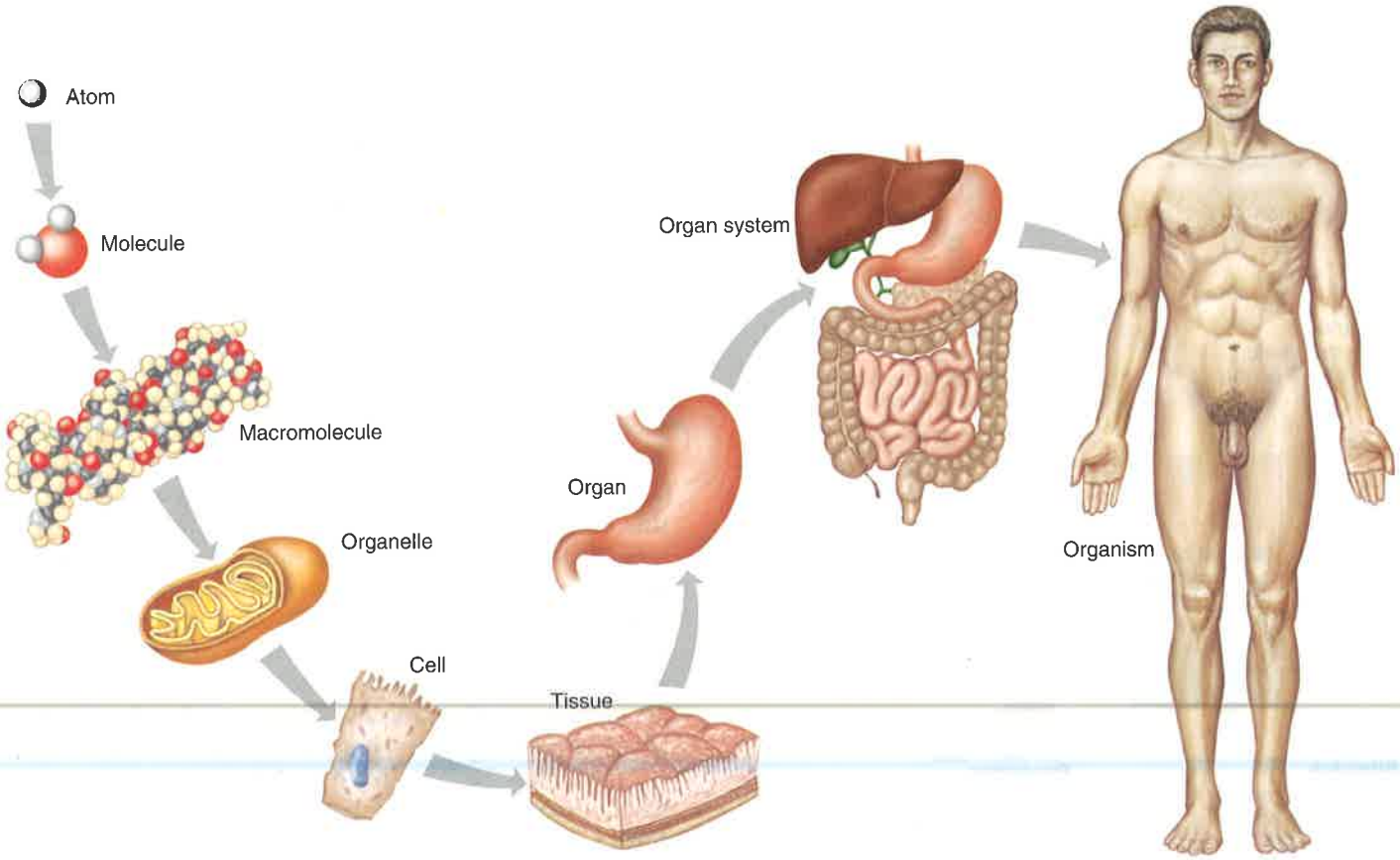


Figure 1.6
A human body is composed of parts within parts, which vary in complexity.

1.6 Organization of the Human Body

The human organism is a complex structure composed of many parts. Its major features include several body cavities, layers of membranes within these cavities, and a variety of organ systems.

Body Cavities

The human organism can be divided into an **axial** (ak´se-al) **portion,** which includes the head, neck, and trunk, and an **appendicular** (ap´´en-dik´u-lar) **portion,** which includes the upper and lower limbs. Within the axial portion are two major cavities: a **dorsal cavity** and a larger **ventral cavity** (fig. 1.7*A*). The organs within such a cavity are called visceral organs, or **viscera** (vis´er-ah). The dorsal cavity can be subdivided into two parts: the **cranial cavity** within the skull, which houses the brain, and the **vertebral canal,** which contains the spinal cord within sections of the backbone (vertebrae). The ventral cavity consists of a **thoracic** (tho-ras´ik) **cavity** and an **abdominopelvic** (ab-dom´´ĭ-no-pel´vik) **cavity.**

The thoracic cavity is separated from the lower abdominopelvic cavity by a broad, thin muscle called the **diaphragm.** The thoracic cavity wall is composed of skin, skeletal (voluntary) muscles, and various bones.

A region called the **mediastinum** (me´´de-as-ti´num) separates the thoracic cavity into two compartments, which contain the right and left lungs. The remaining thoracic viscera—heart, esophagus, trachea, and thymus gland—are located within the mediastinum (fig. 1.7*B*).

The abdominopelvic cavity, which includes an upper abdominal portion and a lower pelvic portion, extends from the diaphragm to the floor of the pelvis. Its wall consists primarily of skin, skeletal muscles, and bones. The viscera within the **abdominal cavity** include the stomach, liver, spleen, gallbladder, kidneys, and most of the small and large intestines.

The **pelvic cavity** is the portion of the abdominopelvic cavity enclosed by the hip bones (see chapter 7, p. 152). It contains the terminal portion of the large intestine, the urinary bladder, and the internal reproductive organs.

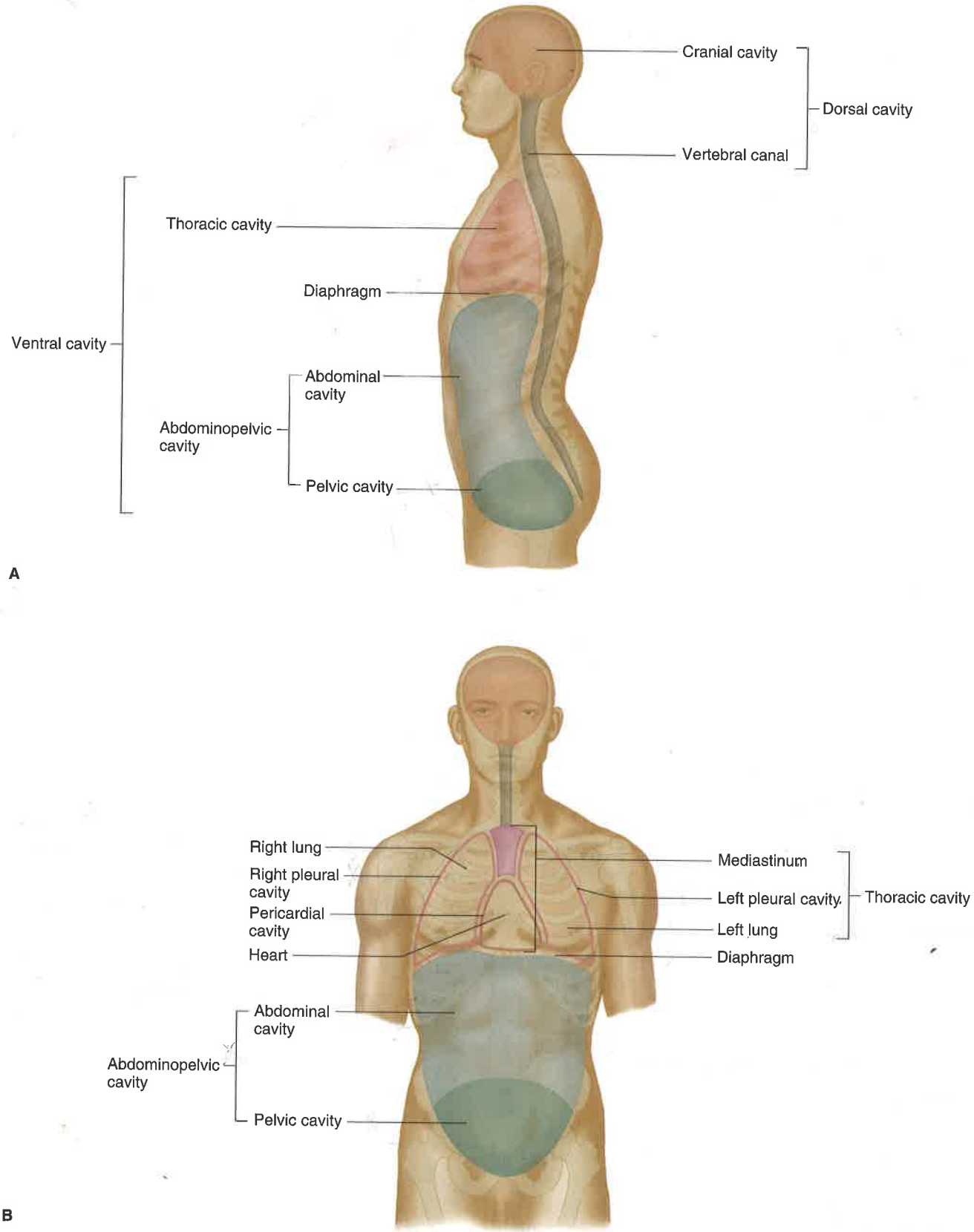


Figure 1.7
Major body cavities. (*A*) Lateral view. (*B*) Coronal view.

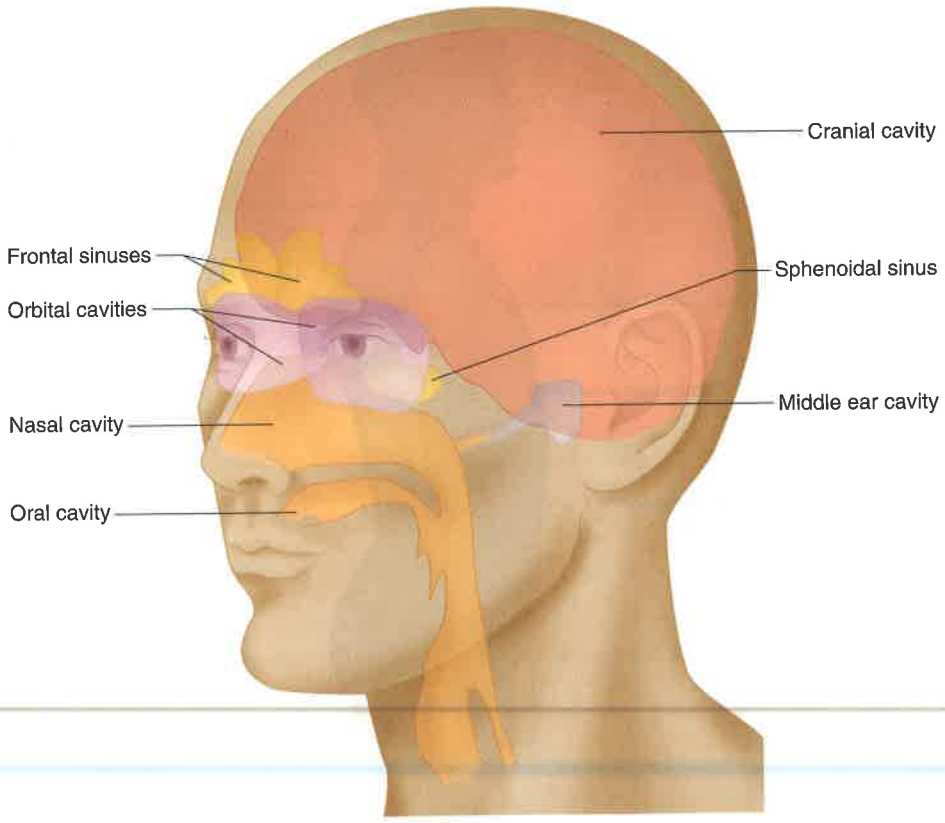


Figure 1.8
The cavities within the head include the cranial, oral, nasal, orbital, and middle ear cavities, as well as several sinuses.

Smaller cavities within the head include (fig. 1.8):

1. **Oral cavity,** containing the teeth and tongue.
2. **Nasal cavity,** located within the nose and divided into right and left portions by a nasal septum. Several air-filled *sinuses* connect to the nasal cavity (see chapter 7, p. 136). These include the frontal and sphenoidal sinuses shown in figure 1.8.
3. **Orbital cavities,** containing the eyes and associated skeletal muscles and nerves.
4. **Middle ear cavities,** containing the middle ear bones.

Thoracic and Abdominopelvic Membranes

The walls of the right and left thoracic compartments, which contain the lungs, are lined with a membrane called the *parietal pleura* (fig. 1.9). A similar membrane, called the *visceral pleura,* covers the lungs themselves. (Note: **Parietal** (pah-rī´ĕ-tal) refers to the membrane attached to the wall of a cavity; **visceral** (vis´er-al) refers to the membrane that is deeper—toward the interior—and covers an internal organ, such as a lung.)

The parietal and visceral **pleural** (ploo´ral) **membranes** are separated by a thin film of watery fluid (serous fluid) that they secrete. While no actual space normally exists between these membranes, the potential space between them is called the *pleural cavity* (see fig. 1.7*B*).

The heart, which is located in the broadest portion of the mediastinum, is surrounded by **pericardial** (per´´ĭ-kar´de-al) **membranes.** A thin *visceral pericardium* covers the heart's surface and is separated from a thicker *parietal pericardium* by a small volume of fluid. The *pericardial cavity* (see fig. 1.7*B*) is the potential space between these membranes.

In the abdominopelvic cavity, the lining membranes are called **peritoneal** (per´´ĭ-to-ne´al) **membranes** (fig. 1.10). A *parietal peritoneum* lines the wall, and a *visceral peritoneum* covers each organ in the abdominal cavity. The *peritoneal cavity* is the potential space between these membranes.

CHECK YOUR RECALL

1. What does *viscera* mean?
2. Which organs occupy the dorsal cavity? The ventral cavity?
3. Name the cavities of the head.
4. Describe the membranes associated with the thoracic and abdominopelvic cavities.

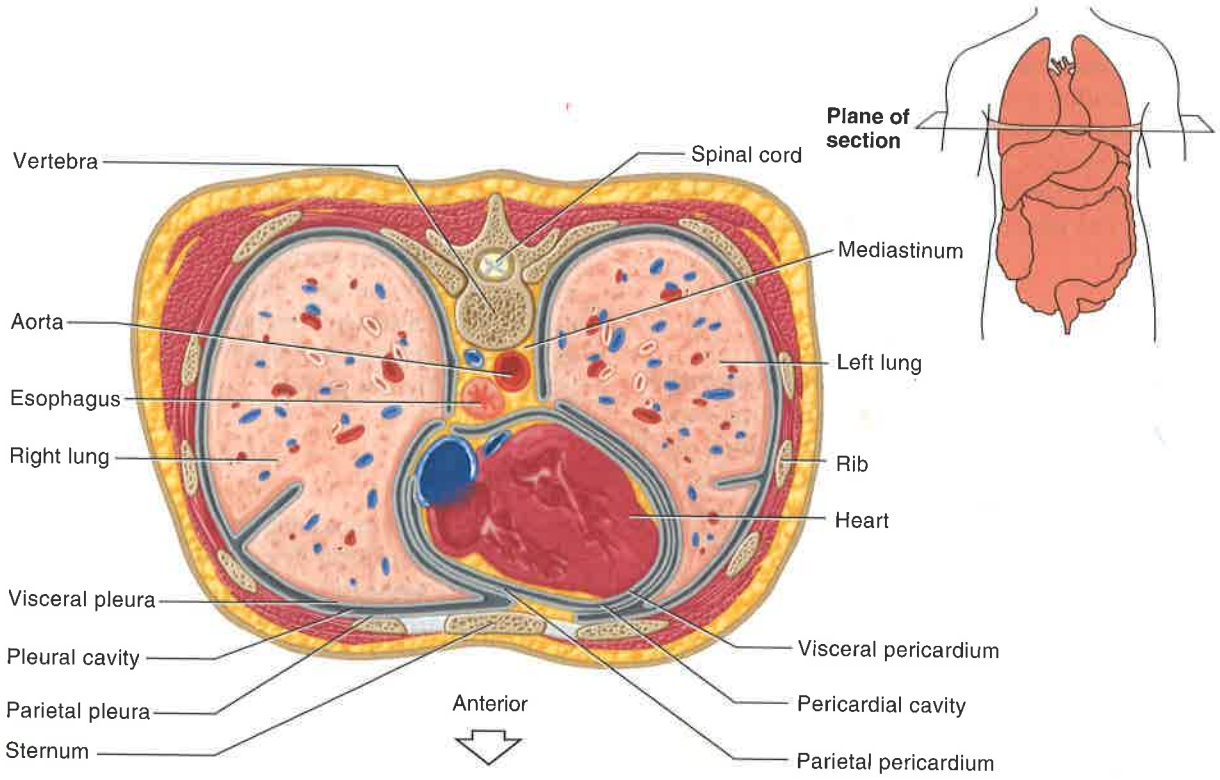


Figure 1.9
A transverse section through the thorax reveals the serous membranes associated with the heart and lungs (*superior view*).

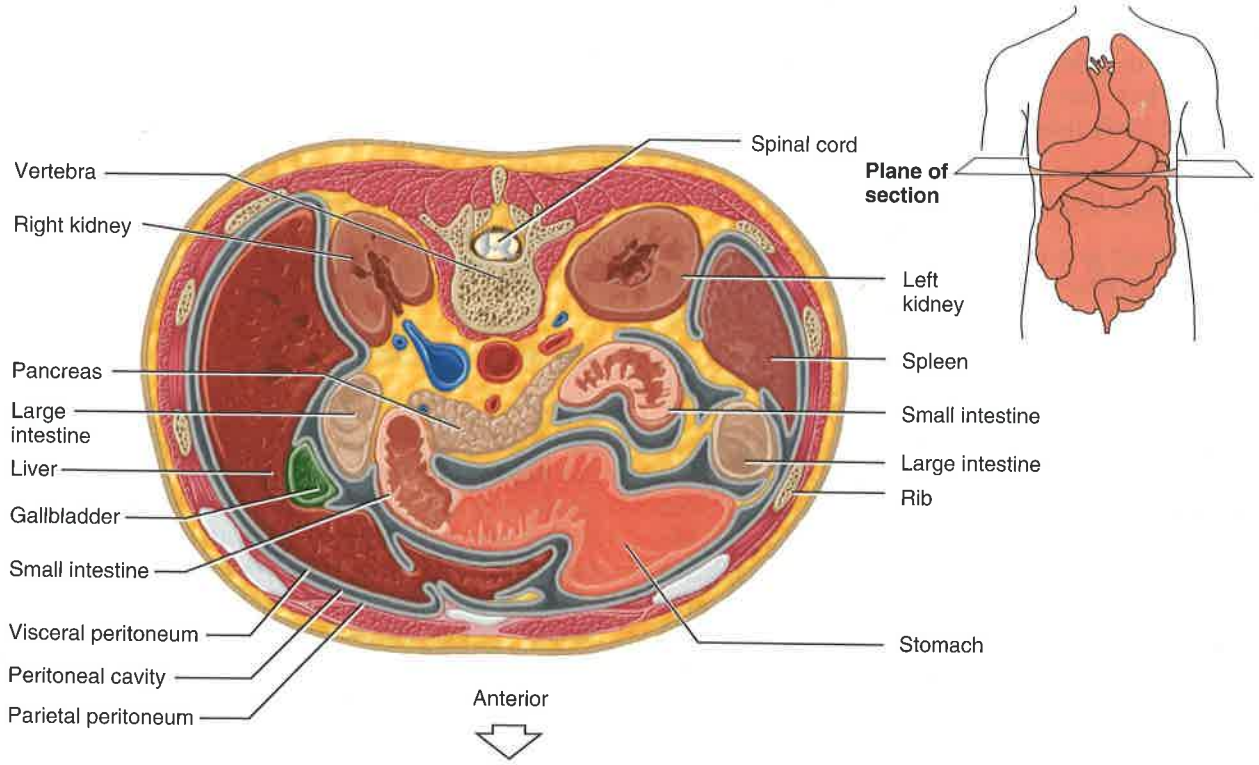


Figure 1.10
Transverse section through the abdomen (*superior view*).

Organ Systems

The human organism consists of several organ systems. Each system includes a set of interrelated organs that work together to provide specialized functions. As you read about each system, you may want to consult the illustrations of the human torso and locate some of the organs listed in the description (see Reference Plates, pp. 21–28).

Body Covering

Organs of the **integumentary** (in-teg-u-men´tar-e) **system** (see chapter 6) include the skin and various accessory organs, such as the hair, nails, sweat glands, and sebaceous glands. These parts protect underlying tissues, help regulate body temperature, house a variety of sensory receptors, and synthesize certain products.

Support and Movement

The organs of the skeletal and muscular systems (see chapters 7 and 8) support and move body parts. The **skeletal** (skel´ĕ-tal) **system** consists of bones, as well as ligaments and cartilages that bind bones together. These parts provide frameworks and protective shields for softer tissues, are attachments for muscles, and act with muscles when body parts move. Tissues within bones also produce blood cells and store inorganic salts.

Muscles are the organs of the **muscular** (mus´ku-lar) **system.** By contracting and pulling their ends closer together, muscles provide forces that cause body movements. They also maintain posture and are the main source of body heat.

Integration and Coordination

For the body to act as a unit, its parts must be integrated and coordinated. The nervous and endocrine systems control and adjust various organ functions, which maintains homeostasis.

The **nervous** (ner´vus) **system** (see chapter 9) consists of the brain, spinal cord, nerves, and sense organs (see chapter 10). Nerve cells within these organs use electrochemical signals called *nerve impulses* to communicate with one another and with muscles and glands. Each impulse produces a relatively short-term effect on its target. Some nerve cells act as specialized sensory receptors that can detect changes inside and outside the body. Other nerve cells receive the impulses transmitted from these sensory receptors and interpret and act on the information received. Still other nerve cells carry impulses from the brain or spinal cord to muscles or glands, stimulating them to contract or to secrete products.

The **endocrine** (en´do-krin) **system** (see chapter 11) includes all the glands that secrete chemical messengers called *hormones*. The hormones, in turn, move away from the glands in body fluids, such as blood or tissue fluid (fluid from the spaces within tissues). A particular hormone affects only a particular group of cells, which are called its *target cells*. The effect of a hormone is to alter the metabolism of the target cells. Compared to nerve impulses, hormonal effects occur over a relatively long time period. Organs of the endocrine system include the pituitary, thyroid, parathyroid, and adrenal glands, as well as the pancreas, ovaries, testes, pineal gland, and thymus gland.

Transport

Two organ systems transport substances throughout the internal environment. The **cardiovascular** (kahr´´de-o-vas´ku-lur) **system** (see chapters 12 and 13) includes the heart, arteries, veins, capillaries, and blood. The heart is a muscular pump that helps force blood through the blood vessels. Blood transports gases, nutrients, hormones, and wastes. It carries oxygen from the lungs and nutrients from the digestive organs to all body cells, where these biochemicals are used in metabolic processes. Blood also transports hormones and carries wastes from body cells to the excretory organs, where the wastes are removed from the blood and released to the outside.

The **lymphatic** (lim-fat´ik) **system** (see chapter 14) is sometimes considered part of the cardiovascular system. It is composed of the lymphatic vessels, lymph fluid, lymph nodes, thymus gland, and spleen. This system transports some of the tissue fluid back to the bloodstream and carries certain fatty substances away from the digestive organs. Cells of the lymphatic system are called lymphocytes, and they defend the body against infections by removing disease-causing microorganisms and viruses from tissue fluid.

Absorption and Excretion

Organs in several systems absorb nutrients and oxygen and excrete various wastes. For example, the organs of the **digestive** (di-jest´tiv) **system** (see chapter 15) receive foods from the outside. Then they break down food molecules into simpler forms that can pass through cell membranes and thus be absorbed. Materials that are not absorbed are transported back to the outside and eliminated. Certain digestive organs also produce hormones and thus function as parts of the endocrine system. The digestive system includes the mouth, tongue, teeth, salivary glands, pharynx, esophagus, stomach, liver, gallbladder, pancreas, small intestine, and large intestine. Chapter 15 (pp. 420–427) also discusses nutrition.

The organs of the **respiratory system** (see chapter 16) move air in and out and exchange gases between the blood and the air. More specifically, oxygen passes from air within the lungs into the blood, and carbon dioxide leaves the blood and enters the air. The nasal cavity, pharynx, larynx, trachea, bronchi, and lungs are parts of this system.

The **urinary** (u´rĭ-ner´´e) **system** (see chapter 17) consists of the kidneys, ureters, urinary bladder, and urethra. The kidneys remove wastes from blood and help maintain the body's water and electrolyte balance. The product of these activities is urine. Other portions of the urinary system store urine and transport it outside the body. Chapter 18 discusses the urinary system's role in maintaining water, electrolyte, and acid-base balance.

Reproduction

Reproduction is the process of producing offspring (progeny). Cells reproduce when they divide and give rise to new cells. The **reproductive** (re´´pro-duk´tiv) **system** of an organism, however, produces whole new organisms like itself (see chapter 19).

The male reproductive system includes the scrotum, testes, epididymides, vasa deferentia, seminal vesicles, prostate gland, bulbourethral glands, penis, and urethra. These parts produce and maintain sperm cells (spermatozoa). Components of the male reproductive system also transfer sperm cells into the female reproductive tract.

The female reproductive system consists of the ovaries, uterine tubes, uterus, vagina, clitoris, and vulva. These organs produce and maintain female sex cells (the egg cells or ova), receive sperm cells, and transport the sperm cells and egg cells within the female system. The female reproductive system also supports the development of prenatal humans, such as embryos and fetuses, and enables the birth process to proceed.

CHECK YOUR RECALL

1. Name each of the major organ systems, and list the organs of each system.
2. Describe the general functions of each organ system.

1.7 Anatomical Terminology

To communicate effectively with one another, researchers and clinicians have developed a set of precise terms to describe anatomy. Some of these terms concern the relative positions of body parts, others relate to imaginary planes along which cuts may be made, and still others describe body regions.

Use of such terms assumes that the body is in the **anatomical position.** This means that the body is standing erect, face forward, with upper limbs at the sides and the palms forward. Note that the terms right and left refer to the right and left of a body in anatomical position.

Relative Positions

Terms of relative position describe the location of one body part with respect to another. They include the following:

1. **Superior** means that a body part is above another part or is closer to the head. (The thoracic cavity is superior to the abdominopelvic cavity.)
2. **Inferior** means that a body part is below another body part or is toward the feet. (The neck is inferior to the head.)
3. **Anterior** (or *ventral*) means toward the front. (The eyes are anterior to the brain.)
4. **Posterior** (or *dorsal*) is the opposite of anterior; it means toward the back. (The pharynx is posterior to the oral cavity.)
5. **Medial** relates to an imaginary midline dividing the body into equal right and left halves. A body part is medial if it is closer to this line than another part. (The nose is medial to the eyes.)
6. **Lateral** means toward the side with respect to the imaginary midline. (The ears are lateral to the eyes.)
7. **Proximal** describes a body part that is closer to a point of attachment than another body part. (The elbow is proximal to the wrist.)
8. **Distal** is the opposite of proximal. It means that a particular body part is farther from a point of attachment than another body part. (The fingers are distal to the wrist.)
9. **Superficial** means situated near the surface. (The epidermis is the superficial layer of the skin.) *Peripheral* also means outward or near the surface. It describes the location of certain blood vessels and nerves. (The nerves that branch from the brain and spinal cord are peripheral nerves.)
10. **Deep** describes parts that are more internal. (The dermis is the deep layer of the skin.)

Body Sections

Observing the relative locations and organization of internal body parts requires cutting or sectioning the

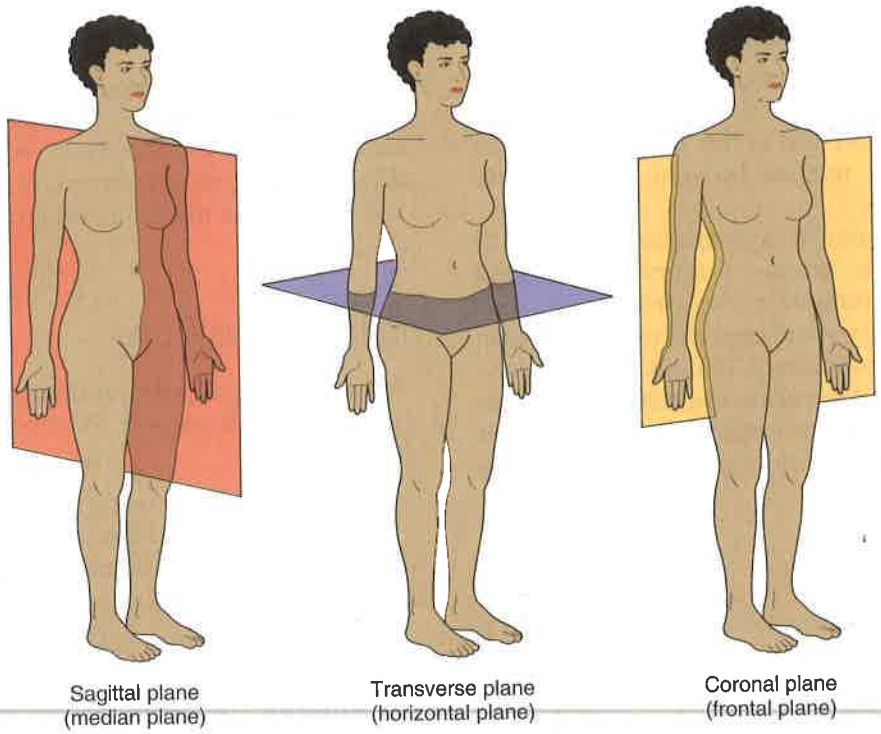


Figure 1.11
Observation of internal parts requires sectioning the body along various planes.

body along various planes (fig. 1.11). The following terms describe such planes and sections:

1. **Sagittal** refers to a lengthwise cut that divides the body into right and left portions. If a sagittal section passes along the midline and divides the body into equal parts, it is called *median* (midsagittal).
2. **Transverse** (or *horizontal*) refers to a cut that divides the body into superior and inferior portions.
3. **Coronal** (or *frontal*) refers to a section that divides the body into anterior and posterior portions.

Sometimes, a cylindrical organ such as a long bone is sectioned. In this case, a cut across the structure is called a *cross section,* an angular cut is an *oblique section,* and a lengthwise cut is a *longitudinal section* (fig. 1.12).

Body Regions

A number of terms designate body regions. The abdominal area, for example, is subdivided into the following nine regions, as figure 1.13*A* shows:

1. **Epigastric region** refers to the upper middle portion.
2. **Left** and **right hypochondriac regions** lie on each side of the epigastric region.
3. **Umbilical region** refers to the middle portion.
4. **Left** and **right lumbar regions** lie on each side of the umbilical region.
5. **Hypogastric region** refers to the lower middle portion.
6. **Left** and **right iliac regions** (left and right inguinal regions) lie on each side of the hypogastric region.

The abdominal area is also often subdivided into four quadrants, as figure 1.13*B* shows.

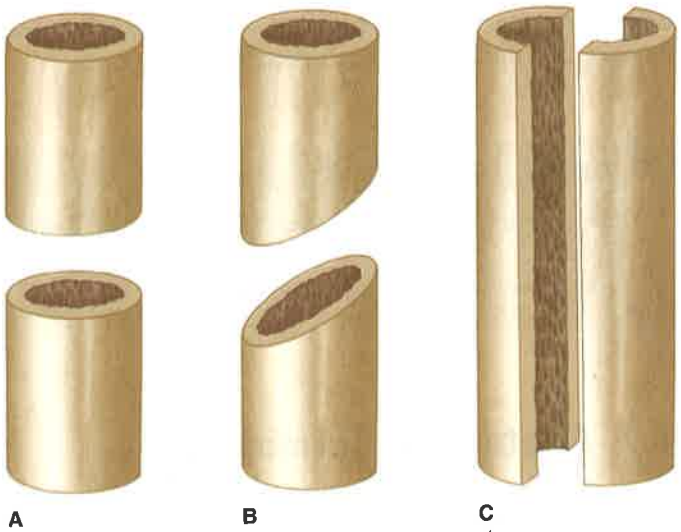


Figure 1.12
Cylindrical parts may be cut in (*A*) cross section, (*B*) oblique section, or (*C*) longitudinal section.

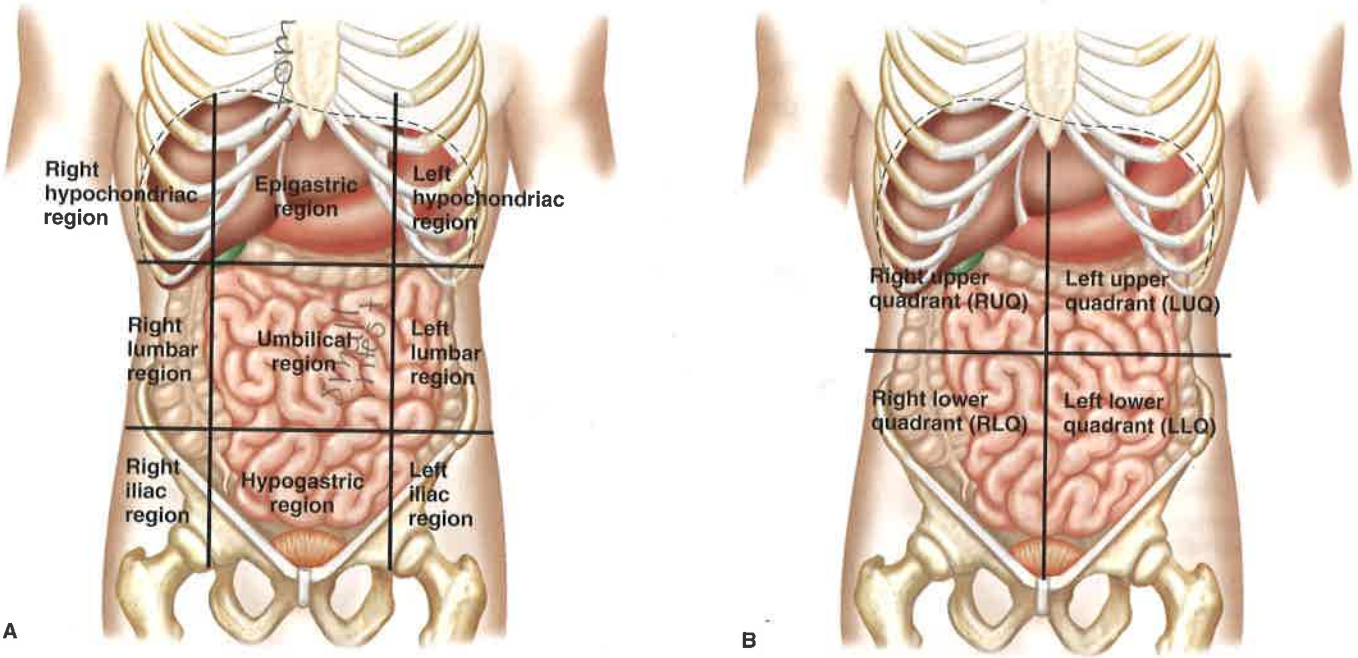
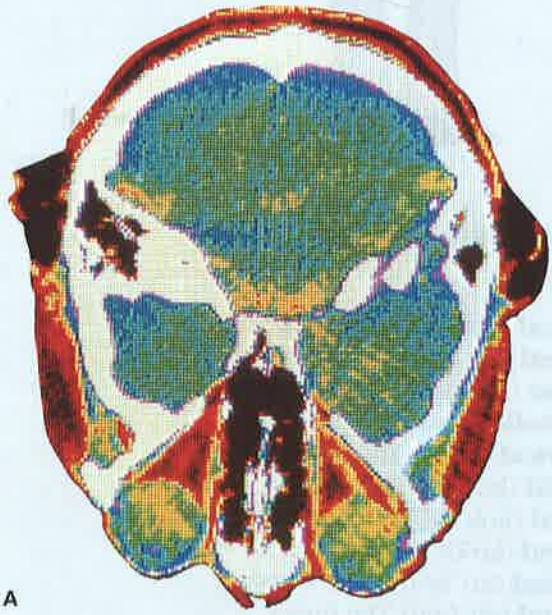


Figure 1.13
There are two common ways to subdivide the abdominal area. (*A*) The abdominal area is subdivided into nine regions. (*B*) The abdominal area may also be subdivided into four quadrants.

Radiologists use a procedure called *computerized tomography*, or CT scanning, to visualize internal organ sections (fig. 1A). In this procedure, an X-ray-emitting device moves around the body region being examined. At the same time, an X-ray detector moves in the opposite direction on the other side. As the devices move, an X-ray beam passes through the body from hundreds of different angles.

Since tissues and organs of varying composition within the body absorb X rays differently, the amount of X ray reaching the detector varies from position to position. A computer records the measurements from the X-ray detector, and combines them mathematically to create a sectional image of the internal body parts on a viewing screen.



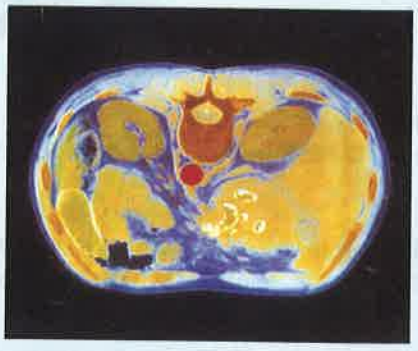


Figure 1A
Falsely colored CT (computerized tomography) scans of the (A) head and (B) abdomen. Note: These are not shown in correct relative size.

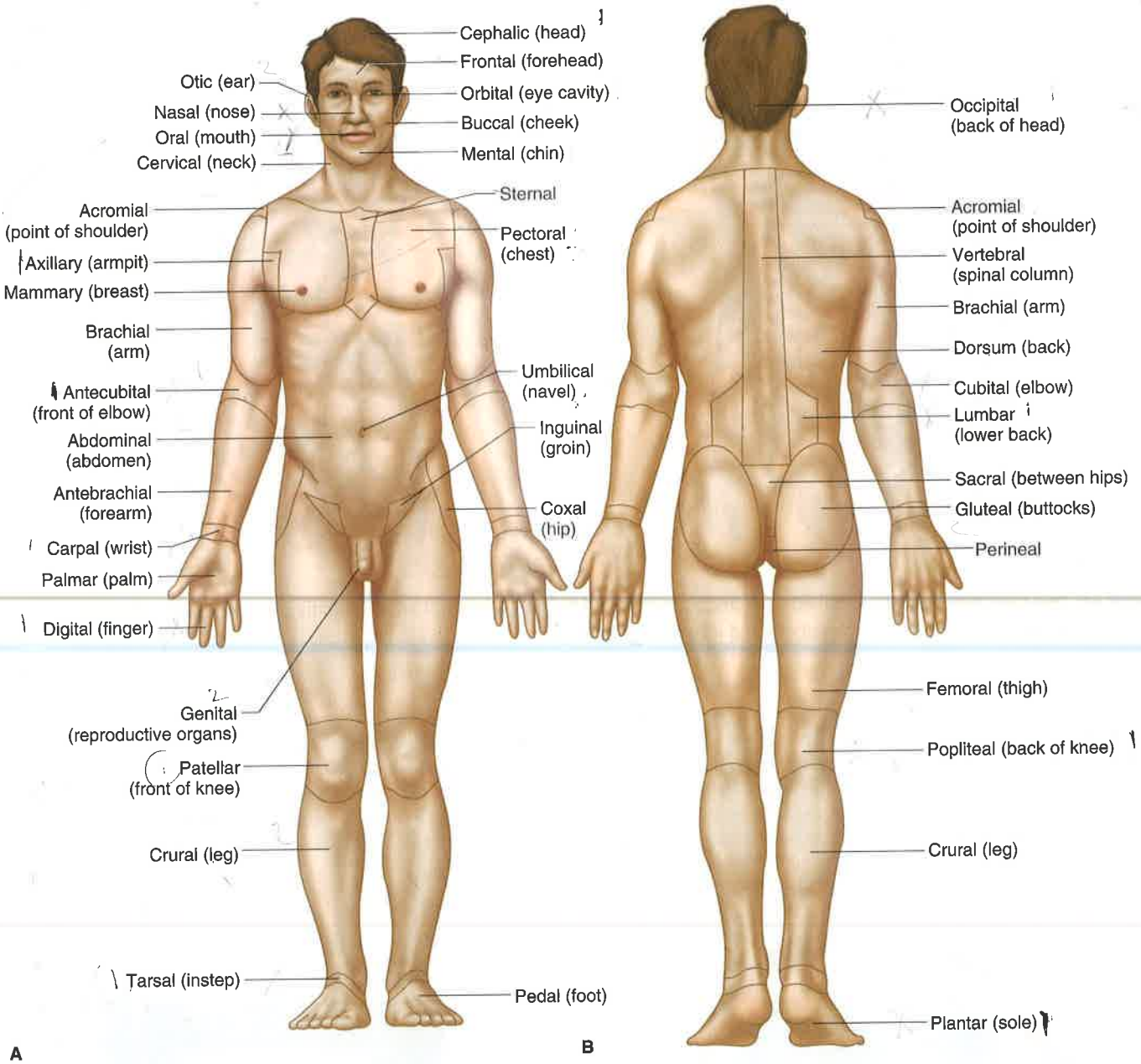


Figure 1.14
Some terms used to describe body regions. (*A*) Anterior regions. (*B*) Posterior regions.

The following terms are commonly used to refer to various body regions, some of which are illustrated in figure 1.14:

abdominal (ab-dom´ĭ-nal) The region between the thorax and pelvis.
acromial (ah-kro´me-al) The point of the shoulder.
antebrachial (an´´te-bra´ke-al) The forearm.
antecubital (an´´te-ku´bĭ-tal) The space in front of the elbow.
axillary (ak´sĭ-ler´´e) The armpit.
brachial (bra´ke-al) The arm.
buccal (buk´al) The cheek.
carpal (kar´pal) The wrist.
celiac (se´le-ak) The abdomen.
cephalic (sĕ-fal´ik) The head.
cervical (ser´vĭ-kal) The neck.
costal (kos´tal) The ribs.
coxal (kok´sal) The hip.
crural (kroor´al) The leg.
cubital (ku´bĭ-tal) The elbow.
digital (dij´ĭ-tal) The finger.
dorsal (dor´sal) The back.

femoral (fem´or-al) The thigh.
frontal (frun´tal) The forehead.
genital (jen´ĭ-tal) The reproductive organs.
gluteal (gloo´te-al) The buttocks.
inguinal (ing´gwĭ-nal) The depressed area of the abdominal wall near the thigh (groin).
lumbar (lum´bar) The region of the lower back between the ribs and the pelvis (loin).
mammary (mam´er-e) The breast.
mental (men´tal) The chin.
nasal (na´zal) The nose.
occipital (ok-sip´ĭ-tal) The lower posterior region of the head.
oral (o´ral) The mouth.
orbital (or´bi-tal) The eye cavity.
otic (o´tik) The ear.
palmar (pahl´mar) The palm of the hand.
patellar (pah-tel´ar) The front of the knee.
pectoral (pek´tor-al) The chest.
pedal (ped´al) The foot.
pelvic (pel´vik) The pelvis.
perineal (per´´ĭ-ne´al) The region between the anus and the external reproductive organs (perineum).
plantar (plan´tar) The sole of the foot.
popliteal (pop´´lĭ-te´al) The area behind the knee.
sacral (sa´kral) The posterior region between the hipbones.
sternal (ster´nal) The middle of the thorax, anteriorly.
tarsal (tahr´sal) The instep of the foot.
umbilical (um-bil´ĭ-kal) The navel.
vertebral (ver´te-bral) The spinal column.

CHECK YOUR RECALL

1. Describe the anatomical position.
2. Using the appropriate terms, describe the relative positions of several body parts.
3. Describe the three types of body sections.
4. Name the nine regions of the abdomen.

Some Medical and Applied Sciences

cardiology (kar´´de-ol´o-je) Branch of medical science dealing with the heart and heart diseases.
cytology (si-tol´o-je) Study of the structure, function, and abnormalities of cells.
dermatology (der´´mah-tol´o-je) Study of the skin and its diseases.
endocrinology (en´´do-krĭ-nol´o-je) Study of hormones, hormone-secreting glands, and their diseases.
epidemiology (ep´´ĭ-de´´me-ol´o-je) Study of the factors determining the distribution and frequency of health-related conditions occurring within a defined human population.
gastroenterology (gas´´tro-en´´ter-ol´o-je) Study of the stomach and intestines and their diseases.
geriatrics (jer´´e-at´riks) Branch of medicine dealing with older individuals and their medical problems.
gerontology (jer´´on-tol´o-je) Study of the aging process.
gynecology (gi´´nĕ-kol´o-je) Study of the female reproductive system and its diseases.
hematology (hēm´´ah-tol´o-je) Study of the blood and blood diseases.
histology (his-tol´o-je) Study of the structure and function of tissues, also called microscopic anatomy.
immunology (im´´u-nol´o-je) Study of the body's resistance to infectious disease.
neonatology (ne´´o-na-tol´o-je) Study of newborns and the treatment of their disorders.
nephrology (nĕ-frol´o-je) Study of the structure, function, and diseases of the kidneys.
neurology (nu-rol´o-je) Study of the nervous system and its disorders.
obstetrics (ob-stet´riks) Branch of medicine dealing with pregnancy and childbirth.
oncology (ong-kol´o-je) Study of cancers.
ophthalmology (of´´thal-mol´o-je) Study of the eye and eye diseases.
orthopedics (or´´tho-pe´diks) Branch of medicine dealing with the muscular and skeletal systems and their problems.
otolaryngology (o´´to-lar´´in-gol´o-je) Study of the ear, throat, and larynx, and their diseases.
pathology (pah-thol´o-je) Study of structural and functional changes that disease causes.
pediatrics (pe´´de-at´riks) Branch of medicine dealing with children and their diseases.
pharmacology (fahr´´mah-kol´o-je) Study of drugs and their uses in the treatment of disease.
podiatry (po-di´ah-tre) Study of the care and treatment of feet.
psychiatry (si-ki´ah-tre) Branch of medicine dealing with the mind and its disorders.
radiology (ra´´de-ol´o-je) Study of X rays and radioactive substances and their uses in the diagnosis and treatment of diseases.
toxicology (tok´´sĭ-kol´o-je) Study of poisonous substances and their effects upon body parts.
urology (u-rol´o-je) Branch of medicine dealing with the urinary system, apart from the kidneys (nephrology) and the male reproductive system, and their diseases.

SUMMARY OUTLINE

1.1 Introduction (p. 3)

1. Early interest in the human body probably developed as people became concerned about injuries and illnesses.
2. Primitive doctors began to learn how certain herbs and potions affected body functions.
3. The belief that humans could understand forces that caused natural events led to the development of modern science.
4. A set of terms originating from Greek and Latin words is the basis for the language of anatomy and physiology.

1.2 Anatomy and Physiology (p. 3)

1. Anatomy describes the form and organization of body parts.
2. Physiology considers the functions of anatomical parts.
3. The function of an anatomical part depends on the way it is constructed.

1.3 Characteristics of Life (p. 4)

Characteristics of life are traits all organisms share.

1. These characteristics include:
   a. Movement—changing body position or moving internal parts.
   b. Responsiveness—sensing and reacting to internal or external changes.
   c. Growth—increasing size without changing shape.
   d. Reproduction—producing offspring.
   e. Respiration—obtaining oxygen, using oxygen to release energy from foods, and removing gaseous wastes.
   f. Digestion—breaking down food substances into component nutrients that the intestine can absorb.
   g. Absorption—moving substances through membranes and into body fluids.
   h. Circulation—moving substances through the body in body fluids.
   i. Assimilation—changing substances into chemically different forms.
   j. Excretion—removing body wastes.
2. Acquisition and use of energy constitute metabolism.

1.4 Maintenance of Life (p. 4)

The structures and functions of body parts maintain the life of the organism.

1. Requirements of organisms
   a. Water is used in many metabolic processes, provides the environment for metabolic reactions, and transports substances.
   b. Food supplies energy, raw materials for building new living matter, and chemicals necessary in vital reactions.
   c. Oxygen releases energy from food materials. This energy drives metabolic reactions.
   d. Heat is a product of metabolic reactions and helps govern the rates of these reactions.
   e. Pressure is an application of force to something. In humans, atmospheric and hydrostatic pressures help breathing and blood movements, respectively.
2. Homeostasis
   a. If an organism is to survive, the conditions within its body fluids must remain relatively stable.
   b. Maintenance of a stable internal environment is called *homeostasis.*
   c. Homeostatic mechanisms help regulate body temperature and blood pressure.
   d. Homeostatic mechanisms act through negative feedback.

1.5 Levels of Organization (p. 7)

The body is composed of parts with different levels of organization.

1. Matter is composed of atoms.
2. Atoms join to form molecules.
3. Organelles are built of groups of large molecules.
4. Cells, which contain organelles, are the basic units of structure and function that form the body.
5. Cells are organized into tissues.
6. Tissues are organized into organs.
7. Organs that function closely together comprise organ systems.
8. Organ systems constitute the organism.
9. These levels of organization vary in complexity from one level to the next.

1.6 Organization of the Human Body (p. 8)

1. Body cavities
   a. The axial portion of the body contains the dorsal and ventral cavities.
      (1) The dorsal cavity includes the cranial cavity and the vertebral canal.
      (2) The ventral cavity includes the thoracic and abdominopelvic cavities, which are separated by the diaphragm.
   b. The organs within a body cavity are called *viscera.*
   c. The mediastinum separates the thoracic cavity into right and left compartments.
   d. Other body cavities include the oral, nasal, orbital, and middle ear cavities.
2. Thoracic and abdominopelvic membranes
   a. Thoracic membranes
      (1) Pleural membranes line the thoracic cavity (parietal pleura) and cover the lungs (visceral pleura).
      (2) Pericardial membranes surround the heart (parietal pericardium) and cover its surface (visceral pericardium).
      (3) The pleural and pericardial cavities are the potential spaces between the respective parietal and visceral membranes.
   b. Abdominopelvic membranes
      (1) Peritoneal membranes line the abdominopelvic cavity (parietal peritoneum) and cover the organs inside (visceral peritoneum).
      (2) The peritoneal cavity is the potential space between the parietal and visceral membranes.
3. Organ systems
   The human organism consists of several organ systems. Each system includes a set of interrelated organs.
   a. Body covering
      (1) The integumentary system includes the skin, hair, nails, sweat glands, and sebaceous glands.
      (2) It protects underlying tissues, regulates body temperature, houses sensory receptors, and synthesizes various substances.
   b. Support and movement
      (1) Skeletal system
         (a) The skeletal system is composed of bones, as well as cartilages and ligaments that bind bones together.
         (b) It provides a framework, protective shields, and attachments for muscles. It also produces blood cells and stores inorganic salts.
      (2) Muscular system
         (a) The muscular system includes the muscles of the body.
         (b) It moves body parts, maintains posture, and produces body heat.

c. Integration and coordination
   (1) Nervous system
      (a) The nervous system consists of the brain, spinal cord, nerves, and sense organs.
      (b) It receives impulses from sensory parts, interprets these impulses, and acts on them by stimulating muscles or glands to respond.
   (2) Endocrine system
      (a) The endocrine system consists of glands that secrete hormones.
      (b) Hormones help regulate metabolism.
      (c) This system includes the pituitary, thyroid, parathyroid, and adrenal glands, as well as the pancreas, ovaries, testes, pineal gland, and thymus gland.
d. Transport
   (1) Cardiovascular system
      (a) The cardiovascular system includes the heart, which pumps blood, and the blood vessels, which carry blood to and from body parts.
      (b) Blood transports oxygen, nutrients, hormones, and wastes.
   (2) Lymphatic system
      (a) The lymphatic system is composed of lymphatic vessels, lymph fluid, lymph nodes, thymus gland, and spleen.
      (b) It transports lymph fluid from tissues to the bloodstream, carries certain fatty substances away from the digestive organs, and aids in defending the body against disease-causing agents.
e. Absorption and excretion
   (1) Digestive system
      (a) The digestive system receives foods, breaks down food molecules into nutrients that can pass through cell membranes, and eliminates materials that are not absorbed.
      (b) It includes the mouth, tongue, teeth, salivary glands, pharynx, esophagus, stomach, liver, gallbladder, pancreas, small intestine, and large intestine.
      (c) Some digestive organs produce hormones.
   (2) Respiratory system
      (a) The respiratory system takes in and sends out air and exchanges gases between the air and blood.
      (b) It includes the nasal cavity, pharynx, larynx, trachea, bronchi, and lungs.
   (3) Urinary system
      (a) The urinary system includes the kidneys, ureters, urinary bladder, and urethra.
      (b) It filters wastes from the blood and helps maintain water, acid-base, and electrolyte balance.
f. Reproduction
   (1) The reproductive systems produce new organisms.
   (2) The male reproductive system includes the scrotum, testes, epididymides, vasa deferentia, seminal vesicles, prostate gland, bulbourethral glands, urethra, and penis, which produce, maintain, and transport male sex cells.
   (3) The female reproductive system includes the ovaries, uterine tubes, uterus, vagina, clitoris, and vulva, which produce, maintain, and transport female sex cells.

1.7 Anatomical Terminology (p. 13)

Terms with precise meanings help investigators communicate effectively.

1. Relative positions
   These terms describe the location of one part with respect to another part.
2. Body sections
   Body sections are planes along which the body may be cut to observe the relative locations and organizations of internal parts.
3. Body regions
   Special terms designate various body regions.

REVIEW EXERCISES

Part A

1. Briefly describe the early development of knowledge about the human body. (p. 3)
2. Distinguish between anatomy and physiology. (p. 3)
3. Explain the relationship between the form and function of body parts. (p. 3)
4. List and describe ten characteristics of life. (p. 4)
5. Define *metabolism.* (p. 4)
6. List and describe five requirements of organisms. (p. 4)
7. Describe two types of pressure that may act on the outside of an organism. (p. 5)
8. Define *homeostasis,* and explain its importance. (p. 5)
9. Explain the control of body temperature. (p. 6)
10. Describe a homeostatic mechanism that helps regulate blood pressure. (p. 6)
11. List the levels of organization within the human body. (p. 7)
12. Distinguish between the axial and appendicular portions of the body. (p. 8)
13. Distinguish between the dorsal and ventral body cavities, and name the smaller cavities within each. (p. 8)
14. Explain what is meant by *viscera.* (p. 8)
15. Describe the mediastinum and its contents. (p. 8)
16. List the cavities of the head and the contents of each cavity. (p. 10)
17. Distinguish between a parietal and a visceral membrane. (p. 10)
18. Name the major organ systems, and describe the general functions of each. (p. 12)
19. List the major organs that comprise each organ system. (p. 12)

Part B

1. Name the body cavity that houses each of the following organs:
   a. Stomach
   b. Heart
   c. Brain
   d. Liver
   e. Trachea
   f. Rectum
   g. Spinal cord
   h. Esophagus
   i. Spleen
   j. Urinary bladder

2. Write complete sentences using each of the following terms correctly:
   a. Superior
   b. Inferior
   c. Anterior
   d. Posterior
   e. Medial
   f. Lateral
   g. Proximal
   h. Distal
   i. Superficial
   j. Peripheral
   k. Deep
3. Sketch a human body, and use lines to indicate each of the following sections:
   a. Sagittal
   b. Transverse
   c. Coronal
4. Sketch the abdominal area, and indicate the location of each of the following regions:
   a. Epigastric
   b. Umbilical
   c. Hypogastric
   d. Hypochondriac
   e. Lumbar
   f. Iliac
5. Provide the common name for the region to which each of the following terms refers:
   a. Acromial
   b. Antebrachial
   c. Axillary
   d. Buccal
   e. Celiac
   f. Coxal
   g. Crural
   h. Femoral
   i. Genital
   j. Gluteal
   k. Inguinal
   l. Mental
   m. Occipital
   n. Orbital
   o. Otic
   p. Palmar
   q. Pectoral
   r. Pedal
   s. Perineal
   t. Plantar
   u. Popliteal
   v. Sacral
   w. Sternal
   x. Tarsal
   y. Umbilical
   z. Vertebral

CRITICAL THINKING

1. Which characteristics of life does an automobile have? Why is a car not alive?
2. What environmental characteristics would be necessary for a human to survive on another planet?
3. Overweight people who lose weight often find it difficult to keep the weight off because a set point for the body's fat stores changes as the body perceives itself as starving. Explain how this protective mechanism, of great frustration to dieters, might operate.
4. Put the following in order, from smallest to largest: organ, molecule, organelle, atom, organ system, tissue, organism, cell, macromolecule.
5. Why is lung cancer that has spread to the mediastinum very dangerous?
6. You are building an android. Choose a human organ system, and state which materials you would use to model it in the android.
7. In health, body parts interact to maintain homeostasis. Illness can threaten the maintenance of homeostasis, requiring treatment. What treatments might be used to help control a patient's (*a*) body temperature, (*b*) blood oxygen concentration, and (*c*) water content?
8. Suppose two individuals develop benign (noncancerous) tumors that produce symptoms because they occupy space and crowd adjacent organs. If one of these persons has the tumor in the ventral cavity and the other has the tumor in the dorsal cavity, which person would be likely to develop symptoms first? Why?
9. If a patient complained of a "stomachache" and pointed to the umbilical region as the site of discomfort, which organs located in this region might be the source of the pain?
10. How might health-care professionals provide the basic requirements of life to an unconscious patient?

WEB CONNECTIONS

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