

Digestive System Anatomy

Overview of Digestive Anatomy

[\[Section 23.1: Overview of the Digestive System\]](#)

[\[Section 23.1.1: Digestive System Organs\]](#)

[\[Figure 23.2: Components of the Digestive System\]](#)

The organs of the digestive system are divided into 2 main groups:

1. the alimentary canal (GI tract)
 - Tube that runs from the mouth to the anus
 - organs include: pharynx, esophagus, stomach, intestines, rectum, anus
 - the lumen of the alimentary canal opens to the external environment at both ends and therefore anything inside the lumen is considered external to the body
2. accessory organs
 - these organs are not part of the tube, i.e. they are not hollow organs that food passes through
 - secrete substances into the tube
 - many of these substances are required for digestion or enhance digestion
 - include: teeth, tongue, salivary glands, liver, gallbladder, and pancreas
 - the liver/gallbladder and pancreas will be considered separately at the end of this lab

Histology of the Alimentary Canal

[\[Section 23.1.2: Histology of the Alimentary Canal\]](#)

[\[Figure 23.3: Layers of the Alimentary Canal\]](#)

MSMS = mucosa, submucosa, muscularis, serosa

1. Mucosa
 - a. epithelium
 - i. in mouth, pharynx, and esophagus the epithelium is stratified squamous
 - ii. in stomach, small intestine and large intestine, the epithelium is simple columnar
 - iii. in anal canal the epithelium becomes stratified squamous again
 - iv. the epithelium has a high rate of turnover (rate of mitosis); some cells live only a few days, others up to a week
 - b. lamina propria
 - i. loose connective tissue containing blood vessels and lymphatic tissues
2. Submucosa
 - a. dense connective tissue

- b. blood vessels and lymphatic vessels for transporting absorbed nutrients from food to rest of body
- 3. Muscularis (aka, muscularis externa)
 - a. in the mouth, pharynx, esophagus, and anal canal this muscular layer is skeletal muscle, providing some voluntary control
 - b. the small intestine has a basic 2-layer organization of smooth muscle (named for direction of fibers):
 - i. inner layer called the **circular** layer
 - ii. outer layer called **longitudinal**
 - c. the 2-layer organization is modified in the stomach with an additional layer
 - i. the **oblique** layer is superficial to the longitudinal layer in the stomach wall
 - d. the large intestine technically has 2 layers, but the outer longitudinal layer is separated into three, narrow bands called **tenia coli**
- 4. Serosa
 - a. present only on organs within the abdominal cavity
 - b. covers the tubular organs in this cavity
 - c. doubles back on itself to form the **mesenteries** that hold the alimentary canal in place within the abdominal cavity

Six Major Processes of Digestion

[\[Section 23.2: Digestive System Processes; Section 23.2.1: Digestive Processes\]](#)

[\[Figure 23.5: Peristalsis; Figure 23.6: Digestive Processes\]](#)

1. Ingestion of food into the mouth
2. Movement of food through the digestive tract
 - swallowing and peristalsis
3. Mechanical digestion of food
 - process of physically grinding bites of food and separating them in to smaller pieces
 - this increases the surface area of the food particles to increase contact with digestive juices
4. Chemical digestion of food
 - unlike mechanical digestion, chemical digestion requires enzymes
 - enzymatic breakdown of large food polymers into their monomers (proteins into amino acids, for example)
5. Absorption of nutrients in the blood
6. Formation and elimination of indigestible materials and waste.

GI Tract: Mouth and Oral Cavity

[\[Section 23.3.1: The Mouth\]](#)

[\[Figure 23.7: Mouth\]](#)

- Mainly mechanical digestion
- Limited amount of chemical digestion with **salivary amylase** and **lingual lipase**

- hard & soft palates – form the roof of the mouth
- tongue – forms the floor of the mouth
- gingiva – gums
- superior and inferior labial frenulum – attaches the lips to the gums
- vestibule - region between teeth and cheek.
- lingual frenulum – attaches the tongue to the gums
 - read more about ankyloglossia in the “Tongue” section of your text
 - it can impair speech, but it can also severely impair a newborn’s ability to latch and breastfeed
- uvula – oval process that hangs down the posterior portion of the oral cavity – prevents food or liquid from moving into the nasal cavity

Tongue

[\[Section 23.3.2: The Tongue\]](#)

[\[Figure 23.8: Tongue\]](#)

muscles of the tongue perform 3 important functions:

1. position food while chewing
2. form and shape food into a bolus
3. position food for swallowing

surface covered with papillae

- most of the surface of the tongue is covered by two types of papillae
 1. **fungiform** that contain the microscopic structures known as taste buds
 2. **filiform** papillae that have touch receptors and create an abrasive surface for moving food around in the mouth

Salivary glands

[\[Section 23.3.3: Salivary Glands\]](#)

[\[Figure 23.9: Salivary Glands\]](#)

1. Parotid (*serous* gland)
2. Submandibular (*mucous + serous* gland)
3. Sublingual (*mucous + serous* gland)

Teeth

[\[Section 23.3.4: The Teeth\]](#)

[\[Figure 23.10: Permanent and Deciduous Teeth; Figure 23.11: Anatomy of a Tooth\]](#)

- Tooth is anchored to the jaw bone by periodontal ligament that lines the embedded part of the tooth, the root.
- Crown is the portion of the tooth above gingiva or gum
- Only inner pulp cavity is filled with living tissue, the pulp.
- Surrounding pulp cavity is dentin, which makes up most of the structural mass of the tooth.

- The exposed crown is covered with enamel, the hardest substance produced by living organisms.

GI Tract: Esophagus

[\[Section 23.3.6: The Esophagus\]](#)

[\[Section 23.3.6.1: Passage of Food through the Esophagus\]](#)

[\[Figure 23.13: Esophagus\]](#)

- food moves from the mouth into the oropharynx, laryngopharynx, and then into the esophagus
- it is a closed tube
- a food lump, bolus, is moved through the esophagus by skeletal muscles – peristalsis
- upper and lower esophageal sphincters

GI Tract: Stomach

[\[Section 23.4: The Stomach\]](#)

[\[Section 23.4.1: Stomach Structure\]](#)

[\[Figure 23.15: Stomach\]](#)

- Four areas of stomach:
 1. cardia
 2. fundus
 3. body
 4. pylorus
- Esophageal or cardiac sphincter – prevents stomach contents from moving into the esophagus
 - remember, the mucosa of the esophagus has a much thinner lamina propria, so acids from stomach can severely erode the esophagus
 - GERD = gastroesophageal reflux disorder (or disease) can be painful and severe, but is also associated with an increased risk of esophageal cancers
- Cardia – where food enters from esophagus
- Z-line – epithelial cells change from squamous to columnar
- Fundus – serves as a temporary holding area for food
- Rugae – large ridges that allow the stomach to be stretched
- Body– the main, central region of stomach
- Pylorus – the lower region of stomach
- Pyloric sphincter – smooth muscle that allows release of stomach contents into the first part of the small intestine

GI Tract: Small Intestine

[\[Section 23.5: The Small and Large Intestines\]](#)

[\[Section 23.5.1: The Small Intestine\]](#)

[\[Figure 23.18: Small Intestine\]](#)

[\[Figure 23.19: Histology of the Small Intestine\]](#)

- primary functions = chemical digestion and nutrient absorption
- Has circular folds, villi, and microvilli to increase surface area
- ileocecal sphincter separates the small and large intestines
- Three distinct regions:
 1. Duodenum
 - first 25 cm of small intestine
 - C-shaped structure that begins at the pyloric sphincter of the stomach
 2. Jejunum
 - approximately 2 meters
 - has a thick layer smooth muscle
 - Site of most nutrient absorption
 3. Ileum
 - approximately 3 meters
 - contains dense numbers of Peyer's patches (clusters of immune cells) to aid in immune defense
 - read more about MALT in chapter 21, the paragraph just above figure 21.11
 - Empties into cecum of large intestine through ileocecal sphincter

GI Tract: Large Intestine

[\[Section 23.5.2: The Large Intestine\]](#)

[\[Figure 23.21: Large Intestine\]](#)

[\[Figure 23.23: Teniae Coli, Haustra, and Epiploic Appendages\]](#)

- approximately 1.4 m long
- major function is absorption of water, vitamins, and solutes & the formation of feces
- Composed of 3 main regions:
 1. cecum
 - a. appendix: may play an immunological role or may serve as bacterial reservoir to replenish colon bacterial after severe diarrhea
 2. colon (4 subdivisions):
 - a. ascending colon
 - b. transverse colon
 - c. descending colon
 - d. sigmoid colon
 3. rectum
 - a. anal canal
 - b. internal anal sphincter is smooth muscle and is involuntary
 - c. external anal sphincter is skeletal muscle and is voluntary

Accessory Organ: Liver

[\[Section 23.6: Accessory Organs in Digestion: The Liver, Pancreas, and Gallbladder\]](#)

[\[Section 23.6.1: The Liver\]](#)

[\[Figure 23.24: Accessory Organs\]](#); [Figure 23.25: Microscopic Anatomy of the Liver](#);
[Figure 23.27: Gallbladder\]](#)

- Liver has 4 lobes
 - **left** and **right lobes** can both be seen from the anterior view
 - on the posterior/inferior view the **caudate** and **quadrate lobes** can also be seen
- Each lobe is organized into microscopic columns called **lobules**.
 - Primarily made of cells called hepatocytes
 - hepatocytes arranged in hexagonal columns around central vein
- Bile is produced by hepatocytes
 - Bile flows through a series of small ducts called canaliculi
 - Canaliculi ducts drain into the right and left hepatic ducts (better seen in figure 23.27)
 - These join to form the common hepatic duct
 - The cystic duct of the gallbladder and common hepatic duct join to form the common bile duct
 - This joins with the pancreatic duct in the pancreas before draining into the duodenum of small intestine

Accessory Organ: Gall Bladder

[\[Section 23.6.3: The Gallbladder\]](#)

[\[Figure 23.24: Accessory Organs\]](#); [Figure 23.27: Gallbladder\]](#)

- Small organ (~3"x1.5")
- Excess bile is pushed up the cystic duct by peristalsis
- Bile is stored and concentrated until needed
- Microvilli on innermost epithelial layer absorb water
- Muscle layer pushes bile back into cystic duct

Accessory Organ: Pancreas

[\[Section 23.6.2: The Pancreas\]](#)

[\[Figure 23.24: Accessory Organs\]](#); [Figure 23.26: Exocrine and Endocrine Pancreas\]](#)

- ~6" long
- Connects to duodenum
- Endocrine gland (produces hormones)
 - Insulin
 - Glucagon
- Exocrine function
 - Produces digestive enzymes

- See, but don't memorize, Table 23.8 for an overview of the major digestive enzymes. Notice how many of the total are produced and secreted by the pancreas

Lab Exercise - Anatomy of the Digestive System Activities:

Overview of Digestive Organs

Mouth

Oropharynx; Esophagus

Stomach; Stomach Histology

Small Intestine; Small Intestine Histology

Large Intestine; Large Intestine Histology

Accessory Organs: Salivary Glands; Appendix; Omentum; Liver; Gall Bladder; Pancreas

- See the Structures of Importance for the list of organs, structures and histology you should know

Learning Objectives

- To describe the overall function of the digestive system
- To describe the functions of the individual organs and structures of the digestive system
- To identify the individual organs of the alimentary canal on a model, in a picture or diagram or in a specimen, and to describe the function of each
- To identify (on a model, in a picture or diagram, or in a microscope slide) and describe the histologic structure of the alimentary canal, and the specific components (layers) that comprise it
 - Mucosa
 - Submucosa
 - Muscularis externa
 - Serosa or adventitia
- To identify the accessory organs of digestion on a model, in a picture or diagram, or in a specimen, and describe the function of each
- To list and identify the specializations of the stomach and the small intestine, and describe how these specializations contribute to the function of each organ
- To identify the histologic structure of the salivary glands, stomach, small intestine, pancreas, liver

- To list the digestive enzymes involved in the digestion of proteins, fats and carbohydrates, and to identify their site of origin
- To identify the end products of protein, fat and carbohydrate digestion
- To discuss the role of temperature and pH on digestive enzyme activity

Structures of importance

Alimentary canal	Oral cavity and esophagus
Mucosa: lamina propria, epithelium and muscularis mucosae	Hard and soft palates
Submucosa, muscularis externa, serosa / adventitia	Salivary glands; parotid, submandibular, sublingual
Duodenum, ileum, jejunum	Pharynx, including nasopharynx, oropharynx and laryngopharynx
Myenteric and submucosal nerve plexuses	Tonsils: lingual and palatine
	Esophagus (be sure to distinguish it from the trachea)
	Labia (lips)
Stomach	Microanatomy of the small intestine
Gastroesophageal (or cardiac, or lower esophageal) and pyloric sphincters	Epithelium – simple columnar (with goblet and absorptive cells)
Cardiac and pyloric regions and body	Villi and microvilli
Fundus	Plicae circularis
Greater and lesser curvatures	Intestinal crypt (crypts of Lieberkuhn)
Layers of smooth muscle: oblique, circular and longitudinal	Lacteal and capillary beds
Rugae	Peyer's patches
Gastric pits, including chief cells, parietal cells, mucus neck cells and gastric glands	
Omenta – greater and lesser	
Mesocolon	

Structures of Importance

Large Intestine	Pancreas
Ileocecal valve	Acinar cells and islet cells (islets of Langerhans)
Cecum and vermiform appendix; ascending, transverse and descending colon	Hepatopancreatic ampulla (Ampulla of Vater)
Taenia coli and epiploic appendages	Sphincter of Oddi
Haustrum (haustra)	Pancreatic duct
Rectum and anal canal	
External anal sphincter	
Epithelium – simple columnar (with goblet and absorptive cells)	
Liver and gall bladder	
Lobes: right, left, caudate and quadrate	
Falciform ligament	
Gall bladder, cystic duct, and bile duct	
Liver lobule	
Portal triad and central vein	
Hepatocytes and Kupffer cells	
Sinusoids	

Structure	Location	Description/Function
Mouth		
Labia		
Labial frenulum		
Gingivae		
Hard palate		
Soft palate		
Tongue		
Fungiform papillae		
Filiform papillae		
Vallate papillae		
Genioglossus		
Parotid gland and duct		
Submandibular gland and duct		
Sublingual gland and duct		
Teeth		
Crown		
Neck		
Root		
Enamel		
Dentine		
Root canal		
Apical foramen		
Alveolar socket		
Canine		

Bicuspid		
Molar		
Pharynx		
Oropharynx		
Nasopharynx		
Laryngopharynx		
Pharyngeal constrictor muscles		
Esophagus and stomach		
Esophageal (cardiac) sphincter		
Cardia		
Fundus		
Body		
Pylorus		
Antrum		
Pyloric sphincter		
Greater curvature		
Lesser curvature		
Rugae		
Intestines and viscera		
Pancreas		
Gall bladder		
Liver: right, left, caudate and quadrate lobes		
Pancreatic duct		

Hepatopancreatic ampulla		
Duodenum		
Jejunum		
Ileum		
Ileocecal valve		
Cecum		
Ascending colon		
Transverse colon		
Descending colon		
Sigmoid colon		
Rectum		
Haustra		
Omental (epiploic) appendages		
Vermiform appendix		
Anal canal		
Greater omentum		
Lesser omentum		
Histology		
Mucosa (including cell types): lamina propria, muscularis mucosae		
Submucosa		
Muscularis externa, circular, middle and longitudinal layers		

Villus		
Microvilli		
Gastric pits		
Lacteal		
Lymph nodules		