

# Introduction to the Human Body

## Learning Objectives

After studying this chapter you should be able to:

### Anatomy and Physiology Defined

1. Define anatomy and physiology.

### Structural Levels of Organization

2. Describe the structural organization of the human body.
3. Identify the 11 systems that make up the human organism.

### The Characteristics of Life

4. State the six characteristics of life.

### Basic Terminology

5. Discuss the location of body parts using proper directional terms.

### The Body Plan

6. Describe the organization of the human body.

### Homeostasis: The Balance of Life

7. Discuss the process of homeostasis and provide an example of negative and positive feedback in human functioning.
8. Define disease and its relationship to homeostasis.

## The Big Picture

In the course of a week or two, you may probably notice several disturbing health-related headlines, such as:

*Flesh-eating Bacteria Takes Another Victim*

*New Study Links Stress and Strokes*

*Hookahs: As Risky as Cigarettes?*

If so, you've probably also wondered how these issues might affect you or your loved ones, and what you could do to stay healthy. Fortunately, you've already taken the first step toward reducing your risk of falling victim to such threats: you've enrolled in a course that's all about your body's structure and function. Success in this course will enable you to understand your body and actively participate in your healthcare. It will also empower you with the ability to make informed choices about your lifestyle, such as what to eat, how much to exercise, and what alcohol, tobacco, and other drugs do to your health.

You might have enrolled in this course because you're thinking of pursuing a health-related career. If this is the case, your study of body structure and function will lay a foundation for later application in your chosen clinical field. The knowledge

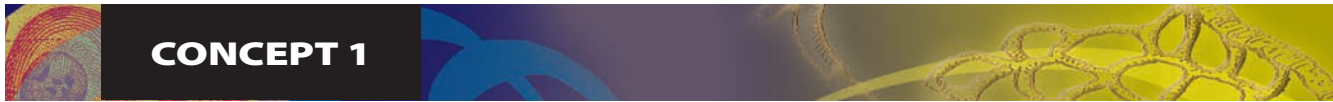
## Key Terms

anabolism  
 anatomy  
 atom  
 catabolism  
 cavity  
 cell  
 disease  
 homeostasis  
 metabolism  
 molecule  
 organ  
 organism  
 physiology  
 system  
 tissue

you gain will prepare you to communicate with other healthcare providers, and help you distinguish between health and disease.

This chapter begins your study of human structure and function. It sets out the basic information we'll build upon in the chapters that follow. The chapter opens by introducing the sciences of structure and function: anatomy and physiology. Next,

it introduces you to the general organization of the body, followed by the characteristics of living things. You'll then begin to learn some of the language of anatomy, which is shared by all healthcare professionals. The chapter concludes by considering the delicate balance that is maintained everyday between health and disease, and the very nature of human disease.



## CONCEPT 1

### Anatomy and Physiology Defined

**Concept:** The study of the human body is an interdisciplinary science. It consists of fields that focus on structure or function at many levels.

The traditional study of the human body is divided into two primary areas of discipline: anatomy and physiology. Anatomy is the study of body structure, and physiology is the study of body function. Together, anatomy and physiology serve to describe the details of the human body. Throughout this book, discussions of anatomy and physiology are carefully interwoven to give you a full and balanced picture of the human body.

#### Anatomy

**Anatomy** (from the Greek words *ana* = up and *tome* = cutting) is the field of study that is concerned with the structure of body parts. It describes the location, appearance, and relationships of the various components of the body. The goal of the anatomist is to answer such basic questions as:

*Where is it located?*

*What does it look like?*

*How does it relate to other body parts?*

The most important tool of the anatomist in determining body structure is the power of observation. In the early years of science and medicine, anatomists relied on their eyesight during postmortem (after death) studies of human bodies. They recorded their careful observations in a library of artistic drawings accompanied by detailed descriptions. From this early body of information arose a basic understanding of *gross anatomy*, which is the study of body structure that is visible without the aid of a microscope.

With the introduction of the microscope during the 17th century, the examination of the body's minute components became possible. This important development gave birth to an area of specialized study

called *microanatomy*, which has brought us a more complete understanding of body structure. Over the years, the microscope has been vastly improved and modified to its present forms, which include powerful electron microscopes capable of amplifying body components by as many as one million times!

As knowledge of body structure has grown over the years, it has become necessary to divide anatomy into more specific areas of study. Gross anatomy includes *surface anatomy*, which refers to a study of general form and surface markings, and *medical anatomy*, which is concerned with structural features that undergo change during disease. A study of microanatomy that focuses on the study of cells (red blood cells, cartilage cells, etc.) is known as *cytology*, and one that studies the combinations of cells that form the body's tissues (muscle tissue, bone tissue, etc.) is known as *histology*.

You should also be aware of two primary approaches to the study of anatomy. *Systematic anatomy* studies all of the structures within a given body *system*, such as the skeletal system or nervous system. *Regional anatomy*, by contrast, examines all structures within a given region of the body, such as the head or leg. This book is organized using the systematic approach to anatomy, and employs both gross anatomy and microanatomy when examining body structures.

#### Physiology

**Physiology** (from the Greek words *physio* = nature and *-logia* = study) is the study of body function. It is a scientific discipline that explains the mechanisms operating body activities. The physiologist's primary goal is to answer the simple question:

*How does it work?*

Discoveries in physiology usually involve conducting experiments, during which an idea, or *hypothesis*, is tested using unbiased methods. Examples of functions of the body that have been discovered experimentally include how muscle contracts to produce movement; how cells of the brain are able to provide you with thoughts, dreams, and memories; and how broken bones repair themselves.

## CONCEPT CHECK

1. What is the focus of study in anatomy?
2. What are the major subdisciplines within anatomy?
3. What question does the physiologist seek to answer?

## CONCEPT 2

### Structural Levels of Organization

**Concept:** The human body is composed of microscopic building blocks arranged into a series of increasingly complex structures. Health depends upon every level functioning properly.

The human body is composed of a series of building blocks that combine to form progressively larger and more complex units. There are six distinct levels, called **structural levels of organization**, which are shown in Figure 1.1. Maintaining the organization of the building blocks is vital to the health of the whole individual.

#### Chemical Level

The most basic level of body organization is the **chemical level**. Chemicals are nonliving substances composed of *elements*; elements are units of matter that cannot be simplified further under natural conditions. Familiar examples are hydrogen, oxygen, and carbon. The smallest quantity of an element is an **atom**. When atoms interact, they may combine by bonding to form **molecules**. Figure 1.1 depicts two atoms of the element hydrogen (H), in red, and an atom of the element oxygen (O), in blue, bonding to form a molecule of water (H<sub>2</sub>O). Large molecules containing many atoms, called macromolecules, provide the structural foundation for the body and include proteins, lipids, carbohydrates, and nucleic acids.

#### Cellular Level

Molecules and macromolecules may combine to form larger, more organized structures known as organelles. A variety of organelles make up the most basic living unit of the body, the **cell**. As living units, all cells perform six functions necessary to sustain life. (These functions are identified shortly.) There are many types of cells in the body, each with

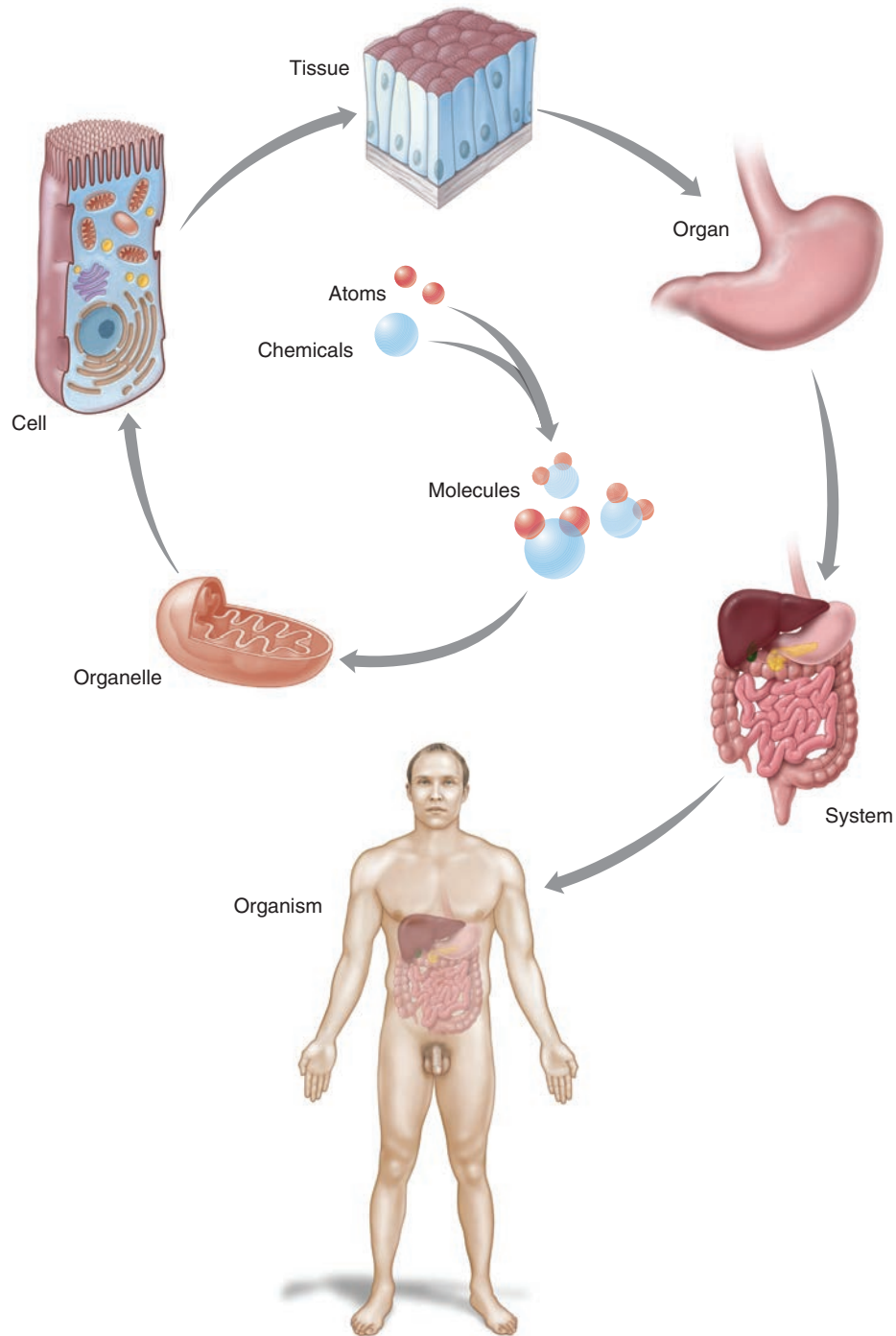
its own role to play for the benefit of the body as a whole. An organelle and a single cell are illustrated in Figure 1.1.

#### Tissue Level

Cells usually form connections with other cells or cell products to form larger, more organized structures known as **tissues**. The individual cells that form a tissue are usually similar in structure and their combination together results in the tissue performing a more widespread function, providing a greater benefit to the body than an individual cell could provide on its own. For example, a tissue may provide protection for larger body structures, movement of a body part, or a means of communication between distant body areas. Thus, a tissue is defined as a group of similar cells that combine to perform a common function. As you will see in Chapter 4, there are only four major types of tissues in the body: *epithelial*, *connective*, *muscle*, and *nerve*. Figure 1.1 shows a group of cells organized to form a tissue. In this case, they are epithelial cells of the stomach.

#### Organ Level

Combinations of tissues form the next level of organization, an **organ**. Organs consist of two or more different types of tissues that, when combined, perform a general function. For example, the stomach is an organ that contains all four types of tissues, and performs the functions of mixing food, storing it, and beginning protein digestion. The stomach is shown in Figure 1.1.





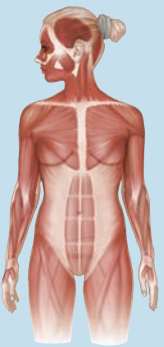
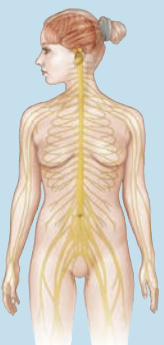
■ **Figure 1.1. Structural levels of organization.** Atoms and molecules make up the chemical level. These combine to make subunits of cells, called organelles, and cells, the smallest living components of the body. Cells combine to form tissues, organs, systems, and the human organism. ► *What is the organized combination of two or more different types of tissue into a single structure called?*

## System Level

A **system** is an organization of two or more different organs, along with their associated structures. Because a system contains more than one organ, the functions it performs are of a more general nature. For example,

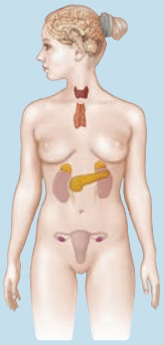
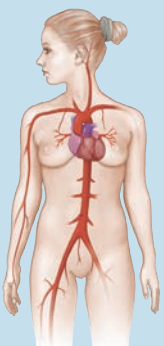
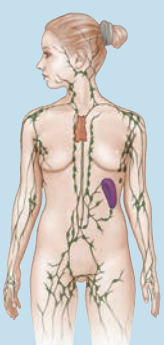
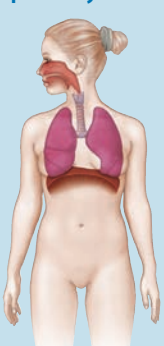
the stomach, liver, and small intestine are a few of the organs of the digestive system (Figure 1.1). Their combined function is the digestion of food into nutrients that can be used by body cells. The 11 systems of the body are identified in Table 1.1.

**Table 1.1 The 11 Systems of the Body**

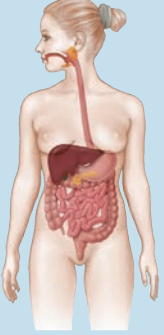
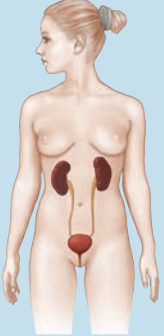
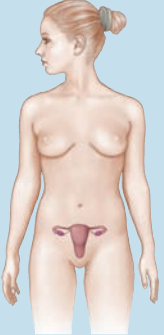
System	Major Organs	System Functions
<b>Integumentary</b> 	Skin	Protects underlying tissues, prevents fluid loss, temperature regulation
<b>Skeletal</b> 	Bones, joints	Supports and protects softer body parts, stores minerals, produces blood cells
<b>Muscular</b> 	Skeletal muscles	Produces movement of bones at joints, generates heat
<b>Nervous</b> 	Brain, spinal cord, nerves	Monitors changes in the environment, interprets the changes, and initiates a response

(continued)

**Table 1.1 The 11 Systems of the Body (continued)**

System	Major Organs	System Functions
<b>Endocrine</b> 	Pituitary gland, thyroid gland, parathyroid glands, adrenal glands, pancreas, thymus	Alters the activity of cells by the release of hormones, in response to changes in the body
<b>Cardiovascular</b> 	Heart, blood vessels	Transports blood throughout all areas of the body
<b>Lymphatic</b> 	Spleen, thymus, tonsils, lymph nodes, lymphatic vessels	Protects the body from foreign particles and cells, removes dead and diseased cells, recycles fluid back to the cardiovascular system
<b>Respiratory</b> 	Nose, pharynx, larynx, trachea, bronchi, lungs	Exchanges gasses between the bloodstream and the external environment

**Table 1.1 The 11 Systems of the Body (continued)**

System	Major Organs	System Functions
<p><b>Digestive</b></p> 	<p>Mouth, salivary glands, pharynx, esophagus, stomach, small intestine, large intestine, liver, pancreas, gallbladder</p>	<p>Simplifies food particles into their basic nutrient subunits for absorption into the bloodstream</p>
<p><b>Urinary</b></p> 	<p>Kidneys, ureters, urinary bladder, urethra</p>	<p>Forms urine to maintain water and salt balance, pH, and nitrogenous waste levels in the blood</p>
<p><b>Reproductive</b></p> 	<p>Male: testes, ductus deferens, urethra, penis, scrotum. Female: ovaries, uterine tubes, uterus, vagina, vulva</p>	<p>Produces gametes to undergo fertilization for the creation of new individuals</p>

Images modified with permission from Nath JL. *Using Medical Terminology: A Practical Approach*, 2nd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2013.

### The Complete Organism

The **organism** is composed of many systems, each of which depends on the others to perform its tasks. When all of the systems of the body are operating in harmony, the organism, or whole individual, is capable of surviving. Survival and reproduction are the ultimate goals underlying all of the body's internal activities.

### CONCEPT CHECK

4. Identify one nonliving building block of the body.
5. What is the basic structural and functional unit of life?
6. Explain how a tissue differs from an organ.

CONCEPT 3

## The Characteristics of Life

**Concept:** All living cells are capable of organization, metabolism, movement, excitability, growth, and reproduction.

You have just learned that cells are the most basic unit of life. Thus, a cell is alive, but its smaller chemical components are not. How does science make the distinction between something that is alive and something that is not? Biologists—scientists who study living things—have arrived at the following basic explanation: any single entity that is capable of organization, metabolism, movement, excitability, growth, and reproduction is capable of life. All cells in the human body share these six characteristics. The life of a cell would be threatened if one or more of these functions were to fail.

### Organization

The molecules that make up our world are governed by a set of physical laws. These laws control the properties of the molecules, such as their mass, their reaction rates, and how fast they move. Because all molecules that make up the cell are governed by the same physical laws, they are able to provide the cell with a structure that is relatively stable. The stable structure, or **organization**, of the cell makes it possible for the cell to perform its various functions. The stable organization of the cell, in turn, provides a structural foundation for the organization of the body.

### Metabolism

The process by which the body obtains and uses energy is called **metabolism** (from the Greek words *metabole* = change and *-ism* = a condition) (meh-TAB-oh-lizm). Because we are not capable of producing our own energy, we meet our energy needs by taking in materials from the external environment. The food we eat is broken down into smaller particles in a process of metabolism known as **digestion**. The particles that are useful to the body as fuel enter into cells, where they are broken down further to release energy. The body uses this energy to power all of life's activities, including the synthesis of new materials, the movement of cells and their components, the transport of materials, and the generation of heat.

There are two types of metabolism. Digestion is an example of the form known as **catabolism** (kah-TAB-oh-lizm). Catabolic processes break larger mol-

ecules apart, reducing them into simpler molecules. During catabolism, energy is released as a byproduct. The second form of metabolism is called **anabolism** (ah-NAB-oh-lizm). In anabolic processes, the body uses energy to build larger molecules, cells, and tissues from simpler molecules. Anabolism allows for growth from infancy to adulthood, tissue maintenance and repair, and the assembly of the thousands of different chemicals the body needs to function each day.

### Movement

The constant **movement** of molecules within and around a cell is an important feature of a cell's dynamic nature. Movement is necessary for the transport of vital materials into, out of, and through different regions of a cell, as well as the transport of waste products out of a cell.

The cell itself may also move. For example, many white blood cells wander throughout the body actively searching for invading microorganisms. Muscle cells also display movement: they change their length by contracting and relaxing. These actions in turn produce the movement of bones at joints, the beating of the heart, the churning actions of the stomach, and many other body movements.

### Excitability

The capability of a cell to respond to changes in its environment is called **excitability** or irritability. An environmental change may be a change in temperature, a change in pressure, an invasion by a foreign substance, exposure to a form of radiation, or exposure to a chemical substance. Environmental changes that influence cells are called *stimuli*. Every cell is capable of receiving stimuli and responding to them. However, different types of cells respond in different ways. For example, certain cells of the nervous and endocrine systems are highly specialized to respond quickly to stimuli and pass this response to other cells. Their goal in this regard is to maintain the body in a stable state despite changes that occur in the environment.

### Growth

**Growth** refers to enlargement of a cell or the body as a whole. All cells are capable of growth at some stage

in their life history. Cellular growth occurs when a cell increases in size as a result of anabolic activities that produce new molecules. When a cell reaches its maximum size, it may divide into two identical cells to increase the number of cells in the body. An increase in cell number provides for the body growth that occurs before birth, during childhood, and through adolescence.

## Reproduction

Cellular **reproduction**, or cell division, is the process by which a single cell divides into two or more cells. Reproduction is the method by which dead cells are replaced and the growth of tissues and organs occurs.

Cell division also provides for the creation of a new organism through the process of sexual reproduction.

## CONCEPT CHECK

7. What is the collective goal of the functions that are characteristic of life?
8. Define metabolism.
9. Explain the difference between the two metabolic processes, anabolism and catabolism.
10. How is the movement of molecules important for life?

## CONCEPT 4

### Basic Terminology

**Concept:** The language used to describe the human body is universal, with an established set of terms.

In the world of science and medicine, a language has developed over the years that improves the accuracy of communication, enabling scientists and health-care professionals to understand one another across the continents despite differences in native language, culture, and position of the subject. This universal language is primarily based on Greek and Latin word parts—prefixes, word roots, and suffixes—that are put together to form new words. The word parts are usually descriptive of the body part or function they identify and help eliminate the need for lengthy explanations. In most cases, a prefix is placed before the word root and modifies its meaning, the word root carries the primary meaning, and the suffix follows the word root. Let's look at some examples:

- The term *hypothalamus* refers to a part of the brain that lies below the thalamus in the center of the brain. The term is composed of the prefix *hypo-*, which means “below” in Greek, and the word root *thalamus*, which is Greek for “middle chamber.”
- The term *renal tubule* refers to a microscopic tube within the kidney: *ren* is a Latin word for “kidney” and *tubule* is Latin for “tiny tube.”
- The term *pericardium* is a membrane surrounding the heart. It is composed of the prefix *peri-*, which is a Latin word part meaning “to surround”; the word root *cardi*, which means “heart” in Latin; and the Latin suffix *-um*, which means “pertaining to.”

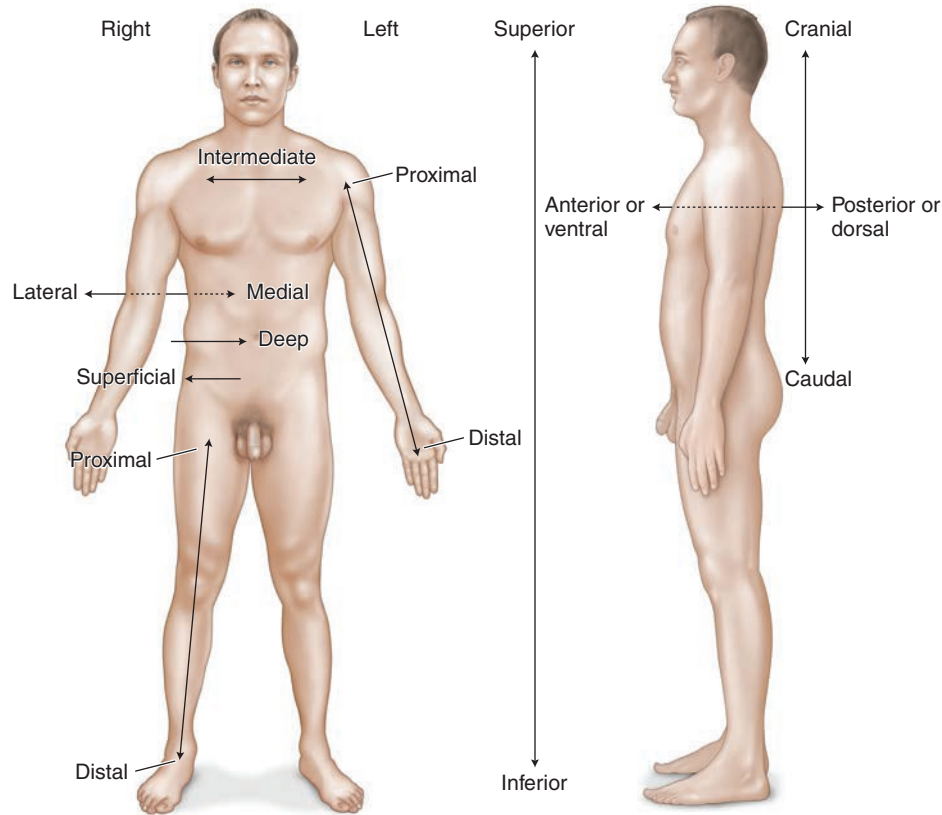
To assist your learning efforts, important anatomy and physiology terms are explained in the following

paragraphs and chapters by presenting their Greek and Latin word parts along with their meanings.

## Directional Terminology

The set of terms used to describe the location of one body structure relative to another is called **directional terminology**. Directional terminology is a valuable tool in anatomy as well as in healthcare because it abbreviates what might otherwise be lengthy and inaccurate descriptions. It also identifies body parts using a universally accepted position of the body as a point of reference. For example, let's say that a nurse wishes to describe the location of a bruise on a patient's arm. Using directional terminology, the nurse records: “The bruise is just distal to the elbow on the posterior right forearm.” This description would remain accurate no matter how the patient positioned the arm. Why? Because the nurse has described the location of the bruise using a universally accepted position of the body known as the **anatomical position**.

By definition, the anatomical position describes a body standing erect (upright) facing the observer, with the arms at the sides and the toes and palms turned forward (Figure 1.2). This position provides a point of reference, much like a direction key on a map pointing north, south, east, and west. It thereby provides directional bearings when you are “mapping” the human body. The directional terms that you will be using throughout your study are presented in Figure 1.2 and summarized in Table 1.2.



**Figure 1.2. Directional terms, with the human figure in an anatomical position. A.** Anterior view. **B.** Lateral view.  
 ► Can you identify a body part that is proximal to the hand?

**Table 1.2 Directional Terminology**

Directional Term	Definition	Example
Superior (cranial)	Toward the head end or upper part of the body	The heart is superior to the diaphragm.
Inferior (caudal)	Away from the head end or toward the lower end of the body	The chest is inferior to the head.
Anterior (ventral)	Toward the front or belly side	The nose is on the anterior side of the head.
Posterior (dorsal)	Toward the back side	The spinal cord extends down the posterior side of the body.
Medial	Toward the midline, an imaginary line extending vertically down the middle of the body	The sternum (breastbone) is medial to the ribs.
Lateral	Away from the midline	The ears are lateral to the nose.
Superficial (external)	Toward the surface of the body	The skin is superficial to the visceral organs.
Deep (internal)	Away from the surface of the body	The heart lies deep to the sternum.
Proximal	Toward a structure's origin or point of attachment to the trunk	The shoulder is proximal to the elbow.
Distal	Away from a structure's origin or point of attachment to the trunk	The wrist is distal to the shoulder.

### Sectional Planes

The problem of describing the structure of our complex, three-dimensional bodies is partly solved by the use of **planes**. A plane is a flat surface that results from a slice, or *section*, through the body. The section may be oriented in any direction so that it may pass through the body at a certain angle to reveal a particular plane. There are three primary body planes typically used by anatomists: frontal, sagittal (SA-jih-tal), and horizontal (Figure 1.3).

The **frontal plane** extends through the long axis of the body (i.e., along the body’s length). Also called the **coronal plane**, it divides the body into anterior (front) and posterior (back) portions. When the subject is standing upright in the anatomical position, the frontal plane extends in a vertical direction.

The **sagittal plane** also extends through the body’s long axis, but it divides the body into right and left portions. A sagittal plane dividing the body into equal right and left halves is called **midsagittal**, whereas one that divides the body unequally is called **parasagittal** (*para-* means “away from normal”).

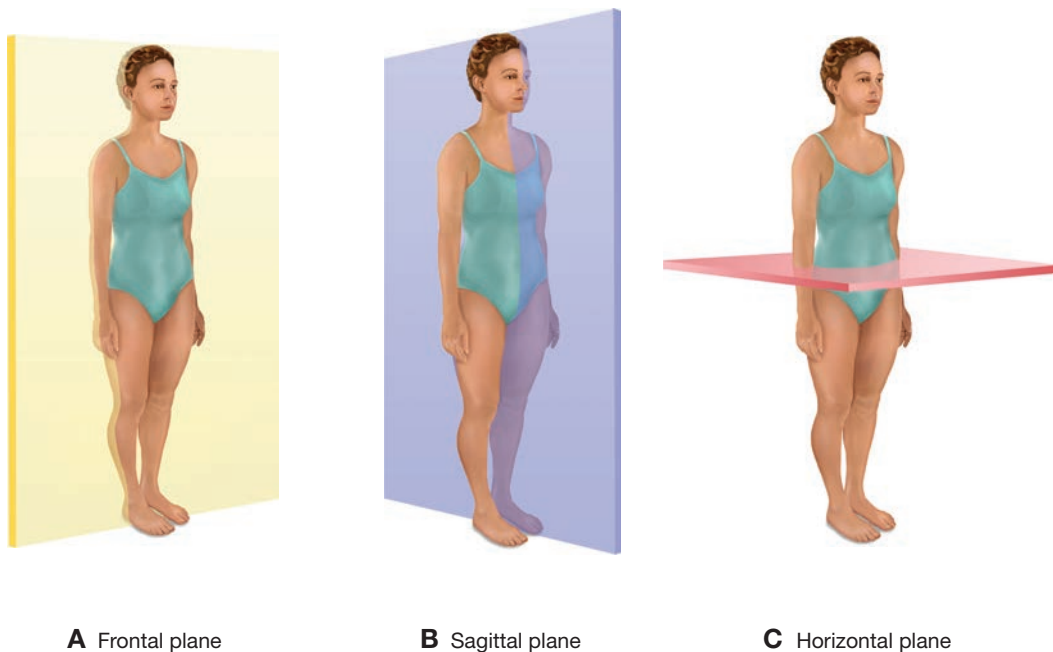
The **horizontal plane** extends in a direction perpendicular to the frontal and sagittal planes

since it divides the body into superior (upper) and inferior (lower) portions. The horizontal plane is also called the **transverse plane**. A section made along the horizontal plane is often referred to as a *cross section*.

When viewing diagnostic images of the body’s interior, it is important to know the plane along which the section was made. Notice that the planes are identified for the photos in the Health Clinic box, “Diagnostic Techniques,” on the next page.

### CONCEPT CHECK

11. What is the purpose of constructing scientific terms from Latin and Greek word parts?
12. Why should you use directional terms when describing the location of body parts instead of more common descriptions, such as on top of, below, or to the side?
13. What is a sectional plane?
14. How many sectional planes can be used to view body structures?



■ **Figure 1.3. Body planes.** **A.** The frontal plane divides the body into anterior and posterior parts. **B.** The sagittal plane divides the body into right and left parts. **C.** The horizontal plane divides the body into superior and inferior parts.

► A midsagittal plane divides the body into what parts?

 **Health Clinic:****Diagnostic Techniques**

Perhaps the greatest challenge in medicine is the reliable identification of the disease responsible for the patient's symptoms—that is, the *diagnosis*. That's because, although sometimes the physician will initiate treatment before making a definitive diagnosis, in most cases, the diagnosis precedes and determines the treatment. Over the past few decades, the technologies used in diagnostic medicine have improved greatly, giving physicians better tools for diagnosing the patient's disease and determining the course of treatment. The most important diagnostic techniques used today include CT scans, PET scans, MRI, and ultrasound.

**CT scans** (also known as CAT scans) send high-energy beams (called X-rays) through the body; the beams undergo computer enhancements to produce three-dimensional images (Figure 1.4A). The acronym "CT" stands for "computed tomography" ("CAT" is an acronym for "computed axial tomography"). In this technique, the energy beams are focused on a specific plane of the body at multiple angles while the patient remains stationary. The computer interprets the information and produces a series of sectional images or "slices" of body regions, which may be along frontal, sagittal, or even transverse planes. CT scans are useful when

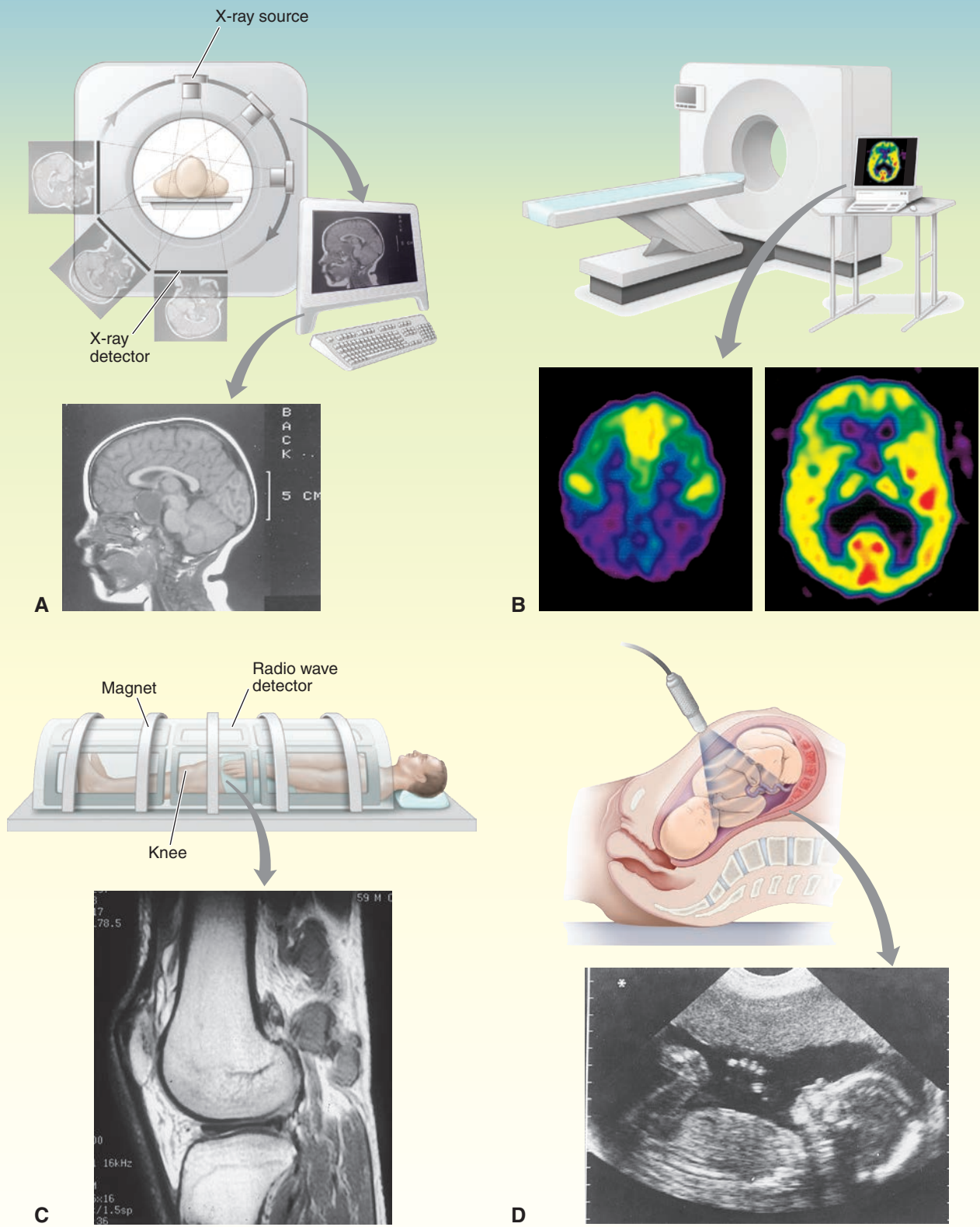
internal images of organs or body cavities are needed. Their relatively high speed and low cost make CT scans the standard for noninvasive diagnoses.

The acronym "PET" stands for "positron emission tomography." **PET scans** use computers and radioactive substances to examine the metabolic activities of various organs, such as the brain and kidneys (Figure 1.4B). A radioactive substance is combined with a metabolically important material, such as glucose (a type of sugar), to form a "cocktail" that is inhaled or injected into the patient. Once inside the body, the cocktail is absorbed into a metabolically active organ and releases its charged particles. The PET computer detects the charged particles and creates color-coded images of the organ's metabolic activity. Because many types of cancerous tumors have an unusually high rate of metabolic activity, PET scans are often used to identify the location of tumors without the need for surgery.

Among all of the diagnostic imaging techniques available, **MRI** (the acronym for "magnetic resonance imaging") has generated the most excitement in the medical community. It offers the clearest, most complete images of soft tissues currently possible (Figure 1.4C). Although MRI is continually

being improved and upgraded, in its present form it uses a powerful magnetic field generated in a chamber within which the patient lies. The magnetic field traces the element hydrogen, which is a component of water molecules, in the patient's body. In this way, MRI can distinguish between internal structures on the basis of their differences in water concentration. Because bones contain very little water compared to soft tissues, MRI can peer directly through them. As the MRI's computer analyzes the scanning data, it creates a three-dimensional image of the region, thereby enabling physicians to detect abnormal structures. Colors may be added by computer enhancement to provide improved clarity. Like a CT scan, an MRI can be applied along a frontal, sagittal, or transverse plane.

**Ultrasound (US) imaging, or sonography**, involves the pulsation of harmless sound waves through a body region. As the waves travel through tissues of varying density, they produce echoes. A computer analyzes the echoes and constructs a sectional image that reveals internal body structures (Figure 1.4D). Because of its harmless nature, ultrasound has proven useful in prenatal care by providing an early view of a developing fetus (a child before birth) within the uterus.



■ **Figure 1.4. Diagnostic imaging techniques.** **A.** CT (CAT) scan of the head along the sagittal plane. **B.** PET scan of the head along the horizontal plane. **C.** MRI of the knee along a sagittal plane. **D.** Ultrasound image of the pelvic region in a pregnant female along the sagittal plane.

## CONCEPT 5

## The Body Plan

**Concept:** The human body is divided into regions. Some regions contain spaces called cavities that house organs.

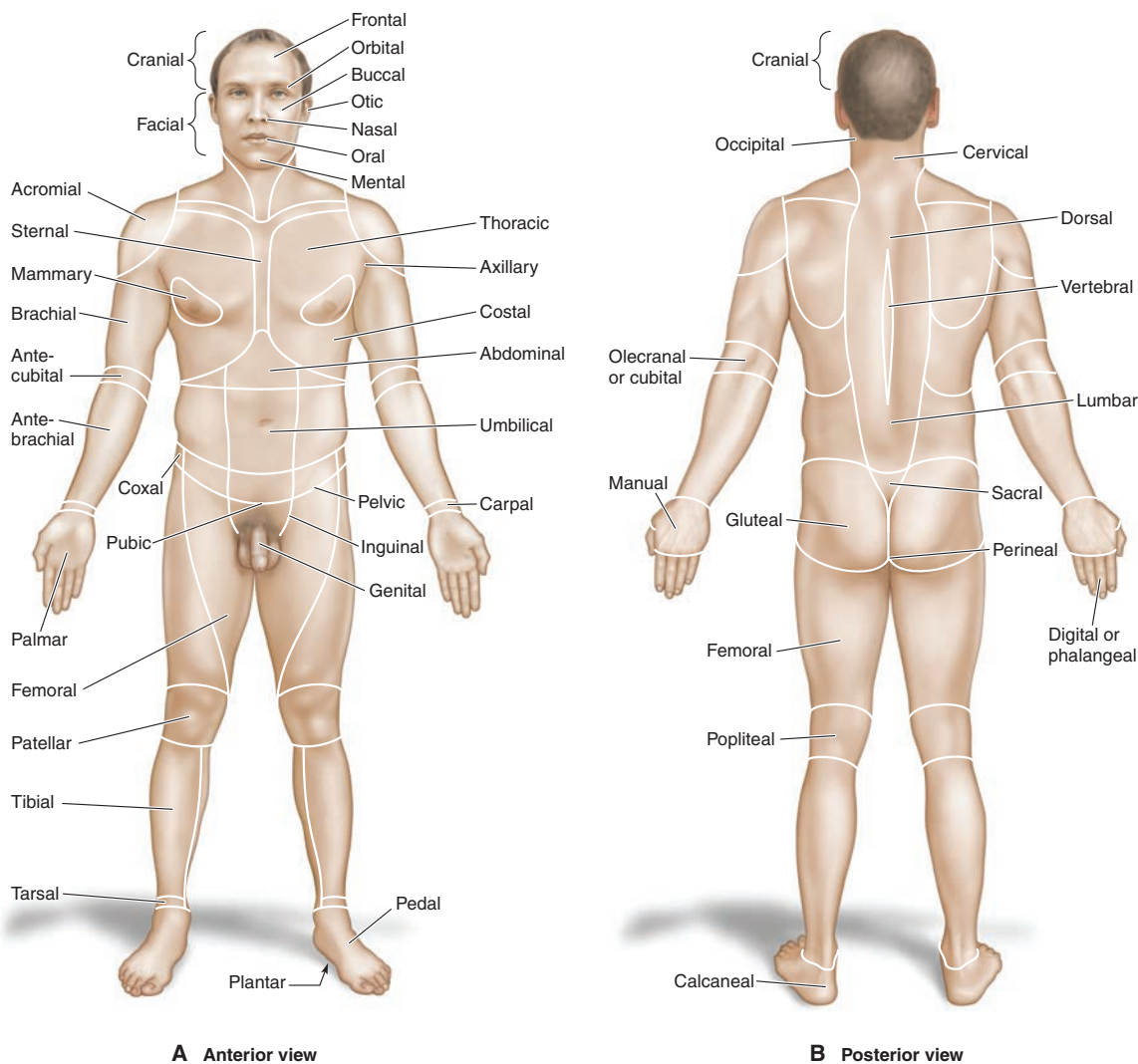
Before studying minor details, it is often helpful to look at the “big picture.” As a first step in our study of the human body, let’s turn now to the “big picture” of human anatomy and observe how the body is organized into regions and cavities.

### Body Regions

The human body is divided into five major areas, or **regions**. The **trunk** is centrally located, receiving the

**neck**, the **upper appendages** (the arm, wrist, and hand), and the **lower appendages** (the leg, ankle, and foot). The **head** is attached to the trunk by way of the narrow neck.

Each major region is divided further into smaller regions (Figure 1.5). For example, the anterior trunk is divided into an upper **thoracic** region, a middle **abdominal** region, and a lower **pelvic** region. The posterior trunk includes the central **dorsal** and lower **lumbar** regions.



**Figure 1.5. Regions of the body.** A. Anterior view. B. Posterior view. ► What is the location of the axillary region relative to the femoral region (in directional terms)?

The major regions of the body and their useful divisions are shown in Figure 1.5. Surface features, or landmarks, that healthcare professionals routinely use during physical examinations are also identified in Figure 1.5. Knowledge of the regions of the body and their landmarks aids the anatomist in describing the relative location of parts and the healthcare professional in identifying internal causes of surface pain.

### Body Cavities

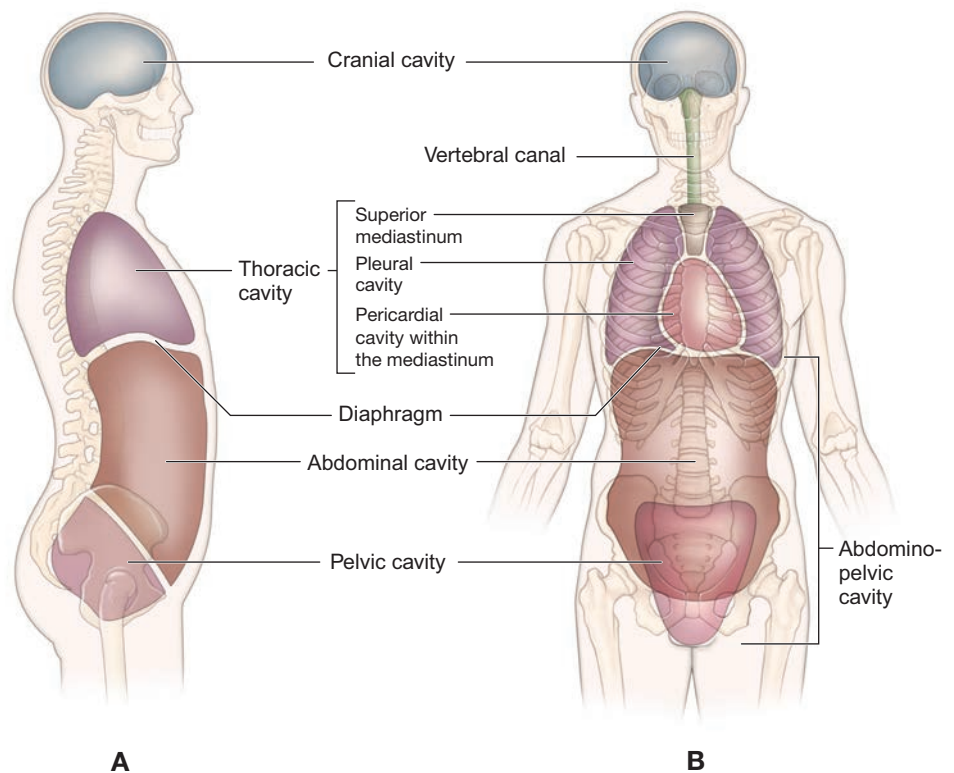
The body is internally divided into several spaces, or **cavities**, which house many of the body's organs (Figure 1.6). Cavities are usually associated with membranes, which are composed of a thin sheet of cells and protein to form a flat covering. In the major body cavities, an outer membrane lines the cavity walls, while an inner membrane covers the outer surface of the organs that are contained within the cavity. In general, the outer membrane is referred to as the **parietal layer** (*parietal* means "wall"), while the inner membrane is called the **visceral layer** (*visceral* means "internal"). The organs contained within a cavity are generally known as **visceral organs**.

There are two major cavities in the body, dorsal and ventral. The smaller of the two is the **dorsal cavity**, located in the posterior (dorsal) side of the body.

It contains a **cranial cavity** within the skull and a **vertebral canal** that extends through the center of the vertebral column (backbone). The cranial cavity, which contains the brain, is a well-protected space formed by the bony plates of the skull. The vertebral canal is protected by the vertebrae and houses the spinal cord.

The larger **ventral cavity** is in the anterior (ventral) side of the body. It includes an upper portion called the **thoracic** (thoh-RAS-ik) **cavity** and a lower portion called the **abdominopelvic** (abdom-ih-noh-PEL-vik) **cavity**. The two are separated by a thin sheet of muscle known as the **diaphragm** (DIE-ah-fragm). The word *diaphragm* means "partition or barrier."

The thoracic cavity is bordered on its anterior side by the ribcage and on its posterior side by the vertebral column. The bones of the ribcage and vertebral column provide the thoracic cavity's vital organs—the right and left lungs and the heart—with a limited amount of protection. Each lung is associated with another cavity, which lies between the membrane attached to the thoracic wall, called the **parietal pleura**, and the membrane attached to the lung's surface, called the **visceral pleura**. This narrow cavity is called the **pleural** (PLOO-ral) **cavity**. The word *pleural* means "rib."



**Figure 1.6. Cavities of the body.** A. Lateral view. B. Anterior view. The dorsal cavity contains the cranial cavity and vertebral canal, and the ventral cavity contains the thoracic cavity and abdominopelvic cavity. ► *What major organs occupy the thoracic cavity?*

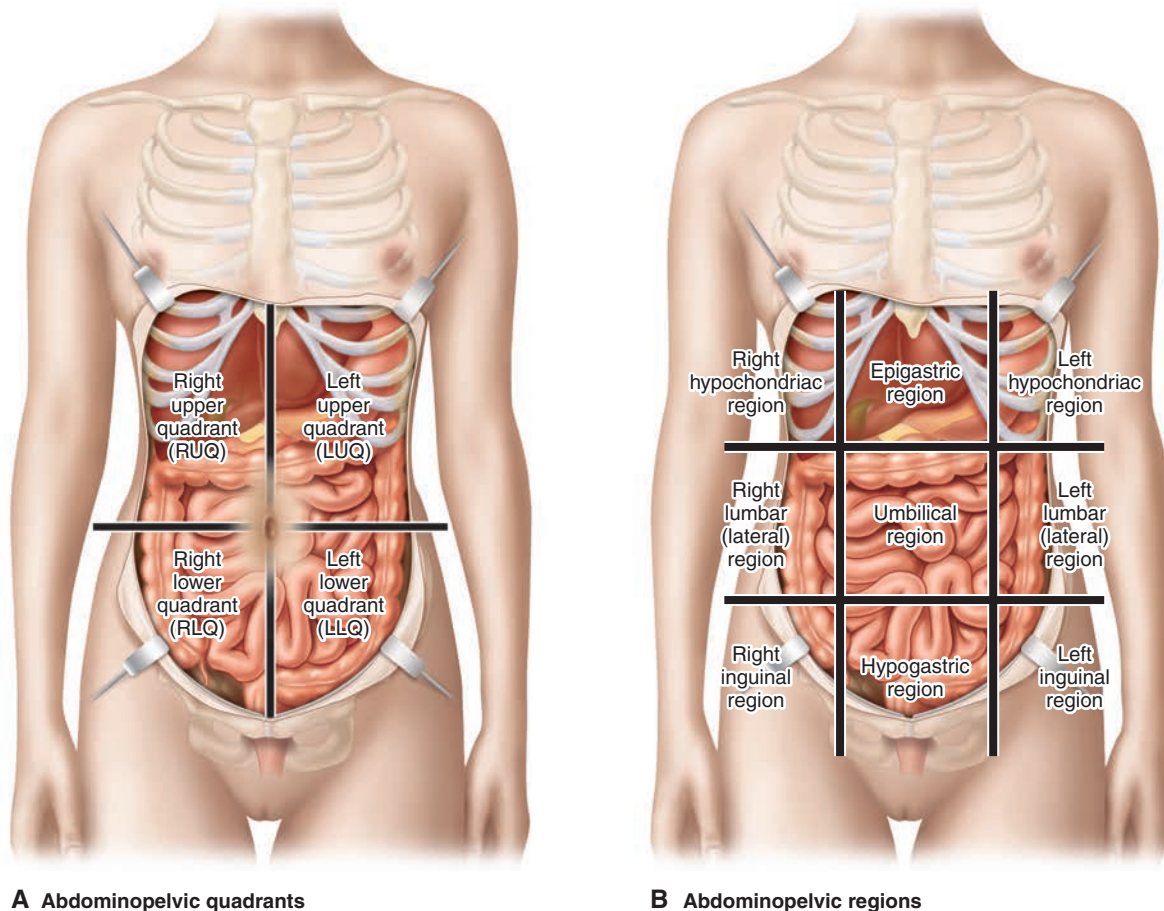
Located between the two lungs is the heart. Like the lungs, the heart is surrounded by a small cavity, which lies between an outer membrane (the **parietal pericardium**) and an inner membrane (the **visceral pericardium**), both of which surround the heart. This cavity is the **pericardial** (*peri-* = to surround, *cardi* = heart, and *-al* = pertaining to) (pair-ih-KAR-dee-al) **cavity**.

The structures within the thoracic cavity between the two lungs form a partition, or septum, in the center of the chest. They are collectively referred to as the **mediastinum** (mee-dee-ah-STI-num), and include the heart, a soft gland superior to the heart known as the thymus, part of the trachea, part of the esophagus, and the major vessels of the heart. The term *mediastinum* means “middle sternum” and refers to its location along the vertical midline of the chest.

In the region inferior to the diaphragm, the abdominopelvic cavity is divided into two main cavities that are separated by an imaginary line extending

between the upper tips of the hipbones (called iliac crests). The upper area is called the **abdominal cavity**. It contains many organs, including the stomach, small intestine, liver, gallbladder, pancreas, spleen, and most of the large intestine. The smaller **pelvic cavity** lies below the iliac crests and is in the shape of a bowl that is formed by the hipbones (*pelvis* means “washbasin”). It contains the urinary bladder, the final segment of the large intestine, and the internal reproductive organs. The membranes of the abdominopelvic cavity include the large **parietal peritoneum**, which lines the abdominal wall, and the **visceral peritoneum**, which covers the surfaces of the organs. The narrow space between these two membranes is known as the **peritoneal cavity**. The term *peritoneum* is derived from a Latin word that means “to stretch over.”

The abdominopelvic cavity is further divided into smaller regions (Figure 1.7). The additional subdivision of this large cavity is useful in healthcare for the purpose of relating a patient’s report of abdominal pain to



■ **Figure 1.7.** Regions of the abdominopelvic cavity, anterior view of the trunk. **A.** The lines form the four abdominopelvic quadrants. **B.** The nine abdominopelvic regions. ► What is the benefit to healthcare professionals of dividing the abdominopelvic cavity into smaller sections?

a potential source within. The smaller regions are separated by invisible lines that are similar to the latitudinal and longitudinal lines on a map. In one method of division, two lines, one horizontal and one vertical, divide the cavity into four areas, or **quadrants**; these are shown in Figure 1.7A. A second method uses two horizontal and two vertical lines to divide the cavity into nine abdominopelvic regions. This method is shown in Figure 1.7B.

**CONCEPT CHECK**

15. Name the five major regions of the body.
16. What is a body cavity?
17. What are the two major cavities in the body?
18. Identify two methods for dividing the abdominopelvic cavity into smaller regions.

**CONCEPT 6**

**Homeostasis: The Balance of Life**

**Concept:** Homeostasis is the process by which the internal environment of the body is kept relatively stable despite changes in the world within and around us.

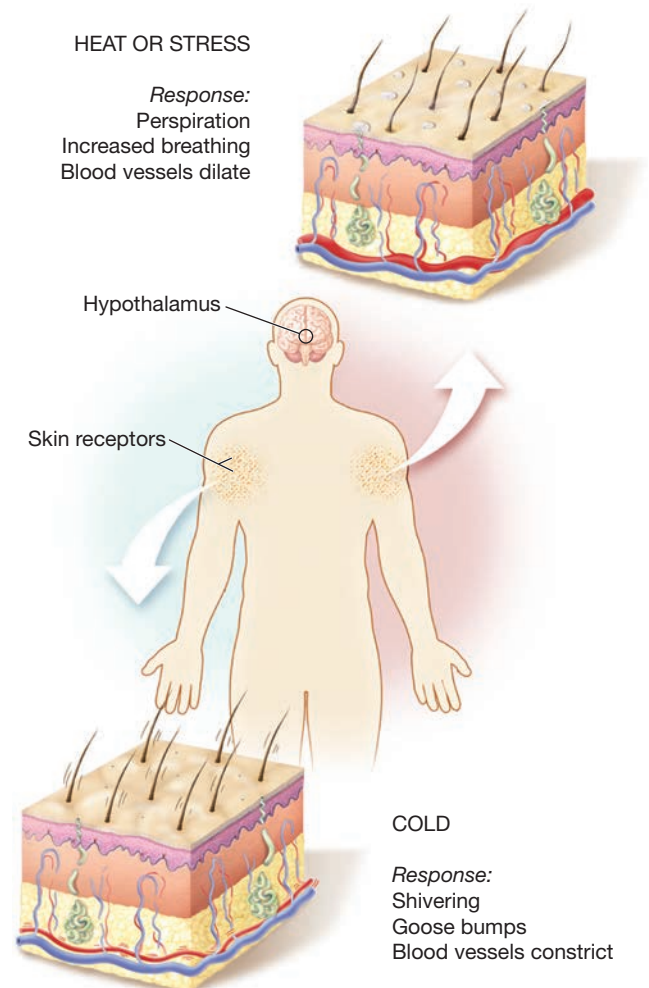
If the world were a perfect place to live, survival would be very easy. There would be plenty of nourishing food to eat, the climate would remain comfortably temperate, there would be no disease; in other words, there would be little stress upon the body. However, our world is by no means perfect. Our bodies are subject to unpredictable changes in environmental temperature, pressure, water and salt availability, and in many areas of the world, food availability; microorganisms that are capable of invading our cells and destroying them abound; and we are being exposed to increasing levels of radiation and chemicals that can damage and destroy cells. How are we able to survive in this world of hazards?

The human body has the remarkable ability to sense a change in the environment, like a change in external temperature or the internal invasion of a population of microorganisms, and to respond by making changes in the body's functions. As a result of these changes, the body's internal environment is kept relatively stable. The process used by the body to maintain internal stability within a relatively narrow range despite changes within and around it is known as **homeostasis** (hoh-mee-oh-STAY-sis). This term combines the Greek words *homeo* (similar) and *stasis* (stationary) to literally mean "similar standing still."

**The Process of Homeostasis**

Many body functions participate in homeostasis. Most are regulated by the nervous system or endocrine system or both, and involve the integration of numerous tissues, organs, and even systems to maintain internal stability. A failure in any of these functions can lead to disease or even death within a relatively short period of time.

An example of a homeostatic process is the control of internal body temperature when the body is exposed to cold or hot weather (Figure 1.8). When



**Figure 1.8. An example of homeostasis.** ▶ Why is it necessary for the body temperature to be maintained within a narrow range?

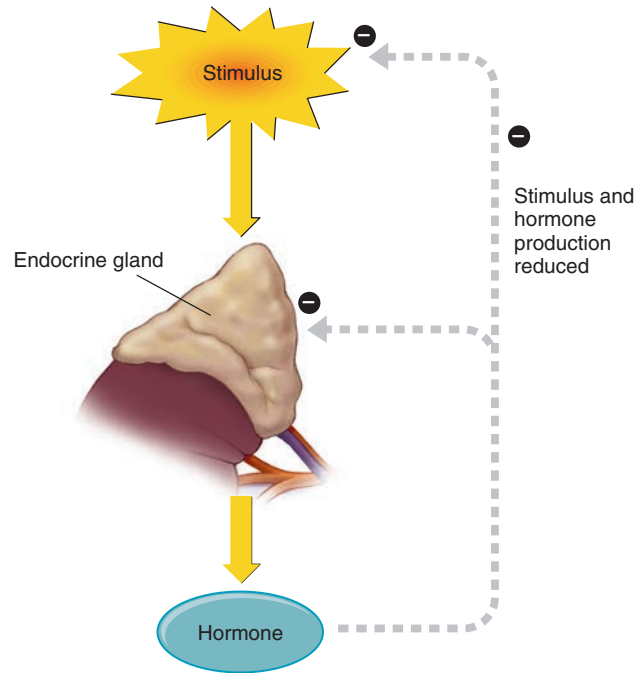
you are cold, sensory receptors in your skin that can detect temperature changes relay this information to the brain. The region of the brain that receives this information, the hypothalamus, functions as a thermostat for the body. It operates in much the same way as the thermostat in your house: when the temperature is perceived as being too cold, it “turns the heat on” and keeps it on until the temperature returns to the desired level. Body heat is generated by the contraction of small groups of muscles. When the hypothalamus stimulates these muscles, you “shiver” from the cold. The hypothalamus also directs blood vessels in the skin to close up, or constrict. This reduces blood flow, and thereby reduces the amount of heat that is normally lost through the surface of the skin. The overall effect of making heat by muscle contraction and reducing heat loss through the skin is to stabilize internal body temperature, enabling other body functions to proceed normally despite the drop in the external temperature.

The process of homeostasis is also active when the body becomes overheated. When the hypothalamus receives the information of increased temperature from nerve cells, it directs the body to make changes that will keep the body from getting too hot. These changes include perspiration, which cools the skin surface as the water evaporates. In addition, blood vessels in the skin open wider or dilate, allowing them to carry a larger volume of blood. As warm blood from the deeper regions of the body reaches the skin surface, it releases body heat. Finally, breathing rate increases, moving a greater volume of heated air from the lungs to the outside.

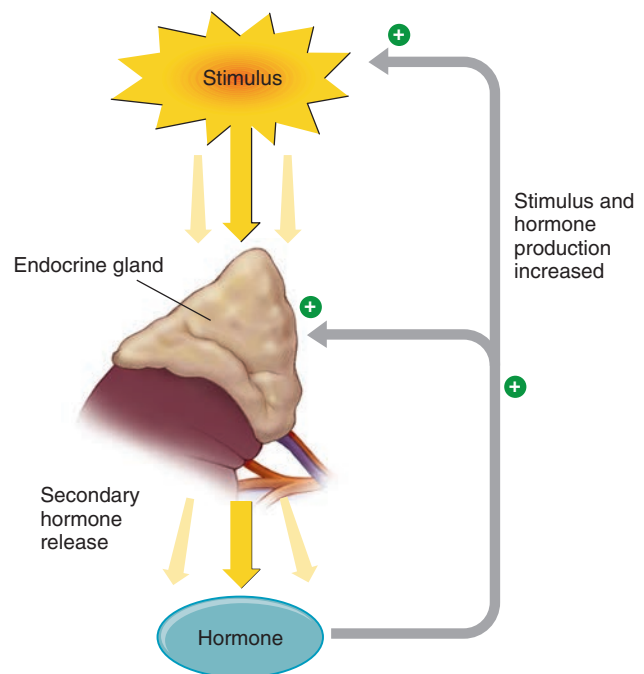
Regulation of body temperature is one example of the many homeostatic mechanisms that function to keep the body’s internal environment stable despite changing conditions. All homeostatic mechanisms are regulated in one of two ways: by negative feedback or by positive feedback.

## Negative Feedback

Most homeostatic processes at work in the body operate by **negative feedback**. The use of the term “negative” refers to a mechanism that reverses a response; in this case, back to a normal state. The term “feedback” refers to the ability of the body to sense information, and send this information back to a control center (usually the brain) where it can be interpreted and a response begun. Thus, negative feedback is a process by which the body maintains homeostasis by first perceiving a change, then reversing the direction of the change until the normal state is returned (Figure 1.9A). The body temperature responses you just considered are examples of negative feedback because the hypothalamus sensed a drop in body temperature and prompted



**A** Negative feedback



**B** Positive feedback

**Figure 1.9. Feedback systems.** **A.** Negative feedback is the most common form of regulation in the body. In this example, the adrenal gland’s production of a hormone is reduced when the hormone is present in the bloodstream, thereby causing a reversal in function. **B.** Positive feedback. In this example, the adrenal gland’s production of a hormone is increased when the hormone is present in the bloodstream, which increases the function further.

▶ Which feedback system causes a reversal of a process?

homeostatic responses to generate heat, or sensed a rise in temperature and stimulated responses to dissipate heat. In either case, the hypothalamus reversed the direction of the response.

## Positive Feedback

**Positive feedback** mechanisms are quite rare in the healthy body. The term “positive” means that when a change from the normal state occurs, the mechanism promotes the change even further (Figure 1.9B). For example, if a thermostat in your house were wired so that an increase in room temperature would cause the heater to turn on rather than the air conditioner, the room temperature would increase further. One example of positive feedback occurs during childbirth, when the contractions of labor prompt the release of a substance that promotes more and stronger contractions. The feedback loop ends with birth.

## Homeostasis in Health and Disease

Maintaining the body’s internal environment within a narrow, steady range demands that all body systems are operating effectively. This ideal state is called optimal health. Any reduction from this ideal state, regardless of its relative impact, is regarded as **disease**.

In a sense, optimal health and a severe, life-threatening disease may be regarded as two extremes of a continuum. Between the two extremes are many gradations, including mild or short-term illnesses, minor injuries, and moderately good health that falls somewhat short of the ideal state. Most of us live somewhere between the extremes of this continuum because our bodies are challenged by minor homeostatic disturbances during every moment of our lives. Fortunately, a body in good health handles most of these disturbances quickly and efficiently, minimizing their threat. However, the pendulum can swing toward serious disease if the body’s homeostatic mechanisms are unable to return internal conditions to stability.

## CONCEPT CHECK

19. What is the goal of homeostasis?
20. You’re eating a bag of salty pretzels outdoors on a winter day. What two homeostatic mechanisms are likely to be activated?
21. How does negative feedback differ from positive feedback?

## CONCEPT BLOCK STUDY SHEET

**CONCEPT 1:** The study of the human body is an interdisciplinary science. It consists of fields that focus on structure or function at many levels.

1. The study of anatomy focuses on both body structure and location.
2. Subdisciplines within anatomy include gross anatomy, microanatomy, and medical anatomy. Microanatomy also includes cytology and histology.
3. The primary question that a physiologist seeks to answer is: how does it work?

**CONCEPT 2:** The human body is composed of microscopic building blocks arranged into a series of increasingly complex structures. Health depends upon every level functioning properly.

4. Nonliving building blocks of the body include atoms and molecules, components of the chemical level.
5. The basic structural and functional unit of life is the cell.

6. A tissue is composed of similar cells that combine to perform a general function, whereas an organ is composed of two or more different types of tissues.

**CONCEPT 3:** All living cells are capable of organization, metabolism, movement, excitability, growth, and reproduction.

7. The collective goal of the functions that are characteristic of life is survival of the organism.
8. Metabolism is the process by which the body obtains and uses energy.
9. Anabolism is the building of new, larger molecules from smaller units. It uses energy. Catabolism is the breakdown of larger molecules into smaller units. It releases energy.
10. Movement is required for transferring molecules within cells and into and out of cells, as well as to enable a cell to carry out its functions in cooperation with other cells.

*(continued)*


**CONCEPT BLOCK STUDY SHEET (CONTINUED)**


**CONCEPT 4:** The language used to describe the human body is universal, with an established set of terms.

11. The purpose of constructing scientific terms from word parts is to establish a universal language for science and medicine.
12. Directional terms should be used because they reduce the lengthiness of the description and thereby improve accuracy, and also because they use the anatomical position as a reference, which is universally accepted.
13. A sectional plane is a flat invisible field that passes through an object to provide orientation and direction.
14. Sectional planes may be used when slicing through a body part or tissue, either with a knife or a computer program.

**CONCEPT 5:** The human body is divided into regions. Some regions contain spaces called cavities that house organs.

15. The five major regions are the trunk, neck, upper appendages, lower appendages, and head.
16. A body cavity is a space within the body containing visceral organs and is usually lined with membranes.
17. The two major body cavities are the ventral cavity and the dorsal cavity.
18. The two methods of dividing the abdominopelvic cavity include nine abdominopelvic regions and four quadrants.

**CONCEPT 6:** Homeostasis is the process by which the internal environment of the body is kept relatively stable despite changes in the world within and around us.

19. The goal of homeostasis is to maintain body stability within narrow limits despite fluctuations in the internal and external environment.
20. Two homeostatic mechanisms likely to be activated are temperature regulation and salt balance.
21. Negative feedback reverses the direction of a process, while positive feedback promotes the process further in the same direction.


**REVIEW QUESTIONS**

**Multiple Choice**

1. Which of the following divisions of study focuses on how the body functions?
  - a. gross anatomy
  - b. systematic anatomy
  - c. physiology
  - d. microanatomy
2. The trunk is inferior to which body part?
  - a. head
  - b. back
  - c. knee
  - d. left foot
3. The brain lies \_\_\_\_\_ to the bones of the skull.
  - a. deep
  - b. distal
  - c. superficial
  - d. anterior
4. The right elbow is distal to the:
  - a. left elbow
  - b. right shoulder
  - c. digits of the right hand
  - d. left kneecap
5. When a child is hanging upside down on a jungle gym, the thorax is considered \_\_\_\_\_ to the pelvis.
  - a. anterior
  - b. inferior
  - c. superior
  - d. medial
6. The body plane that divides the body into right and left portions is called the:
  - a. frontal plane
  - b. horizontal plane
  - c. sagittal plane
  - d. transverse plane
7. The basic structural and functional unit of life is the:
  - a. molecule
  - b. protein
  - c. tissue
  - d. cell
8. A group of similar cells that combine to perform a certain function is called a:
  - a. tissue
  - b. molecule
  - c. system
  - d. organ

9. The body cavity that lies superior to the diaphragm and contains the heart is the:
- ventral cavity
  - thoracic cavity
  - pericardial cavity
  - all of the above
10. The abdominopelvic cavity:
- lies superior to the diaphragm
  - lies within the trunk region
  - contains the lungs
  - does not contain organs
11. The characteristic function of living cells by which the body obtains and uses energy is called:
- homeostasis
  - metabolism
  - movement
  - excitability
12. The ability of a cell to perceive a change in the environment and respond to it is called:
- anabolism
  - growth
  - excitability
  - organization
13. The process by which the body maintains internal conditions within a relatively narrow range despite changes in the environment is called:
- disease
  - metabolism
  - homeostasis
  - excitability
14. Any state in which the internal balance of the body becomes disturbed is called:
- health
  - disease
  - homeostasis
  - symptom

### Critical-thinking Questions

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- List the six levels of structural organization and discuss how they interrelate to support the survival of the complete organism.
- Describe the body plan by identifying the locations of the body regions, cavities, and a few representative organs.
- The day of the high school track meet was hot and dry. As the participants crossed the finish line, they were panting and drenched in sweat, and their faces were beet red. Using your new understanding of homeostasis, explain why. Is this an example of negative feedback or positive feedback?