leaves the body through the anus as feces. The breakdown activities that begin in the mouth are completed in the small intestine. From that point on, the major function of the digestive system is to reclaim water. The liver is considered a digestive organ because the bile it produces helps to break down fats. The pancreas, which delivers digestive enzymes to the small intestine, also is functionally a digestive organ.

Urinary System

The body produces wastes as by-products of its normal functions, and these wastes must be disposed of. One type of waste contains nitrogen (examples are urea and uric acid), which results when the body cells break down proteins and nucleic acids. The **urinary system** removes the nitrogen-containing wastes from the blood and flushes them from the body in urine. This system, often called the *excretory system,* is composed of the kidneys, ureters, bladder, and urethra. Other important functions of this system include maintaining the body's water and salt (electrolyte) balance and regulating the acid-base balance of the blood.

Reproductive System

The **reproductive system** exists primarily to produce offspring. The testes of the male produce sperm. Other male reproductive system structures are the scrotum, penis, accessory glands, and the duct system, which carries sperm to the outside of the body. The ovaries of the female produce eggs, or ova; the female duct system consists of the uterine tubes, uterus, and vagina. The uterus provides the site for the development of the fetus (immature infant) once fertilization has occurred.

DID YOU GET IT?

3. At which level of structural organization is the stomach? At which level is a glucose molecule?
4. Which organ system includes the trachea, lungs, nasal cavity, and bronchi?

For answers, see Appendix D.

Maintaining Life

✓ List eight functions that humans must perform to maintain life.

✓ List the five survival needs of the human body.

Necessary Life Functions

Now that we have introduced the structural levels composing the human body, a question naturally follows: What does this highly organized human body do? Like all complex animals, human beings maintain their boundaries, move, respond to environmental changes, take in and digest nutrients, carry out metabolism, dispose of wastes, reproduce themselves, and grow. We will discuss each of these necessary life functions briefly here and in more detail in later chapters.

Organ systems do not work in isolation; instead, they work together to promote the well-being of the entire body (**Figure 1.3**). Because this theme is emphasized throughout this book, it is worthwhile to identify the most important organ systems contributing to each of the necessary life functions. Also, as you read through this material, you may want to refer back to the more detailed descriptions of the organ systems provided on pp. 3 through 7 and in Figure 1.2.

Maintaining Boundaries

Every living organism must be able to maintain its boundaries so that its "inside" remains distinct from its "outside." Every cell of the human body is surrounded by an external membrane that contains its contents and allows needed substances in while generally preventing entry of potentially damaging or unnecessary substances. The body as a whole is also enclosed by the integumentary system, or skin. The integumentary system protects internal organs from drying out (which would be fatal), from bacteria, and from the damaging effects of heat, sunlight, and an unbelievable number of chemical substances in the external environment.

Movement

Movement includes all the activities promoted by the muscular system, such as propelling ourselves from one place to another (by walking, swimming, and so forth) and manipulating the external environment with our fingers. The skeletal system provides the bones that the muscles pull on as they work. Movement also occurs when substances such as blood, foodstuffs, and urine are propelled through the internal organs of the cardiovascular, digestive, and urinary systems, respectively.

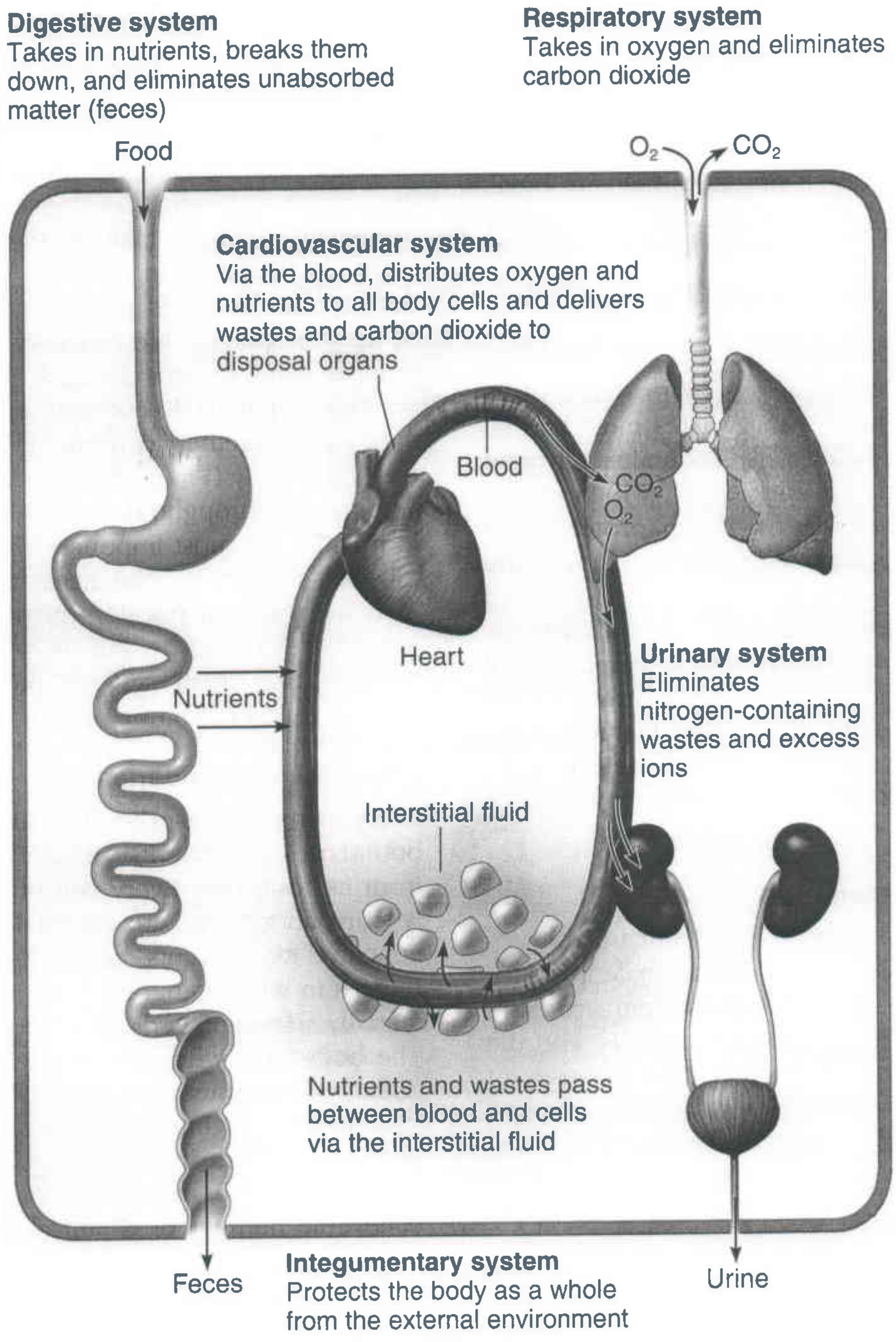


Figure 1.3 Examples of selected interrelationships among body organ systems.

Responsiveness

Responsiveness, or **irritability,** is the ability to sense changes (stimuli) in the environment and then to react to them. For example, if you cut your hand on broken glass, you involuntarily pull your hand away from the painful stimulus (the broken glass). You do not need to think about it—it just happens! Likewise, when the amount of carbon dioxide in your blood rises to dangerously high levels, your breathing rate speeds up to blow off the excess carbon dioxide.

Because nerve cells are highly irritable and can communicate rapidly with each other via electrical impulses, the nervous system bears the major responsibility for responsiveness. However, all body cells are irritable to some extent.

Digestion

Digestion is the process of breaking down ingested food into simple molecules that can then be absorbed into the blood. The nutrient-rich blood is then distributed to all body cells by the cardiovascular system. In a simple, one-celled organism such as an amoeba, the cell itself is the "digestion factory," but in the complex, multicellular human body, the digestive system performs this function for the entire body.

Metabolism

Metabolism is a broad term that refers to all chemical reactions that occur within body cells. It includes breaking down complex substances into simpler building blocks, making larger structures from smaller ones, and using nutrients and oxygen to produce molecules of adenosine triphosphate (ATP), the energy-rich molecules that power cellular activities. Metabolism depends on the digestive and respiratory systems to make nutrients and oxygen available to the blood and on the cardiovascular system to distribute these needed substances throughout the body. Metabolism is regulated chiefly by hormones secreted by the glands of the endocrine system.

Excretion

Excretion is the process of removing *excreta* (ek-skre′tah), or wastes, from the body. If the body is to continue to operate as we expect it to, it must get rid of the nonuseful substances produced during digestion and metabolism. Several organ systems participate in excretion. For example, the digestive system rids the body of indigestible food residues in feces, and the urinary system disposes of nitrogen-containing metabolic wastes in urine.

Reproduction

Reproduction, the production of offspring, can occur on the cellular or organismal level. In cellular reproduction, the original cell divides, producing two identical daughter cells that may then be used for body growth or repair. Reproduction of the human organism, or making a whole new person, is the task of the organs of the reproductive system, which produce sperm and eggs. When a sperm unites with an egg, a fertilized egg forms, which then develops into a baby within the mother's body. The function of the reproductive system is regulated very precisely by hormones of the endocrine system.

Growth

Growth is an increase in size, usually accomplished by an increase in the number of cells. For growth to occur, cell-constructing activities must occur at a faster rate than cell-destroying ones. Hormones released by the endocrine system play a major role in directing growth.

Survival Needs

The goal of nearly all body systems is to maintain life. However, life is extraordinarily fragile and requires that several factors be available. These factors, which we will call *survival needs,* include nutrients (food), oxygen, water, and appropriate temperature and atmospheric pressure.

Nutrients, which the body takes in through food, contain the chemicals used for energy and cell building. Carbohydrates are the major energy-providing fuel for body cells. Proteins and, to a lesser extent, fats are essential for building cell structures. Fats also cushion body organs and provide reserve fuel. Minerals and vitamins are required for the chemical reactions that go on in cells and for oxygen transport in the blood.

All the nutrients in the world are useless unless **oxygen** is also available. Because the chemical reactions that release energy from foods require oxygen, human cells can survive for only a few minutes without it. Approximately 20 percent of the air we breathe is oxygen. It is made available to the blood and body cells by the cooperative efforts of the respiratory and cardiovascular systems.

Water accounts for 60 to 80 percent of body weight. It is the single most abundant chemical substance in the body and provides the fluid base for body secretions and excretions. We obtain water chiefly from ingested foods or liquids and we lose it by evaporation from the lungs and skin and in body excretions.

If chemical reactions are to continue at life-sustaining levels, **normal body temperature** must be maintained. As body temperature drops below 37°C (98°F), metabolic reactions become slower and slower and finally stop. When body temperature is too high, chemical reactions proceed too rapidly, and body proteins begin to

(Continues on page 12)

break down. At either extreme, death occurs. Most body heat is generated by the activity of the skeletal muscles.

The force exerted on the surface of the body by the weight of air is referred to as **atmospheric pressure.** Breathing and the exchange of oxygen and carbon dioxide in the lungs depend on appropriate atmospheric pressure. At high altitudes, where the air is thin and atmospheric pressure is lower, gas exchange may be too slow to support cellular metabolism.

The mere presence of these survival factors is not sufficient to maintain life. They must be present in appropriate amounts as well; excesses and deficits may be equally harmful. For example, the food ingested must be of high quality and in proper amounts; otherwise, nutritional disease, obesity, or starvation is likely.

DID YOU GET IT?

5. In addition to being able to metabolize, grow, digest food, and excrete wastes, what other functions must an organism perform if it is to survive?

6. Oxygen is a survival need. Why is it so important?

For answers, see Appendix D.

Homeostasis

✓ Define *homeostasis,* and explain its importance.

✓ Define *negative feedback,* and describe its role in maintaining homeostasis and normal body function.

When you really think about the fact that your body contains trillions of cells in nearly constant activity, and that remarkably little usually goes wrong with it, you begin to appreciate what a marvelous machine your body really is. The word **homeostasis** (ho″me-o-sta′sis) describes the body's ability to maintain relatively stable internal conditions even though the outside world is continuously changing. Although the literal translation of *homeostasis* is "unchanging" (*homeo* = the same; *stasis* = standing still), the term does not really mean an unchanging state. Instead, it indicates a *dynamic* state of equilibrium, or a balance in which internal conditions change and vary but always within relatively narrow limits.

In general, the body demonstrates homeostasis when its needs are being adequately met and it is functioning smoothly. Virtually every organ system plays a role in maintaining the constancy of the internal environment. Adequate blood levels of vital nutrients must be continuously present, and heart activity and blood pressure must be constantly monitored and adjusted so that the blood is propelled with adequate force to reach all body tissues. Additionally, wastes must not be allowed to accumulate, and body temperature must be precisely controlled.

Homeostatic Controls

Communication within the body is essential for homeostasis and is accomplished chiefly by the nervous and endocrine systems, which use electrical signals delivered by nerves or bloodborne hormones, respectively, as information carriers. The details of how these two regulating systems operate are the subjects of later chapters, but we explain the basic characteristics of the neural and hormonal control systems that promote homeostasis here.

Regardless of the factor or event being regulated (this is called the *variable*), all homeostatic control mechanisms have at least three components (**Figure 1.4**). The first component is a **receptor.** Essentially, it is some type of sensor that monitors and responds to changes in the environment. It responds to such changes, called *stimuli,* by sending information (input) to the second element, the *control center.* Information flows from the receptor to the control center along the *afferent pathway.* (It may help to remember that information traveling along the *afferent* pathway *approaches* the control center.)

The **control center,** which determines the level (set point) at which a variable is to be maintained, analyzes the information it receives and then determines the appropriate response or course of action.

The third component is the **effector,** which provides the means for the control center's response (output) to the stimulus. Information flows from the control center to the effector along the *efferent pathway.* (*Efferent* information *exits* from the control center.) The results of the response then *feed back* to influence the stimulus, either by depressing it (negative feedback), so that the whole control mechanism is shut off; or by enhancing it (positive feedback), so that the reaction continues at an even faster rate.

Q: *If this control system were regulating room temperature, what apparatus would be the effector?*

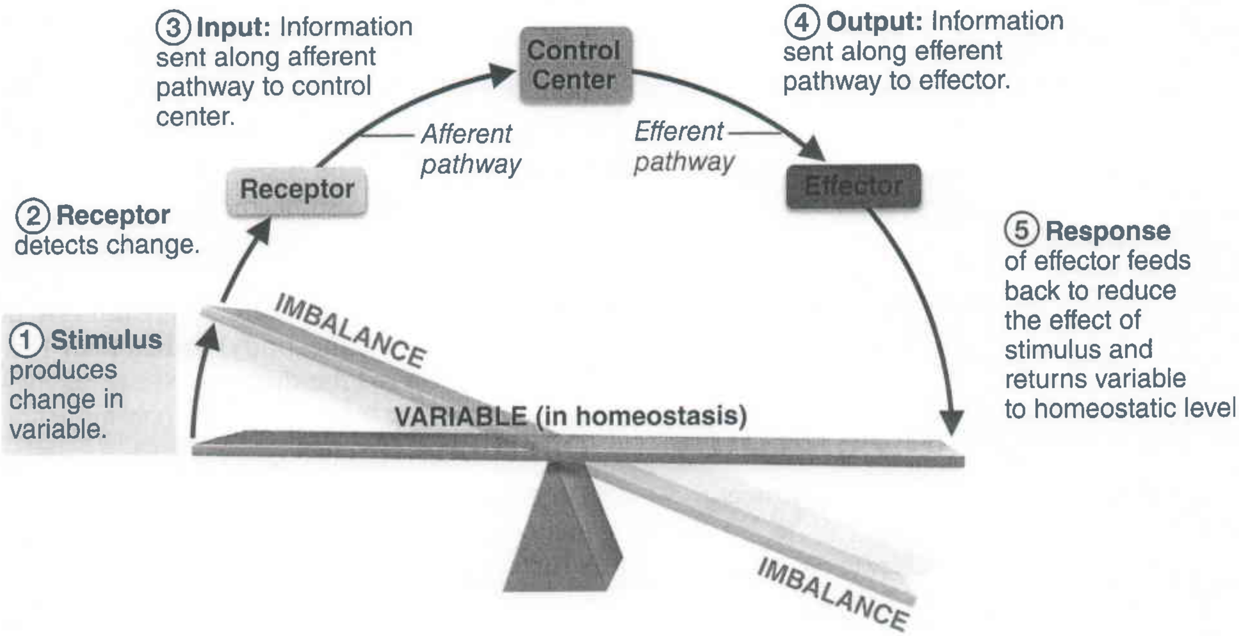


Figure 1.4 The elements of a homeostatic control system. Interaction between the receptor, control center, and effector is essential for normal operation of the system.

Most homeostatic control mechanisms are **negative feedback mechanisms.** In such systems, the net effect of the response to the stimulus is to shut off the original stimulus or reduce its intensity. A good example of a nonbiological negative feedback system is a home heating system connected to a thermostat. In this situation, the thermostat contains both the receptor and the control center. If the thermostat is set at 20°C (68°F), the heating system (effector) will be triggered ON when the house temperature drops below that setting. As the furnace produces heat, the air is warmed. When the temperature reaches 20°C or slightly higher, the thermostat sends a signal to shut off the furnace. Your body "thermostat," located in a part of your brain called the *hypothalamus,* operates in a similar way to regulate body temperature. Other negative feedback mechanisms regulate heart rate, blood pressure, breathing rate, and blood levels of glucose, oxygen, carbon dioxide, and minerals.

Positive feedback mechanisms are rare in the body because they tend to increase the original disturbance (stimulus) and to push the variable *farther* from its original value. Typically these mechanisms control infrequent events that occur explosively and do not require continuous adjustments. Blood clotting and the birth of a baby are the most familiar examples of positive feedback mechanisms.

HOMEOSTATIC IMBALANCE

Homeostasis is so important that most disease can be regarded as a result of its disturbance, a condition called **homeostatic imbalance.** As we age, our body organs become less efficient, and our internal conditions become less and less stable. These events place us at an increasing risk for illness and produce the changes we associate with aging.

We provide examples of homeostatic imbalance throughout this book to enhance your understanding of normal physiological mechanisms.

A: The heat-generating furnace or oil burner.

These homeostatic imbalance sections are preceded by the symbol to alert you that an abnormal condition is being described.

DID YOU GET IT?

7. When we say that the body demonstrates homeostasis, do we mean that conditions in the body are unchanging? Explain your answer.
8. When we begin to become dehydrated, we usually get thirsty, which causes us to drink liquids. Is the thirst sensation part of a negative or a positive feedback control system? Defend your choice.

For answers, see Appendix D.

The Language of Anatomy

✓ Verbally describe or demonstrate the anatomical position.

✓ Use proper anatomical terminology to describe body directions, surfaces, and body planes.

✓ Locate the major body cavities, and list the chief organs in each cavity.

Learning about the body is exciting, but our interest sometimes dwindles when we are faced with the terminology of anatomy and physiology. Let's face it. You can't just pick up an anatomy and physiology book and read it as though it were a novel. Unfortunately, confusion is inevitable without specialized terminology. For example, if you are looking at a ball, "above" always means the area over the top of the ball. Other directional terms can also be used consistently because the ball is a sphere. All sides and surfaces are equal. The human body, of course, has many protrusions and bends. Thus, the question becomes: Above what? To prevent misunderstanding, anatomists use a set of terms that allow body structures to be located and identified clearly with just a few words. We present and explain this language of anatomy next.

Anatomical Position

To accurately describe body parts and position, we must have an initial reference point and use directional terms. To avoid confusion, we always assume that the body is in a standard position called the **anatomical position.** It is important to understand this position because most body terminology used in this book refers to this body positioning *regardless* of the position the body happens to be in. The face-front diagrams in Figure 1.5 and **Table 1.1** illustrate the anatomical position. As you can see, the body is erect with the feet parallel and the arms hanging at the sides with the palms facing forward.

- Stand up and assume the anatomical position. Notice that it is similar to "standing at attention" but is less comfortable because the palms are held unnaturally forward (with thumbs pointing away from the body) rather than hanging cupped toward the thighs.

Directional Terms

Directional terms allow medical personnel and anatomists to explain exactly where one body structure is in relation to another. For example, we can describe the relationship between the ears and the nose informally by saying, "The ears are located on each side of the head to the right and left of the nose." Using anatomical terminology, this condenses to, "The ears are lateral to the nose." Using anatomical terminology saves a good deal of description and, once learned, is much clearer. Commonly used directional terms are defined and illustrated in Table 1.1. Although most of these terms are also used in everyday conversation, keep in mind that their anatomical meanings are very precise.

Before continuing, take a minute to check your understanding of what you have read in Table 1.1. Give the relationship between the following body parts using the correct anatomical terms.

The wrist is _______ to the hand.

The breastbone is _______ to the spine.

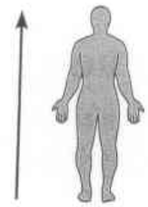
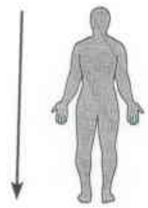
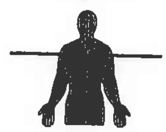
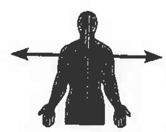
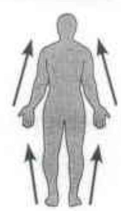
The brain is _______ to the spinal cord.

The thumb is _______ to the fingers. (Be careful here. Remember the anatomical position.)

Regional Terms

There are many visible landmarks on the surface of the body. Once you know their proper anatomical names, you can be specific in referring to different regions of the body.

Table 1.1 Orientation and Directional Terms

Term	Definition	Illustration	Example
Superior (cranial or cephalad)	Toward the head end or upper part of a structure or the body; above		The forehead is superior to the nose.
Inferior (caudal)*	Away from the head end or toward the lower part of a structure or the body; below		The navel is inferior to the breastbone.
Ventral (anterior)†	Toward or at the front of the body; in front of		The breastbone is anterior to the spine.
Dorsal (posterior)†	Toward or at the backside of the body; behind		The heart is posterior to the breastbone.
Medial	Toward or at the midline of the body; on the inner side of		The heart is medial to the arm.
Lateral	Away from the midline of the body; on the outer side of		The arms are lateral to the chest.
Intermediate	Between a more medial and a more lateral structure		The collarbone is intermediate between the breastbone and the shoulder.
Proximal	Close to the origin of the body part or the point of attachment of a limb to the body trunk		The elbow is proximal to the wrist (meaning that the elbow is closer to the shoulder or attachment point of the arm than the wrist is).
Distal	Farther from the origin of a body part or the point of attachment of a limb to the body trunk		The knee is distal to the thigh.
Superficial (external)	Toward or at the body surface		The skin is superficial to the skeleton.
Deep (internal)	Away from the body surface; more internal		The lungs are deep to the rib cage.

*The term *caudal*, literally "toward the tail," is synonymous with *inferior* only to the inferior end of the spine.
†*Ventral* and *anterior* are synonymous in humans; this is not the case in four-legged animals. *Ventral* refers to the "belly" of an animal and thus is the inferior surface of four-legged animals. Likewise, although the dorsal and posterior surfaces are the same in humans, the term *dorsal* refers to an animal's back. Thus, the dorsal surface of four-legged animals is their superior surface.

Q: *Study this figure for a moment to answer these two questions. Where would you hurt if you (1) pulled a groin muscle or (2) cracked a bone in your olecranal area?*

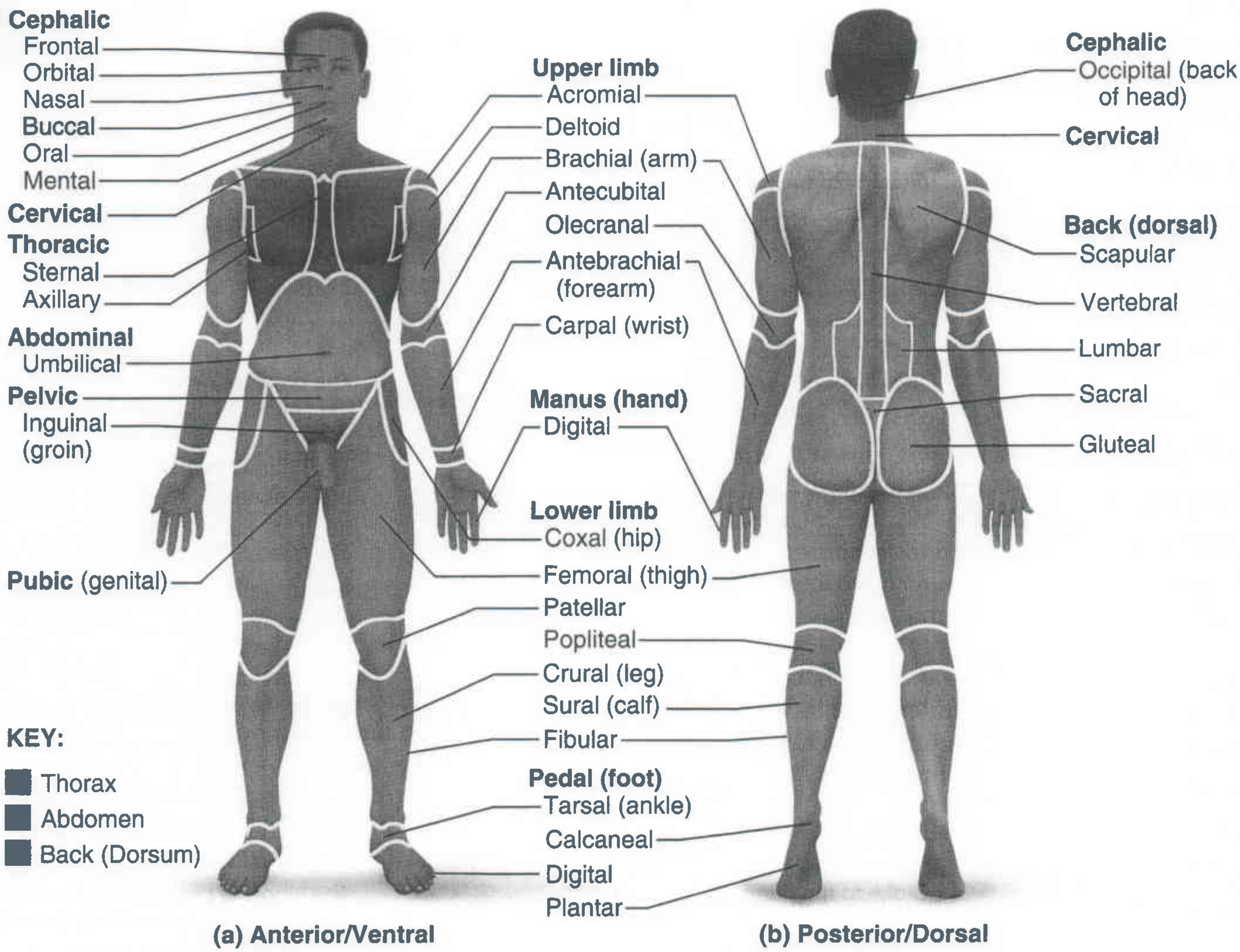


Figure 1.5 Regional terms used to designate specific body areas. (a) The anatomical position. **(b)** The heels are raised slightly to show the inferior plantar surface (sole) of the foot, which is actually on the inferior surface of the body.

Anterior Body Landmarks

Look at **Figure 1.5a** to find the following body regions. Once you have identified all the anterior body landmarks, cover the labels that describe what the structures are. Then go through the list again, pointing out these areas on your own body.

- **abdominal** (ab-dom′ĭ-nal): anterior body trunk inferior to ribs
- **acromial** (ah-kro′me-ul): point of shoulder
- **antebrachial** (an″te-bra′ke-ul): forearm
- **antecubital** (an″te-ku′bĭ-tal): anterior surface of elbow
- **axillary** (ak′sĭ-lar″e): armpit
- **brachial** (bra′ke-al): arm
- **buccal** (buk′al): cheek area
- **carpal** (kar′pal): wrist
- **cervical** (ser′vĭ-kal): neck region
- **coxal** (kox′al): hip
- **crural** (kroo′ral): leg

A: (1) Your inguinal area. (2) Your posterior elbow region.

- **deltoid** (del′toyd): curve of shoulder formed by large deltoid muscle
- **digital** (dij′ĭ-tal): fingers, toes
- **femoral** (fem′or-al): thigh
- **fibular** (fib′u-lar): lateral part of leg
- **frontal** (frun′-tal): forehead
- **inguinal** (in′gwĭ-nal): area where thigh meets body trunk; groin
- **mental** (men′tul): chin
- **nasal** (na′zul): nose area
- **oral** (o′ral): mouth
- **orbital** (or′bĭ-tal): eye area
- **patellar** (pah-tel′er): anterior knee
- **pelvic** (pel′vik): area overlying the pelvis anteriorly
- **pubic** (pu′bik): genital region
- **sternal** (ster′nul): breastbone area
- **tarsal** (tar′sal): ankle region
- **thoracic** (tho-ras′ik): chest
- **umbilical** (um-bil′ĭ-kal): navel

Posterior Body Landmarks

Identify the following body regions in Figure 1.5b, and then locate them on yourself without referring to this book.

- **calcaneal** (kal-ka′ne-ul): heel of foot
- **cephalic** (seh-fă′lik): head
- **femoral** (fem′or-al): thigh
- **gluteal** (gloo′te-al): buttock
- **lumbar** (lum′bar): area of back between ribs and hips, the loin
- **occipital** (ok-sip′ĭ-tal): posterior surface of head or base of skull
- **olecranal** (ol-eh-cra′nel): posterior surface of elbow
- **popliteal** (pop-lit′e-al): posterior knee area
- **sacral** (sa′krul): area between hips
- **scapular** (skap′u-lar): shoulder blade region
- **sural** (soo′ral): the posterior surface of leg; the calf
- **vertebral** (ver′tĕ-bral): area of spinal column

The **plantar** region, or the sole of the foot, actually on the inferior body surface, is illustrated along with the posterior body landmarks in Figure 1.5b.

DID YOU GET IT?

9. What is the anatomical position and why is understanding this position important to an anatomy student?

10. The axillary and the acromial areas are both in the general area of the shoulder. To what specific body area does each of these terms apply?

For answers, see Appendix D.

Body Planes and Sections

When preparing to look at the internal structures of the body, medical students make a **section,** or cut. When the section is made through the body wall or through an organ, it is made along an imaginary line called a **plane.** Because the body is three-dimensional, we can refer to three types of planes or sections that lie at right angles to one another (**Figure 1.6**).

A **sagittal** (saj′ĭ-tal) **section** is a cut along the lengthwise, or longitudinal, plane of the body, dividing the body into right and left parts. If the cut is down the median plane of the body and the right and left parts are equal in size, it is called a **median,** or **midsagittal, section.** All other sagittal sections are parasagittal sections (para = near).

A **frontal section** is a cut along a lengthwise plane that divides the body (or an organ) into anterior and posterior parts. It is also called a **coronal** (ko-ro′nal, "crown") **section.**

A **transverse section** is a cut along a horizontal plane, dividing the body or organ into superior and inferior parts. It is also called a **cross section.**

Sectioning a body or one of its organs along different planes often results in very different views. For example, a transverse section of the body trunk at the level of the kidneys would show kidney structure in cross section very nicely; a frontal section of the body trunk would show a different view of kidney anatomy; and a midsagittal section would miss the kidneys completely. Information on body organ positioning that can be gained by taking magnetic resonance imaging (MRI) scans along different body planes is illustrated in Figure 1.6. (MRI scans are described further in "A Closer Look" on pp. 10–11).

Q: *Which section type would separate the two eyes?*

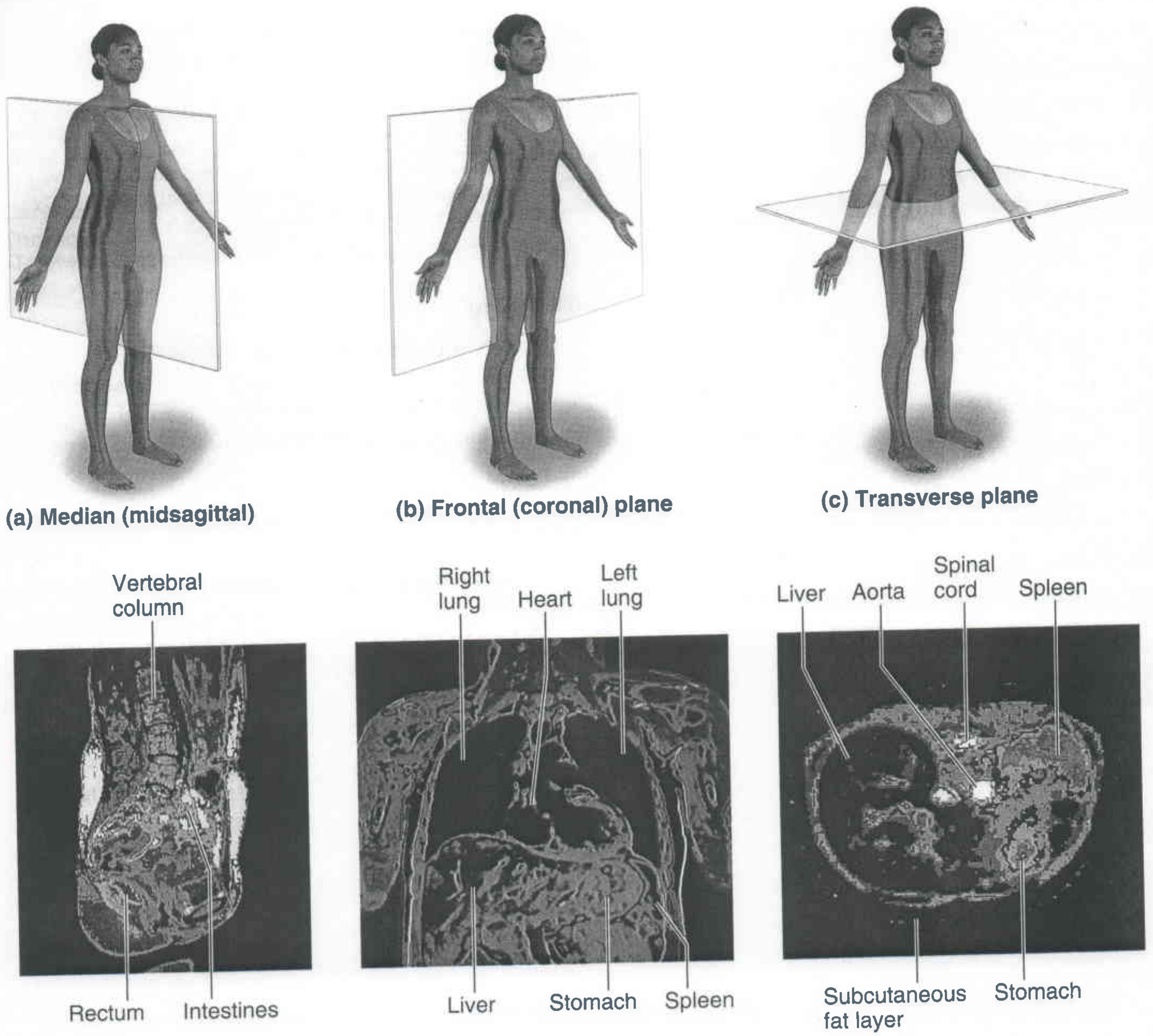


Figure 1.6 The anatomical position and planes of the body—median, frontal, and transverse with corresponding MRI scans.

Body Cavities

Anatomy and physiology textbooks typically describe two sets of internal body cavities, called the dorsal and ventral body cavities, that provide different degrees of protection to the organs within them (**Figure 1.7**). Because these cavities differ in their mode of embryological development and in their lining membranes, many anatomy reference books do not identify the dorsal, or neural, body cavity as an internal body cavity. However, the idea of two major sets of internal body cavities is a useful learning concept, so we will continue to use it here.

A: A midsagittal section would separate the two eyes.

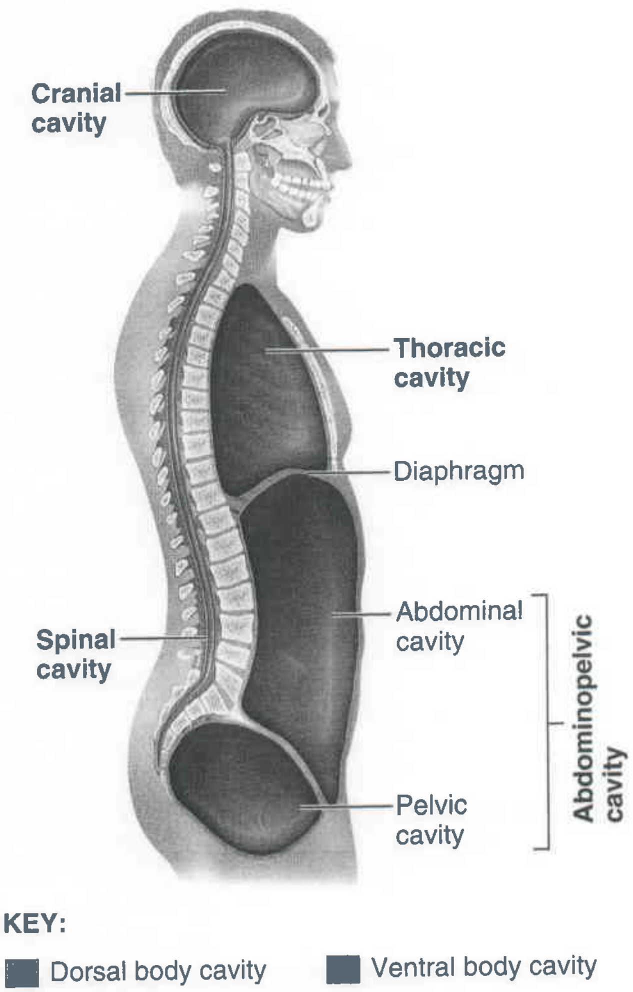


Figure 1.7 Body cavities. Notice the angular relationship between the abdominal and pelvic cavities.

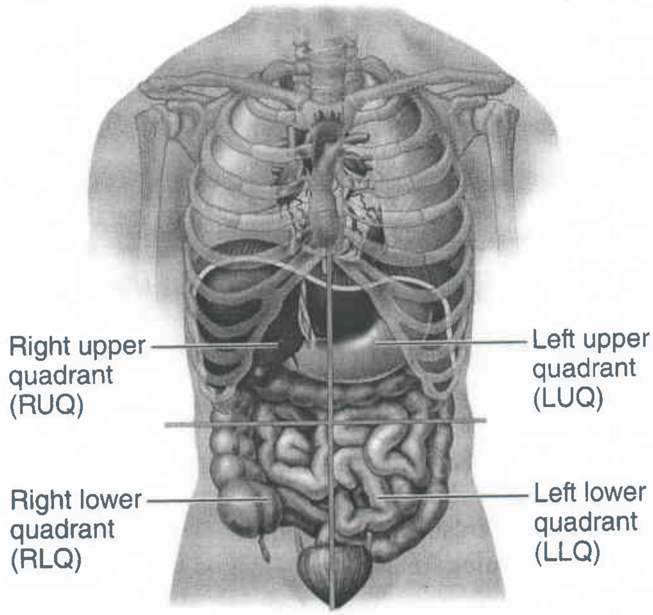


Figure 1.8 The four abdominopelvic quadrants. In this scheme, the abdominopelvic cavity is divided into four quadrants by two planes.

Dorsal Body Cavity

The **dorsal body cavity** has two subdivisions, which are continuous with each other. The **cranial cavity** is the space inside the bony skull. The brain is well protected because it occupies the cranial cavity. The **spinal cavity** extends from the cranial cavity nearly to the end of the vertebral column. The spinal cord, which is a continuation of the brain, is protected by the vertebrae, which surround the spinal cavity.

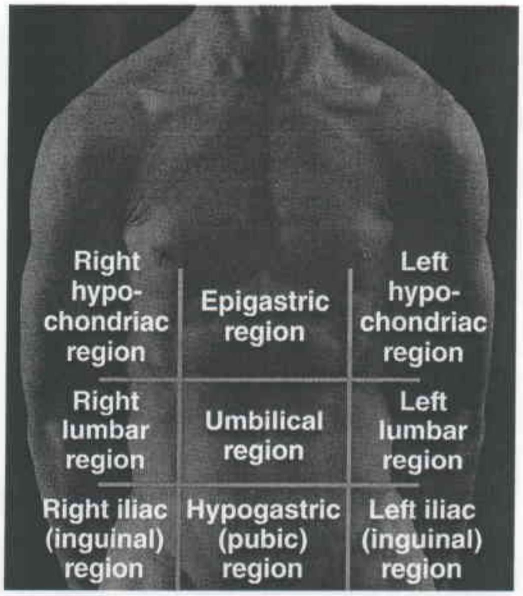
Ventral Body Cavity

The **ventral body cavity** is much larger than the dorsal cavity. It contains all the structures within the chest and abdomen, that is, the visceral organs in those regions. Like the dorsal cavity, the ventral body cavity is subdivided. The superior **thoracic cavity** is separated from the rest of the ventral cavity by a dome-shaped muscle, the **diaphragm** (di′ah-fram). The organs in the thoracic cavity (lungs, heart, and others) are somewhat protected by the rib cage. A central region called the **mediastinum** (me″de-as-ti′num) separates the lungs into right and left cavities in the thoracic cavity. The mediastinum itself houses the heart, trachea, and other visceral organs.

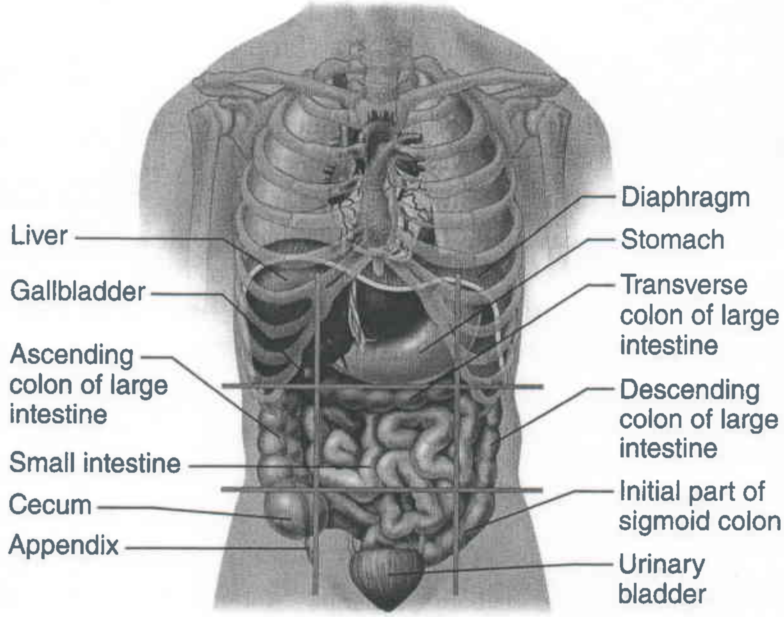
The cavity inferior to the diaphragm is the **abdominopelvic** (ab-dom″ĭ-no-pel′vik) **cavity.** Some prefer to subdivide it into a superior **abdominal cavity,** containing the stomach, liver, intestines, and other organs, and an inferior **pelvic cavity,** with the reproductive organs, bladder, and rectum. However, there is no actual physical structure dividing the abdominopelvic cavity. If you look carefully at Figure 1.7, you will see that the pelvic cavity is not continuous with the abdominal cavity in a straight plane, but that it tips away from the abdominal cavity in the posterior direction.

HOMEOSTATIC IMBALANCE

When the body is subjected to physical trauma (as often happens in an automobile accident, for example), the most vulnerable abdominopelvic organs are those within the abdominal cavity. The reason is that the abdominal cavity walls are formed only of trunk muscles and are not reinforced by bone. The pelvic organs receive a somewhat greater degree of protection from the bony pelvis in which they reside. ◗



(a) Nine regions delineated by four planes



(b) Anterior view of the nine regions showing the superficial organs

Figure 1.9 The nine abdominopelvic regions. In **(a)** the superior transverse plane is just superior to the ribs; the inferior transverse plane is just superior to the hip bones; and the parasaggital planes lie just medial to the nipples.

Because the abdominopelvic cavity is quite large and contains many organs, it helps to divide it up into smaller areas for study. A scheme commonly used by medical personnel divides the abdominopelvic cavity into four more or less equal regions called *quadrants*. The quadrants are then simply named according to their relative positions—that is, right upper quadrant (RUQ), right lower quadrant (RLQ), left upper quadrant (LUQ), and left lower quadrant (LLQ) (**Figure 1.8**).

Another system, used mainly by anatomists, divides the abdominopelvic cavity into nine separate *regions* by four planes, as shown in **Figure 1.9a**. Although the names of the nine regions are unfamiliar to you now, with a little patience and study they will become easier to remember. As you locate these regions in the figure, notice the organs they contain by referring to Figure 1.9b.

- The **umbilical region** is the centermost region, deep to and surrounding the umbilicus (navel).
- The **epigastric** (ep″ĭ-gas′trik) **region** is located superior to the umbilical region (*epi* = upon, above; *gastric* = stomach).
- The **hypogastric (pubic) region** is inferior to the umbilical region (*hypo* = below).
- The **right** and **left iliac,** or **inguinal, regions** are lateral to the hypogastric region (*iliac* = superior part of the hip bone).
- The **right** and **left lumbar regions** lie lateral to the umbilical region (*lumbus* = loin).
- The **right** and **left hypochondriac** (hi″po-kon′dre-ak) **regions** flank the epigastric region and contain the lower ribs (*chondro* = cartilage).

Other Body Cavities

In addition to the large closed body cavities, there are several smaller body cavities. Most of these are in the head and open to the body exterior. With the exception of the middle ear cavities, the body regions that house these cavities are all shown in Figure 1.5.

- **Oral and digestive cavities.** The oral cavity, commonly called the mouth, contains the teeth and tongue. This cavity is part of and continuous with the cavity of the digestive organs, which opens to the exterior at the anus.

- **Nasal cavity.** Located within and posterior to the nose, the nasal cavity is part of the respiratory system passageways.
- **Orbital cavities.** The orbital cavities (orbits) in the skull house the eyes and present them in an anterior position.
- **Middle ear cavities.** The middle ear cavities carved into the skull lie just medial to the eardrums. These cavities contain tiny bones that transmit sound vibrations to the hearing receptors in the inner ears.

DID YOU GET IT?

11. If you wanted to separate the thoracic cavity from the abdominal cavity of a cadaver, which type of section would you make?

12. Of the spinal cord, small intestine, uterus, and heart, which are in the dorsal body cavity?

13. Joe went to the emergency room where he complained of severe pains in the lower right quadrant of his abdomen. What might be his problem?

For answers, see Appendix D.

Summary

Access more review material and fun learning activities online—visit **www.anatomyandphysiology.com** and select Essentials of Human Anatomy & Physiology, 10th edition. In addition, references to Interactive Physiology are included below.

IP = Interactive Physiology

An Overview of Anatomy and Physiology (pp. 1–2)

1. Anatomy is the study of structure. Observation is used to see the sizes and relationships of body parts.
2. Physiology is the study of how a structure (which may be a cell, an organ, or an organ system) functions or works.
3. Structure determines what functions can occur; therefore, if the structure changes, the function must also change.

Levels of Structural Organization (pp. 2–7)

1. There are six levels of structural organization. Atoms (at the chemical level) combine, forming the unit of life, the cell. Cells are grouped into tissues, which in turn are arranged in specific ways to form organs. A number of organs form an organ system that performs a specific function for the body (which no other organ system can do). Together, all of the organ systems form the organism, or living body.
2. For a description of organ systems naming the major organs and functions, see pp. 3–7.

Maintaining Life (pp. 7–12)

1. To sustain life, an organism must be able to maintain its boundaries, move, respond to stimuli, digest nutrients and excrete wastes, carry on metabolism, reproduce itself, and grow.
2. Survival needs include food, oxygen, water, appropriate temperature, and normal atmospheric pressure. Extremes of any of these factors can be harmful.

Homeostasis (pp. 12–14)

1. Body functions interact to maintain homeostasis, or a relatively stable internal environment within the body. Homeostasis is necessary for survival and good health; its loss results in illness or disease.
2. All homeostatic control mechanisms have three components: (1) a receptor that responds to environmental changes, (2) a control center that assesses those changes and produces a response by activating (3) the effector.
3. Most homeostatic control systems are negative feedback systems, which act to reduce or stop the initial stimulus.

The Language of Anatomy (pp. 14–22)

1. Anatomical terminology is relative and assumes that the body is in the anatomical position (erect, palms facing forward).
2. Directional terms
   a. Superior (cranial, cephalad): above something else, toward the head.
   b. Inferior (caudal): below something else, toward the tail.
   c. Ventral (anterior): toward the front of the body or structure.
   d. Dorsal (posterior): toward the rear or back of the body or structure.