

## Digestive System

Digestion mechanically and chemically breaks down food and absorbs the products. The digestive system consists of an alimentary canal and several accessory organs.

### General Characteristics of the Alimentary Canal

*The alimentary canal is a muscular tube.*

1. Structure of the wall
  - a. The wall consists of four (4) layers.
  - b. The layers are the (1) mucosa, (2) submucosa, (3) muscular layer, and (4) serosa.
2. Movements of the tube
  - a. Motor functions including mixing and propelling movements.
  - b. Peristalsis is responsible for propelling movements.
  - c. The wall of the tube undergoes receptive relaxation just ahead of the peristaltic wave.
3. Innervation of the tube
  - a. The tube is innervated by branches of the sympathetic and parasympathetic divisions of the autonomic nervous system.
  - b. Parasympathetic impulses generally cause an increase in digestive activities; sympathetic impulses generally inhibit digestive activities.
  - c. Sympathetic impulses are responsible for the contraction of certain sphincter muscles that control movement through the alimentary canal.

### Mouth

*The mouth is adapted to receive food and begin preparing it for digestion. It also serves as an organ of speech and sensory perception.*

1. Cheeks and lips
  - a. Cheeks form the lateral walls of the mouth.
  - b. Lips are highly mobile and possess a variety of sensory receptors useful in judging the characteristics of food.
2. Tongue
  - a. The tongue is a thick, muscular organ that aids in mixing food with saliva and moving it toward the pharynx.
  - b. The rough surface of the tongue aids in handling food and contains taste buds.
  - c. Lingual tonsils are located on the root of the tongue.
3. Palate
  - a. The palate comprises the roof of the mouth and includes hard and soft portions.
  - b. The soft palate closes the opening to the nasal cavity during swallowing.

- c. Palatine tonsils are located on either side of the tongue in the back of the mouth.
  - d. Tonsils consist of lymphatic tissues.
4. Teeth
- a. Two sets of teeth develop in sockets of the mandibular and maxillary bones.
  - b. There are 20 primary (deciduous) and 32 secondary (permanent) teeth.
  - c. Teeth break food into smaller pieces, increasing the surface area of food that is exposed to digestive actions.
  - d. Different kinds of teeth are adapted to handle foods in different ways, such as biting, grasping, or grinding.
  - e. Each tooth consists of a crown and root, and is composed of enamel, dentin, pulp, nerves, and blood vessels.
  - f. A tooth is attached to the alveolar process by collagenous fibers of the periodontal ligament.

### Salivary Glands

*Salivary glands secrete saliva, which moistens food, helps bind food particles together, begins digestion of carbohydrates, makes taste possible, helps cleanse the mouth, and regulates pH in the mouth.*

- 1. Salivary secretions
  - a. Salivary glands include serous cells that secrete digestive enzymes and mucous cells that secrete mucous.
  - b. Parasympathetic impulses stimulate the secretion of serous fluid.
- 2. Major Salivary Glands
  - a. The parotid glands are the largest, and they secrete saliva that is rich in amylase.
  - b. The submandibular glands in the floor of the mouth produce viscid saliva.
  - c. The sublingual glands in the floor of the mouth primarily secrete mucus.

### Pharynx and Esophagus

*The pharynx and esophagus serve as passageways.*

- 1. Structure of the pharynx
  - a. The pharynx is divided into a nasopharynx, oropharynx, and laryngopharynx.
  - b. The muscular walls of the pharynx contain fibers arranged in circular and longitudinal groups.
- 2. Swallowing Mechanism
  - a. The act of swallowing occurs in three stages.
    - i. Food is mixed with saliva and forced into the pharynx.
    - ii. Involuntary reflex actions move the food into the esophagus.

- iii. Food is transported to the stomach.
3. Esophagus
  - a. The esophagus passes through the mediastinum and penetrates the diaphragm.
  - b. Circular muscle fibers at the distal end of the esophagus help prevent regurgitation of food from the stomach.

## Stomach

*The stomach receives food, mixes it with gastric juice, carries on a limited amount of absorption, and moves food into the small intestine.*

1. Parts of the Stomach
  - a. The stomach is divided into the cardiac, fundic, body, and pyloric regions.
  - b. The pyloric sphincter serves as a valve between the stomach and the small intestine.
2. Gastric Secretions
  - a. Gastric gland secrete gastric juice.
  - b. Gastric juice contains pepsin, hydrochloric acid, lipase, and intrinsic factor.
3. Regulation of Gastric Secretions
  - a. Gastric secretions are enhanced by parasympathetic impulses and by gastrin, a hormone.
  - b. The three stages of gastric secretion are the cephalic, gastric and intestinal phases.
  - c. The presence of food in the small intestine reflexly inhibits gastric secretions.
4. Gastric Absorption
  - a. The stomach is not well adapted for absorption.
  - b. A few substances such as water and other small molecules may be absorbed through the stomach wall.
5. Mixing and Emptying Actions
  - a. As the stomach fills, it stretches, but its internal pressure remains unchanged.
  - b. Mixing movements aid in producing chyme, peristaltic waves move the chyme into the pyloric region.
  - c. The muscular wall of the pyloric region pumps chyme into the small intestine.
  - d. The rate of emptying depends on the fluidity of the chyme and the type of food present.
  - e. The upper part of the small intestine fills, and enterogastric reflex cause the peristaltic wave in the stomach to be inhibited.

- f. Vomiting results from a complex reflex that can be stimulated by a variety of factors.

## Pancreas

1. Structure of the pancreas
  - a. The pancreas is closely associated with the duodenum.
  - b. It produces pancreatic juice that is secreted into a pancreatic duct.
  - c. The pancreatic duct leads to the duodenum.
2. Pancreatic juice
  - a. Pancreatic juice contains enzymes that can split carbohydrates, proteins, fats, and nucleic acids.
  - b. Pancreatic juice has a high bicarbonate ion concentration that helps to neutralize chyme and cause the intestinal contents to be alkaline.
3. Regulation of pancreatic secretion
  - a. Secretion from the duodenum stimulates the release of pancreatic juice that contains few digestive enzymes but has a high bicarbonate ion concentration.
  - b. Cholecystokinin from the intestinal wall stimulates the release of pancreatic juice that has a high concentration of digestive enzymes.

## Liver

1. Functions of the liver
  - a. The liver is located in the upper right and central portion of the abdominal cavity.
  - b. It carries out a variety of important functions involving the metabolism of carbohydrates, lipids, and proteins; the storage of substances; the filtering of blood; the destruction of toxic chemicals; and the secretion of bile.
  - c. Bile is the only liver secretion that directly affects digestion.
2. Structure of the liver
  - a. The liver is a highly vascular organ, enclosed in a fibrous capsule, and divided into lobes.
  - b. Each lobe contains hepatic lobules, the functional units of the liver.
  - c. Bile from the lobules is carried by the bile canals to hepatic ducts that unit to form the common bile duct.
3. Composition of bile
  - a. Bile contains bile salts, bile pigments, cholesterol, and various electrolytes.
  - b. Only the bile salts have a digestive function.
  - c. Bile pigments are products of red blood cell breakdown.
4. Gallbladder and its functions
  - a. The gallbladder stores bile between meals.

- b. Release of bile from the common bile duct is controlled by a sphincter muscle.
  - c. Gallstones may sometimes form within the gallbladder.
- 5. Regulation of bile release
  - a. Release of bile is stimulated by cholecystokinin from the small intestine.
  - b. The sphincter muscle at the base of the common bile duct relaxes as a peristaltic wave in the duodenal wall approaches.
- 6. Functions of bile salts
  - a. Bile salts emulsify fats and aid in the absorption of fatty acids, cholesterol, and certain vitamins.
  - b. Bile salts are reabsorbed by the small intestine.

### Small Intestine

*The small intestine extends from the pyloric sphincter to the large intestine. It receives secretions from the pancreas and liver, completes the digestion of nutrients, absorbs the products of digestion, and transports the residues to the large intestine.*

- 1. Parts of the small intestine
  - a. The small intestine consists of the duodenum, jejunum and ileum.
  - b. The small intestine is suspended from the posterior abdominal wall by mesentery.
- 2. Structure of the intestinal wall
  - a. The wall is lined with villi that increase the surface area and aid in mixing and absorption.
  - b. Microvilli on the free ends of epithelial cells greatly increase the surface area.
  - c. Intestinal glands are located between the villi.
  - d. Circular folds in the lining of the intestinal wall also increase its surface area.
- 3. Secretions of the small intestine
  - a. Intestinal glands primarily secrete a watery fluid that lacks digestive enzymes but provides a vehicle for moving food substances to the villi.
  - b. Digestive enzymes embedded in the surfaces of microvilli can split molecules of sugars, proteins, and fats.
- 4. Regulation of intestinal secretions
  - a. Secretions are enhanced by the presence of gastric juice and chyme.
  - b. Reflexes stimulated by distention of the small intestinal wall also increase intestinal secretions.
- 5. Absorption in the small intestine
  - a. Monosaccharides, amino acids, fatty acids, and glycerol are absorbed by the villi.
  - b. Villi also absorb water and electrolytes.

- c. Fat molecules with longer chains of carbon atoms enter the lacteals of the villi; fatty acids with relatively short carbon chains enter the blood capillaries of the villi.
6. Movements of the small intestine
    - a. Movements include mixing by segmentation and peristalsis.
    - b. Overdistention or irritation may stimulate a peristaltic rush and result in diarrhea.
    - c. The ileocecal valve controls movement of the intestinal contents from the small intestine to the large intestine.

## Large Intestine

*The large intestine reabsorbs water and electrolytes, and forms and stores feces.*

1. Parts of the large intestine
  - a. The large intestine consists of the cecum, colon, rectum, and anal canal.
  - b. The colon is divided into ascending, transverse, descending, and sigmoid portions.
2. Structure of the large intestinal wall
  - a. Basically, the large intestine wall is like the wall in other parts of the alimentary canal.
  - b. Unique features include a layer of longitudinal muscle fibers that are arranged in distinct bands.
3. Functions of the large intestine
  - a. The large intestine has little or no digestive function, although it secretes mucus.
  - b. The rate of mucus secretion is controlled by mechanical stimulation and parasympathetic impulses.
  - c. Absorption in the large intestine is generally limited to water and electrolytes.
  - d. Many bacteria inhabit the large intestine and may aid the body by synthesizing certain vitamins.
4. Movements of the large intestine
  - a. Movements are similar to those in the small intestine.
  - b. Mass movements occur two to three times each day.
  - c. Defecation is stimulated by a defecation reflex.
5. Feces
  - a. Feces are formed and stored in the large intestine.
  - b. Feces consist largely of water, undigested material, mucus, and bacteria.
  - c. The color of feces is due to the bile salts that have been altered by bacterial action.

