A young woman was hit by a car while crossing a street. Upon arrival at the scene, paramedics found the patient to be a bit dazed but reasonably lucid, complaining of pain in her abdomen and the left side of her chest. Otherwise, her vital signs were within normal limits. Initial evaluation in the emergency room revealed a very tender abdomen and left chest. The chest radiograph demonstrated a collapsed left lung resulting from air in the pleural space (pneumothorax). The emergency room physician inserted a drainage tube into the left chest (into the pleural space) to treat the pneumothorax. Attention was then turned to the abdomen. Because of the finding of tenderness, a peritoneal lavage was performed. This procedure involves penetrating the abdominal wall and inserting a tube into the peritoneal cavity. Clear fluid such as sterile water or normal saline is then instilled into the abdomen and siphoned out again. The fluid used in this procedure is called lavage fluid. A return of lavage fluid containing blood, fecal matter, or bile indicates injury to an abdominal organ that requires surgery. The return of lavage fluid from this patient was clear. However, the nurse stated that lavage fluid was draining out of the chest tube.

From what you know about how the various body cavities are organized, do you suppose this phenomenon could be explained based on normal anatomy? What might have caused it to occur in our patient? Does the absence of bile, blood, etc., in the peritoneal lavage fluid guarantee that no organ has been ruptured? If it does not, explain why in terms of the relationship of the various organs to the membranes within the abdomen.
CLASSIFICATION AND CHARACTERISTICS OF HUMANS

Humans are biological organisms belonging to the phylum Chordata within the kingdom Animalia and to the family Hominidae within the class Mammalia and the order Primates.

Objective 1 Classify humans according to the taxonomic system.

Objective 2 List the characteristics that identify humans as chordates and as mammals.

Objective 3 Describe the anatomical characteristics that set humans apart from other primates.

The human organism, or Homo sapiens, as we have named ourselves, is unique in many ways. Our scientific name translates from the Latin to “man the intelligent,” and indeed our intelligence is our most distinguishing feature. It has enabled us to build civilizations, conquer dread diseases, and establish cultures. We have invented a means of communicating through written symbols. We record our own history, as well as that of other organisms, and speculate about our future. We continue to devise ever more ingenious ways for adapting to our changing environment. At the same time, we are so intellectually specialized that we are not self-sufficient. We need one another as much as we need the recorded knowledge of the past.

We are constantly challenged to learn more about ourselves. As we continue to make new discoveries about our structure and function, our close relationship to other living organisms becomes more and more apparent. Often, it is sobering to realize our biological imperfections and limitations.

We share many characteristics with all living animals. As human organisms, we breathe, eat and digest food, excrete bodily wastes, locomote, and reproduce our own kind. We are subject to disease, injury, pain, aging, mutations, and death. Because we are composed of organic materials, we will decompose after death as microorganisms consume our flesh as food. The processes by which our bodies produce, store, and utilize energy are similar to those used by all living organisms. The genetic code that regulates our development is found throughout nature. The fundamental patterns of development of many nonhuman animals also characterize the formation of the human embryo.

In the classification, or taxonomic, system established by biologists to organize the structural and evolutionary relationships of living organisms, each category of classification is referred to as a taxon. The highest taxon is the kingdom and the most specific taxon is the species. Humans are species belonging to the animal kingdom. Phylogeny (fi-loj’ene) is the science that studies relatedness on the basis of taxonomy.

Phylum Chordata

Human beings belong to the phylum Chordata (fi’lum kor-dat’a), along with fishes, amphibians, reptiles, birds, and other mammals. All chordates have three structures in common: a notochord (no’to-kord), a dorsal hollow nerve cord, and pharyngeal (fär-in’je-al) pouches (fig. 2.1). These chordate characteristics are well expressed during the embryonic period of development and, to a certain extent, are present in an adult. The notochord is a flexible rod of tissue that extends the length of the back of an embryo. A portion of the notochord persists in the adult as the nucleus pulposus, located within each intervertebral disc (fig. 2.2). The dorsal hollow nerve cord is positioned above the notochord and develops into the brain and spinal cord, which are supremely functional as the central nervous system in the adult. Pharyngeal pouches form gill openings in fishes and some

taxon: Gk. taxis, order

phylogeny: L. phylum, tribe; Gk. logos, study
amphibians. In other chordates, such as humans, embryonic pharyngeal pouches develop, but only one of the pouches persists, becoming the middle-ear cavity. The **auditory** (eustachian) (yoo-sta'šun) **tube**, is a persisting connection between the middle-ear cavity and the **pharynx** (far'ingks) (throat area).

The function of an intervertebral disc and its nucleus pulposus is to allow flexibility between vertebrae for movement of the entire spinal column while preventing compression. Spinal nerves exit between vertebrae, and the discs maintain the spacing to avoid nerve damage. A “slipped disc,” resulting from straining the back, is a misnomer. What actually occurs is a herniation, or rupture, because of a weakened wall of the nucleus pulposus. This may cause severe pain as a nerve is compressed.

**Class Mammalia**

Mammals are chordate animals with hair and mammary glands. Hair is a thermoregulatory protective covering for most mammals, and mammary glands serve for suckling the young (fig. 2.3). Other characteristics of mammals include three auditory ossicles (bones), heterodont dentition (teeth of various shapes), squamosal-dentary jaw articulation (a joint between the lower jaw and skull), an attached placenta (plă-cen'tā), well-developed facial muscles, a muscular diaphragm, and a four-chambered heart with a left aortic arch (fig. 2.4).

**Order Primates**

There are several subdivisions of closely related groupings of mammals. These are called orders. Humans, along with lemurs, monkeys, and great apes, belong to the order called Primates. Members of this order have prehensile hands (fig. 2.5), digits modified for grasping, and relatively large, well-developed brains (fig. 2.6).

**Family Hominidae**

Humans are the sole living members of the family Hominidae. Homo sapiens is included within this family, to which all the varieties or ethnic groups of humans belong (fig. 2.7). Each “racial group” has distinguishing features that have been established in isolated populations over thousands of years. Our classification pedigree is presented in table 2.1.

Fostered by greater ease of travel and communication, more frequent contact between diverse cultures has led to a breakdown of some of the traditional barriers to interracial marriage. This may lead to a mixing of the “gene pool,” so that distinct ethnic groups become less evident. Perhaps multiple ethnic ties in everyone’s pedigree would help reduce cultural hostility and strife.

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**heterodont**: Gk. heteros, other; odontos, tooth
**placenta**: L. placenta, flat cake
**Primates**: L. primas, first
**prehensile**: L. prehensus, to grasp
Characteristics of Humans

As human beings, certain of our anatomical characteristics are so specialized that they are diagnostic in separating us from other animals, and even from other closely related mammals. We also have characteristics that are equally well developed in other animals, but when these function with the human brain, they provide us with remarkable and unique capabilities. Our anatomical characteristics include the following:

1. A large, well-developed brain. The adult human brain weighs between 1,350 and 1,400 grams (3 pounds). This gives us a large brain-to-body-weight ratio. But more important is the development of portions of the brain. Certain extremely specialized regions and structures within the brain account for emotion, thought, reasoning, memory, and even precise, coordinated movement.

2. Bipedal locomotion. Because humans stand and walk on two appendages, our style of locomotion is said to be bipedal. Upright posture imposes other diagnostic structural features, such as the sigmoid (S-shaped) curvature of the

sigmoid: Gk. sigma, shaped like the letter S

bipedal: L. bi, two; pedis, foot
Figure 2.5 An opposable thumb enables a prehensile grip, which is characteristic of primates.

Figure 2.6 The brains of various vertebrates showing the relative size of the cerebrum (shaded pink) to other structures. (The brains are now drawn to scale. Note that only mammals have a convoluted cerebrum.)
3. **An opposable thumb.** The human thumb is structurally adapted for tremendous versatility in grasping objects. The saddle joint at the base of the thumb allows a wide range of movement (see fig. 8.13). All primates have opposable thumbs.

4. **Well-developed vocal structures.** Humans, like no other animals, have developed articulated speech. The anatomical structure of our vocal organs (larynx, tongue, and lips), and our well-developed brain have made this possible.

5. **Stereoscopic vision.** Although this characteristic is well developed in several other animals, it is also keen in humans. Our eyes are directed forward so that when we focus on an object, we view it from two angles. Stereoscopic vision gives us depth perception, or a three-dimensional image.
We also differ from other animals in the number and arrangement of our vertebrae (vertebral formula), the kinds and number of our teeth (tooth formula), the degree of development of our facial muscles, and the structural organization of various body organs.

The human characteristics just described account for the splendor of our cultural achievements. As bipedal animals, we have our hands free to grasp and manipulate objects with our opposable thumbs. We can store information in our highly developed brain, make use of it at a later time, and even share our learning through oral or written communication.

Knowledge Check

1. What is a chordate? Why are humans considered members of the phylum Chordata?
2. Why are humans designated as vertebrates, mammals, and primates? What characteristics distinguish humans from other primates?
3. Which characteristics of humans are adaptive for social organization?

Body Organization

Structural and functional levels of organization characterize the human body, and each of its parts contributes to the total organism.

Objective 4 Identify the components of a cell, tissue, organ, and system, and explain how these structures relate to one another in constituting an organism.

Objective 5 Describe the general function of each system.

Cellular Level

The cell is the basic structural and functional component of life. Humans are multicellular organisms composed of 60 to 100 trillion cells. It is at the microscopic cellular level that such vital functions of life as metabolism, growth, irritability (responsiveness to stimuli), repair, and replication are carried on.

Cells are composed of atoms—minute particles that are bound together to form larger particles called molecules (fig. 2.8). Certain molecules, in turn, are grouped in specific ways to form small functional structures called organelles (or “gâ-nélz”). Each organelle carries out a specific function within the cell. A cell’s nucleus, mitochondria, and endoplasmic reticulum are organelles. The structure of cells and the functions of the organelles will be examined in detail in chapter 3.

The human body contains many distinct kinds of cells, each specialized to perform specific functions. Examples of specialized cells are bone cells, muscle cells, fat cells, blood cells, and nerve cells. The unique structure of each of these cell types is directly related to its function.

Tissue Level

Tissues are layers or groups of similar cells that perform a common function. The entire body is composed of only four principal kinds of tissues: epithelial, connective, muscular, and nervous tissue. An example of a tissue is the muscle within the heart, whose function it is to pump the blood through the body. The outer layer of skin is a tissue (epithelium) because it is composed of similar cells that together serve as a protective shield for the body. Histology is the science concerned with the microscopic study of tissues. The characteristic roles of each tissue type are discussed fully in chapter 4.

Organ Level

An organ is an aggregate of two or more tissue types that performs a specific function. Organs occur throughout the body and vary greatly in size and function. Examples of organs are the heart, spleen, pancreas, ovary, skin, and even any of the bones within the body. Each organ usually has one or more primary tissues and several secondary tissues. In the stomach, for example, the inside epithelial lining is considered the primary tissue because the basic functions of secretion and absorption occur within this layer. Secondary tissues of the stomach are the connective, nervous, and muscle tissues.

System Level

The systems of the body constitute the next level of structural organization. A body system consists of various organs that have similar or related functions. Examples of systems are the circulatory system, nervous system, digestive system, and endocrine system. Certain organs may serve two systems. For example, the pancreas functions with both the endocrine and digestive systems, and the pharynx serves both the respiratory and digestive systems. All the systems of the body are interrelated and function together, making up the organism.
Growth is a normal process by which an organism increases in size as a result of the accretion of cells and tissues similar to those already present within organs. Growth is an integral part of development that continues until adulthood. Normal growth depends not only on proper nutrition but on the concerted effect of several hormones (chemicals produced by endocrine glands), including insulin, growth hormone, and (during adolescence) the sex hormones. It is through the growth process that each of the body systems eventually matures (fig. 2.9). Puberty is the developmental transition during the growth process when sexual features become expressed in several of the body systems and the reproductive organs become functional.

A systematic (systemic) approach to studying anatomy emphasizes the purposes of various organs within a system. For example, the functional role of the digestive system can be best understood if all of the organs within that system are studied together. In a regional approach, all of the organs and structures in one particular region are examined at the same time. The regional approach has merit in graduate professional schools (medical, dental, etc.) because the structural relationships of portions of several systems can be observed simultaneously. Dissections of cadavers are usually conducted on a regional basis. Trauma or injury usually affects a region of the body, whereas a disease that affects a region may also involve an entire system.

This text uses a systematic approach to anatomy. In the chapters that follow, you will become acquainted, system by system, with the functional anatomy of the entire body. An overview of the structure and function of each of the body systems is presented in figure 2.10.

Knowledge Check

4. Construct a diagram to illustrate the levels of structural organization that characterize the body. Which of these levels are microscopic?
5. Why is the skin considered an organ?
6. Which body systems control the functioning of the others? Which are supportive of the organism? Which serve a transportive role?
ANATOMICAL NOMENCLATURE

In order to understand the science of anatomy, students must master its descriptive terminology.

Objective 6 Explain how anatomical terms are derived.
Objective 7 Describe what is meant by prefixes and suffixes.

Aatomy is a descriptive science. Analyzing anatomical terminology can be a rewarding experience in that one learns something of the character of antiquity in the process. However, understanding the roots of words is not only of academic interest. Familiarity with technical terms reinforces the learning process. Most anatomical terms are derived from Greek or Latin, but some of the more recent terms are of German and French origin. As mentioned in chapter 1, some anatomical structures bear the names of people who discovered or described them. Such terms are totally nondescriptive; unfortunately, they have little meaning in and of themselves.

Many Greek and Latin terms were coined more than 2,000 years ago. Deciphering the meanings of these terms affords a glimpse into our medical heritage. Many terms referred to common plants or animals. Thus, the term vermis means worm; cochlea means snail shell; cancer means crab; and uvula means little grape. Even the term muscle comes from the Latin musculus, which means mouse. Other terms suggest the warlike environment of ancient Greece and Rome. Thyroid, for example, means shield; xiphos means sword; and thorax, breastplate. Sella means saddle and stapes means stirrup. Various tools or instruments were referred to in early anatomy. The malleus and anvil resemble miniatures of a blacksmith’s implements, and tympanum refers to a drum.

You will encounter many new terms throughout your study of anatomy. You can learn these terms more easily if you know the meaning of their prefixes and suffixes. Use the glossary of prefixes and suffixes (on the inside front cover) as an aid in learning new terms. Pronouncing these terms as you learn them will also help you remember them. A guide to the singular and plural forms of words is presented in table 2.2.

The material presented in the remainder of this chapter provides a basic foundation for anatomy, as well as for all medical and paramedical fields. Aatomy is a very precise science because of its universally accepted reference language for describing body parts and locations.

Knowledge Check

7. Explain the statement, Aatomy is a descriptive science.
8. Refer to the glossary of prefixes and suffixes on the front inside front cover to decipher the terms blastocoel, hypodermic, dermatitis, and orchietomy.
Integumentary system
Function: external support and protection of body

Skeletal system
Function: internal support and flexible framework for body movement; production of blood cells

Muscular system
Function: body movement; production of body heat

Lymphatic system
Function: body immunity; absorption of fats; drainage of tissue fluid

Endocrine system
Function: secretion of hormones for chemical regulation

Urinary system
Function: filtration of blood; maintenance of volume and chemical composition of blood; removal of metabolic wastes from body

FIGURE 2.10 The body systems.
Respiratory system
Function: gaseous exchange between external environment and blood

Nervous system
Function: control and regulation of all other systems of the body

Circulatory system
Function: transport of life-sustaining materials to body cells; removal of metabolic wastes from cells

Digestive system
Function: breakdown and absorption of food materials

Female reproductive system
Function: production of female sex cells (ova); receptacle for sperm from male; site for fertilization of ovum, implantation, and development of embryo and fetus; delivery of fetus

Male reproductive system
Function: production of male sex cells (sperm); transfer of sperm to reproductive system of female

FIGURE 2.10 The body systems.
All of the descriptive planes of reference and terms of direction used in anatomy are standardized because of their reference to the body in anatomical position.

**Objective 8** Identify the planes of reference used to locate structures within the body.

**Objective 9** Describe the anatomical position.

**Objective 10** Define and be able to properly use the descriptive and directional terms that refer to the body.

**Planes of Reference**

In order to visualize and study the structural arrangements of various organs, the body may be sectioned (cut) and diagrammed according to three fundamental planes of reference: a **sagittal plane**, a **coronal plane**, and a **transverse plane** (figs. 2.11 and 2.12). A sagittal plane extends vertically through the body dividing it into right and left portions. A midsagittal (median) plane is a sagittal plane that passes lengthwise through the midplane of the body, dividing it equally into right and left halves. Coronal, or frontal, planes also pass lengthwise and divide the body into anterior (front) and posterior (back) portions. Transverse planes, also called horizontal, or cross-sectional, planes, divide the body into superior (upper) and inferior (lower) portions.

The value of the computerized tomographic X-ray (CT) scan (see fig. 1.19a) is that it displays an image along a transverse plane similar to that which could otherwise be obtained only in an actual section through the body. Prior to the development of this technique, the vertical plane of conventional radiographs made it difficult, if not impossible, to assess the extent of body irregularities.

**Descriptive Terminology**

**Anatomical Position**

All terms of direction that describe the relationship of one body part to another are made in reference to the anatomical position. In the anatomical position, the body is erect, the feet are parallel to each other and flat on the floor, the eyes are directed forward, and the arms are at the sides of the body with the palms of the hands turned forward and the fingers pointed straight down (fig. 2.13).
Palpation. Applying the fingers with firm pressure to the surface of the body to feel surface landmarks, lumps, tender spots, or pulsations.

Percussion. Tapping sharply on various locations on the thorax or abdomen to detect resonating vibrations as an aid in locating excess fluids or organ abnormalities.

Auscultation. Listening to the sounds that various organs make (breathing, heartbeat, digestive sounds, and so forth).

Reflex testing. Observing a person's automatic (involuntary) response to a stimulus. One test of a reflex mechanism involves tapping a predetermined tendon with a reflex hammer and noting the response.

**Directional Terms**

Directional terms are used to locate structures and regions of the body relative to the anatomical position. A summary of directional terms is presented in table 2.3.

**Clinical Procedures**

Certain clinical procedures are important in determining anatomical structure and function in a living individual. The most common of these are as follows:

- **Inspection.** Visually observing the body to note any clinical symptoms, such as abnormal skin color, swelling, or rashes. Other observations may include needle marks on the skin, irregular breathing rates, or abnormal behavior.

- **Palpation.** Applying the fingers with firm pressure to the surface of the body to feel surface landmarks, lumps, tender spots, or pulsations.

- **Percussion.** Tapping sharply on various locations on the thorax or abdomen to detect resonating vibrations as an aid in locating excess fluids or organ abnormalities.

- **Auscultation.** Listening to the sounds that various organs make (breathing, heartbeat, digestive sounds, and so forth).

- **Reflex testing.** Observing a person's automatic (involuntary) response to a stimulus. One test of a reflex mechanism involves tapping a predetermined tendon with a reflex hammer and noting the response.

**Knowledge Check**

9. Explain why a transverse plane through an organ is more important in studying specific systems than a transverse plane through the body.

10. What do we mean when we say that directional terms are relative and must be used in reference to a body structure or a body in anatomical position?
11. Write a list of statements, similar to the examples in Table 2.3, that correctly express the directional terms used to describe the relative positions of various body structures.

**Table 2.3 Directional Terms for the Human Body**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior (cranial, cephalic)</td>
<td>Toward the head; toward the top</td>
<td>The thorax is superior to the abdomen.</td>
</tr>
<tr>
<td>Inferior (caudal)</td>
<td>Away from the head; toward the bottom</td>
<td>The neck is inferior to the head.</td>
</tr>
<tr>
<td>Anterior (ventral)</td>
<td>Toward the front</td>
<td>The navel is on the anterior side of the body.</td>
</tr>
<tr>
<td>Posterior (dorsal)</td>
<td>Toward the back</td>
<td>The kidneys are posterior to the intestine.</td>
</tr>
<tr>
<td>Medial</td>
<td>Toward the midline of the body</td>
<td>The heart is medial to the lungs.</td>
</tr>
<tr>
<td>Lateral</td>
<td>Away from the midline of the body</td>
<td>The ears are lateral to the nose.</td>
</tr>
<tr>
<td>Internal (deep)</td>
<td>Away from the surface of the body</td>
<td>The brain is internal to the cranium.</td>
</tr>
<tr>
<td>External (superficial)</td>
<td>Toward the surface of the body</td>
<td>The skin is external to the muscles.</td>
</tr>
<tr>
<td>Proximal</td>
<td>Toward the trunk of the body</td>
<td>The knee is proximal to the foot.</td>
</tr>
<tr>
<td>Distal</td>
<td>Away from the trunk of the body</td>
<td>The hand is distal to the elbow.</td>
</tr>
</tbody>
</table>

**Objective 11** List the regions of the body and the principal local areas that make up each region.

**Objective 12** Explain why it is important to be able to describe the body areas and regions in which major internal organs are located.

**Body Regions**

The human body is divided into regions and specific local areas that can be identified on the surface. Each region contains internal organs, the locations of which are anatomically and clinically important.
are the head, neck, trunk, upper extremity, and lower extremity (fig. 2.14). The trunk is frequently divided into the thorax, abdomen, and pelvis.

**Head**

The head is divided into a **facial region**, which includes the eyes, nose, and mouth, and a **cranial region**, or **cranium** (kra'ne-um), which covers and supports the brain. The identifying names for specific surface regions of the face are based on associated organs— for example, the orbital (eye), nasal (nose), oral (mouth), and auricular (ear) regions—or underlying bones—for example, the frontal, temporal parietal, zygomatic, and occipital regions.

**Neck**

The neck, referred to as the **cervical region**, supports the head and permits it to move. As with the head, detailed subdivisions of the neck can be identified. Additional information concerning the neck region can be found in chapter 10.
Trunk

The trunk, or torso, is the portion of the body to which the neck and upper and lower extremities attach. It includes the thorax, abdomen, and pelvic region.

Thorax

The thorax (thor’aks), or thoracic (tho˘-ras’ik) region, is commonly referred to as the chest. The mammary region of the thorax surrounds the nipple and in sexually mature females is enlarged as the breast. Between the mammary regions is the sternal region. The armpit is called the axillary fossa, or simply the axilla, and the surrounding area, the axillary region. The vertebral region extends the length of the back, following the vertebral column.

Abdomen

The abdomen (ab’dô-men) is located below the thorax. Centered on the front of the abdomen, the umbilicus (navel) is an obvious landmark. The abdomen has been divided into nine regions to describe the location of internal organs. The subdivisions of the abdomen are diagrammed in figure 2.15 and the internal organs located within these regions are identified in table 2.4. Subdividing the abdomen into four quadrants (fig. 2.16) is a common clinical practice for locating the sites of pains, tumors, or other abnormalities.

Pelvic Region

The pelvic region forms the lower portion of the trunk. Within the pelvic region is the pubic area, which is covered with pubic hair in sexually mature individuals. The perineum (per”i-ne’um) (fig. 2.17) is the region containing the external sex organs and the anal opening. The center of the back side of the abdomen, commonly called the small of the back, is the lumbar region. The sacral region is located further down, at the point where the vertebral column terminates. The large hip muscles form the buttock, or gluteal region. This region is a common injection site for hypodermic needles.

Upper Extremity

The upper extremity is anatomically divided into the shoulder, brachium (bra’ke-um) (arm), antebrachium (forearm), and manus (hand) (see fig. 2.14). The shoulder is the region between
the pectoral girdle and the brachium that contains the shoulder joint. The shoulder is also referred to as the omos, or deltoid region. The cubital region is the area between the arm and forearm that contains the elbow joint. The cubital fossa is the depressed anterior portion of the cubital region. It is an important site for intravenous injections or the withdrawal of blood.

The manus has three principal divisions: the carpus, containing the carpal bones (see fig. 7.8); the metacarpus, containing the metacarpal bones; and the five digits (commonly called fingers), containing the phalanges. The front of the hand is referred to as the palmar region (palm) and the back of the hand is called the dorsum of the hand.

**Lower Extremity**

The lower extremity consists of the hip, thigh, knee, leg, and pes (foot). The thigh is commonly called the upper leg, or femoral region. The knee has two surfaces: the front surface is
the patellar region, or kneecap; the back of the knee is called the popliteal (pop“li-te’al) fossa. The leg has anterior and posterior crural regions (see fig. 2.14). The shin is a prominent bony ridge extending longitudinally along the anterior crural region, and the calf is the thickened muscular mass of the posterior crural region.

The pes has three principal divisions: the tarsus, containing the tarsal bones (see fig. 7.19); the metatarsus, containing the metatarsal bones; and the five digits (commonly called toes), containing the phalanges. The ankle is the junction between the leg and the foot. The heel is the back of the foot, and the sole of the foot is referred to as the plantar surface. The dorsum of the foot is the top surface.

Knowledge Check

12. Using yourself as a model, identify the various body regions depicted in figure 2.14. Which of these regions have surface landmarks that help distinguish their boundaries?

13. In which region of the body are intravenous injections given?

14. Distinguish the pubic area and perineum within the pelvic region.

15. Identify the joint between the following regions: the brachium and antebrachium, the pectoral girdle and brachium, the leg and foot, the antebrachium and hand, and the thigh and leg.

16. Explain how knowledge of the body regions is applied in a clinical setting.
and a pericardial (per"ı˘-kar’d-e-al) cavity surrounding the heart (fig. 2.21). The area between the two pleural cavities is known as the mediastinum (me"de-a˘-sti’num).

The abdominopelvic cavity consists of an upper abdominal cavity and a lower pelvic cavity. The abdominal cavity contains the stomach, small intestine, large intestine, liver, gallbladder, pancreas, spleen, and kidneys. The pelvic cavity is occupied by the terminal portion of the large intestine, the urinary bladder, and certain reproductive organs (uterus, uterine tubes, and ovaries in the female; seminal vesicles and prostate in the male).

A summary of the principal body cavities is presented in figure 2.22.

Body cavities serve to confine organs and systems that have related functions. The major portion of the nervous system occupies the posterior cavity; the principal organs of the respiratory and circulatory systems are in the thoracic cavity; the primary organs of digestion are in the abdominal cavity; and the reproductive organs are in the pelvic cavity. Not only do these cavities house and support various body organs, they also effectively compartmentalize them so that infections and diseases cannot spread from one compartment to another. For example, pleurisy of one lung membrane does not usually spread to the other, and an injury to the thoracic cavity will usually result in the collapse of only one lung rather than both.

In addition to the large anterior and posterior cavities, there are several smaller cavities and spaces within the head. The oral cavity functions primarily in digestion and secondarily in respiration. It contains the teeth and tongue. The nasal cavity, which is part of the respiratory system, has two chambers created by a nasal septum. There are two orbits, each of which houses an eyeball and its associated muscles, vessels, and nerves. Likewise, there are two middle-ear cavities containing the auditory ossicles (ear bones). The location of the cavities and spaces within the head is shown in figure 2.23.

orbital; L. orbit, circle
Body Membranes

Body membranes are composed of thin layers of connective and epithelial tissue that cover, separate, and support visceral organs and line body cavities. There are two basic types of body membranes: mucous (myoo’kus) membranes and serous (se’rus) membranes.

Mucous membranes secrete a thick, sticky fluid called mucus. Mucus generally lubricates or protects the associated organs where it is secreted. Mucous membranes line various cavities and tubes that enter or exit the body, such as the oral and nasal cavities and the tubes of the respiratory, reproductive, urinary, and digestive systems.

Serous membranes line the thoracic and abdominopelvic cavities and cover visceral organs, secreting a watery lubricant called serous fluid. Pleurae are serous membranes associated with the lungs. Each pleura (pleura of right lung and pleura of left lung) has two parts. The visceral pleura adheres to the outer surface of the lung, whereas the parietal (pā’ri-tal) pleura lines the thoracic walls and the thoracic surface of the diaphragm. The moistened space between the two pleurae is known as the pleural cavity (fig. 2.21).

Pericardial membranes are the serous membranes covering the heart. A thin visceral pericardium covers the surface of the heart, and a thicker parietal pericardium surrounds the heart. The space between these two membranes is called the pericardial cavity.

Serous membranes of the abdominal cavity are called peritoneal (per”i-to-ne’al) membranes. The parietal peritoneum lines the abdominal wall, and the visceral peritoneum covers the abdominal viscera. The peritoneal cavity is the potential space within the abdominopelvic cavity between the parietal peritoneum and the visceral peritoneum.
and visceral peritoneal membranes. The lesser omentum and the greater omentum are folds of the peritoneum that extend from the stomach. They store fat and cushion and protect the abdominal viscera. Certain organs, such as the kidneys, adrenal glands, and the medial portion of the pancreas, which are within the abdominopelvic cavity, are positioned behind the parietal peritoneum, and are therefore said to be retroperitoneal. Mesenteries (mes’en-ter’ēz) are double folds of peritoneum that connect the parietal peritoneum to the visceral peritoneum (see figs. 2.20 and 18.3).

Knowledge Check

17. Describe the divisions and boundaries of the anterior body cavity and list the major organs contained within each division.

18. Distinguish between mucous and serous membranes and list the specific serous membranes of the thoracic and abdominopelvic cavities.

19. Explain the importance of separate and distinct body cavities.

Clinical Case Study Answer

Normally, the thoracic cavity is effectively separated from the abdominopelvic cavity by the diaphragm, peritoneum, and pleura. The phenomenon of peritoneal lavage fluid draining out of a tube properly placed in the chest can be explained only by the presence of a defect in the diaphragm. The defect in our patient is likely a traumatic rupture or laceration of the diaphragm that was caused by a sharp blow to the abdomen. The blow would have produced sudden upward pressure against the diaphragm, causing it to rupture. The absence of bile, blood, etc., in peritoneal lavage fluid does not guarantee the absence of trauma to organs such as the duodenum and pancreas. These organs are not located within the peritoneal cavity; rather they are retroperitoneal, or fully posterior to the peritoneal membrane. This keeps blood or leaked enzymes from these organs out of the peritoneal space and away from lavage fluid. Other signs must therefore be relied upon, and a high index of suspicion maintained, so as not to overlook injury to these organs. Evidence of injury to any of the intraabdominal organs, or the presence of diaphragmatic rupture, calls for emergency laparotomy (abdominal incision) to repair the structures involved.
**FIGURE 2.21** Serous membranes of the thorax (a) surrounding the lungs and (b) surrounding the heart.
Body cavities
Differentiate during development

Anterior (ventral) cavity (coelom)
Protects visceral organs; permits organ movement during peristalsis; contains lubricating serous fluid

Posterior (dorsal) cavity
Protects and buoys the brain and spinal cord

Separated into

Thoracic cavity
Contains and protects heart, lungs, trachea, esophagus, major vessels, and nerves

Abdominopelvic cavity
Contains peritoneal cavity and its contents

Cranial cavity
Maintains consistency of brain while keeping it immobile

Spinal cavity
Maintains consistency of spinal cord while allowing it to be flexible

Subdivided into

Right pleural cavity
Surrounds right lung and contains lubricating pleural fluid

Mediastinum
Contains trachea, esophagus, major vessels, and nerves

Left pleural cavity
Surrounds left lung and contains lubricating pleural fluid

Pericardial cavity
Surrounds heart and contains lubricating pericardial fluid

Abdominal cavity
Contains abdominal viscera and lubricating peritoneal fluid

Pelvic cavity
Contains some urinary and reproductive organs, terminal portion of digestive tract, and lubricating peritoneal fluid

FIGURE 2.22 Organization of body cavities.
**Chapter Summary**

**Classification and Characteristics of Humans (pp. 00)**

1. Our scientific name, Homo sapiens, means “man the intelligent,” and our intelligence is our most distinguishing feature.
2. Humans belong to the phylum Chordata because of the presence of a notochord, a dorsal hollow nerve cord, and pharyngeal pouches during the embryonic stage of human development.
3. Humans are mammals, and as such have mammalian characteristics. These include hair, mammary glands, three auditory ossicles, heterodontia, a placenta, a muscular diaphragm, and a four-chambered heart with a left aortic arch.
4. Humans are also classified within the order Primates. Primates have prehensile hands, digits modified for grasping, and well-developed brains.
5. Humans are the sole members of the family Hominidae.
6. Some of the characteristics of humans are a large, well-developed brain; bipedal locomotion; an opposable thumb; well-developed vocal structures; and stereoscopic vision.

**Body Organization (pp. 00)**

1. Cells are the fundamental structural and functional components of life.
2. Tissues are aggregations of similar cells that perform specific functions.
3. An organ is a structure consisting of two or more tissues that performs a specific function.
4. A body system is composed of a group of organs that function together.

**Anatomical Nomenclature (p. 00)**

1. Most anatomical terms are derived from Greek or Latin words that provide clues to the meaning of the terms.
2. Familiarity with the basic prefixes and suffixes facilitates learning and remembering anatomical terminology.
3. Anatomy is a foundation science for all of the medical and paramedical fields.

**Planes of Reference and Descriptive Terminology (pp. 00)**

1. The body or organs of the body may be sectioned according to planes of reference. These include a midsagittal plane that runs vertically through a structure, dividing it into right and left halves; a sagittal plane that runs vertically through a structure, dividing it into right and left portions; a coronal (frontal) plane that runs vertically through a structure, dividing it into anterior (front) and posterior (back) portions; and a transverse (cross-sectional) plane that runs horizontally through a structure, dividing it into upper and lower portions.
2. In the anatomical position, the subject is standing with feet parallel, eyes directed forward, and arms at the sides of the body with palms turned forward and fingers pointing downward.
3. Directional terms are used to describe the location of one body part with respect to another part in anatomical position.
4. Clinical procedures include observation (visual inspection), palpation (feeling with firm pressure), percussion (detecting resonating vibrations), auscultation (listening to organ sounds), and reflex-response testing (determining involuntary movements).
Body Regions (pp. 00)

1. The head is divided into a facial region, which includes the eyes, nose, and mouth, and a cranial region, which covers and supports the brain.
2. The neck is called the cervical region and functions to support the head and permit movement.
3. The front of the thorax is an axillary fossa and a lateral pectoral region.
4. On either side of the thorax is an axillary fossa and a lateral pectoral region.
5. The abdomen may be divided into nine anatomical regions or four quadrants.
6. Regional names pertaining to the upper extremity include the shoulder, brachium, antebrachium, and manus.
7. Regional names pertaining to the lower extremity include the hip, thigh, leg, and foot.

Body Cavities and Membranes (pp. 00)

1. The posterior cavity, which encompasses the cranial and spinal cavities, encloses and protects the brain and spinal cord—the central nervous system.
2. The anterior cavity, which encompasses the thoracic and abdominopelvic cavities, contains the visceral organs.
3. Other body cavities include the oral, nasal, and middle-ear cavities.
4. The body has two principal types of membranes: mucous membranes, which secrete protective mucus, and serous membranes, which line the ventral cavities and cover visceral organs. Serous membranes secrete a lubricating serous fluid.
5. Serous membranes may be categorized as pleural membranes (associated with the lungs), pericardial membranes (associated with the heart), or peritoneal membranes (associated with the abdominal viscera).

Review Activities

Objective Questions

1. Which of the following is not a principal chordate characteristic?
   (a) a dorsal hollow nerve cord
   (b) a distinct head, thorax, and abdomen
   (c) a notochord
   (d) pharyngeal pouches

2. Prehensile hands, digits modified for grasping, and large, well-developed brains are structural characteristics of the grouping of animals referred to as
   (a) primates.
   (b) vertebrates.
   (c) mammals.
   (d) chordates.

3. Layers or aggregations of similar cells that perform specific functions are called
   (a) organelles.
   (b) tissues.
   (c) organs.
   (d) glands.

4. Filtration and maintenance of the volume and the chemical composition of the blood are functions of
   (a) the urinary system.
   (b) the lymphatic system.
   (c) the circulatory system.
   (d) the endocrine system.

5. The cubital fossa is located in
   (a) the thorax.
   (b) the upper extremity.
   (c) the abdomen.
   (d) the lower extremity.

6. Because it is composed of more than one tissue type, the skin is considered
   (a) a composite tissue.
   (b) a system.
   (c) an organ.
   (d) an organism.

7. Which of the following is not a reference plane?
   (a) coronal
   (b) transverse
   (c) vertical
   (d) sagittal

8. The external genitalia (reproductive organs) are located in
   (a) the popliteal fossa.
   (b) the perineum.
   (c) the hypogastric region.
   (d) the epigastric region.

9. The region of the thoracic cavity between the two pleural cavities is called
   (a) the mediastinum.
   (b) the ventral cavity.
   (c) the ventral cavity.
   (d) the median cavity.

10. The abdominal region superior to the umbilical region that contains most of the stomach is
    (a) the hypochondriac region.
    (b) the epigastric region.
    (c) the diaphragmatic region.
    (d) the inguinal region.

11. Regarding serous membranes, which of the following word pairs is incorrect?
    (a) visceral pleura/bronchus
    (b) parietal peritoneum/body wall
    (c) mesentery/heart
    (d) parietal pleura/body wall
    (e) visceral peritoneum/intestines

12. The plane of reference that divides the body into anterior and posterior portions is
    (a) sagittal.
    (b) transverse.
    (c) coronal.
    (d) cross-sectional.

13. In the anatomical position, the arms are extended away from the body.
    (a) the arms are extended away from the body.
    (b) the palms of the hands face posteriorly.
    (c) the body is erect and the palms face anteriorly.
    (d) the body is in a fetal position.

14. Listening to sounds that functioning visceral organs make is called
    (a) percussion.
    (b) palpation.
    (c) auscultation.
    (d) audiometric.

Essay Questions

1. Discuss the characteristics an animal must possess to be classified as a chordate; a mammal; a human.
2. Describe the relationship of the notochord to the vertebral column, the pharyngeal pouches to the ear, and the dorsal hollow nerve cord to the central nervous system.
3. Which major region of the body contains the visceral organs?
4. List the anatomical characteristics that distinguish humans.
5. Identify the levels of complexity that characterize the human body.
6. Outline the systems of the body and identify the major organs that compose each system.
7. What is meant by anatomical position? Why is the anatomical position important in studying anatomy?
8. Define the terms palpation, percussion, and auscultation.
9. Which major region of the body contains each of the following structures or minor regions?
   (a) scapular region.
   (b) brachium.
   (c) popliteal fossa.
   (d) lumbar region.
   (e) cubital fossa.
   (f) hypochondriac region.
   (g) perineum.
   (h) axillary fossa.
10. List the cavities and spaces found within the head and explain the functions of each.

11. Diagram the thoracic cavity showing the relative position of the pericardial cavity, pleural cavities, and mediastinum.

12. What is a serous membrane? Explain how the names of the serous membranes differ in accordance with each body cavity.

Critical-Thinking Questions
1. Smooth muscle is a tissue type. Using examples, discuss the level of body organization “below” smooth muscle tissue and the level of body organization “above” smooth muscle tissue. Which of these levels would be studied as microscopic anatomy and which would be studied as gross anatomy?

2. Arteries transport blood away from the heart and veins transport blood toward the heart. Using the terms anterior, proximal, distal, medial, and lateral, describe blood flow from the heart to the palm of the hand and right thumb and back to the heart. In answering this question, keep the anatomical position in mind. Also, be aware that adding an “ly” to these directional terms changes them from adjectives to adverbs.

3. Vital body organs are those that are essential for critical body functions. Examples are the heart in pumping blood, the liver in processing foods and breaking down worn blood cells, the kidneys in filtering blood, the lungs in exchanging respiratory gasses, and the brain in controlling and correlating body functions. Death of a person occurs when one or more of the vital body organs falters in its function. Explain why the reproductive organs are not considered vital body organs?

4. A 25-year-old man sustained trauma to the left lateral side of his rib cage following a rock-climbing accident. Upon arrival at the hospital emergency room, the ER doctor indicated that the extent of the injury could be determined only through the techniques of inspection, palpation, percussion, and auscultation. Describe how each of these techniques may be used to assess the condition of the thorax and thoracic organs.

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