- List at least three functions of the large intestine
- List at least four functions of the liver
- Explain how the pancreas helps digest foods
- Describe at least five diseases of the digestive system
- Define, pronounce, and spell all key terms

KEY TERMS

alimentary canal *(ahl-ih-men′-tar″-ee)*
anus
colon *(coh′-lun)*
digestive system
duodenum *(dew-oh-deh′-num)*
esophagus *(ee″-sof′-eh-gus)*
gallbladder
hard palate
ileum *(ill′-ee″-um)*
jejunum *(jeh-jew′-num)*
large intestine
liver
mouth
pancreas *(pan′-cree″-as)*
peristalsis *(pair″-ih-stall″-sis)*
pharynx *(far′-inks)*
rectum
salivary glands
small intestine
soft palate
stomach
teeth
tongue
vermiform appendix
villi *(vil′-lie)*

RELATED HEALTH CAREERS

- Dental Assistant
- Dental Hygienist
- Dentist
- Dietetic Assistant
- Dietitian
- Enterostomal RN or Technician
- Gastroenterologist
- Hepatologist
- Internist
- Proctologist

7:11 INFORMATION

The **digestive system,** also known as the *gastrointestinal system,* is responsible for the physical and chemical breakdown of food so that it can be taken into the bloodstream and used by body cells and tissues. The system consists of the alimentary canal and accessory organs (figure 7-56). The **alimentary canal** is a long, muscular tube that begins at the mouth and includes the mouth (oral cavity), pharynx, esophagus, stomach, small intestine, large intestine, and anus. The accessory organs are the salivary glands, tongue, teeth, liver, gallbladder, and pancreas.

PARTS OF THE ALIMENTARY CANAL

The **mouth,** also called the *buccal cavity* (figure 7-57) receives food as it enters the body. While food is in the mouth, it is tasted, broken down physically by the teeth, lubricated and partially digested by saliva, and swallowed. The **teeth** are special structures in the mouth that physically break down food by chewing and grinding. This process is called *mastication.* The **tongue** is a muscular organ that contains special receptors called *taste buds.* The taste buds allow a person to taste sweet, salty, sour, and bitter sensations. The

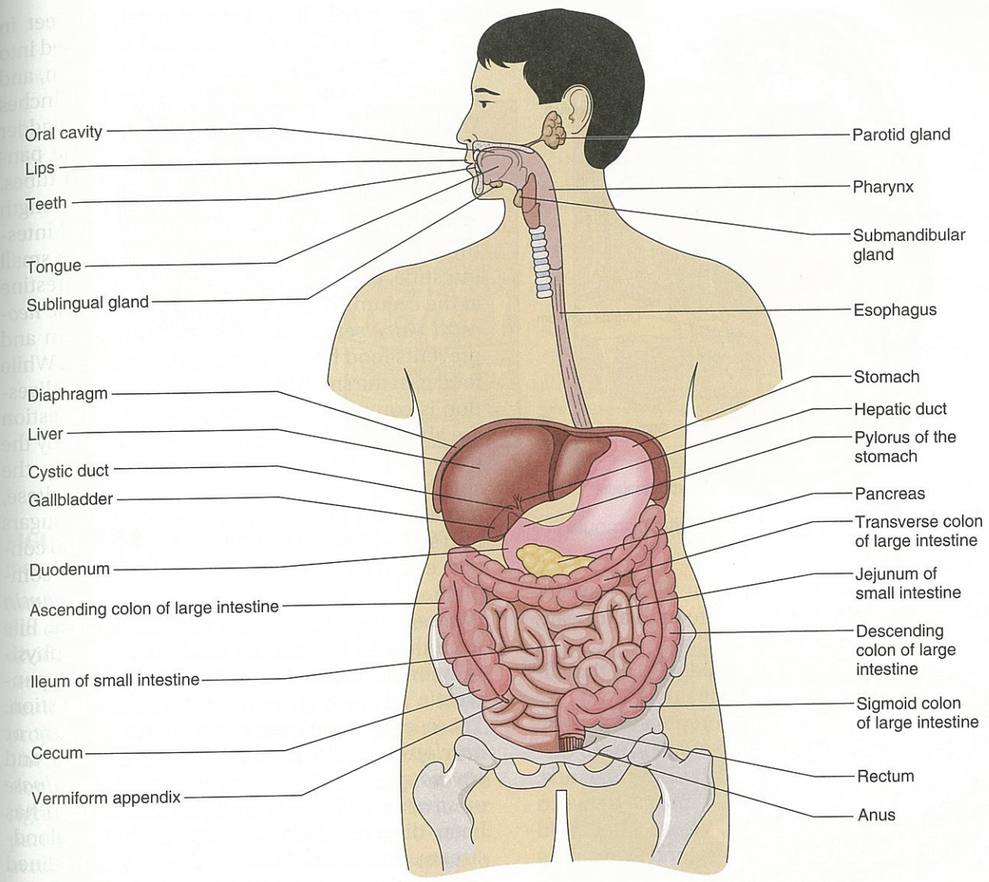

FIGURE 7-56 The digestive system.

tongue also aids in chewing and swallowing food. The **hard palate** is the bony structure that forms the roof of the mouth and separates the mouth from the nasal cavities. Behind the hard palate is the **soft palate,** which separates the mouth from the nasopharynx. The *uvula,* a cone-shaped muscular structure, hangs from the middle of the soft palate. It prevents food from entering the nasopharynx during swallowing. Three pairs of **salivary glands,** the parotid, sublingual, and submandibular, produce a liquid called *saliva.* Saliva lubricates the mouth during speech and chewing and moistens food so that it can be swallowed easily. Saliva also contains an enzyme (a substance that speeds up a chemical reaction) called *salivary amylase,* formerly known as *ptyalin.* Salivary amylase begins the chemical breakdown of carbohydrates, or starches, into sugars that can be taken into the body.

After the food is chewed and mixed with saliva, it is called a *bolus.* When the bolus is swallowed, it enters the **pharynx** (throat). The pharynx is a tube that carries both air and food. It carries the air to the trachea, or windpipe, and food to the esophagus. When a bolus is being swallowed, muscle action causes the epiglottis to close over the larynx, preventing the bolus from entering the respiratory tract and causing it to enter the esophagus.

The **esophagus** is the muscular tube dorsal to (behind) the trachea. This tube receives the bolus from the pharynx and carries the bolus to the stomach. The esophagus, like the remaining part of the alimentary canal, relies on a rhythmic,

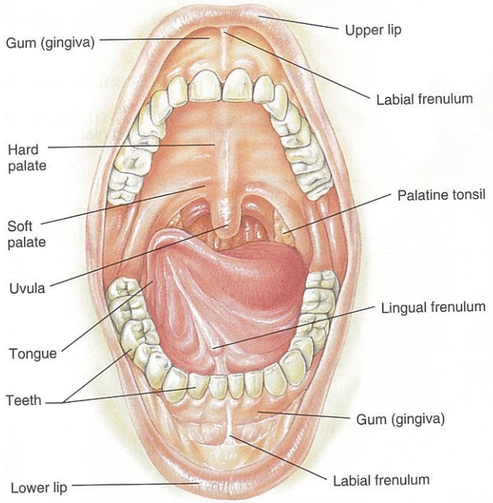

FIGURE 7-57 Parts of the oral cavity, or mouth.

wavelike, involuntary movement of its muscles called **peristalsis** to move the food in a forward direction.

The **stomach** is an enlarged part of the alimentary canal. It receives the food from the esophagus. The mucous membrane lining of the stomach contains folds, called *rugae.* These disappear as the stomach fills with food and expands. The cardiac sphincter, a circular muscle between the esophagus and stomach, closes after food enters the stomach and prevents food from going back up into the esophagus. The pyloric sphincter, a circular muscle between the stomach and small intestine, keeps food in the stomach until the food is ready to enter the small intestine. Food usually remains in the stomach for approximately 2–4 hours. During this time, food is converted into a semifluid material, called *chyme,* by gastric juices produced by glands in the stomach. The gastric juices contain hydrochloric acid and enzymes. Hydrochloric acid kills bacteria, facilitates iron absorption, and activates the enzyme pepsin. The enzymes in gastric juices include lipase, which starts the chemical breakdown of fats, and pepsin, which starts protein digestion. In infants, the enzyme rennin is also secreted to aid in the digestion of milk. Rennin is not present in adults.

When the food, in the form of chyme, leaves the stomach, it enters the small intestine. The **small intestine** is a coiled section of the alimentary canal. It is approximately 20 feet in length and 1 inch in diameter, and is divided into three sections: the duodenum, the jejunum, and the ileum. The **duodenum** is the first 9–10 inches of the small intestine. Bile (from the gallbladder and liver) and pancreatic juice (from the pancreas) enter this section through ducts, or tubes. The **jejunum** is approximately 8 feet in length and forms the middle section of the small intestine. The **ileum** is the final 12 feet of the small intestine, and it connects with the large intestine at the cecum. The circular muscle called the *ileocecal valve* separates the ileum and cecum and prevents food from returning to the ileum. While food is in the small intestine, the process of digestion is completed, and the products of digestion are absorbed into the bloodstream for use by the body cells. Intestinal juices, produced by the small intestine, contain the enzymes maltase, sucrase, and lactase, which break down sugars into simpler forms. The intestinal juices also contain enzymes known as *peptidases,* which complete the digestion of proteins, and *steapsin (lipase),* which aids in the digestion of fat. Bile from the liver and gallbladder emulsifies (physically breaks down) fats. Enzymes from the pancreatic juice complete the process of digestion. These enzymes include pancreatic *amylase* or *amylopsin* (which acts on sugars), *trypsin* and *chymotrypsin* (which act on proteins), and *lipase* or *steapsin* (which acts on fats). After food has been digested, it is absorbed into the bloodstream. The walls of the small intestine are lined with fingerlike projections called **villi** (figure 7-58). The villi contain blood capillaries and lacteals. The blood capillaries absorb the digested nutrients and carry them to the liver, where they are either stored or released into general circulation for use by the body cells. The lacteals absorb most of the digested fats and carry them to the thoracic duct in the lymphatic system, which releases them into the circulatory system. When food has completed its passage through the small intestine, only wastes, indigestible materials, and excess water remain.

The **large intestine** is the final section of the alimentary canal. It is approximately 5 feet in length and 2 inches in diameter. Functions include absorption of water and any remaining nutrients; storage of indigestible materials before they are eliminated from the body; synthesis (formation) and absorption of some B-complex vitamins and vitamin K by bacteria present in the

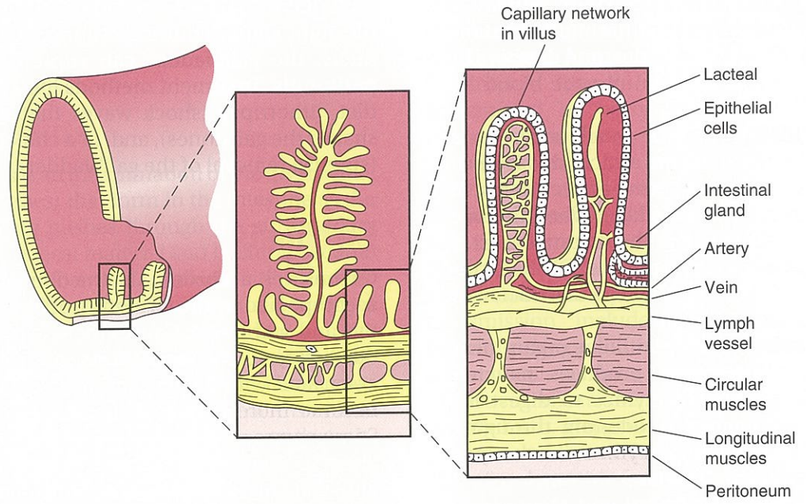

FIGURE 7-58 Lymphatic and blood capillaries in the villi of the small intestine provide for the absorption of the products of digestion.

intestine; and transportation of waste products out of the alimentary canal. The large intestine is divided into a series of connected sections. The *cecum* is the first section and is connected to the ileum of the small intestine. It contains a small projection, called the **vermiform appendix.** The next section, the **colon,** has several divisions. The *ascending colon* continues up on the right side of the body from the cecum to the lower part of the liver. The *transverse colon* extends across the abdomen, below the liver and stomach and above the small intestine. The *descending colon* extends down the left side of the body. It connects with the *sigmoid colon,* an S-shaped section that joins with the rectum. The **rectum** is the final 6–8 inches of the large intestine and is a storage area for indigestibles and wastes. It has a narrow canal, called the *anal canal,* which opens at a hole, called the **anus.** Fecal material, or stool, the final waste product of the digestive process, is expelled through this opening.

ACCESSORY ORGANS

The **liver** (figure 7-59), is the largest gland in the body and is an accessory organ to the digestive system. It is located under the diaphragm and in the upper right quadrant of the abdomen. The liver secretes bile, which is used to emulsify fats in the digestive tract. Bile also makes fats water

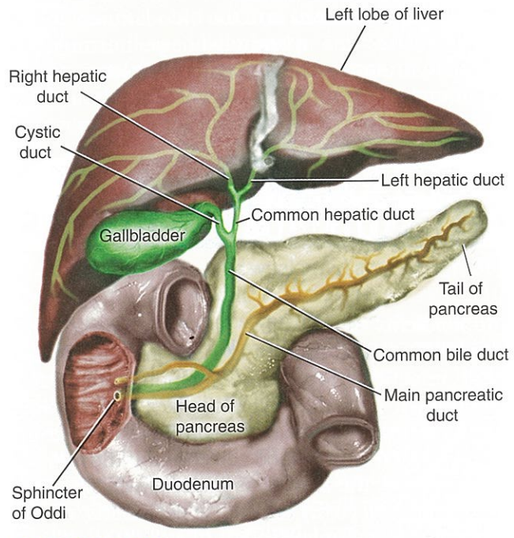

FIGURE 7-59 The liver, gallbladder, and pancreas.

soluble, which is necessary for absorption. The liver stores sugar in the form of glycogen. The glycogen is converted to glucose and released into the bloodstream when additional blood sugar is needed. The liver also stores iron and certain vitamins. It produces heparin, which prevents clotting of the blood; blood proteins such as fibrinogen and prothrombin, which aid in clot-

ting of the blood; and cholesterol. Finally, the liver detoxifies (renders less harmful) substances such as alcohol and pesticides, and destroys bacteria that have been taken into the blood from the intestine.

The **gallbladder** is a small, muscular sac located under the liver and attached to it by connective tissue. It stores and concentrates bile, which it receives from the liver. When the bile is needed to emulsify fats in the digestive tract, the gallbladder contracts and pushes the bile through the cystic duct into the common bile duct, which drains into the duodenum.

The **pancreas** is a glandular organ located behind the stomach. It produces pancreatic juices, which contain enzymes to digest food. These juices enter the duodenum through the pancreatic duct. The enzymes in the juices include pancreatic amylase or amylopsin (to break down sugars), trypsin and chymotrypsin (to break down proteins), and lipase or steapsin (to act on fats). The pancreas also produces insulin, which is secreted into the bloodstream. Insulin regulates the metabolism, or burning, of carbohydrates to convert glucose (blood sugar) to energy.

DISEASES AND ABNORMAL CONDITIONS

Appendicitis

Appendicitis is an acute inflammation of the appendix, usually resulting from an obstruction and infection. Symptoms include generalized abdominal pain that later localizes at the lower right quadrant, nausea and vomiting, mild fever, and elevated white blood cell count. If the appendix ruptures, the infectious material will spill into the peritoneal cavity and cause peritonitis, a serious condition. Appendicitis is treated by an appendectomy (surgical removal of the appendix).

Cholecystitis

Cholecystitis is an inflammation of the gallbladder. When gallstones form from crystallized cholesterol, bile salts, and bile pigments, the condition is known as *cholelithiasis*. Symptoms frequently occur after eating fatty foods and include indigestion, nausea and vomiting, and pain that starts under the rib cage and radiates to the right shoulder. If a gallstone blocks the bile ducts, the gallbladder can rupture and cause peritonitis. Treatment methods include a low-fat diet, lithotripsy (shock waves that are used to shatter the gallstones), and/or a cholecystectomy (surgical removal of the gallbladder).

Cirrhosis

Cirrhosis is a chronic destruction of liver cells accompanied by the formation of fibrous connective and scar tissue. Causes include hepatitis, bile duct disease, chemical toxins, and malnutrition associated with alcoholism. Symptoms vary and become more severe as the disease progresses. Some common symptoms are liver enlargement, anemia, indigestion, nausea, edema in the legs and feet, hematemesis (vomiting blood), nosebleeds, jaundice (yellow discoloration), and ascites (an accumulation of fluid in the abdominal peritoneal cavity). When the liver fails, disorientation, hallucinations, hepatic coma, and death occur. Treatment is directed toward preventing further damage to the liver. Alcohol avoidance, proper nutrition, vitamin supplements, diuretics (to reduce ascites and edema), rest, infection prevention, and appropriate exercise are encouraged. A liver transplant may be performed if too much of the liver is destroyed.

Constipation

Constipation is when fecal material remains in the colon too long, causing excessive reabsorption of water. The feces or stool becomes hard, dry, and difficult to eliminate. Causes include poor bowel habits, chronic laxative use leading to a "lazy" bowel, a diet low in fiber, and certain digestive diseases. The condition is usually corrected by a high-fiber diet, adequate fluids, and exercise. Although laxatives are sometimes used to stimulate defecation, frequent laxative use may be habit forming and lead to chronic constipation.

Diarrhea

Diarrhea is a condition characterized by frequent watery stools. Causes include infection, stress, diet, an irritated colon, and toxic substances. Diarrhea can be extremely dangerous in infants and small children because of the excessive fluid loss. Treatment is directed toward eliminating the cause, providing adequate fluid intake, and modifying the diet.

Diverticulitis

Diverticulitis is an inflammation of the diverticula, pouches (or sacs) that form in the intestine as the mucosal lining pushes through the surrounding muscle. When fecal material and bacteria become trapped in the diverticula, inflammation occurs. This can result in an abscess or rupture, leading to peritonitis. Symptoms vary depending on the amount of inflammation but may include abdominal pain, irregular bowel movements, flatus (gas), constipation or diarrhea, abdominal distention (swelling), low-grade fever, and nausea and vomiting. Treatment methods include antibiotics, stool-softening medications, pain medications, high-fiber diet, and in severe cases, surgery to remove the affected section of colon.

Gastroenteritis

Gastroenteritis is an inflammation of the mucous membrane that lines the stomach and intestinal tract. Causes include food poisoning, infection, and toxins. Symptoms include abdominal cramping, nausea, vomiting, fever, and diarrhea. Usual treatment methods are rest and increased fluid intake. In severe cases, antibiotics, intravenous fluids, and medications to slow peristalsis may be used.

Hemorrhoids

Hemorrhoids are painful dilated or varicose veins of the rectum and/or anus. They may be caused by straining to defecate, constipation, pressure during pregnancy, insufficient fluid intake, laxative abuse, and prolonged sitting or standing. Symptoms include pain, itching, and bleeding. Treatment methods include a high-fiber diet; increased fluid intake; stool softeners; sitz baths or warm, moist compresses; and in some cases, a hemorrhoidectomy (surgical removal of the hemorrhoids).

Hepatitis

Hepatitis is a viral inflammation of the liver. *Type A, HAV* or infectious hepatitis, is highly contagious and is transmitted in food or water contaminated by the feces of an infected person. It is the most benign form of hepatitis and is usually self-limiting. A vaccine is available to prevent hepatitis A. *Type B, HBV,* or serum hepatitis, is transmitted by body fluids including blood, serum, saliva, urine, semen, vaginal secretions, and breast milk. It is more serious than type A and can lead to chronic hepatitis or to cirrhosis of the liver. A vaccine developed to prevent hepatitis B is recommended for all health care workers. *Type C,* or *HCV,* is also spread through contact with blood or body fluids. The main methods of transmission include sharing needles while injecting drugs, getting stuck with a contaminated needle or sharps while on the job, or passing the virus from an infected mother to the infant during birth. Hepatitis C is much more likely to progress to chronic hepatitis, cirrhosis, or both. There is no vaccine for type C. Other strains of the hepatitis virus that have been identified include types D and E. Symptoms include fever, anorexia (lack of appetite), nausea, vomiting, fatigue, dark-colored urine, clay-colored stool, myalgia (muscle pain), enlarged liver, and jaundice. Treatment methods include rest and a diet high in protein and calories and low in fat. A liver transplant may be necessary if the liver is severely damaged.

Hernia

A hernia, or rupture, occurs when an internal organ pushes through a weakened area or natural opening in a body wall. A hiatal hernia is when the stomach protrudes through the diaphragm and into the chest cavity through the opening for the esophagus (figure 7-60). Symptoms include heartburn, stomach distention, chest pain, and difficult swallowing. Treatment methods include a bland diet, small frequent meals, staying upright after eating, and surgical repair. An inguinal hernia is when a section of the small intestine protrudes through the inguinal rings of the lower abdominal wall. If the hernia cannot be reduced (pushed back in place), a herniorrhaphy (surgical repair) is performed.

Pancreatitis

Pancreatitis is an inflammation of the pancreas. The pancreatic enzymes begin to digest the pancreas itself, and the pancreas becomes necrotic, inflamed, and edematous. If the damage extends

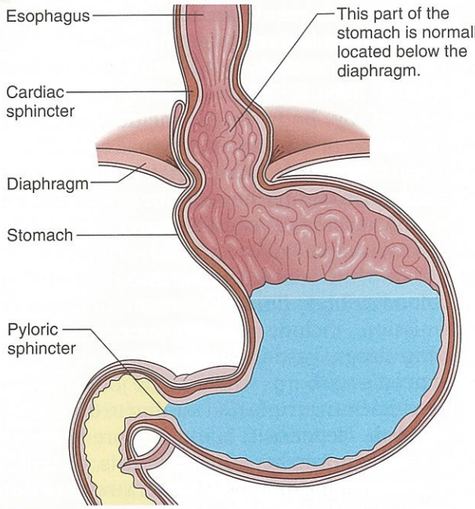

FIGURE 7-60 A hiatal hernia occurs when the stomach protrudes through the diaphragm.

to blood vessels in the pancreas, hemorrhage and shock occur. Pancreatitis may be caused by excessive alcohol consumption or blockage of pancreatic ducts by gallstones. Many cases are *idiopathic,* or of unknown cause. Symptoms include severe abdominal pain that radiates to the back, nausea, vomiting, diaphoresis (excessive perspiration), and jaundice if swelling blocks the common bile duct. Treatment depends on the cause. A cholecystectomy, removal of the gall bladder, is performed if gallstones are the cause. Analgesics for pain and nutritional support are used if the cause of pancreatitis is alcoholism or idiopathic. This type of pancreatitis has a poor prognosis and often results in death.

Peritonitis

Peritonitis, an inflammation of the abdominal peritoneal cavity, usually occurs when a rupture in the intestine allows the intestine contents to enter the peritoneal cavity. A ruptured appendix or gallbladder can cause this condition. Symptoms include abdominal pain and distention, fever, nausea, and vomiting. Treatment methods include antibiotics and, if necessary, surgical repair of the damaged intestine.

Ulcer

An ulcer is an open sore on the lining of the digestive tract. Peptic ulcers include gastric (stomach) ulcers and duodenal ulcers. The major cause is a bacterium, *Helicobacter pylori (H. pylori),* that burrows into the stomach membranes, allowing stomach acids and digestive juices to create an ulcer. Symptoms include burning pain, indigestion, hematemesis (bloody vomitus), and melena (dark, tarry stool). Usual treatment methods are antacids, a bland diet, decreased stress, and avoidance of irritants such as alcohol, fried foods, tobacco, and caffeine. If the *H. pylori* bacteria are present, treatment with antibiotics and a bismuth preparation, such as Pepto-Bismol, usually cures the condition. In severe cases, surgery is performed to remove the affected area.

Ulcerative Colitis

Ulcerative colitis is a severe inflammation of the colon accompanied by the formation of ulcers and abscesses. It is thought to be caused by stress, food allergy, or an autoimmune reaction. The main symptom is diarrhea containing blood, pus, and mucus. Other symptoms include weight loss, weakness, abdominal pain, anemia, and anorexia. Periods of remission and exacerbation are common. Treatment is directed toward controlling inflammation, reducing stress with mild sedation, maintaining proper nutrition, and avoiding substances that aggravate the condition. In some cases, surgical removal of the affected colon and creation of a colostomy (an artificial opening in the colon that allows fecal material to be excreted through the abdominal wall) is necessary.

STUDENT: *Go to the workbook and complete the assignment sheet for 7:11, Digestive System.*

7:12 Urinary System

Objectives

After completing this section, you should be able to:

- Label a diagram of the urinary system
- Explain the action of the following parts of a nephron: glomerulus, Bowman's capsule, convoluted tubule, and collecting tubule
- State the functions of the ureter, bladder, and urethra
- Explain why the urethra is different in male and female individuals
- Interpret at least five terms used to describe conditions that affect urination
- Describe at least three diseases of the urinary system
- Define, pronounce, and spell all key terms

KEY TERMS

bladder
Bowman's capsule
cortex *(core'-tex)*
excretory system *(ex'-kreh-tor"-ee)*
glomerulus *(glow"-mare'-you-luss)*
hilum
homeostasis
kidneys
medulla *(meh-due'-la)*
nephrons *(nef'-ronz)*
renal pelvis
ureters *(you'-reh"-turz)*
urethra *(you"-wreath'-rah)*
urinary meatus *(you'-rih-nah-ree" me-ate'-as)*
urinary system
urine
void

RELATED HEALTH CAREERS

- Dialysis Technician
- Medical Laboratory Technologist/Technician
- Nephrologist
- Urologist

7:12 INFORMATION

The **urinary system,** also known as the **excretory system,** is responsible for removing certain wastes and excess water from the body and for maintaining the body's acid–base balance. It is one of the major body systems that maintains **homeostasis,** a state of equilibrium or constant state of natural balance in the internal environment of the body. The parts of the urinary system are two kidneys, two ureters, one bladder, and one urethra (figure 7-61).

The **kidneys** (figure 7-62) are two bean-shaped organs located on either side of the vertebral column, behind the upper part of the abdominal cavity, and separated from this cavity by the peritoneum. Their location is often described as retroperitoneal. The kidneys are protected by the ribs and a heavy cushion of fat. Connective tissue helps hold the kidneys in position. Each kidney is enclosed in a mass of fatty tissue, called an *adipose capsule,* and covered externally by a tough, fibrous tissue, called the *renal fascia,* or *fibrous capsule.*

Each kidney is divided into two main sections: the cortex and the medulla. The **cortex** is the outer section of the kidney. It contains most of the nephrons, which aid in the production of urine. The **medulla** is the inner section of the kidney. It contains most of the collecting tubules, which carry the urine from the nephrons through the kidney. Each kidney has a **hilum,** a notched or indented area through which the ureter, nerves, blood vessels, and lymph vessels enter and leave the kidney.

Nephrons (figure 7-63) are microscopic filtering units located in the kidneys. There are more than one million nephrons per kidney. Each