

14

PART C

The Digestive System and Body Metabolism

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ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY

EIGHTH EDITION

ELAINE N. MARIEB

Salivary Glands

- Saliva-producing glands
 - Parotid glands – located anterior to ears
 - Submandibular glands
 - Sublingual glands

Saliva

- Mixture of mucus and serous fluids
- Helps to form a food bolus
- Contains salivary amylase to begin starch digestion
- Dissolves chemicals so they can be tasted

Teeth

- The role is to masticate (chew) food
- Humans have two sets of teeth
 - Deciduous (baby or milk) teeth
 - 20 teeth are fully formed by age two

Teeth

- Permanent teeth
 - Replace deciduous teeth beginning between the ages of 6 to 12
 - A full set is 32 teeth, but some people do not have wisdom teeth

Classification of Teeth

- Incisors
- Canines
- Premolars
- Molars

Classification of Teeth

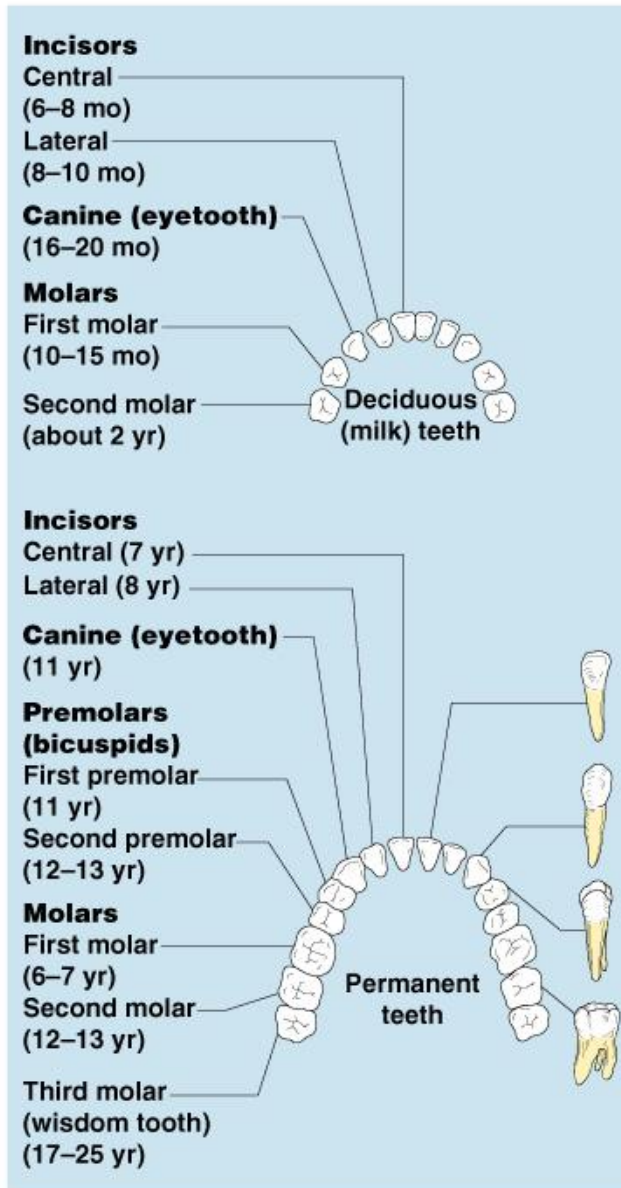


Figure 14.9

Regions of a Tooth

- Crown – exposed part
 - Outer enamel
 - Dentin
 - Pulp cavity
- Neck
 - Region in contact with the gum
- Root
 - Connects crown to root

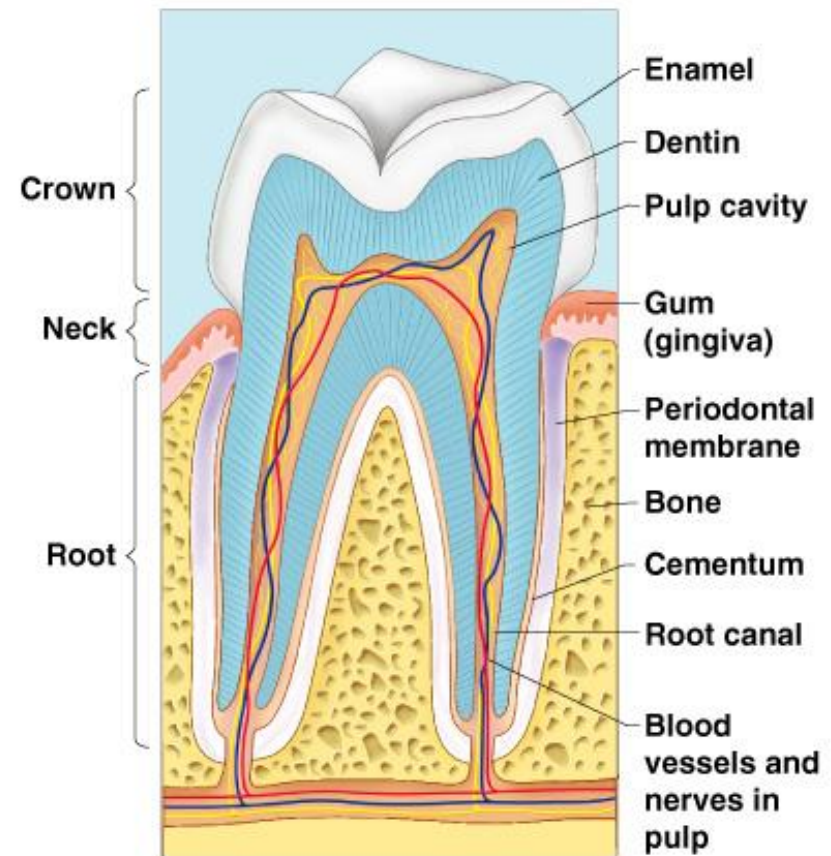


Figure 14.10

Regions of a Tooth

- Root
 - Periodontal membrane attached to the bone
 - Root canal carrying blood vessels and nerves

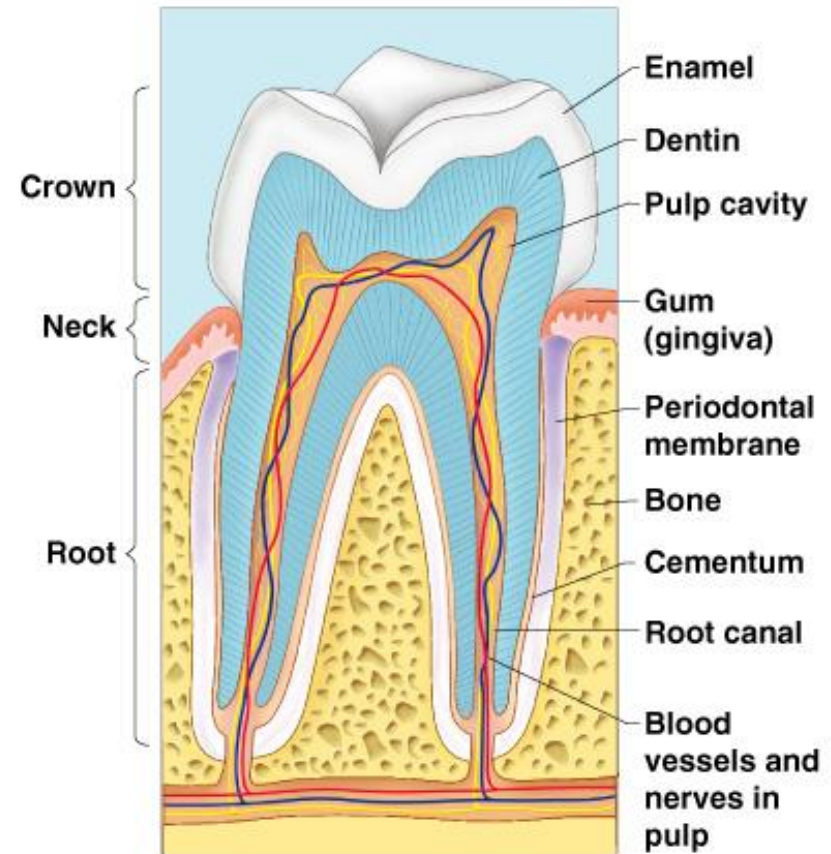


Figure 14.10

Pancreas

- Produces a wide spectrum of digestive enzymes that break down all categories of food
- Enzymes are secreted into the duodenum
- Alkaline fluid introduced with enzymes neutralizes acidic chyme
- Endocrine products of pancreas
 - Insulin
 - Glucagons

Liver

- Largest gland in the body
- Located on the right side of the body under the diaphragm
- Consists of four lobes suspended from the diaphragm and abdominal wall by the falciform ligament
- Connected to the gall bladder via the common hepatic duct

Bile

- Produced by cells in the liver
- Composition
 - Bile salts
 - Bile pigment (mostly bilirubin from the breakdown of hemoglobin)
 - Cholesterol
 - Phospholipids
 - Electrolytes

Gall Bladder

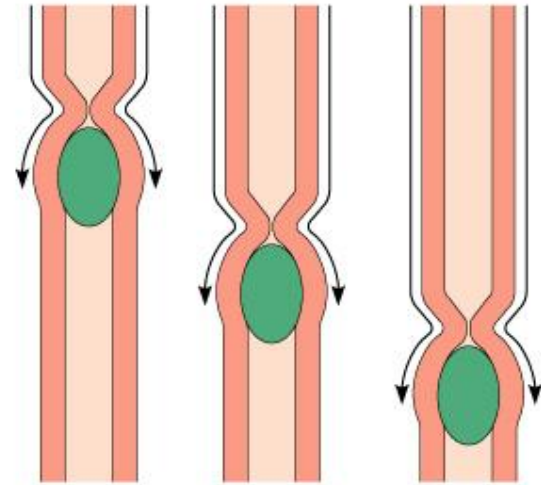
- Sac found in hollow fossa of liver
- Stores bile from the liver by way of the cystic duct
- Bile is introduced into the duodenum in the presence of fatty food
- Gallstones can cause blockages

Processes of the Digestive System

- Ingestion – getting food into the mouth
- Propulsion – moving foods from one region of the digestive system to another

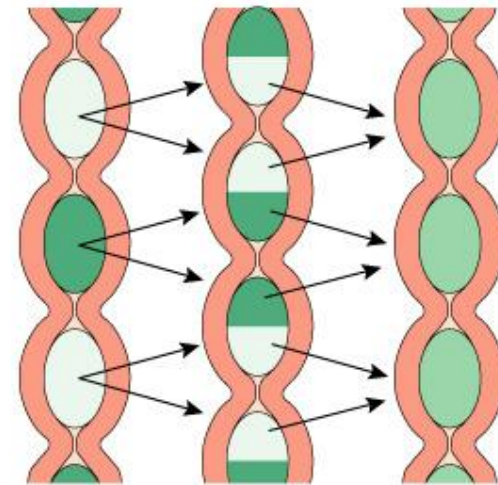
Processes of the Digestive System

- Peristalsis – alternating waves of contraction



(a)

- Segmentation – moving materials back and forth to aid in mixing



(b)

Figure 14.12

Processes of the Digestive System

- Mechanical digestion
 - Mixing of food in the mouth by the tongue
 - Churning of food in the stomach
 - Segmentation in the small intestine

Processes of the Digestive System

- Chemical Digestion
 - Enzymes break down food molecules into their building blocks
 - Each major food group uses different enzymes
 - Carbohydrates are broken to simple sugars
 - Proteins are broken to amino acids
 - Fats are broken to fatty acids and alcohols

Processes of the Digestive System

- Absorption
 - End products of digestion are absorbed in the blood or lymph
 - Food must enter mucosal cells and then into blood or lymph capillaries
- Defecation
 - Elimination of indigestible substances as feces

Processes of the Digestive System

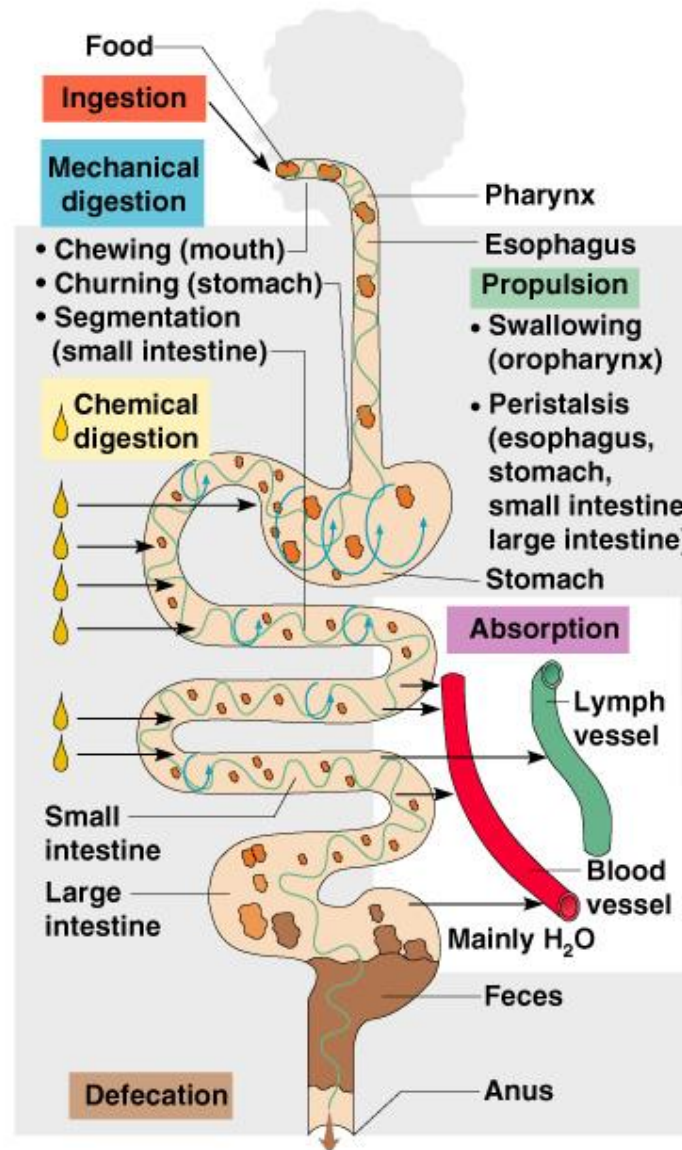


Figure 14.11

Control of Digestive Activity

- Mostly controlled by reflexes via the parasympathetic division
- Chemical and mechanical receptors are located in organ walls that trigger reflexes

Control of Digestive Activity

- Stimuli include:
 - Stretch of the organ
 - pH of the contents
 - Presence of breakdown products
- Reflexes include:
 - Activation or inhibition of glandular secretions
 - Smooth muscle activity

Digestive Activities of the Mouth

- Mechanical breakdown
 - Food is physically broken down by chewing
- Chemical digestion
 - Food is mixed with saliva
 - Breaking of starch into maltose by salivary amylase

Activities of the Pharynx and Esophagus

- These organs have no digestive function
- Serve as passageways to the stomach

Deglutition (Swallowing)

- Buccal phase
 - Voluntary
 - Occurs in the mouth
 - Food is formed into a bolus
 - The bolus is forced into the pharynx by the tongue

Deglutition (Swallowing)

- Pharyngeal-esophageal phase
 - Involuntary transport of the bolus
 - All passageways except to the stomach are blocked
 - Tongue blocks off the mouth
 - Soft palate (uvula) blocks the nasopharynx
 - Epiglottis blocks the larynx

Deglutition (Swallowing)

- Pharyngeal-esophageal phase (continued)
 - Peristalsis moves the bolus toward the stomach
 - The cardioesophageal sphincter is opened when food presses against it

Deglutition (Swallowing)

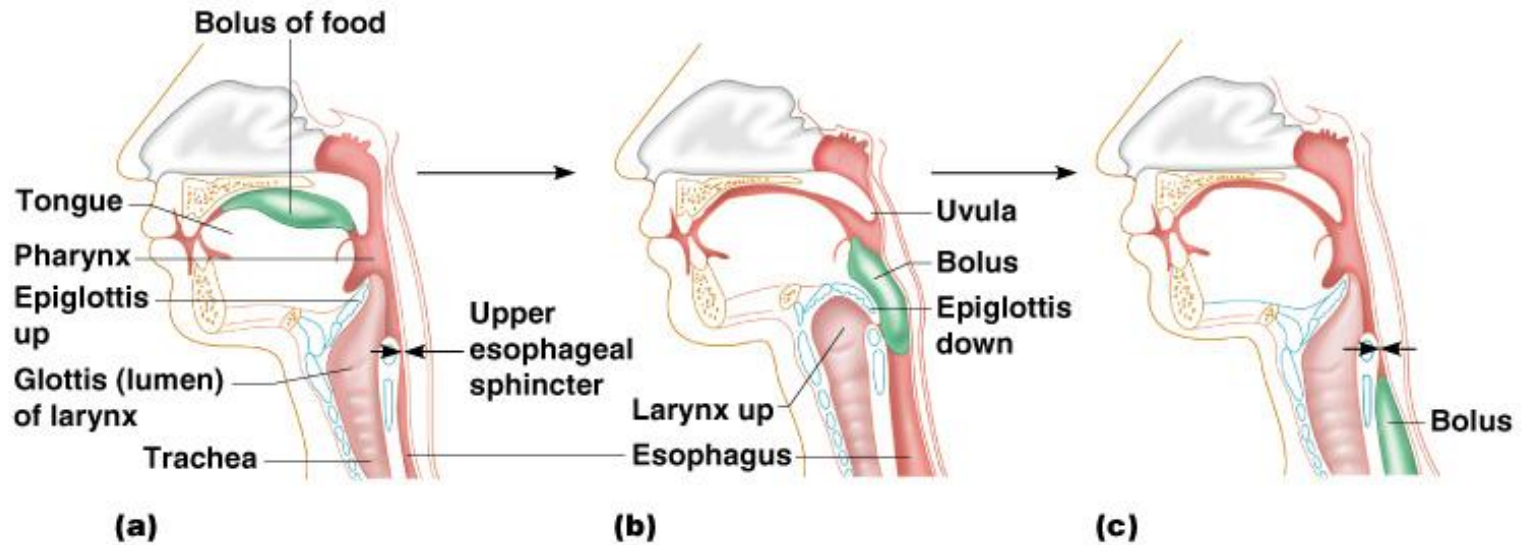


Figure 14.14

Food Breakdown in the Stomach

- Gastric juice is regulated by neural and hormonal factors
- Presence of food or falling pH causes the release of gastrin
- Gastrin causes stomach glands to produce protein-digesting enzymes
- Hydrochloric acid makes the stomach contents very acidic

Necessity of an Extremely Acid Environment in the Stomach

- Activates pepsinogen to pepsin for protein digestion
- Provides a hostile environment for microorganisms

Digestion and Absorption in the Stomach

- Protein digestion enzymes
 - Pepsin – an active protein digesting enzyme
 - Rennin – works on digesting milk protein
- The only absorption that occurs in the stomach is of alcohol and aspirin

Propulsion in the Stomach

- Food must first be well mixed
- Rippling peristalsis occurs in the lower stomach

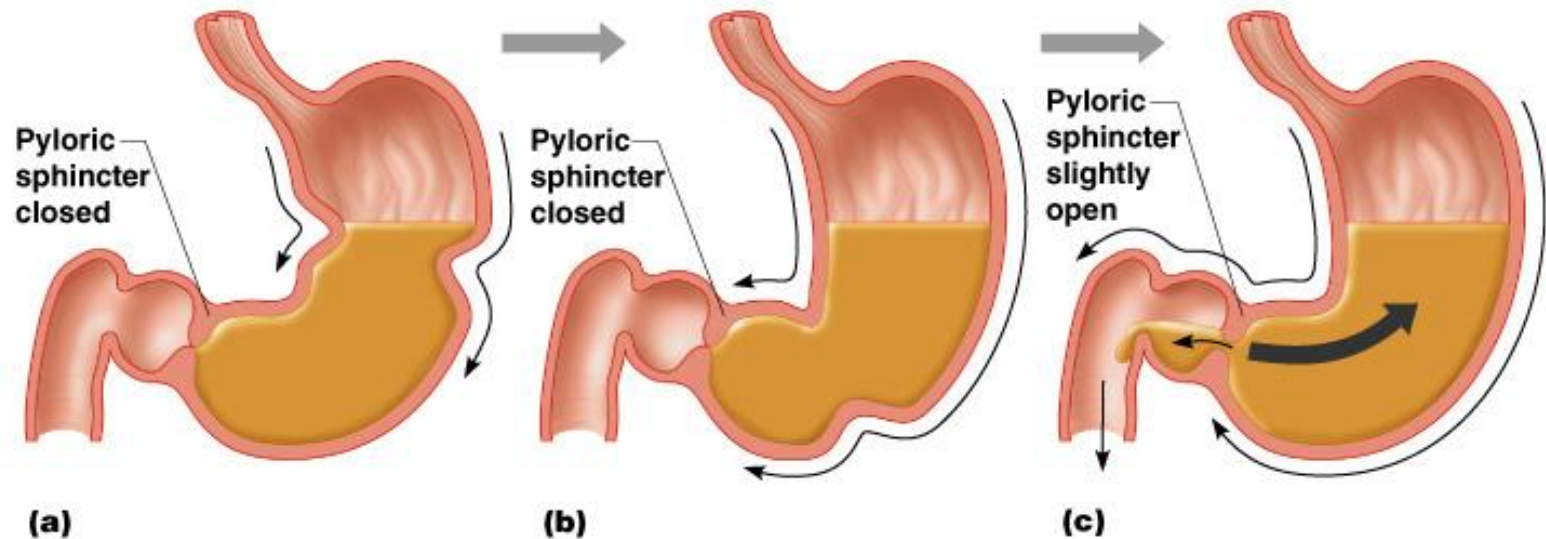


Figure 14.15

Propulsion in the Stomach

- The pylorus meters out chyme into the small intestine (30 ml at a time)
- The stomach empties in four to six hours

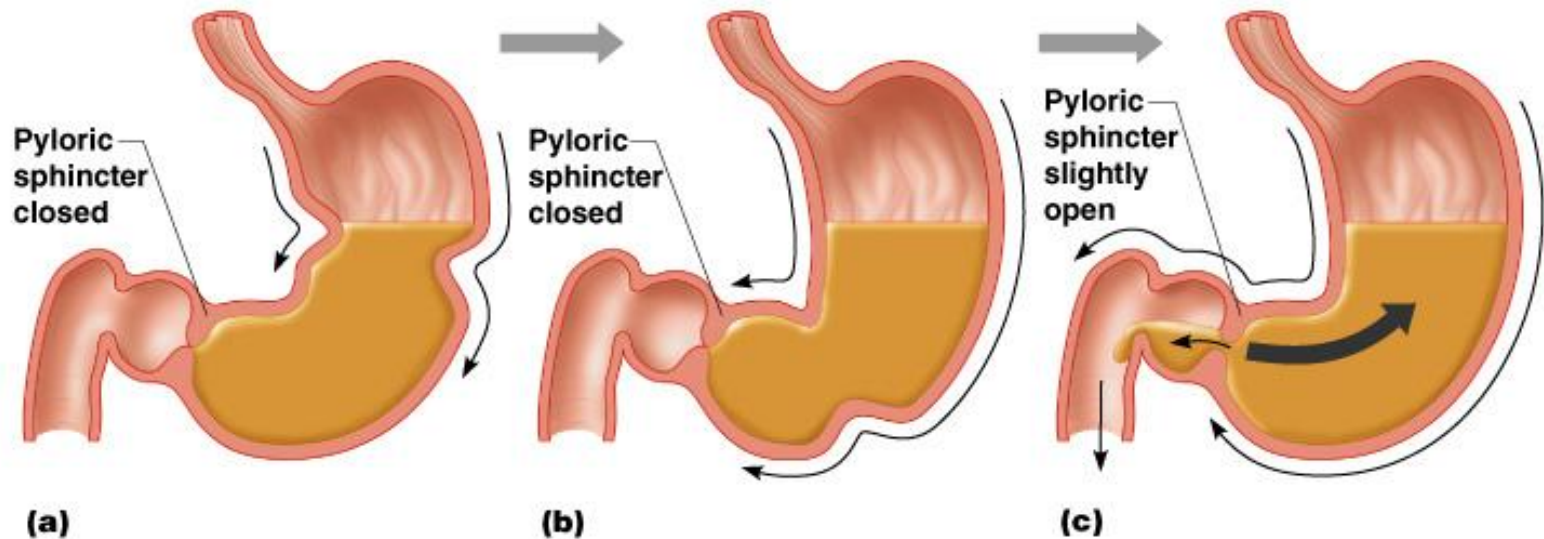


Figure 14.15

Digestion in the Small Intestine

- Enzymes from the brush border
 - Break double sugars into simple sugars
 - Complete some protein digestion
- Pancreatic enzymes play the major digestive function
 - Help complete digestion of starch (pancreatic amylase)
 - Carry out about half of all protein digestion (trypsin, etc.)

Digestion in the Small Intestine

- Pancreatic enzymes play the major digestive function (continued)
 - Responsible for fat digestion (lipase)
 - Digest nucleic acids (nucleases)
 - Alkaline content neutralizes acidic chyme

Stimulation of the Release of Pancreatic Juice

- Vagus nerve
- Local hormones
 - Secretin
 - Cholecystokinin

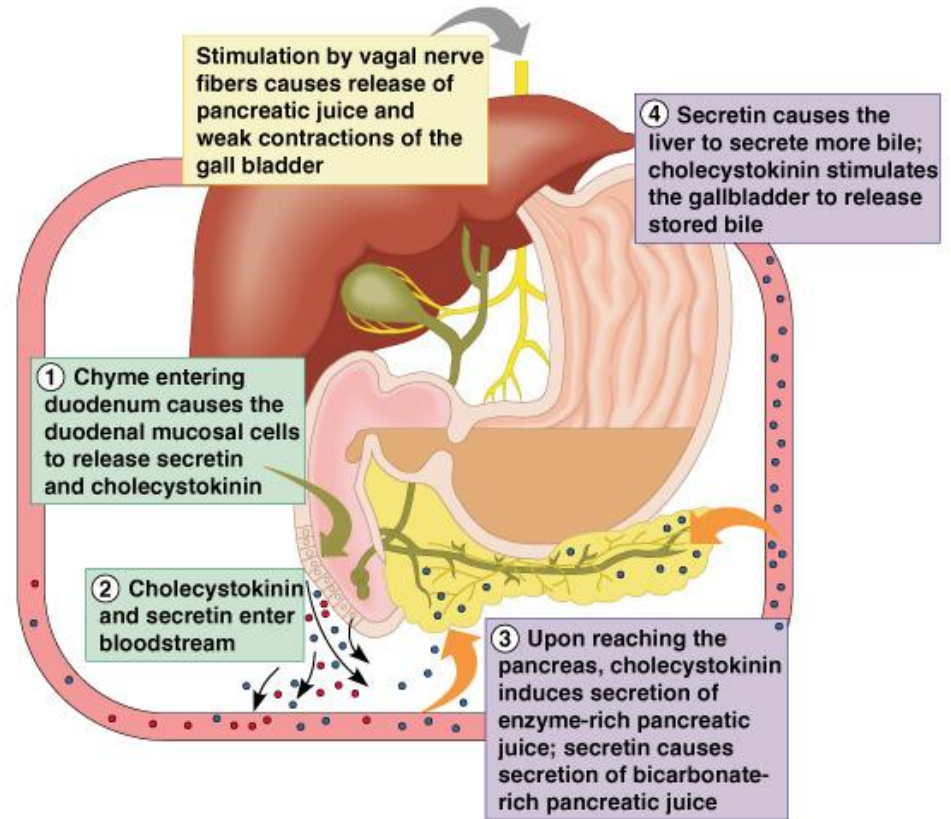


Figure 14.16

Absorption in the Small Intestine

- Water is absorbed along the length of the small intestine
- End products of digestion
 - Most substances are absorbed by active transport through cell membranes
 - Lipids are absorbed by diffusion
- Substances are transported to the liver by the hepatic portal vein or lymph

Propulsion in the Small Intestine

- Peristalsis is the major means of moving food
- Segmental movements
 - Mix chyme with digestive juices
 - Aid in propelling food

Food Breakdown and Absorption in the Large Intestine

- No digestive enzymes are produced
- Resident bacteria digest remaining nutrients
 - Produce some vitamin K and B
 - Release gases
- Water and vitamins K and B are absorbed
- Remaining materials are eliminated via feces

Propulsion in the Large Intestine

- Sluggish peristalsis
- Mass movements
 - Slow, powerful movements
 - Occur three to four times per day
- Presence of feces in the rectum causes a defecation reflex
 - Internal anal sphincter is relaxed
 - Defecation occurs with relaxation of the voluntary (external) anal sphincter

Nutrition

- Nutrient – substance used by the body for growth, maintenance, and repair
- Categories of nutrients
 - Carbohydrates
 - Lipids
 - Proteins
 - Vitamins
 - Mineral
 - Water

Dietary Sources of Major Nutrients

- Carbohydrates
 - Most are derived from plants
 - Exceptions: lactose from milk and small amounts of glycogens from meats
- Lipids
 - Saturated fats from animal products
 - Unsaturated fats from nuts, seeds, and vegetable oils
 - Cholesterol from egg yolk, meats, and milk products

Dietary Sources of Major Nutrients

- Proteins
 - Complete proteins – contain all essential amino acids
 - Most are from animal products
 - Legumes and beans also have proteins, but are incomplete
- Vitamins
 - Most vitamins are used as cofactors and act with enzymes
 - Found in all major food groups

Dietary Sources of Major Nutrients

- Minerals
 - Play many roles in the body
 - Most mineral-rich foods are vegetables, legumes, milk, and some meats

Metabolism

- Chemical reactions necessary to maintain life
 - Catabolism – substances are broken down to simpler substances
 - Anabolism – larger molecules are built from smaller ones
 - Energy is released during catabolism

Carbohydrate Metabolism

- The body's preferred source to produce cellular energy (ATP)
- Glucose (blood sugar) is the major breakdown product and fuel to make ATP

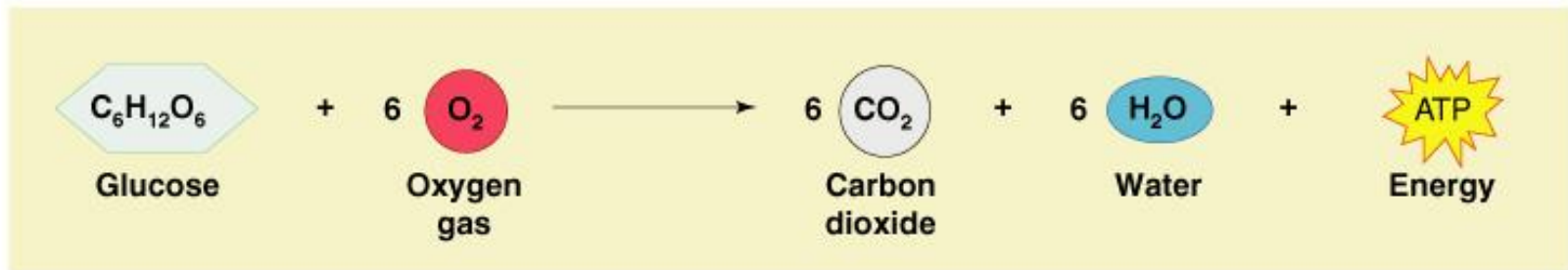


Figure 14.17

Cellular Respiration

- Oxygen-using events take place within the cell to create ATP from ADP
- Carbon leaves cells as carbon dioxide (CO₂)
- Hydrogen atoms are combined with oxygen to form water
- Energy produced by these reactions adds a phosphorus to ADP to produce ATP
- ATP can be broken down to release energy for cellular use