PART 1: OVERVIEW OF THE DIGESTIVE SYSTEM (pp. 851–858; Figs. 23.1–23.6)

A. Digestive system organs fall into two main groups: the alimentary canal and the accessory organs (pp. 852–853; Fig. 23.1).

1. The alimentary canal, or gastrointestinal (GI) tract, is the continuous muscular digestive tube that winds through the body digesting and absorbing foodstuff; its organs include: the mouth, pharynx, esophagus, stomach, small intestine, and large intestine.

2. Accessory digestive organs aid digestion physically and produce secretions that break down foodstuff in the GI tract; the organs involved are the teeth, tongue, gallbladder, salivary glands, liver, and pancreas.

I. Digestive Processes (pp. 853–854; Figs. 23.2–23.3)

A. Ingestion is the simple act of putting food into the mouth (p. 853).

B. Propulsion moves food through the alimentary canal and includes both swallowing and peristalsis (p. 853; Fig. 23.3).

C. Mechanical digestion is the physical process of preparing the food for chemical digestion and involves chewing, mixing, churning, and segmentation (pp. 853–854).

D. Chemical digestion is a series of catabolic steps in which complex food molecules are broken down to their chemical building blocks by enzymes (p. 854).

E. Absorption is the passage of digested end products from the lumen of the GI tract through the mucosal cells into the blood or lymph (p. 854).

F. Defecation eliminates indigestible substances from the body via the anus as feces (p. 854).

PART 2: FUNCTIONAL ANATOMY OF THE DIGESTIVE SYSTEM (pp. 858–895; Figs. 23.7–23.31; Tables 23.1–23.3)

IV. The Mouth and Associated Organs (pp. 858–864; Figs. 23.7–23.11)

A. The mouth is a stratified squamous epithelial mucosa-lined cavity with boundaries of the lips, cheeks, palate, and tongue (pp. 858–864; Figs. 23.7–23.11).

1. The lips and cheeks have a core of skeletal muscle covered externally by skin that helps to keep food between the teeth when we chew and plays a small role in speech.

2. The palate forms the roof of the mouth and has two parts: the hard palate anteriorly and the soft palate posteriorly.

3. The tongue is made of interlacing bundles of skeletal muscle and is used to reposition food when chewing, mix food with saliva, initiate swallowing, and help form consonants for speech.

4. Salivary glands produce saliva, which cleanses the mouth, dissolves food chemicals for taste, moistens food, and contains chemicals that begin the breakdown of starches.

5. The teeth tear and grind food, breaking it into smaller pieces.

V. The Pharynx (p. 864)

A. The pharynx (oropharynx and laryngopharynx) provides a common passageway for food, fluids, and air (p. 864).

VI. The Esophagus (pp. 864–866; Fig. 23.12)

A. The esophagus provides a passageway for food and fluids from the laryngopharynx to the stomach where it joins at the cardiac orifice (pp. 864–866; Fig. 23.12).

VII. Digestive Processes: Mouth to Esophagus (p. 866; Fig. 23.13)

A. Mastication, or chewing, begins the mechanical breakdown of food and mixes the food with saliva (p. 866).

B. Deglutition, or swallowing, is a complicated process that involves two major phases (p. 866; Fig. 23.13).

1. The buccal phase is voluntary and occurs in the mouth where the bolus is forced into the oropharynx.

2. The pharyngeal-esophageal phase is involuntary and occurs when food is squeezed through the pharynx and into the esophagus.

VIII. The Stomach (pp. 866–877; Figs. 23.14–23.20; Tables 23.1–23.2)

A. The stomach is a temporary storage tank where the chemical breakdown of proteins is initiated and food is converted to chyme (pp. 866–869; Fig. 23.14).

1. The adult stomach varies from 15–25 cm long; its diameter and volume vary depending on the amount of food it contains.

a. The major regions of the stomach include the cardiac region, fundus, body, and pyloric region.

b. The convex lateral surface of the stomach is its greater curvature, and its convex medial surface is its lesser curvature.

c. Extending from the curvatures are the lesser omentum and the greater omentum, which help to tie the stomach to other digestive organs and the body wall.

B. Microscopic Anatomy (pp. 869–871; Figs. 23.15–23.16; Table 23.1)

1. The surface epithelium of the stomach mucosa is a simple columnar epithelium composed of goblet cells, which produce a protective two-layer coat of alkaline mucus.

2. The gastric glands of the stomach produce gastric juice, which may be composed of a combination of mucus, hydrochloric
Chemical digestion is accomplished by enzymes, secreted by intrinsic and accessory glands of the alimentary canal, used in hydrolysis reactions.

Chemical digestion is a catabolic process in which large food molecules are broken down to chemical building blocks (monomers), which are small enough to be absorbed by the GI tract lining (pp. 895–897; Figs. 23.32–23.34). Chemical digestion is accomplished by enzymes, secreted by intrinsic and accessory glands of the alimentary canal, used in hydrolysis reactions.

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2. Chemical digestion is accomplished by enzymes, secreted by intrinsic and accessory glands of the alimentary canal, used in hydrolysis reactions.
3. Carbohydrates
   a. Monosaccharides are simple sugars that are absorbed immediately (glucose, galactose, and fructose).
   b. Disaccharides are composed of two monosaccharides bonded together (maltose, lactose, and sucrose).
   c. The digestible polysaccharide found in the diet is starch; other polysaccharides, such as cellulose, are not able to be broken down by humans.
   d. Chemical digestion of carbohydrates begins in the mouth, where salivary amylase breaks large polysaccharides into smaller fragments.

### IX. Small Intestine and Associated Structures (pp. 877–890; Figs. 23.21–23.28; Table 23.3)

A. The small intestine is the site of the completion of digestion and absorption of nutrients (pp. 877–880; Figs. 23.21–23.23).
1. It extends from the pyloric sphincter to the ileocecal valve where it joins the large intestine. It has three subdivisions: the duodenum, the jejunum, and the ileum.
2. It is highly adapted for absorption with three microscopic modifications: plicae circulares, villi, and microvilli.
3. The intestinal crypts, or the crypts of Lieberkühn, secrete intestinal juice that serves as a carrier fluid for absorbing nutrients from chyme.
4. Bile is a yellow-green, alkaline solution containing bile salts, bile pigments (primarily bilirubin), cholesterol, neutral fats, phospholipids, and a variety of electrolytes.
5. The gallbladder stores and concentrates bile that is not needed immediately for digestion.
6. Bile does not usually enter the small intestine until the gallbladder contracts when stimulated by cholecystokinin.
C. The pancreas is an accessory gland that is retroperitoneal (pp. 885–886; Figs. 23.26–23.28).
1. Pancreatic juice consists mainly of water and contains enzymes that break down all categories of foodstuffs and electrolytes.
2. Secretion of pancreatic juice is regulated by local hormones and the parasympathetic nervous system.
D. Digestive Processes Occurring in the Small Intestine (pp. 887–890; Table 23.3)
1. Food takes 3 to 6 hours to complete its digestive path through the small intestine, the site of virtually all nutrient absorption.
2. Most substances required for chemical digestion within the small intestine are imported from the pancreas and the liver.
3. Optimal digestive activity in the small intestine depends on a slow, measured delivery of chyme from the stomach.
4. Segmentation is the most common motion of the small intestine.

### X. The Large Intestine (pp. 890–895; Figs. 23.29–23.31)

A. The large intestine absorbs water from indigestible food residues and eliminates the latter as feces (pp. 890–895; Figs. 23.29–23.30).
1. The large intestine exhibits three unique features: teniae coli, haustra, and epiploic appendages, and has the following subdivisions: cecum, appendix, colon, rectum, and anal canal.
2. The mucosa of the large intestine is thick and has crypts with a large number of mucus-producing goblet cells.
3. Bacteria entering the colon via the small intestine and anus colonize the colon and ferment some of the indigestible carbohydrates.
B. Digestive Processes Occurring in the Large Intestine (pp. 893–895; Fig. 23.31)
1. The movements seen in the large intestine include haustral contractions and mass movements.
2. Feces forced into the rectum by mass movements stretch the rectal wall and initiate the defecation reflex.

### XI. Chemical Digestion (pp. 895–897; Figs. 23.32–23.34)

A. Chemical digestion is a catabolic process in which large food molecules are broken down to chemical building blocks (monomers), which are small enough to be absorbed by the GI tract lining (pp. 895–897; Figs. 23.32–23.34).
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3. Proteins digested into amino acids in the GI tract include not only dietary proteins but also enzyme proteins secreted into the GI tract lumen.
   a. Pepsin, secreted by the chief cells, begins the chemical digestion of proteins in the stomach.
   b. Rennin is produced in infants and breaks down milk proteins.
   c. Pancreatic enzymes, such as trypsin and chymotrypsin, further break down proteins in the small intestine.
   d. The brush border enzymes carboxypeptidase, aminopeptidase, and dipeptidase work on freeing single amino acids in the small intestine.
4. The small intestine is the sole site for lipid digestion.
   a. Lipases are secreted by the pancreas and are the enzymes that digest fats after they have been pretreated with bile.
5. Nucleic acids (both DNA and RNA) are hydrolyzed to their nucleotide monomers by pancreatic nucleases present in pancreatic juice.

XIII. Developmental Aspects of the Digestive System (pp. 901, 904–905; Fig. 23.35)
A. Embryonic Development (pp. 901, 904; Fig. 23.35)
   1. The epithelial lining of the developing alimentary canal forms from the endoderm with the rest of the wall arising from the mesoderm.
   2. The anteriormost endoderm touches the depressed area of the surface ectoderm where the membranes fuse to form the oral membrane and ultimately the mouth.
   3. The end of the hindgut fuses with an ectodermal depression, called the proctodeum, to form the cloacal membrane and ultimately the anus.
   4. By week 8 the alimentary canal is a continuous tube stretching from the mouth to the anus.
B. Aging (pp. 904–905)
   1. GI tract motility declines, digestive juice production decreases, absorption is less efficient, and peristalsis slows, resulting in less frequent bowel movements and often constipation.
   2. Diverticulosis, fecal incontinence, and cancer of the GI tract are fairly common problems in the elderly.