Chapter 17

The Digestive System
Objectives

• List in sequence each of the component parts or segments of the alimentary canal from the mouth to the anus and identify the accessory organs of digestion
Objectives

• List and describe the major disorders of the digestive organs
• Discuss the basics of protein, fat, and carbohydrate digestion and give the end-products of each process
• Define and contrast mechanical and chemical digestion
The Digestive System

- **Alimentary canal or GI tract**
  - Extends from mouth to anus—9 m (29 feet)
  - Involved in digestion, absorption and metabolism of nutrients

- **System includes main and accessory organs**
  - Main organs: mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anal canal
  - Accessory organs: teeth and tongue, salivary glands, liver, gallbladder, pancreas, and vermiform appendix
Mouth

• Also known as *oral cavity*—hollow chamber with a roof, floor, and walls

• Roof—formed by hard palate (parts of maxillary and palatine bones) and soft palate (an arch-shaped muscle separating mouth from pharynx)
Mouth

- Uvula—a downward projection of the soft palate
  - Uvula and soft palate prevent food and liquid from entering nasal cavities
  - Assists in speech and swallowing (deglutition)
Mouth

- Floor—formed by tongue and its muscles
  - Lingual frenulum—fold of mucous membrane that helps anchor the tongue to the floor of the mouth
  - Papillae—small elevations on mucosa of tongue
  - Taste buds—found in many papillae
Teeth

- Types of teeth—incisors, cuspids, bicuspids, and tricuspid s
  - Deciduous (also known as baby or primary) teeth—full set equals 20 teeth
    - First tooth erupts at about 6 months
    - Complete set in place at about 2 years of age
Teeth

• Permanent teeth—full set equals 32 in most; 28 teeth is a normal variation in others
  – First permanent tooth erupts at about 6 years of age
  – Set complete between ages 17 and 24 years

• Structures of a typical tooth—crown, neck, and root
Disorders of the Mouth and Teeth

- Infections, cancer, congenital defects, and other disorders can cause serious complications including malnutrition
  - Infections and cancer of the mouth may spread to other parts of the body
    - Leukoplakia—precancerous mouth tissue
      - Snuff dipper’s pouch—from use of chewing tobacco
      - Squamous cell carcinoma—most common form of mouth cancer
Disorders of the mouth and teeth. A, Snuff dipper’s pouch. B, Squamous cell carcinoma of lip. Excessive long-term exposure to ultraviolet light (UV) such as in sunlight increases the risk of skin cancer. C, Dental caries.
Disorders of the Mouth and Teeth

• Dental caries
  – Tooth disease resulting in permanent defect called “cavity”
  – Infection may spread to other adjacent tissues or to blood
  – Lost or diseased teeth may be replaced by dentures or implants

• Gingivitis—gum inflammation or infection
  – Most cases result from poor oral hygiene
  – Can be a complication of diabetes, vitamin deficiency, or pregnancy
Dental Implant
Disorders of the Mouth and Teeth

• Thrush, or oral candidiasis—caused by yeastlike fungal organism
  – Patches of “cheesy”-looking exudate form over an inflamed tongue and oral mucosa, which itches and bleeds easily
  – Common in immunosuppressed individuals (AIDS) or after antibiotic therapy

• Periodontitis—inflammation of periodontal membrane
  – Often a complication of advanced or untreated gingivitis
  – Leading cause of tooth loss among adults
Oral Thrush-inflamed mucous membrane
Disorders of the Mouth and Teeth

• Cleft lip and cleft palate are most common types
  – May occur alone or together
  – Caused by failure of mouth structures to fuse during embryonic development
Salivary Glands

• Three pairs of salivary glands
  – Secrete about 1 L of saliva/day
  – Located outside of GI tract
  – Convey secretions via ducts into tract lumen

• Parotid glands—largest of salivary glands
  – Located in front of ear at angle of jaw
  – Inflamed in mumps
Salivary Glands

- Submandibular glands—ducts open on either side of lingual frenulum
- Sublingual glands—ducts open into floor of mouth
- Saliva contains salivary amylase—begins digestion of carbohydrates
Pharynx

• Muscular tube (throat) lined with mucous membrane
• Functions as part of both respiratory and digestive systems
• Subdivided into three anatomical segments
Stomach

- Pouch for food that lies in upper part of abdominal cavity just under diaphragm
  - The size of a large sausage when empty
  - Expands considerably after a large meal
- Contraction of muscular walls of stomach mixes food with gastric juice and breaks it down into chyme
Stomach

• Mucous membrane lines the stomach
  – Membrane lies in folds (rugae) when stomach is empty
  – Many microscopic glands secrete gastric juice and hydrochloric acid into stomach

• Divisions of stomach—fundus, body, and pylorus

• Pyloric sphincter muscle closes opening of pylorus (lower part of stomach) to retain food to facilitate partial digestion
Disorders of the Stomach

• Gastroenterology—study of stomach and intestines and their diseases
  – Stomach is site of numerous diseases and conditions
  – Gastric diseases often exhibit the following signs or symptoms: gastritis (inflammation), anorexia (appetite loss), nausea (upset stomach), and emesis (vomiting)
Disorders of the Stomach

• **Pylorospasm**—abnormal spasms of the pyloric sphincter
  – Common in infants
  – Pyloric stenosis is similar abnormality—obstructive narrowing of the pyloric opening

• **Ulcers**—open wounds caused by acid in gastric juice
  – Often occurs in duodenum or stomach
  – Associated with infection by the bacterium *Helicobacter pylori* and use of NSAIDs
  – Current treatment involves triple therapy
Disorders of the Stomach

• Stomach cancer
  – Associated with consumption of alcohol or preserved food and use of chewing tobacco
  – No practical way to screen for early stages
Small Intestine

- About 7 m (20 feet) long but only 2 cm or so in diameter
- Divisions
  - Duodenum
  - Jejunum
  - Ileum
- Wall—contains smooth muscle fibers that contract to produce peristalsis
Disorders of the Small Intestine

- Enteritis—intestinal inflammation
- Gastroenteritis—inflammation of stomach and intestines
- Malabsorption syndrome—group of symptoms resulting from failure to absorb nutrients properly (anorexia, abdominal bloating, cramps, anemia, and fatigue)
Liver and Gallbladder

• Liver
  – Size and location
    • Liver is largest gland
    • Fills upper right section of abdominal cavity and extends over into left side
  – Classified as exocrine gland
    • Secretes bile
    • Has a variety of metabolic functions
Liver and Gallbladder

• Liver
  – Ducts
    • Hepatic—drains bile from liver
    • Cystic—duct by which bile enters and leaves gallbladder
    • Common bile—formed by union of hepatic and cystic ducts and drains bile from hepatic or cystic ducts into duodenum

• Gallbladder
  – Location—undersurface of the liver
  – Function—concentrates and stores bile produced in the liver
Disorders of the Liver and Gallbladder

• Gallstones—calculi (stones) made of crystallized bile pigments and calcium salts
  – Cholelithiasis—condition of having gallstones
  – Cholecystitis—inflammation of the gallbladder; may accompany cholelithiasis
  – Stones can obstruct bile canals, causing jaundice
Disorders of the Liver and Gallbladder

• Hepatitis—liver inflammation
  – Characterized by liver enlargement, jaundice, anorexia, discomfort, gray-white feces, and dark urine
  – Caused by a variety of factors—toxins, bacteria, viruses, and parasites
Disorders of the Liver and Gallbladder

- **Cirrhosis**—degeneration of liver tissue involving replacement of normal (but damaged) tissue with fibrous and fatty tissue.

- **Portal hypertension**—high blood pressure in the hepatic portal veins caused by obstruction of blood flow in a diseased liver.
Pancreas

• Location—behind stomach

• Functions
  – Pancreatic cells secrete pancreatic juice into pancreatic ducts; main duct empties into duodenum
  – Pancreatic islets (of Langerhans)—cells not connected with pancreatic ducts; secrete hormones glucagons and insulin into the blood
Pancreas

• Pancreatic disorders
  – Pancreatitis—inflammation of pancreas
    • Acute pancreatitis results from blocked ducts that force pancreatic juice to backflow
    • Pancreatic enzymes digest the gland
  – Cystic fibrosis—thick secretions block flow of pancreatic juice
  – Pancreatic cancer is very serious—fatal in the majority of cases
Large Intestine

- Size and location—1.5 m long; forms lower, or terminal, portion of digestive tract
- Opening to exterior—anus
Disorders of the Large Intestine

- Disorders of the large intestine often relate to abnormal motility (rate of movement of contents)
  - Diarrhea—results from abnormally increased intestinal motility; may result in dehydration or convulsions
  - Constipation—results from decreased intestinal motility
  - Diverticulitis (inflammation of abnormal outpouchings called *diverticula*)—may cause constipation
Disorders of the Large Intestine

– Colitis—general name for any inflammatory condition of the large intestine
– Colorectal cancer—a common malignancy of the colon and rectum associated with colonic polyps; advanced age; low-fiber, high-fat diets; and genetic predisposition
Appendix and Appendicitis

• Vermiform appendix is blind tube attached directly to cecum; no important digestive function in humans
• Appendicitis—inflammation or infection of appendix
  – If appendix ruptures, infectious material may spread to other organs
  – Most common acute abdominal condition requiring surgery
  – Affects 7% to 12% of population younger than 30 years
Digestion

• Definition—process that transforms food into a form that can be absorbed and used by cells
  – Mechanical digestion—chewing, swallowing, and peristalsis break food into tiny particles, mix them well with digestive juices, and move them along the digestive tract
  – Chemical digestion—breaks up large food molecules into compounds having smaller molecules; brought about by digestive enzymes
Digestion

• Carbohydrate digestion—mainly in small intestine
  – Pancreatic amylase—changes starches to maltose
  – Intestinal juice enzymes
    • Maltase—changes maltose to glucose
    • Sucrase—changes sucrose to glucose
    • Lactase—changes lactose to glucose
• Protein digestion—starts in stomach; completed in small intestine
  – Gastric juice enzymes, rennin and pepsin, partially digest proteins
  – Pancreatic enzyme, trypsin, completes digestion of proteins to amino acids
  – Intestinal enzymes, peptidases, complete digestion of partially digested proteins to amino acids
Fat digestion

- Bile contains no enzymes but emulsifies fats (breaks fat droplets into very small droplets)
- Pancreatic lipase changes emulsified fats to fatty acids and glycerol in small intestine
Absorption

• Definition—digested food moves from intestine into blood or lymph
• Absorption site—foods and most water are absorbed from small intestine; some water also absorbed from large intestine