

Anatomy of the Digestive System

The digestive system provides all the nutrients, water, and electrolytes necessary for health to the body.

This system consists of a hollow tube extending from the mouth to the anus. Food material within this tube, known as the alimentary canal, is technically outside the body because it has contact only with the cells that line the tract.

Ingested food must first be physically broken down by chewing and churning. Next food must be chemically broken down through enzymatic hydrolysis into smaller diffusible molecules. This process is called digestion. The digested end products can then pass through the epithelial cells lining the tract into the blood for distribution to the body cells. This process is called absorption.

The digestive system organs are separated into two major groups: the alimentary canal, or gastrointestinal (GI) tract, and the accessory digestive organs.

- The alimentary canal is about 9 m long in a cadaver. It consists of the mouth, pharynx, esophagus, stomach, and small and large intestines.
- The accessory structures include the teeth, salivary glands, gallbladder, liver, and pancreas.

General Histological Plan of the Alimentary Canal

The alimentary canal walls have four basic tunics or layers. From the lumen outward: the mucosa, the submucosa, the muscularis externa, and either a serosa or adventitia.

- The mucosa is the wet epithelial membrane lining the lumen. It has a surface epithelium, a lamina propria,, and a muscularis mucosae. Its major functions are secretion (enzymes, mucus, hormones, etc.), absorption of digested foods and protection against bacterial invasion.
- The submucosa is superficial to the mucosa and is a moderately dense connective tissue containing blood vessels, lymphatic vessels, scattered lymph nodules, and nerve fibers.

- The muscularis externa is also known as the muscularis. It is usually a bilayer of smooth muscle.
- The serosa is the outermost layer and is the visceral peritoneum. It contains mesothelium associated with a thin layer of areolar connective tissue. In areas outside the abdominopelvic cavity, the adventitia replaces the serosa. The adventitia is a layer of coarse fibrous connective tissue that binds the organ to surrounding tissues. The serosa functions to reduce friction and the adventitia anchors and protects the surrounded organ.

Organs of the Alimentary Canal

Oral Cavity or Mouth

Food enters the digestive tract through the oral cavity that contains the gums, teeth, tongue, and openings of the salivary gland ducts. The palate comprises the roof of the mouth. The anterior portion of the palate is the hard palate and the posterior portion of the palate is the soft palate. A fingerlike projection of the soft palate, known as the uvula, extends inferiorly from its posterior margin. The floor of the cavity is covered by the tongue which is supported by the mylohyoid muscle. The membranous lingual frenulum secures the inferior midline of the tongue to the floor of the mouth. The vestibule is the space between the lips and cheeks and the teeth and the oral cavity proper is the area that lies within the teeth and gums.

The palatine tonsils, masses of lymphoid tissue, are located posteriorly on both sides of the mouth.

- Tonsillitis occurs when the palatine tonsils become inflamed and enlarged. This swelling partially blocks the posterior entrance to the pharynx resulting in difficulty and pain when swallowing.

With the physical process of chewing and the chemical activity of saliva, the breakdown of food begins before it even leaves the mouth.

Pharynx

The pharynx is subdivided into three parts: the nasopharynx (behind the nasal cavity), the oropharynx (behind the oral cavity extending from the soft palate to the epiglottis overlying the larynx), and the laryngopharynx (extending from the epiglottis to the base of the larynx).

The pharyngeal walls contain two layers of skeletal muscles: an inner layer of longitudinal muscle (levator muscles) and an outer layer of circular constrictor muscles.

Esophagus

The esophagus extends from the pharynx to the gastroesophageal sphincter in the stomach. In humans, it is about 25cm long and serves as a food passageway to the stomach. The gastroesophageal sphincter, a thickening of smooth muscle at the esophagus-stomach junction, controls food passage into the stomach.

Stomach

The stomach contains different regions, including: the cardiac region, the fundus, the body, and the pyloric region.

The lesser curvature is the concave medial surface of the stomach and the greater curvature is the convex lateral surface. The lesser omentum extends from the liver to the lesser curvature of the stomach. The greater omentum is saclike and extends from the greater curvature of the stomach downward and blends with the mesocolon.

Gastric glands of the mucosa secrete hydrochloric acid and hydrolytic enzymes which breakdown proteins. The mucosal glands also secrete a viscous mucus that prevents the stomach from digesting itself.

The stomach is the temporary storage region for food and serves as a site for the physical and chemical breakdown of food. Once the food is broken down into chyme, a creamy mass, it enters the small intestine.

- You should be able to identify the following on a stomach model and/or a slide: gastric pit, surface epithelium, lamina propria, and muscularis mucosa.

Small Intestine

The small intestine is a tube that is 6 to 7 meters long in a cadaver and only 2 m long in life because of muscle tone. It is suspended by a double layer of peritoneum, the fan-shaped mesentery, from the posterior abdominal wall. The small intestine has three subdivisions: the duodenum, the jejunum, and the ileum which joins the large intestine at the ileocecal valve.

Almost all nutrient absorption occurs in the small intestine, where three structural modifications that increase the mucosa absorptive area occur:

- The microvilli that are minute projections of the surface plasma membranes of the columnar epithelial lining cells of the mucosa.
- The villi that are the fingerlike projections of the mucosa tunic.
- The plicae circulares that are deep folds of the mucosa and submucosa layers that force the chyme through the intestine.

Peyer's patches, nodules of lymphoid tissue, are found in the small intestine.

Large Intestine

The large intestine is about 1.5m long and extends from the ileocecal valve to the anus. It encircles the small intestine on three sides and consists of the cecum, vermiform appendix, colon, rectum, and anal canal.

The colon is divided into several regions: the ascending colon, the transverse colon, the descending colon, and the sigmoid colon.

The longitudinal muscle layer of the large intestine is reduced to three longitudinal muscle bands called the teniae coli. The teniae coli cause the wall to pucker into small sacs called haustra.

The major function of the large intestine is to consolidate and propel the unusable fecal matter toward the anus for elimination. It also provides a site for the bacterial manufacturing of vitamins B and K for absorption into the bloodstream and it reclaims most of the remaining water from the undigested food.

Accessory Digestive Organs

Teeth

Two sets of teeth have developed in humans by the age of 21. The first set, the deciduous teeth, appears between 6 months and 2.5 years, beginning with the lower central incisors. The deciduous teeth begin to be lost around 6 years of age and are replaced by the permanent teeth.

Teeth are classified as incisors, canines, premolars (bicuspid), and molars.

Dentition is described by a dental formula that designates the numbers, types, and position of the teeth in one side of the jaw.

The dental formula for the deciduous teeth is :

Upper teeth: 2 incisors, 1 canine, 0 premolars, 2 molars x 2 = 20
Lower teeth: 2 incisors, 1 canine, 0 premolars, 2 molars

It is abbreviated as: $\frac{2, 1, 0, 2}{2, 1, 0, 2} \times 2 = 20$

The permanent teeth are indicated by: $\frac{2, 1, 2, 3}{2, 1, 2, 3} \times 2 = 32$

A tooth consists of the crown and the root. Enamel covers the tooth. Underneath the enamel is the dentin that composes the bulk of the tooth. The pulp cavity is the central portion of the tooth and extends into distal portions of the root and becomes the root canal.

Salivary Glands

Three pairs of glands secrete into the oral cavity: parotid glands, submandibular glands, and the sublingual glands. The salivary amylase begins the digestion of starch by breaking it down into disaccharides and glucose.

Liver and Gallbladder

The liver is the largest gland in the body. It has four lobes. Its digestive function is to produce bile that leaves through the common hepatic duct and enters the duodenum through the bile duct. Bile emulsifies fat but has no enzymatic action.

When digestive activity is not occurring, bile backs up into the cystic duct and enters the gallbladder where it is stored until needed. When fat-rich food enters the duodenum, hormones cause the gallbladder to contract and release the stored bile into the duodenum.

- If bile backs up into the liver it is forced into the bloodstream resulting in jaundice.
- Hepatitis is an inflammation of the liver, usually caused by a pathogen.
- Cirrhosis is a hardening of the liver, usually caused by heavy alcohol consumption, but not always.

Kupffer cells line the sinusoids of the liver and are phagocytic cells that remove bacteria and other debris from the blood as it flows by.

Pancreas

The pancreas has both an endocrine function (insulin and glucagon) and an exocrine (enzyme-producing) function. The pancreatic juice neutralizes the acidic chyme entering the duodenum from the stomach (optimal pH in the stomach is very acidic, while for the small intestine is slightly alkaline).