

The Digestive System and Body Metabolism

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- Digestion
 - Breakdown of ingested food
 - Absorption of nutrients into the blood
- Metabolism
 - Production of cellular energy (ATP)
 - Constructive and degradative cellular activities

Organs of the Digestive System

- Two main groups
 - Alimentary canal – continuous coiled hollow tube
 - Accessory digestive organs

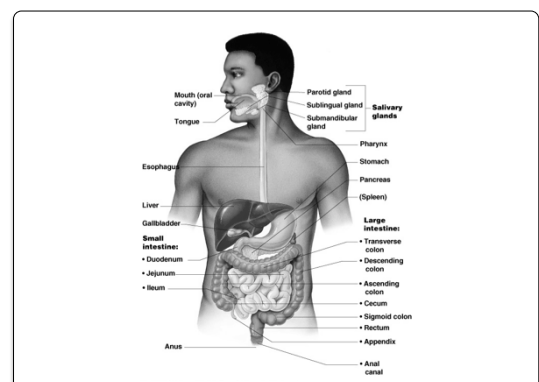
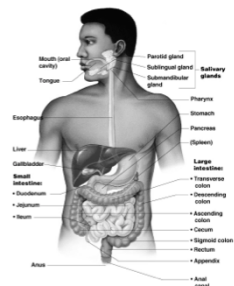


Figure 14.1

Organs of the Alimentary Canal

- Mouth
- Pharynx
- Esophagus
- Stomach
- Small intestine
- Large intestine
- Anus



Mouth (Oral Cavity) Anatomy

- Lips – protect the anterior opening
- Hard palate – forms the anterior (front) roof of the mouth
- Soft palate – forms the posterior (back) roof
- Uvula – fleshy projection of the soft palate

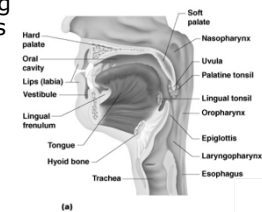


Figure 14.2b

- Oral cavity – area contained by the teeth
- Tongue – Muscular extension aiding in speech and balling of food.
- Tonsils
 - Palatine tonsils
 - Lingual tonsils

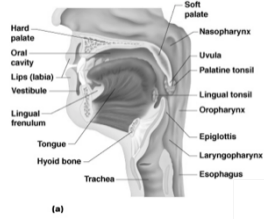


Figure 14.2a

Processes of the Mouth

- Mastication (chewing) of food
- Mixing masticated food with saliva
- Initiation of swallowing by the tongue
- Allowing for the sense of taste

Pharynx Function

- Serves as a passageway for air and food
- Food is propelled to the esophagus by two muscle layers
 - Longitudinal inner layer
 - Circular outer layer
- Food movement is by alternating contractions of the muscle layers (peristalsis)

Esophagus

- Runs from pharynx to stomach through the diaphragm
- Conducts food by peristalsis (slow rhythmic squeezing)

Layers of Alimentary Canal Organs

- Mucosa
 - Innermost layer
 - Moist membrane
 - Small amount of connective tissue
 - Small smooth muscle layer

Layers of Alimentary Canal Organs

- Submucosa
 - Just beneath the mucosa
 - Soft connective tissue with blood vessels, nerve endings, and lymphatics

Layers of Alimentary Canal Organs

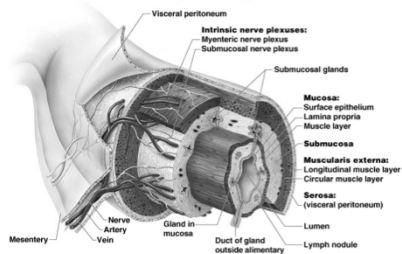
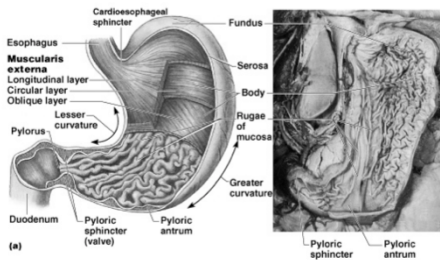


Figure 14.3

- Located on the left side of the abdominal cavity
- Food enters at the cardioesophageal sphincter
- Food empties into the small intestine at the pyloric sphincter

Stomach Anatomy



Stomach Anatomy

Figure 14.4a

- Acts as a storage tank for food
- Site of food breakdown
- Chemical breakdown of protein begins
- Delivers chyme (processed food) to the small intestine

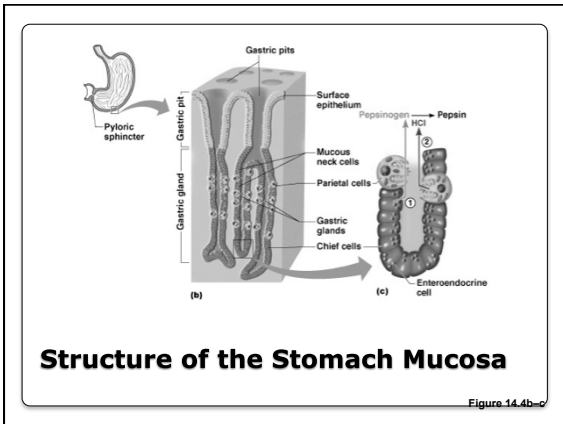
Stomach Functions

- Simple columnar epithelium
 - Mucous neck cells – produce a sticky alkaline mucus
 - Gastric glands – secrete gastric juice
 - Chief cells – produce protein-digesting enzymes (pepsinogens)
 - Parietal cells – produce hydrochloric acid
 - Endocrine cells – produce gastrin

Specialized Mucosa of the Stomach

- Gastric pits formed by folded mucosa
- Glands and specialized cells are in the gastric gland region

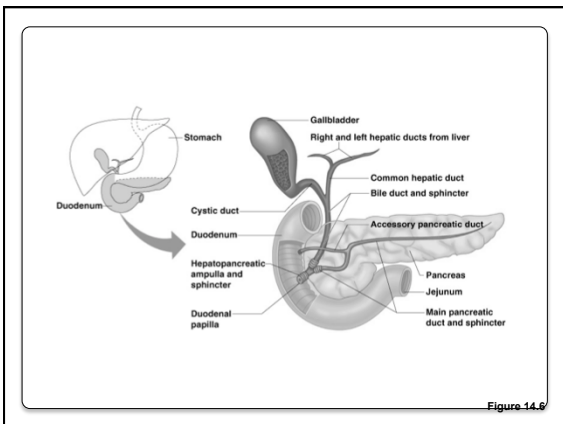
Structure of the Stomach Mucosa



- The body's major digestive organ
 - Site of nutrient absorption into the blood
 - Suspended from the posterior abdominal wall by the mesentery
- Small Intestine**

- Subdivisions of the Small Intestine**
- Duodenum
 - Attached to the stomach
 - Curves around the head of the pancreas
 - Jejunum
 - Attaches anteriorly to the duodenum
 - Ileum
 - Extends from jejunum to large intestine

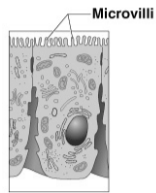
- Source of enzymes that are mixed with chyme
 - Intestinal cells
 - Pancreas
 - Bile enters from the gall bladder
- Chemical Digestion in the Small Intestine**



- Villi of the Small Intestine**
- Fingerlike structures formed by the mucosa
 - Give the small intestine more surface area
-
- (a) Small Intestine
- Figure 14.7a

Microvilli of the Small Intestine

- Small projections of the plasma membrane
- Found on absorptive cells



(c) Absorptive cells

Figure 14.7c

Structures Involved in Absorption of Nutrients

- Absorptive cells
- Blood capillaries

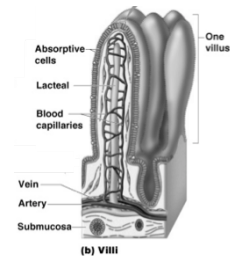


Figure 14.7b

Large Intestine

- Larger in diameter, but shorter than the small intestine
- Frames the internal abdomen

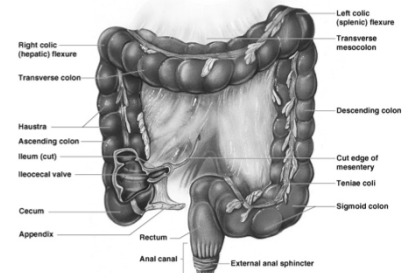


Figure 14.8

Functions of the Large Intestine

- Absorption of water
- Eliminates indigestible food from the body as feces
- Does not participate in digestion of food
- Goblet cells produce mucus to act as a lubricant

Structures of the Large Intestine

- Cecum – saclike first part of the large intestine
- Appendix
 - Accumulation of lymphatic tissue that sometimes becomes inflamed (appendicitis)
 - Hangs from the cecum

Structures of the Large Intestine

- Colon
- Rectum
- Anus – external body opening

Accessory Digestive Organs

- Salivary glands
- Teeth
- Pancreas
- Liver
- Gall bladder

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

Classification of Teeth

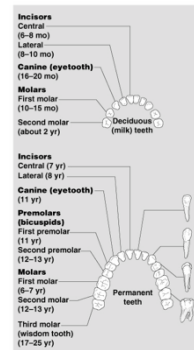


Figure 14.9

Pancreas

- Produces digestive enzymes that break down all categories of food into the duodenum
- Alkaline fluid introduced with enzymes neutralizes acidic chyme
- Endocrine product of the pancreas
 - Insulin

Liver

- Largest gland in the body and produces bile
- Located on the right side of the body under the diaphragm
- Connected to the gall bladder via the common hepatic duct

Gall Bladder

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

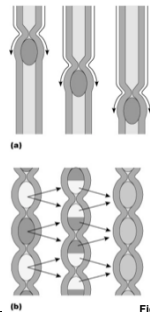


Figure 14.12

Processes of the Digestive System

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

Processes of the Digestive System

- Chemical Digestion
 - Enzymes break down food molecules into their building blocks
 - Each major food group uses different enzymes

Processes of the Digestive System

- Absorption
 - End products of digestion are absorbed in the blood or lymph
- Defecation
 - Elimination of indigestible substances as feces

Processes of the Digestive System

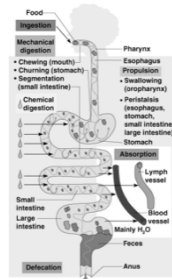


Figure 14.4

Digestive Activities of the Mouth

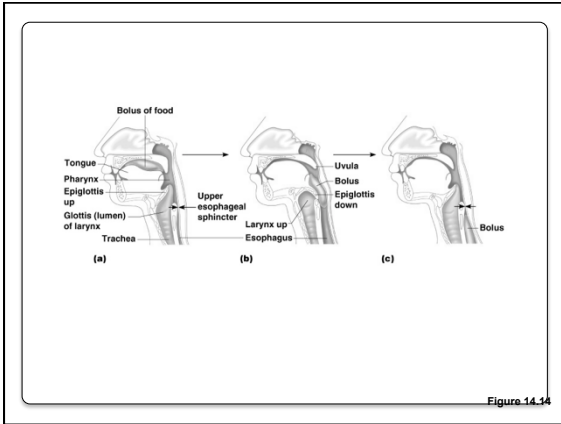
- Mechanical breakdown
 - Food is physically broken down by chewing
- Chemical digestion
 - Food is mixed with saliva
 - Breaking of starch into maltose by salivary amylase

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 and forced into the pharynx by the tongue



Food Breakdown in the Stomach

- Gastric juice is regulated by neural and hormonal factors
- 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

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

Digestion in the Small Intestine

- Pancreatic enzymes play the major digestive function
 - 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

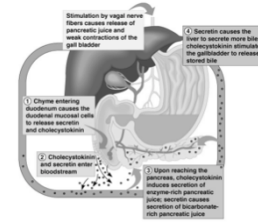


Figure 14.36

Absorption in the Small Intestine

- Water is absorbed along the length of the small intestine
- End products of digestion

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

Developmental Aspects of the Digestive System

- The alimentary canal is a continuous tube by the fifth week of development
- Digestive glands bud from the mucosa of the alimentary tube
- The developing fetus receives all nutrients through the placenta
- In newborns, feeding must be frequent, peristalsis is inefficient, and vomiting is common

Developmental Aspects of the Digestive System

- Teething begins around age six months
- Metabolism decreases with old age
- Middle age digestive problems
 - Ulcers
 - Gall bladder problems

Developmental Aspects of the Digestive System

- Activity of digestive tract in old age
 - Fewer digestive juices
 - Peristalsis slows
 - Diverticulosis and cancer are more common