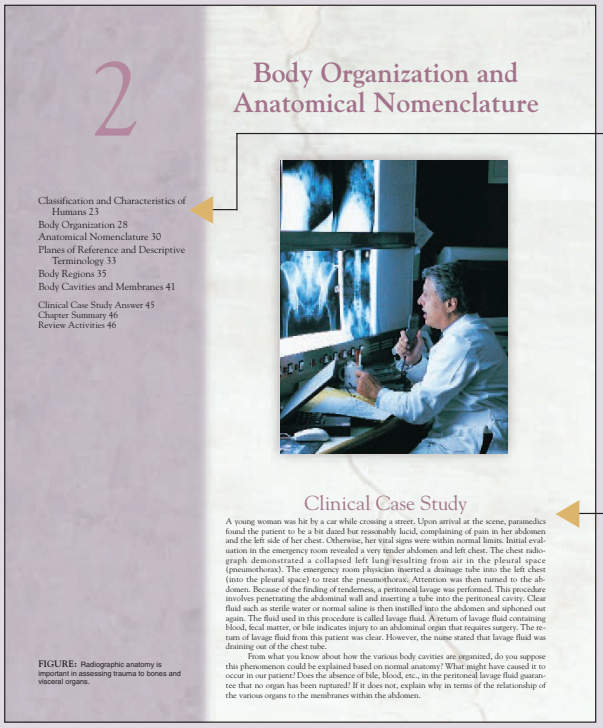
Visual Guide



2

Body Organization and Anatomical Nomenclature

FIGURE: Radiographic anatomy is important in assessing trauma to bones and visceral organs.

Clinical Case Study

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.

Chapter Outline

A page-referenced preview of major topics is included on the opening page of each chapter, allowing you to see at a glance what the upcoming chapter covers.

Clinical Case Study

A hypothetical medical situation sets the stage for the chapter by underscoring the clinical relevance of the chapter content. As you read the chapter, watch for the background information needed to solve the case study, then check your answer against the solution given at the end of the chapter.

Concept Statement

A carefully worded expression of the main idea, or organizing principle, of the information contained in a chapter section gives you a quick overview of the material that will follow.

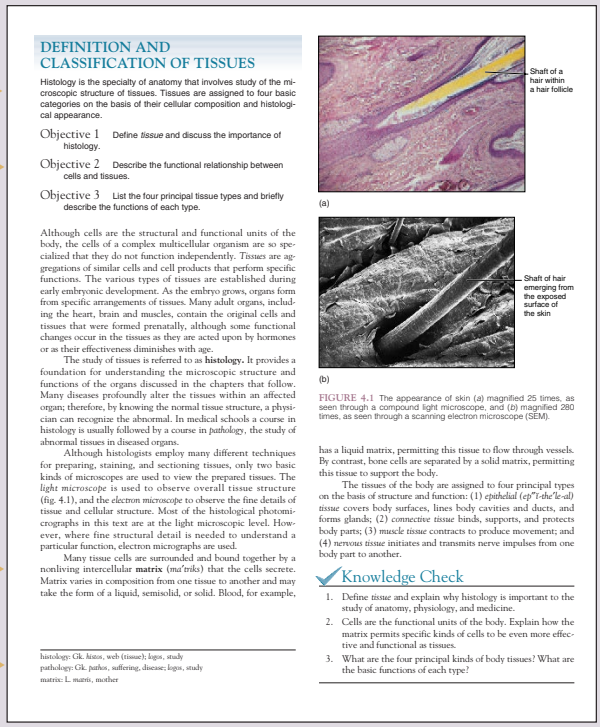
Learning Objectives

Each chapter section begins with a set of learning objectives that indicate the level of competency you should attain in order to thoroughly understand the concept and apply it in practical situations.

Vocabulary Aids

New terms appear in boldface print as they are introduced and immediately defined in context. Definitions and phonetic pronunciations for boldfaced terms are gathered in the glossary at the end of the book.

The Greek or Latin derivations of many terms are provided in footnotes at the bottom of the page on which the term first appears.



DEFINITION AND CLASSIFICATION OF TISSUES

Histology is the specialty of anatomy that involves study of the microscopic structure of tissues. Tissues are assigned to four basic categories on the basis of their cellular composition and histological appearance.

Objective 1 Define *tissue* and discuss the importance of histology.

Objective 2 Describe the functional relationship between cells and tissues.

Objective 3 List the four principal tissue types and briefly describe the functions of each type.

Although cells are the structural and functional units of the body, the cells of a complex multicellular organism are so specialized that they do not function independently. Tissues are aggregations of similar cells and cell products that perform specific functions. The various types of tissues are established during early embryonic development. As the embryo grows, organs form from specific arrangements of tissues. Many adult organs, including the heart, brain and muscles, contain the original cells and tissues that were formed prenatally, although some functional changes occur in the tissues as they are acted upon by hormones or as their effectiveness diminishes with age.

The study of tissues is referred to as **histology.** It provides a foundation for understanding the microscopic structure and functions of the organs discussed in the chapters that follow. Many diseases profoundly alter the tissues within an affected organ; therefore, by knowing the normal tissue structure, a physician can recognize the abnormal. In medical schools a course in histology is usually followed by a course in *pathology*, the study of abnormal tissues in diseased organs.

Although histologists employ many different techniques for preparing, staining, and sectioning tissues, only two basic kinds of microscopes are used to view the prepared tissues. The *light microscope* is used to observe overall tissue structure (fig. 4.1), and the *electron microscope* to observe the fine details of tissue and cellular structure. Most of the histological photomicrographs in this text are at the light microscopic level. However, where fine structural detail is needed to understand a particular function, electron micrographs are used.

Many tissue cells are surrounded and bound together by a nonliving intercellular **matrix** (*ma'triks*) that the cells secrete. Matrix varies in composition from one tissue to another and may take the form of a liquid, semisolid, or solid. Blood, for example, has a liquid matrix, permitting this tissue to flow through vessels. By contrast, bone cells are separated by a solid matrix, permitting this tissue to support the body.

The tissues of the body are assigned to four principal types on the basis of structure and function: (1) *epithelial (ep"i-the'le-al) tissue* covers body surfaces, lines body cavities and ducts, and forms glands; (2) *connective tissue* binds, supports, and protects body parts; (3) *muscle tissue* contracts to produce movement; and (4) *nervous tissue* initiates and transmits nerve impulses from one body part to another.

histology: Gk. *histos*, web (tissue); *logos*, study
pathology: Gk. *pathos*, suffering, disease; *logos*, study
matrix: L. *matrix*, mother

Shaft of a hair within a hair follicle

(a)

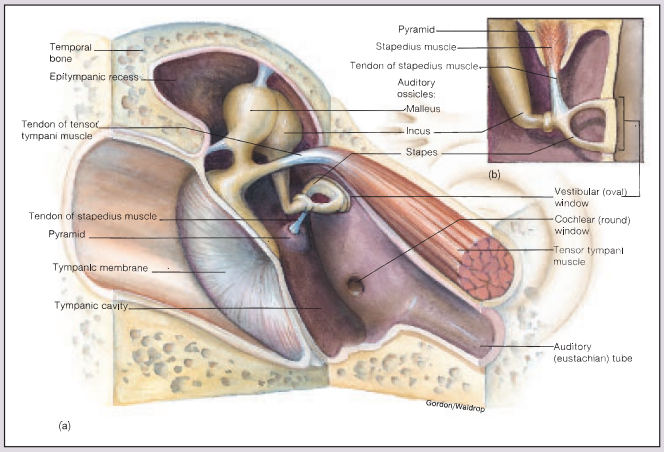
Shaft of hair emerging from the exposed surface of the skin

(b)

FIGURE 4.1 The appearance of skin (*a*) magnified 25 times, as seen through a compound light microscope, and (*b*) magnified 280 times, as seen through a scanning electron microscope (SEM).

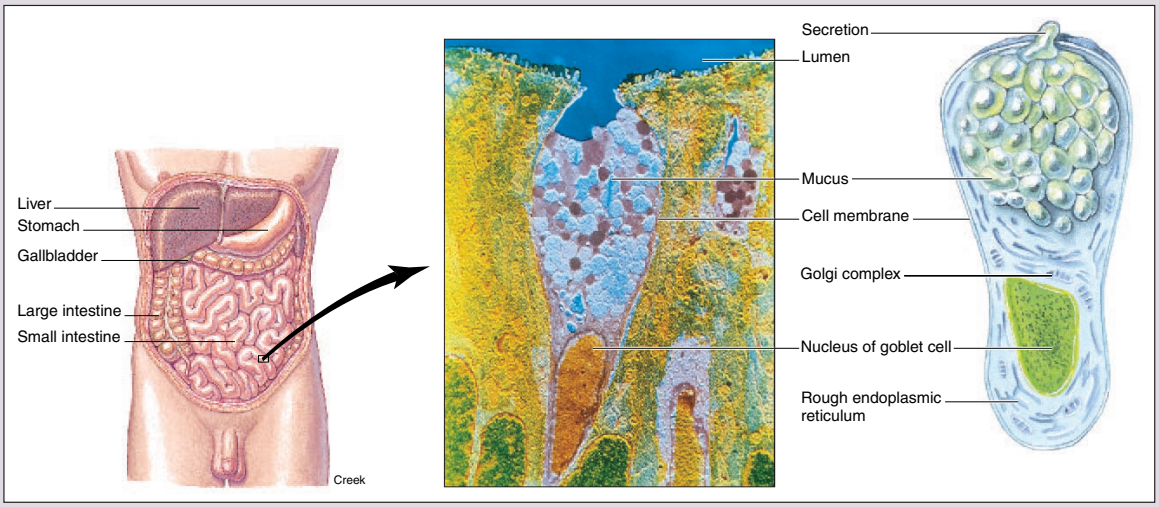
Knowledge Check

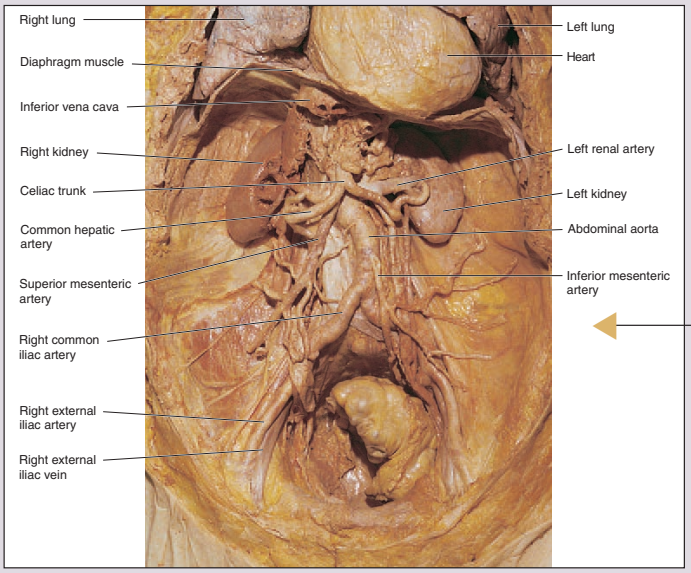
1. Define *tissue* and explain why histology is important to the study of anatomy, physiology, and medicine.
2. Cells are the functional units of the body. Explain how the matrix permits specific kinds of cells to be even more effective and functional as tissues.
3. What are the four principal kinds of body tissues? What are the basic functions of each type?



Beautifully Rendered Full-Color Art

Carefully prepared, accurate illustrations are a hallmark of this text. Human anatomy is a visual science, and realistic art is essential. Vibrant four-color illustrations are often paired with photographs, reinforcing the detail conveyed in the drawings with direct comparisons of actual structures.





Atlas-Quality Cadaver Images

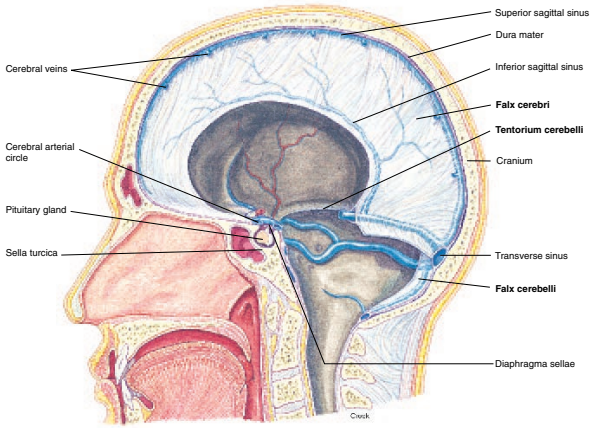
Precisely labeled photographs of dissected human cadavers provide detailed views of human anatomy that allow students concrete visualization of anatomical structures and their position relative to other parts of the body.

Illustrated Tables

Selected tables combine artwork with summarized content to provide comprehensive topic coverage in an easy-to-follow format.

TABLE 11.6 Septa of the Cranial Dura Mater

Septa	Location
Falx cerebri	Extends downward into the longitudinal fissure to partition the right and left cerebral hemispheres; anchored anteriorly to the crista galli of the ethmoid bone and posteriorly to the tentorium
Tentorium cerebelli	Separates the occipital and temporal lobes of the cerebrum from the cerebellum; anchored to the tentorium, petrous parts of the temporal bones, and occipital bone
Falx cerebelli	Partitions the right and left cerebellar hemispheres; anchored to the occipital crest
Diaphragma sellae	Forms the roof of the sella turcica



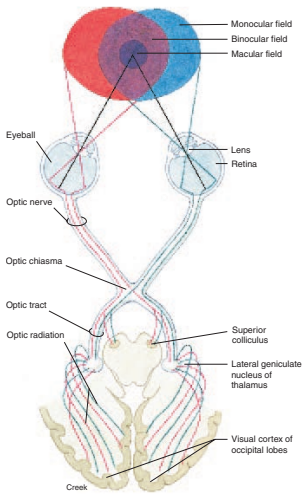


FIGURE 15.27 Visual fields of the eyes and neural pathways for vision. An overlapping of the visual field of each eye provides binocular vision—the ability to perceive depth.

superior colliculi stimulate the **extrinsic ocular muscles** (see table 15.3), which are the skeletal muscles that move the eyes.

Two types of eye movements are coordinated by the superior colliculi. *Smooth pursuit movements* track moving objects and keep the image focused on the fovea centralis. *Saccadic (să-kad'ik) eye movements* are quick (lasting 20–50 msec), jerky movements that occur while the eyes appear to be still. These saccadic movements are believed to be important in maintaining visual acuity.

The tectal system is also involved in the control of the **intrinsic ocular muscles**—the smooth muscles of the iris and of the ciliary body. Shining a light into one eye stimulates the *pupillary reflex* in which both pupils constrict. This is caused by activation of parasympathetic neurons by fibers from the superior colliculi. Postganglionic neurons in the ciliary ganglia behind the eyes, in turn, stimulate constrictor fibers in the iris. Contraction of the ciliary body during *accommodation* also involves stimulation of the superior colliculi.

Processing of Visual Information

For visual information to have meaning, it must be associated with past experience and integrated with information from other senses. Some of this higher processing occurs in the inferior temporal lobes of the cerebral cortex. Experimental removal of these areas from monkeys impairs their ability to remember visual tasks that they previously learned and hinders their ability to associate visual images with the significance of the objects viewed. Monkeys with their inferior temporal lobes removed, for example, will fearlessly handle a snake. The symptoms produced by loss of the inferior temporal lobes are known as *Klüver–Bucy syndrome*.

In an attempt to reduce the symptoms of severe epilepsy, surgeons at one time would cut the corpus callosum in some patients. This fiber tract, as previously described, transmits impulses between the right and left cerebral hemispheres. The right cerebral hemisphere of patients with such *split brains* would therefore, receive sensory information only from the left half of the external world. The left hemisphere, similarly cut off from communication with the right hemisphere, would receive sensory information only from the right half of the external world. In some situations, these patients would behave as if they had two separate minds.

Experiments with split-brain patients have revealed that the two hemispheres have separate abilities. This is true even though each hemisphere normally receives input from both halves of the external world through the corpus callosum. If the sensory image of an object, such as a key, is delivered only to the left hemisphere (by showing it only to the right visual field), the object can be named. If the object is presented to the right cerebral cortex, the person knows what the object is but cannot name it. Experiments such as this suggest that (in right-handed people) the left hemisphere is needed for language and the right hemisphere is responsible for pattern recognition.

Knowledge Check

15. List the accessory structures of the eye that either cause the eye to move or protect it within the orbit.
16. Diagram the structure of the eye and label the following: sclera, cornea, choroid, retina, fovea centralis, iris, pupil, lens, and ciliary body. What are the principal cells or tissues in each of the three layers of the eye?
17. Trace the path of light through the two cavities of the eye and explain the mechanism of light refraction. Describe how the eye is focused for viewing distant and near objects.
18. List the different layers of the retina and describe the path of light and of nerve activity through these layers. Continue tracing the path of a visual impulse to the cerebral cortex, and list in order the structures traversed.

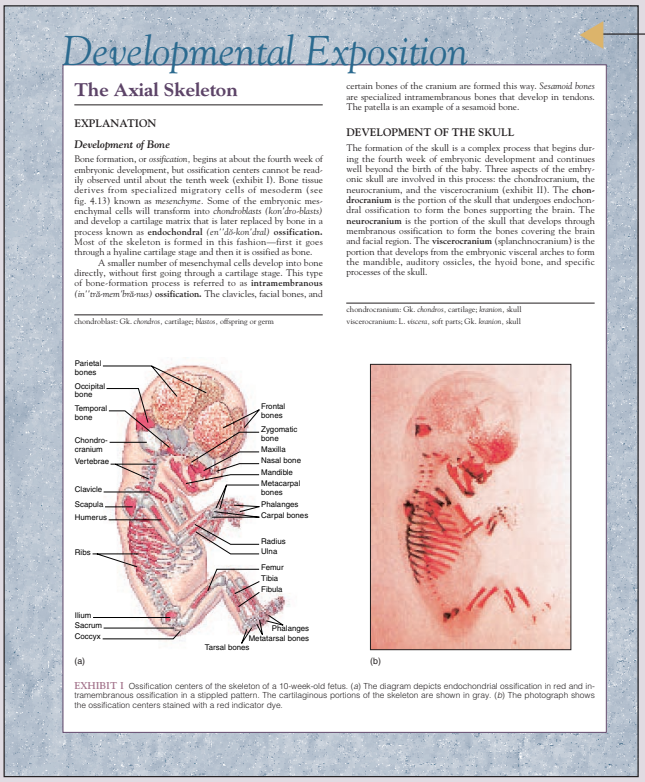
Klüver–Bucy syndrome: from Heinrich Klüver, German neurologist, 1897–1979 and Paul C. Bucy, American neurologist, b. 1904

Topic Icons

Topic icons highlight information of practical application and special interest. These commentaries reinforce the importance of learning the preceding facts. The five icon images and the topics they represent are: clinical information (stethoscope), aging (hourglass), developmental information (embryo), homeostasis (gear mechanism), and academic interest information (mortarboard).

Knowledge Check

Placed at the end of each major section, Knowledge Check questions help you test your understanding of the material and encourage concept application.



Developmental Exposition

The Axial Skeleton

EXPLANATION

Development of Bone

Bone formation, or *ossification*, begins at about the fourth week of embryonic development, but ossification centers cannot be readily observed until about the tenth week (exhibit I). Bone tissue derives from specialized migratory cells of mesoderm (see fig. 4.13) known as *mesenchyme*. Some of the embryonic mesenchymal cells will transform into *chondroblasts (kon'dro-blasts)* and develop a cartilage matrix that is later replaced by bone in a process known as **endochondral** *(en''dō-kon'dral)* **ossification.** Most of the skeleton is formed in this fashion—first it goes through a hyaline cartilage stage and then it is ossified as bone.

A smaller number of mesenchymal cells develop into bone directly, without first going through a cartilage stage. This type of bone-formation process is referred to as **intramembranous** *(in''trā-mem'brā-nus)* **ossification.** The clavicles, facial bones, and certain bones of the cranium are formed this way. *Sesamoid bones* are specialized intramembranous bones that develop in tendons. The patella is an example of a sesamoid bone.

chondroblast: Gk. *chondros*, cartilage; *blastos*, offspring or germ

DEVELOPMENT OF THE SKULL

The formation of the skull is a complex process that begins during the fourth week of embryonic development and continues well beyond the birth of the baby. Three aspects of the embryonic skull are involved in this process: the chondrocranium, the neurocranium, and the viscerocranium (exhibit II). The **chondrocranium** is the portion of the skull that undergoes endochondral ossification to form the bones supporting the brain. The **neurocranium** is the portion of the skull that develops through membranous ossification to form the bones covering the brain and facial region. The **viscerocranium** (splanchnocranium) is the portion that develops from the embryonic visceral arches to form the mandible, auditory ossicles, the hyoid bone, and specific processes of the skull.

chondrocranium: Gk. *chondros*, cartilage; *kranion*, skull
viscerocranium: L. *viscera*, soft parts; Gk. *kranion*, skull

EXHIBIT I Ossification centers of the skeleton of a 10-week-old fetus. (a) The diagram depicts endochondrial ossification in red and intramembranous ossification in a stippled pattern. The cartilaginous portions of the skeleton are shown in gray. (b) The photograph shows the ossification centers stained with a red indicator dye.

Developmental Expositions

Each systems chapter includes a discussion of the morphogenic events involved in the prenatal development of the profiled body system.

Clinical Considerations

These special sections appearing at the end of most chapters describe selected developmental disorders, diseases, or dysfunctions of specific organ systems, as well as relevant clinical procedures. The effects of aging in regard to specific body systems are also profiled.

CLINICAL CONSIDERATIONS

The clinical aspects of the central nervous system are extensive and usually complex. Numerous diseases and developmental problems directly involve the nervous system, and the nervous system is indirectly involved with most of the diseases that afflict the body because of the location and activity of sensory pain receptors. Pain receptors are free nerve endings that are present throughout living tissue. The pain sensations elicited by disease or trauma are important in localizing and diagnosing specific diseases or dysfunctions.

Only a few of the many clinical considerations of the central nervous system will be discussed here. These include neurological assessment and drugs, developmental problems, injuries, infections and diseases, and degenerative disorders.

Neurological Assessment and Drugs

Neurological assessment has become exceedingly sophisticated and accurate in the past few years. In a basic physical examination, only the reflexes and sensory functions are assessed. But if the physician suspects abnormalities involving the nervous system, further neurological tests may be done, employing the following techniques.

A **lumbar puncture** is performed by inserting a fine needle between the third and fourth lumbar vertebrae and withdrawing a sample of CSF from the subarachnoid space (fig. 11.45). A **cisternal puncture** is similar to a lumbar puncture except that the CSF is withdrawn from a cisterna at the base of the skull, near the foramen magnum. The pressure of the CSF, which is normally about 10 mmHg, is measured with a *manometer*. Samples of CSF may also be examined for abnormal constituents. In addition, excessive fluid, accumulated as a result of disease or trauma, may be drained.

The condition of the arteries of the brain can be determined through a **cerebral angiogram** *(an'je-ō-gram)*. In this technique, a radiopaque substance is injected into the common carotid arteries and allowed to disperse through the cerebral vessels. Aneurysms and vascular constrictions or displacements by tumors may then be revealed on radiographs.

The development of the **CT scanner,** or **computerized axial tomographic scanner,** has revolutionized the diagnosis of brain disorders. The CT scanner projects a sharply focused, detailed tomogram, or cross section, of a patient's brain onto a television screen. The versatile CT scanner allows quick and accurate diagnoses of tumors, aneurysms, blood clots, and hemorrhage. The CT scanner may also be used to detect certain types of birth defects, brain damage, scar tissue, and evidence of old or recent strokes.

A machine with even greater potential than the CT scanner is the **DSR,** or **dynamic spatial reconstructor.** Like the CT scanner, the DSR is computerized to transform radiographs into composite video images. However, with the DSR, a three-dimensional view is obtained, and the image is produced much faster than with the CT scanner. The DSR can produce 75,000 cross-sectional images in 5 seconds, whereas the CT scanner can produce only one. With that speed, body functions as well as structures may be studied. Blood flow through vessels of the brain can be observed. These types of data are important in detecting early symptoms of a stroke or other disorders.

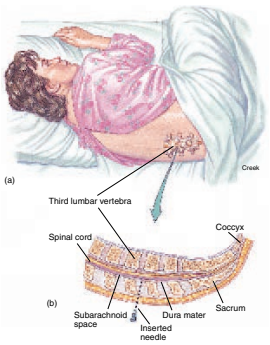


FIGURE 11.45 (*a*) A lumbar puncture is performed by inserting a needle between the third and fourth lumbar vertebrae (L3–L4) and (*b*) withdrawing cerebrospinal fluid from the subarachnoid space.

Certain disorders of the brain may be diagnosed more simply by examining brain-wave patterns using an **electroencephalogram** (see Table 11.5). Sensitive electrodes placed on the scalp record particular EEG patterns being emitted from evoked cerebral activity. EEG recordings are used to monitor epileptic patients to predict seizures and to determine proper drug therapy, and also to monitor comatose patients.

The fact that the nervous system is extremely sensitive to various drugs is fortunate; at the same time, this sensitivity has potential for disaster. *Drug abuse* is a major clinical concern because of the addictive and devastating effect that certain drugs have on the nervous system. Much has been written on drug abuse, and it is beyond the scope of this text to elaborate on the effects of drugs. A positive aspect of drugs is their administration in medicine to temporarily interrupt the passage or perception of sensory impulses. Injecting an anesthetic drug near a nerve, as in dentistry, desensitizes a specific area and causes a *nerve block*. Nerve blocks of a limited extent occur if an appendage is cooled or if a nerve is compressed for a period of time. Before the

Clinical Practicums

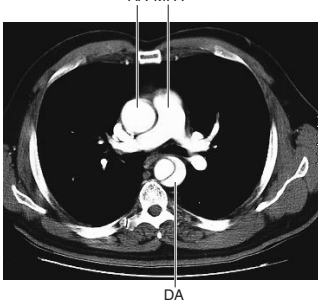
These focused clinical scenarios challenge you to put your knowledge of anatomy to work in a clinical setting. Given a brief patient history and accompanying diagnostic images, you must apply the chapter material to diagnose a condition, explain the origin of symptoms, or even recommend a course of treatment. Detailed answers to the Clinical Practicum questions are provided in Appendix B.

CLINICAL PRACTICUM 16.1

A 75-year-old male with a long history of hypertension presents to the emergency room with complaints of stabbing chest pain that goes through to his back. On physical exam, the patient's lungs are clear, and heart sounds are also normal with regular rate and rhythm. An electrocardiogram is also normal. Because of his symptoms, you suspect an aortic dissection and order a CT scan. (MRA = main pulmonary artery, AA = ascending aorta, DA = descending aorta.)

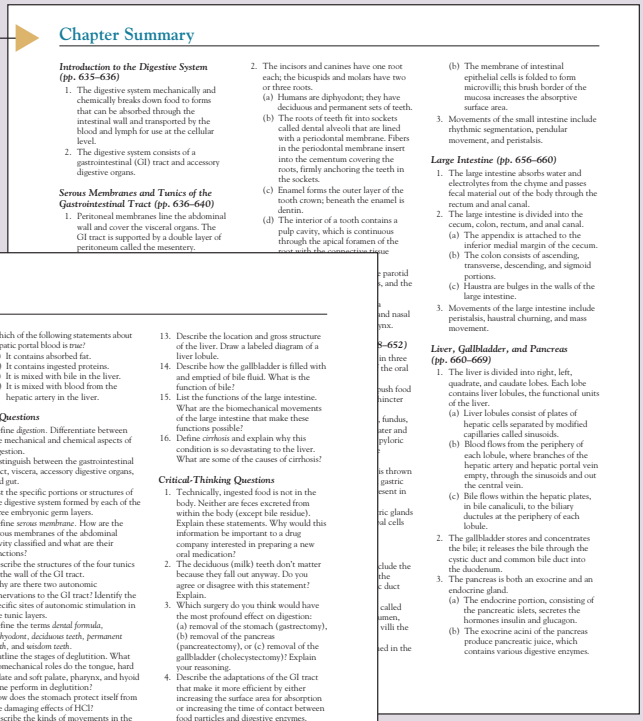
QUESTIONS

1. What is the dark line noted within the contrast-filled aorta?
2. Which portions of the aorta are involved?
3. You also note that the patient has a difference in blood pressure between the left and right arm, with the left arm having a significantly lower blood pressure. What could be the cause?



Chapter Summary

At the end of each chapter, a summary in outline form reinforces your mastery of the chapter content.



Chapter Summary

Introduction to the Digestive System (pp. 635–636)

1. The digestive system mechanically and chemically breaks down food to forms that can be absorbed through the intestinal wall and transported by the blood and lymph for use at the cellular level.
2. The digestive system consists of a gastrointestinal (GI) tract and accessory digestive organs.

Serous Membranes and Tunics of the Gastrointestinal Tract (pp. 636–640)

1. Peritoneal membranes line the abdominal wall and cover the visceral organs. The GI tract is supported by a double layer of peritoneum called the mesentery.
2. The incisors and canines have one root each; the bicuspids and molars have two or three roots.
   (a) Humans are diphyodont; they have deciduous and permanent sets of teeth.
   (b) The roots of teeth fit into sockets called dental alveoli that are lined with a periodontal membrane. Fibers in the periodontal membrane insert into the cementum covering the roots, firmly anchoring the teeth in the sockets.
   (c) Enamel forms the outer layer of the tooth crown; beneath the enamel is dentin.
   (d) The interior of a tooth contains a pulp cavity, which is continuous through the apical foramen of the
   (b) The membrane of intestinal epithelial cells is folded to form microvilli; this brush border of the mucosa increases the absorptive surface area.
3. Movements of the small intestine include rhythmic segmentation, pendular movement, and peristalsis.

Large Intestine (pp. 656–660)

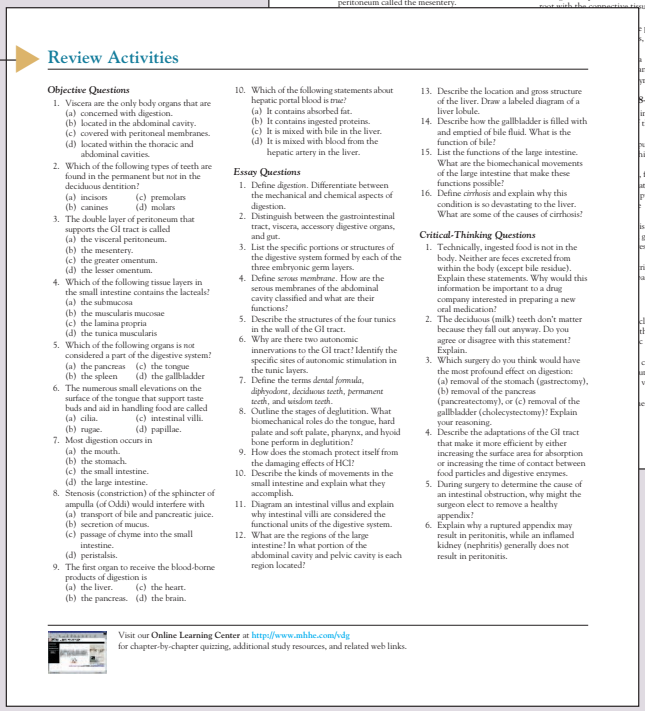
1. The large intestine absorbs water and electrolytes from the chyme and passes fecal material out of the body through the rectum and anal canal.
2. The large intestine is divided into the cecum, colon, rectum, and anal canal.
   (a) The appendix is attached to the inferior medial margin of the cecum.
   (b) The colon consists of ascending, transverse, descending, and sigmoid portions.
   (c) Haustra are bulges in the walls of the large intestine.
3. Movements of the large intestine include peristalsis, haustral churning, and mass movement.

Liver, Gallbladder, and Pancreas (pp. 660–669)

1. The liver is divided into right, left, quadrate, and caudate lobes. Each lobe contains liver lobules, the functional units of the liver.
   (a) Liver lobules consist of plates of hepatic cells separated by modified capillaries called sinusoids.
   (b) Blood flows from the periphery of each lobule, where branches of the hepatic artery and hepatic portal vein empty, through the sinusoids and out the central vein.
   (c) Bile flows within the hepatic plates, in bile canaliculi, to the biliary ductules at the periphery of each lobule.
2. The gallbladder stores and concentrates the bile; it releases the bile through the cystic duct and common bile duct into the duodenum.
3. The pancreas is both an exocrine and an endocrine gland.
   (a) The endocrine portion, consisting of the pancreatic islets, secretes the hormones insulin and glucagon.
   (b) The exocrine acini of the pancreas produce pancreatic juice, which contains various digestive enzymes.

Review Activities

Objective, essay, and critical thinking questions at the end of each chapter allow you to test the depth of your understanding and learning. Answers and explanations to the objective questions are given in Appendix A. The essay and critical thinking exercises are answered in the Instructor's Manual.



Review Activities

Objective Questions

1. Viscera are the only body organs that are
   (a) concerned with digestion.
   (b) located in the abdominal cavity.
   (c) covered with peritoneal membranes.
   (d) located within the thoracic and abdominal cavities.
2. Which of the following types of teeth are found in the permanent but not in the deciduous dentition?
   (a) incisors (c) premolars
   (b) canines (d) molars
3. The double layer of peritoneum that supports the GI tract is called
   (a) the visceral peritoneum.
   (b) the mesentery.
   (c) the greater omentum.
   (d) the lesser omentum.
4. Which of the following tissue layers in the small intestine contains the lacteals?
   (a) the submucosa
   (b) the muscularis mucosae
   (c) the lamina propria
   (d) the tunica muscularis
5. Which of the following organs is not considered a part of the digestive system?
   (a) the pancreas (c) the tongue
   (b) the spleen (d) the gallbladder
6. The numerous small elevations on the surface of the tongue that support taste buds and aid in handling food are called
   (a) cilia. (c) intestinal villi.
   (b) rugae. (d) papillae.
7. Most digestion occurs in
   (a) the mouth.
   (b) the stomach.
   (c) the small intestine.
   (d) the large intestine.
8. Stenosis (constriction) of the sphincter of ampulla (of Oddi) would interfere with
   (a) transport of bile and pancreatic juice.
   (b) secretion of mucus.
   (c) passage of chyme into the small intestine.
   (d) peristalsis.
9. The first organ to receive the blood-borne products of digestion is
   (a) the liver. (c) the heart.
   (b) the pancreas. (d) the brain.
10. Which of the following statements about hepatic portal blood is true?
    (a) It contains absorbed fat.
    (b) It contains ingested proteins.
    (c) It is mixed with bile in the liver.
    (d) It is mixed with blood from the hepatic artery in the liver.

Essay Questions

1. Define *digestion*. Differentiate between the mechanical and chemical aspects of digestion.
2. Distinguish between the gastrointestinal tract, viscera, accessory digestive organs, and gut.
3. List the specific portions or structures of the digestive system formed by each of the three embryonic germ layers.
4. Define *serous membrane*. How are the serous membranes of the abdominal cavity classified and what are their functions?
5. Describe the structures of the four tunics in the wall of the GI tract.
6. Why are there two autonomic innervations to the GI tract? Identify the specific sites of autonomic stimulation in the tunic layers.
7. Define the terms *dental formula, diphyodont, deciduous teeth, permanent teeth,* and *wisdom teeth.*
8. Outline the stages of deglutition. What biomechanical roles do the tongue, hard palate and soft palate, pharynx, and hyoid bone perform in deglutition?
9. How does the stomach protect itself from the damaging effects of HCl?
10. Describe the kinds of movements in the small intestine and explain what they accomplish.
11. Diagram an intestinal villus and explain why intestinal villi are considered the functional units of the digestive system.
12. What are the regions of the large intestine? In what portion of the abdominal cavity and pelvic cavity is each region located?
13. Describe the location and gross structure of the liver. Draw a labeled diagram of a liver lobule.
14. Describe how the gallbladder is filled with and emptied of bile fluid. What is the function of bile?
15. List the functions of the large intestine. What are the biomechanical movements of the large intestine that make these functions possible?
16. Define *cirrhosis* and explain why this condition is so devastating to the liver. What are some of the causes of cirrhosis?

Critical-Thinking Questions

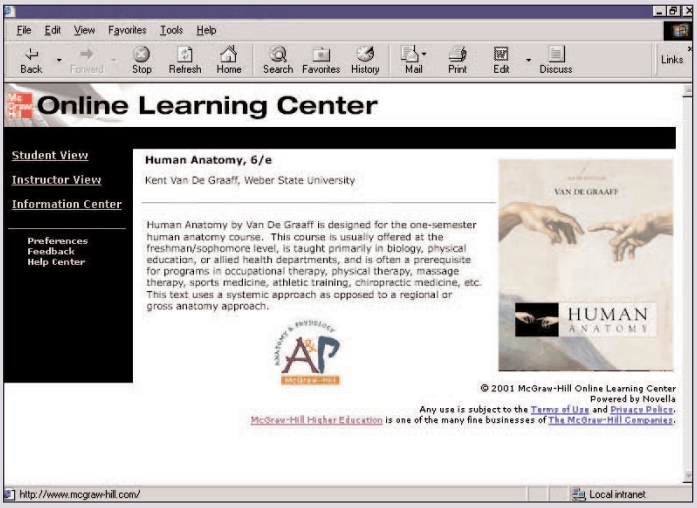
1. Technically, ingested food is not in the body. Neither are feces excreted from within the body (except bile residue). Explain these statements. Why would this information be important to a drug company interested in preparing a new oral medication?
2. The deciduous (milk) teeth don't matter because they fall out anyway. Do you agree or disagree with this statement? Explain.
3. Which surgery do you think would have the most profound effect on digestion: (a) removal of the stomach (gastrectomy), (b) removal of the pancreas (pancreatectomy), or (c) removal of the gallbladder (cholecystectomy)? Explain your reasoning.
4. Describe the adaptations of the GI tract that make it more efficient by either increasing the surface area for absorption or increasing the time of contact between food particles and digestive enzymes.
5. During surgery to determine the cause of an intestinal obstruction, why might the surgeon elect to remove a healthy appendix?
6. Explain why a ruptured appendix may result in peritonitis, while an inflamed kidney (nephritis) generally does not result in peritonitis.

Visit our **Online Learning Center** at http://www.mhhe.com/vdg for chapter-by-chapter quizzing, additional study resources, and related web links.

Multimedia Resources

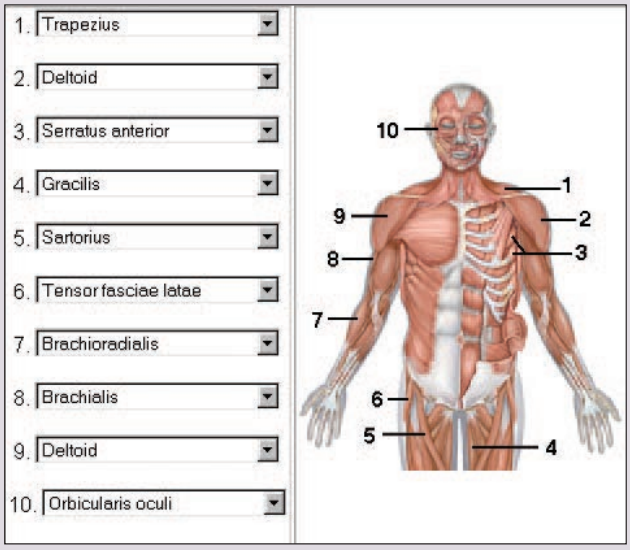
Online Learning Center

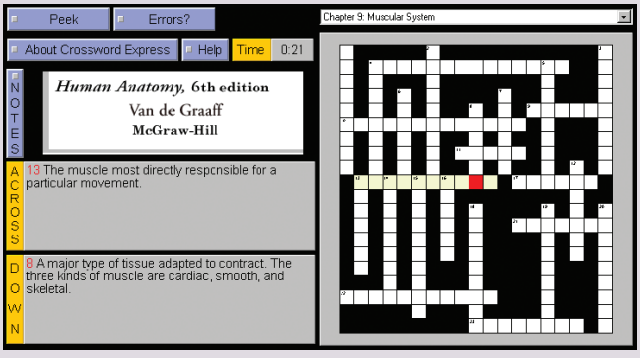
The Online Learning Center (OLC) that accompanies this text is found at www.mhhe.com/vdg. This online resource offers an extensive array of learning tools that are tailored to coincide with each chapter of the text.

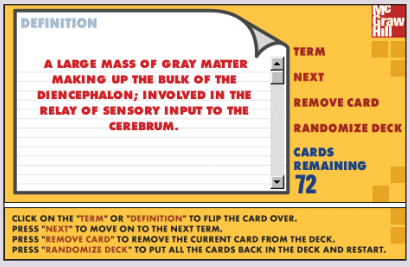


Learning Activities

Among the activities awaiting you at the OLC are chapter quizzes, crossword puzzles, art labeling exercises, vocabulary flashcards, and animation-based activities. In addition, the OLC offers numerous case studies and clinical applications, cutting-edge online reference materials, and links to related anatomy and physiology Internet sites.





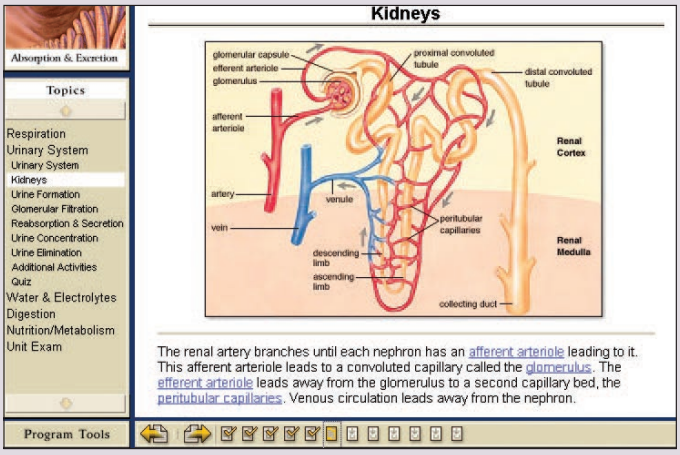


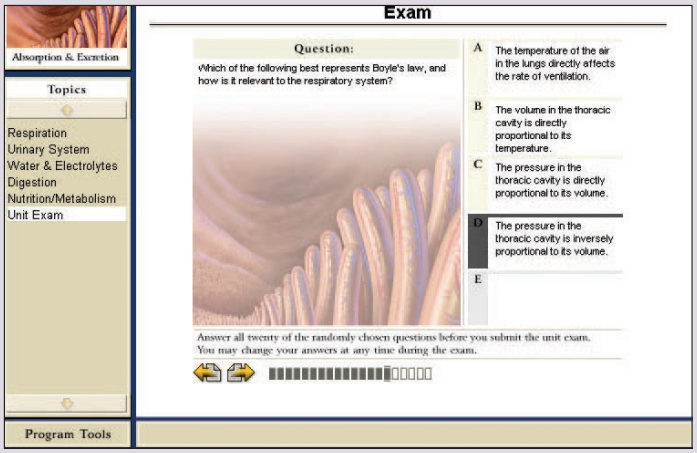
Premium Study Tools

Logging on to the OLC gives you access to premium interactive study tools like the Essential Study Partner, adam Online Anatomy, and BioCourse.com.

Essential Study Partner

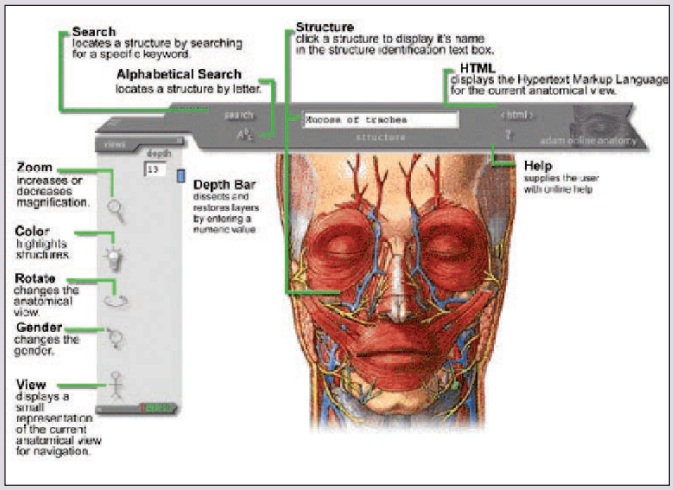
This interactive study tool contains hundreds of animations and learning activities designed to help you grasp complex concepts. Interactive diagrams and quizzes make learning anatomy and physiology stimulating and fun.





adam Online Anatomy

This comprehensive digital database of detailed anatomical images allows you to point, click, and identify more than 20,000 anatomical structures within fully dissectible male and female bodies in anterior, lateral, medial, and posterior views. You can dissect the body layer by layer, or use a scroll bar to navigate up to a depth of 330 layers. You can also highlight a specific structure for an in-depth study or search by anatomical term to locate all instances of a structure. Other features include an alphabetized glossary and labeled structures for easy identification.



BioCourse.com

This online forum provides a wealth of information and learning opportunities for students of the life sciences. Keep abreast of breaking news by clicking the latest scientific headlines from *The New York Times* or links to prominent journals in the *Briefing Room*. Visit the *Student Center* to ask a question on the discussion boards, brush up on test-taking tips, or perform job and internship searches. Conduct a virtual laboratory experiment at *BioLabs*, or head to *The Quad* to browse the vast array of rich, multimedia content specific to your course. BioCourse.com is the place where science comes to life!