Digestive System

The digestive system Composed of gastrointestinal tract (GIT) or (Alimentary canal) and accessory organs.

1. Alimentary canal – mouth, pharynx, esophagus, stomach, small intestine, and large intestine

2. Accessory digestive organs – teeth, tongue, gallbladder, salivary glands, liver, and pancreas.

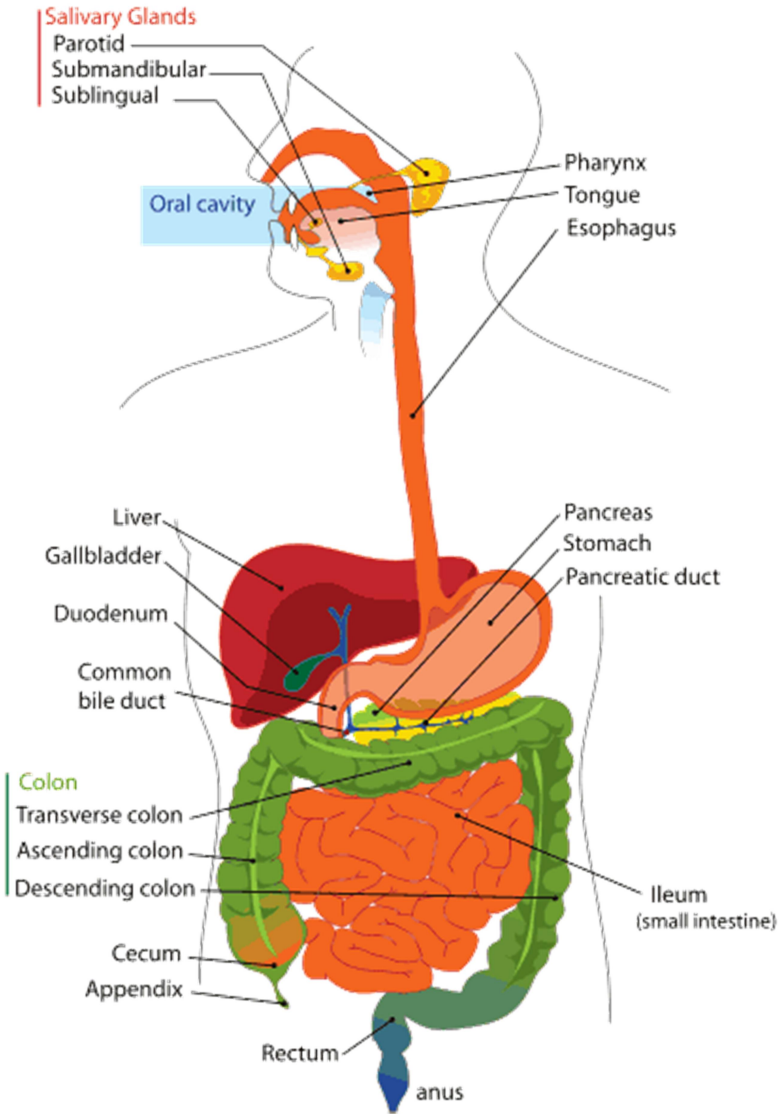


Figure: gastrointestinal tract (GIT)

Functions of Digestive System

1. Ingestion, taking food into the digestive tract.
2. Propulsion – swallowing and peristalsis.
   - Peristalsis – waves of contraction and relaxation of muscles in the organ walls.
3. Digestion
   - Mechanical, chewing, mixing, and churning food.
   - Chemical, catabolic breakdown of food.
4. Absorption, movement of nutrients from the GI tract to the blood or lymph.
5. Defecation, elimination of indigestible solid wastes.

Histology of the Alimentary Canal

From esophagus to the anal canal the walls of the GI tract have the same four tunics:

1.Mucosa, which secretes gastric juices, absorbs nutrients, and protects the tissue through the production of mucus. It consist of a single layer of epithelial tissue that is attached to the lamina propria (a layer of connective tissue). The lamina propria contain the mucus-associated lymphatic tissue(MALT). The mucosa also contain muscularis mucosae – smooth muscle cells that produce local movements of mucosa.

2. Submucosa , it holds blood, lymphatic, and nervous tissues that serve to nourish, protect, and communicate.

3.muscularis layer, consist of circular and longitudinal muscles layers that contract and relax around the tube in a wavelike movement termed peristalsis.

4.Serosa , The serosa and visceral peritoneum are synonymous. Serosa is outermost layer, which consists of connective tissue covered by squamous epithelium. The serosa secretes a watery fluid that lubricates the GI tract, allowing it to slide against other organs.

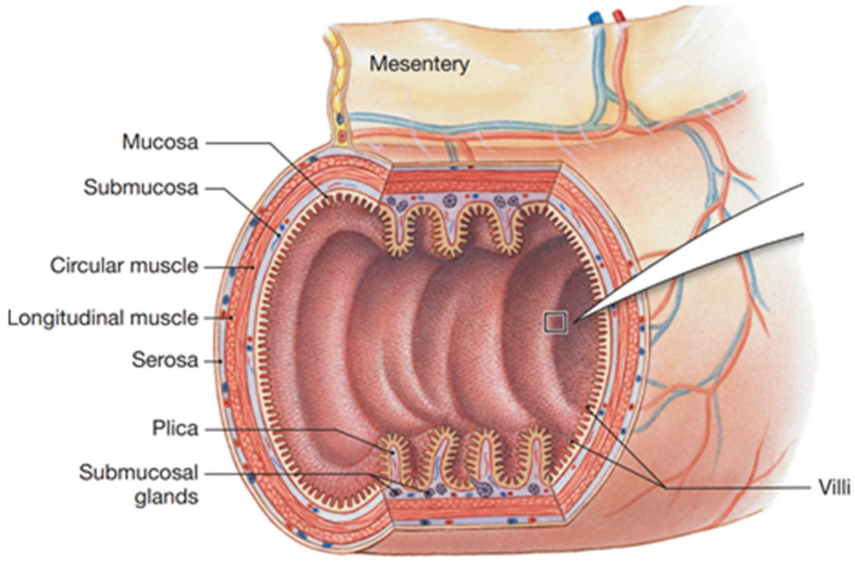


Figure: structure of the wall of GIT .

Neural control of GIT

The gut is innervated by 2 sets of nerves.

1) The **intrinsic nervous system, enteric nervous system (ENS),**

Consists of nerves that innervate the gut, with cell bodies located within the gut wall ; these include:

Myenteric plexus / plexus of Auerbach (within muscular layer).

Submucosal plexus / plexus of Meissner (within submucosa).

2. extrinsic nervous system

is defined as nerves that innervate the gut, with cell bodies located outside the gut wall; these are actually part of the autonomic nervous system (ANS). The Sympathetic nerves decrease GI secretions & motility while ,parasympathetic nerves increase GI secretion and motility.

Some GI functions are mediated entirely by the ENS, yet others dependent on the extrinsic nervous system. However, extrinsic nerves can often modulate the function of intrinsic nervous system. This extrinsic and intrinsic components--- innervating the gut, are sometimes collectively referred to as the **"brain-gut axis."**

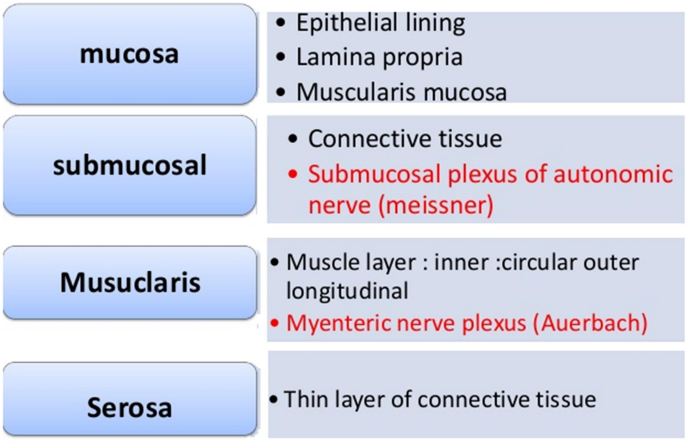


Figure: Histology of the wall of GIT

Peritoneum

The peritoneum is a double-sided membrane that holds many of the organs inside the abdominopelvic cavity. The outer side of the membrane, near the body wall, is termed the parietal peritoneum, whereas the inner side, near the organs, is the visceral peritoneum. The peritoneal cavity is divided into two main regions: the greater sac and the lesser sac. These two regions are connected by an opening termed the epiploic foramen (also called the foramen of Winslow).

The peritoneal cavity contain small amount of serous fluid facilitating movement between the organs. **Ascites,** for example, is an abnormal accumulation of this peritoneal fluid in the abdominopelvic cavity.

Retroperitoneal organ

Not all of the organs in the abdominopelvic cavity lie within the peritoneum. Some, for example, the aorta, kidneys, ureters, duodenum, and pancreas are outside and behind the peritoneum in the retroperitoneum.

The mesenteries

The mesenteries are extensions of the visceral peritoneum that stretch out to hold many of the abdominal organs and serve as a channel for blood vessels, nerves and lymphatic vessels traveling to and from the organs Mesenteries are named for the organs that they hold (e.g mesocolon—mesentery that surrounds the colon, mesoappendix—mesentery that surrounds the appendix).

The Mouth

The mouth consist of the following structure:

- the cheeks consist of skin, adipose tissue, skeletal muscles, and an inner lining of moist stratified squamous epithelium.
- The lips contain a lot of sensory nerve fibers that can judge the temperature of food before it enters the mouth.

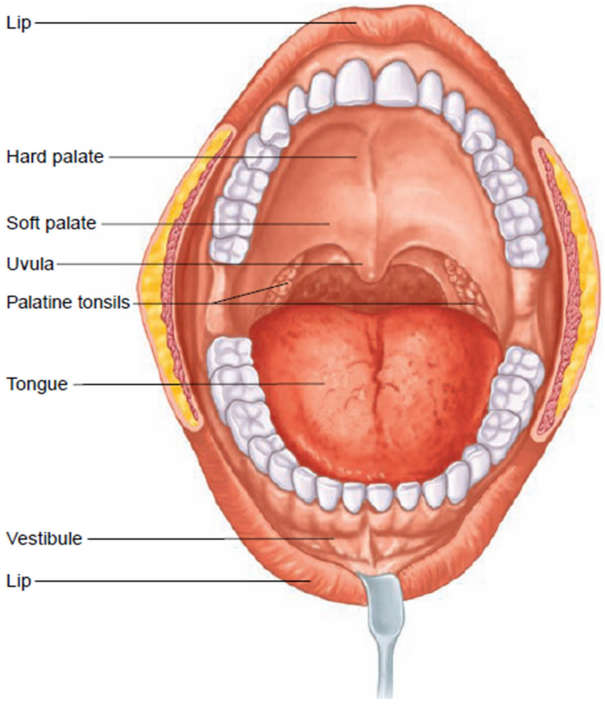


Figure : Structures of the mouth.

- The tongue is mostly made of skeletal muscles and is covered by a mucous membrane. The superior surface bears large of number of papillae. In between the papillae are nervelike cells called taste buds that have receptors for the five known tastes: sour, sweet, salty, bitter, and savory (umami). Tounge functions include: gripping and repositioning food during chewing, mixing food with saliva and forming the bolus and Initiation of swallowing, and speech.
- The palate is the roof of the mouth. It functions to separate the oral cavity from the nasal cavity. The front of the palate, the hard palate, is rigid because it has bony plates in it. The back of the palate, soft palate. The back of the soft palate hangs down into the throat, and this portion of the soft palate is called the uvula. The uvula acts to prevent food and liquids from entering the nose during swallowing.

- At the back of the mouth are two masses of lymphatic tissue called palatine tonsils.
- Teeth act to decrease the size of food particles, the Primary or deciduous teeth is 20 in number and erupt at intervals between 6 and 24 months. Permanent teeth that enlarge and develop causing the root of deciduous teeth to be resorbed and fall out. The number of Permanent teeth is 32, all of them erupted between the ages of 6 and 12 years, except the third molars erupted by the end of adolescence.

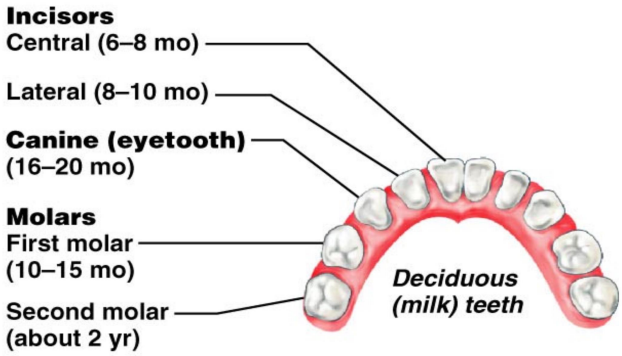


Figure: Primary or deciduous teeth

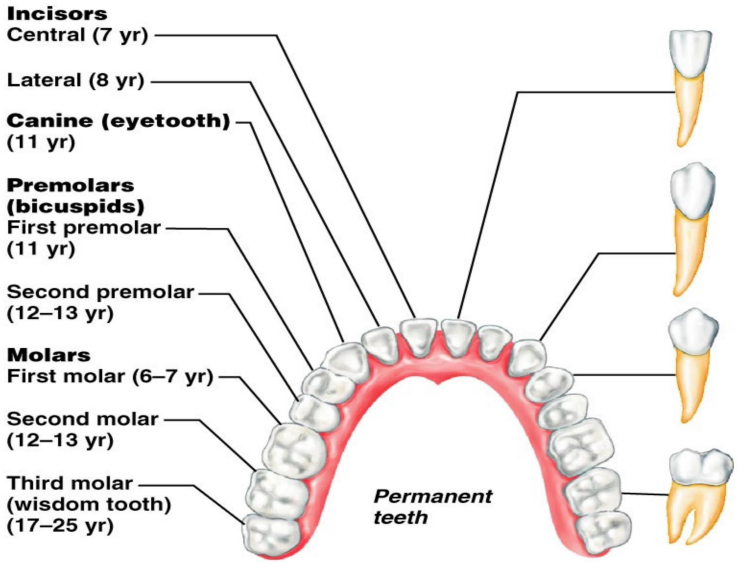


Figure: Permanent teeth.

salivary glands

The major salivary glands are,

- Parotid – lies anterior to the ear between the masseter muscle and skin. Parotid duct opens into the vestibule next to second upper molar.
- Submandibular – lies along the medial aspect of the mandibular body Its ducts open at the base of the lingual frenulum.
- Sublingual – lies anterior to the submandibular gland under the tongue.It opens via 10-12 ducts into the floor of the mouth.

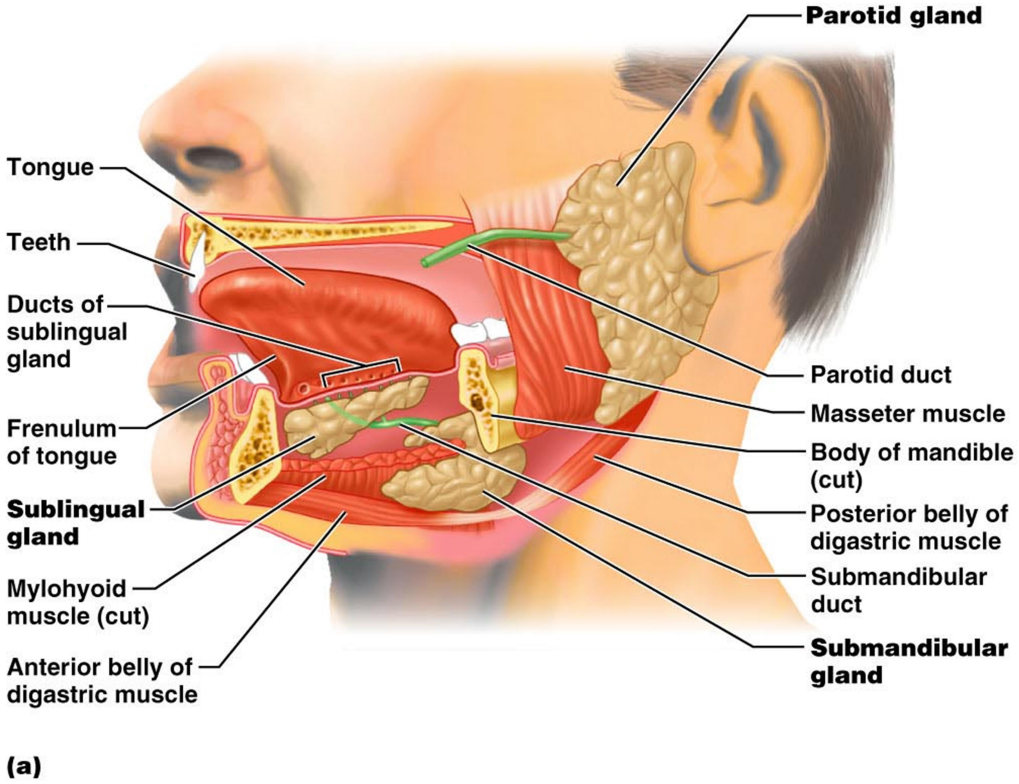


Figure: salivary gland

Pharynx

The throat, or pharynx, is the passageway that connects the oral and nasal cavities with the esophagus. It can be divided into three main parts: the nasopharynx, the oropharynx, and the hypopharynx. The pharynx has two skeletal muscle layers lined with stratified squamous epithelium and allow passage of food and fluids to the esophagus and air to the trachea.

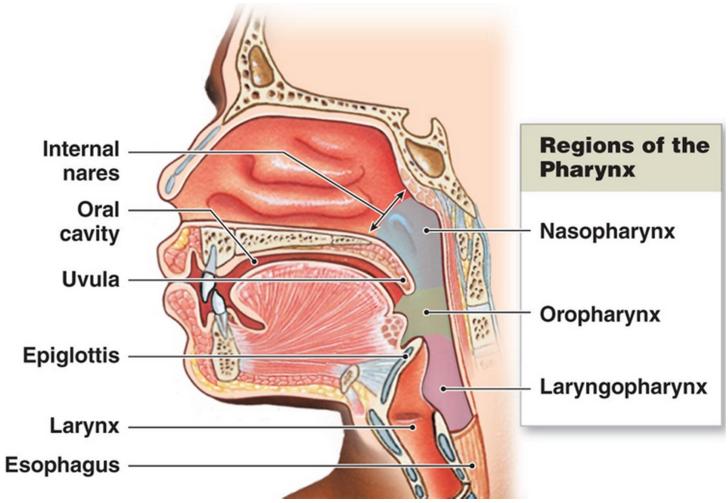


Figure: Pharynx.

Esophagus

Esophagus is a muscular tube going from the laryngopharynx to the stomach. Travels through the mediastinum and pierces the diaphragm to Joins the stomach at the cardiac orifice which guarded by gastroesophageal sphincter, or the cardiac sphincter.It transports food to stomach.

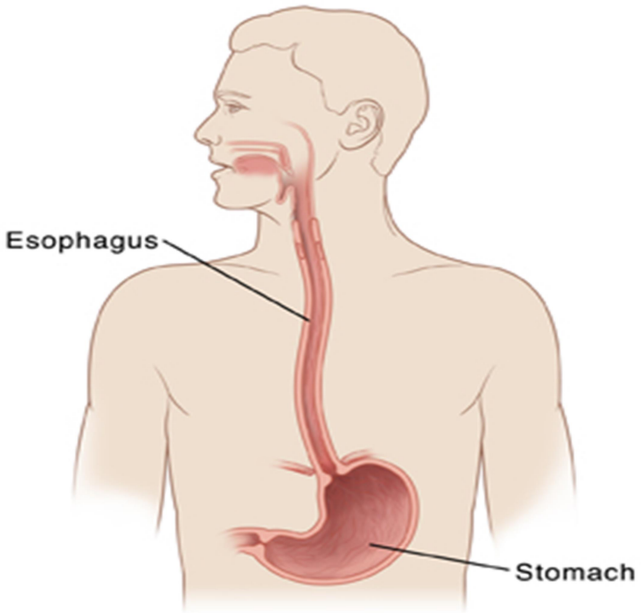


Figure: Esophagus.

The stomach

Anatomical structure

The stomach lies below the diaphragm in the upper left region of the abdominal cavity. It functions to receive food from the esophagus, mix food with gastric juice, start protein digestion, and move food into the small intestine. The beginning portion of the stomach that is attached to the esophagus is called the cardiac region. The portion of the stomach that balloons over the cardiac portion is called the fundic region, or fundus. The main part of the stomach is called the body, and the narrow portion that is connected to the small intestine is called the pyloric region or pylorus. A sphincter called the pyloric sphincter controls the movement of substances from the pyloric region of the stomach into the small intestine.

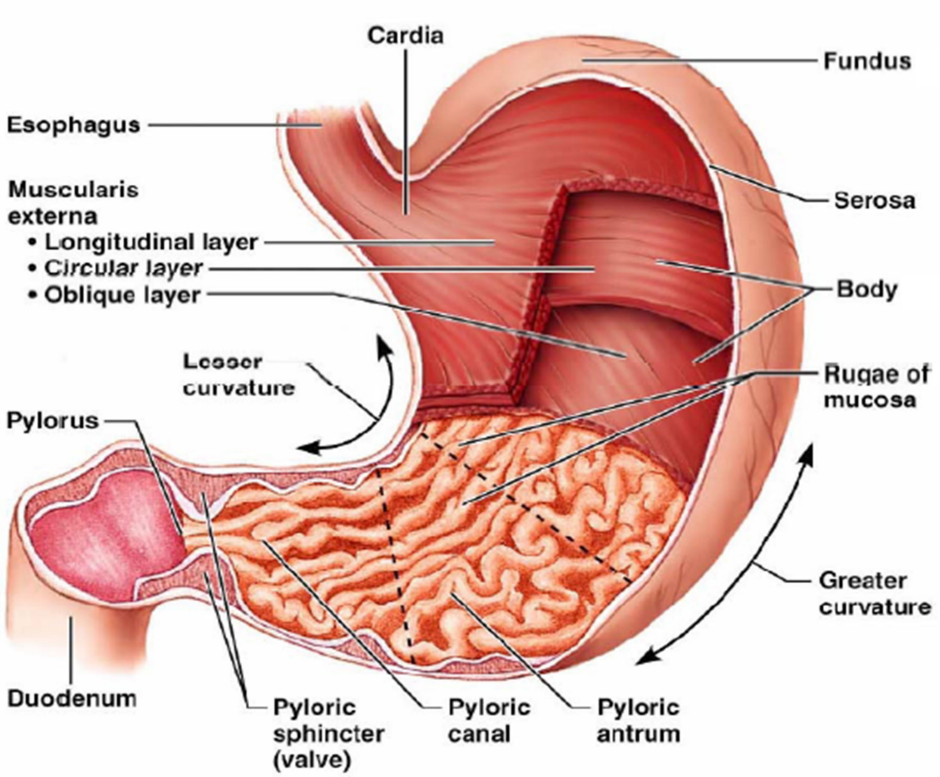


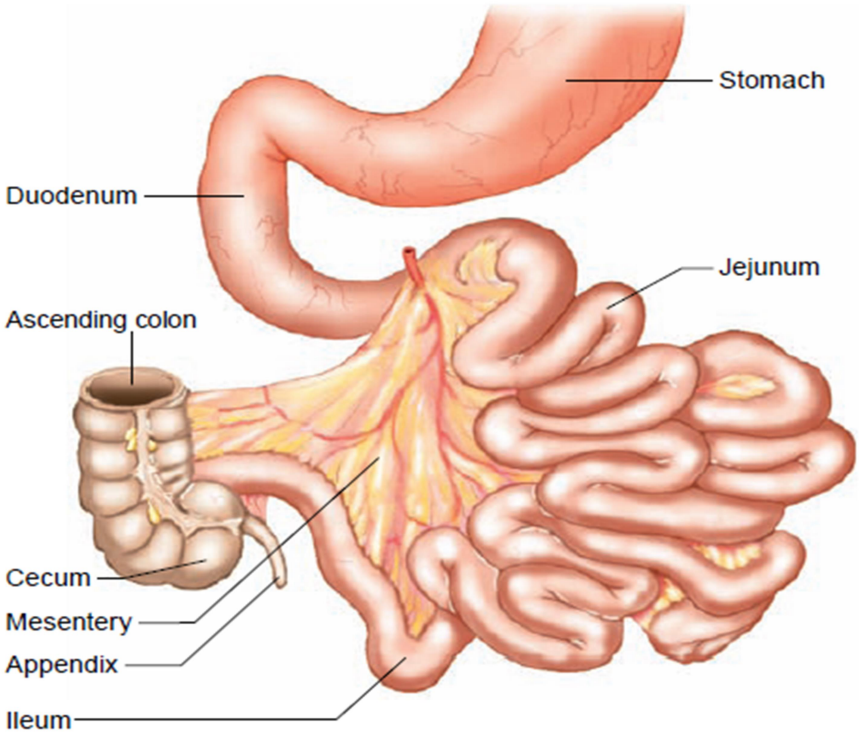
Figure: The stomach.

The Small Intestine

The small intestine is a tubular organ that extends from the stomach to the large intestine. The small intestine carries out most of the digestion in the body and is responsible for absorbing most of the nutrients into the blood. It consist of :

- The duodenum, it is C-shaped and relatively short.

- The middle portion of the small intestine is called the jejunum. It is coiled and forms the majority of the small intestine.
- The last portion of the small intestine is called the ileum, and it is directly attached to the large intestine .



Figure; small intestine

Structure and secretion of small intestine

Structurally, the mucosa of small intestine had wrinkles or folds called plicae circulares. From the plicae circulares project microscopic finger-like pieces of tissue called villi . The individual epithelial cells also have finger-like projections known as microvilli. The function of the plicae circulares, the villi and the microvilli is to increase the amount of surface area available for the absorption of nutrients. The lining of the small intestine also contains intestinal glands that secrete various substances. The following are the major enzymes secreted by the small intestine:

- Peptidases, These enzymes digest proteins.
- Sucrase, maltase, lactase enzymes digest carbohydrate.
- Intestinal lipase. This enzyme digests fats.

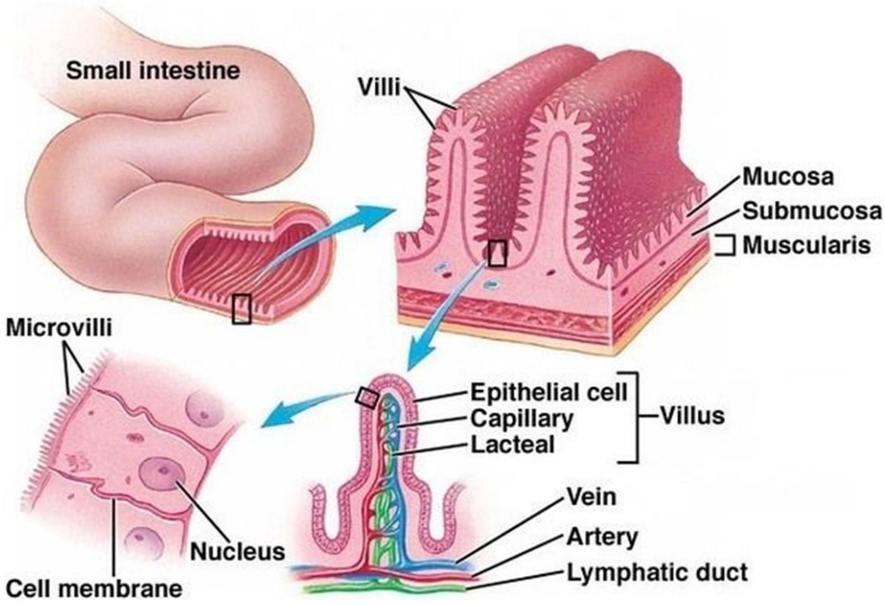


Figure: intestinal villi.

The Large Intestine

The large intestine extends from the ileum to the anus. The beginning of the large intestine is the cecum. Projecting off the cecum is the vermiform appendix. The appendix is mostly made of lymphoid tissue and has no significant function in humans. The cecum eventually gives rise to the ascending colon, which

runs up the right side of the abdominal cavity and attached to the transverse colon , this part is continue with the descending colon as it descends the left side of the abdominal cavity. In the pelvic cavity, the descending colon then forms an S-shaped tube called the sigmoid colon. Eventually the sigmoid colon straightens out to become the rectum. The last few centimeters of the rectum is called the anal canal, and the opening of the anal canal to the outside world is called the anus. As chyme leaves the small intestine and enters the large intestine, the proximal portion of the large intestine absorbs water and a few electrolytes from it. The leftover chyme is then called feces.

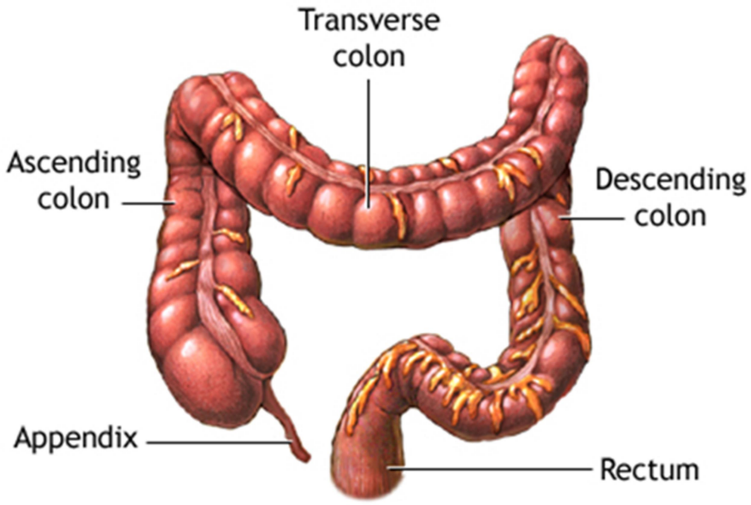
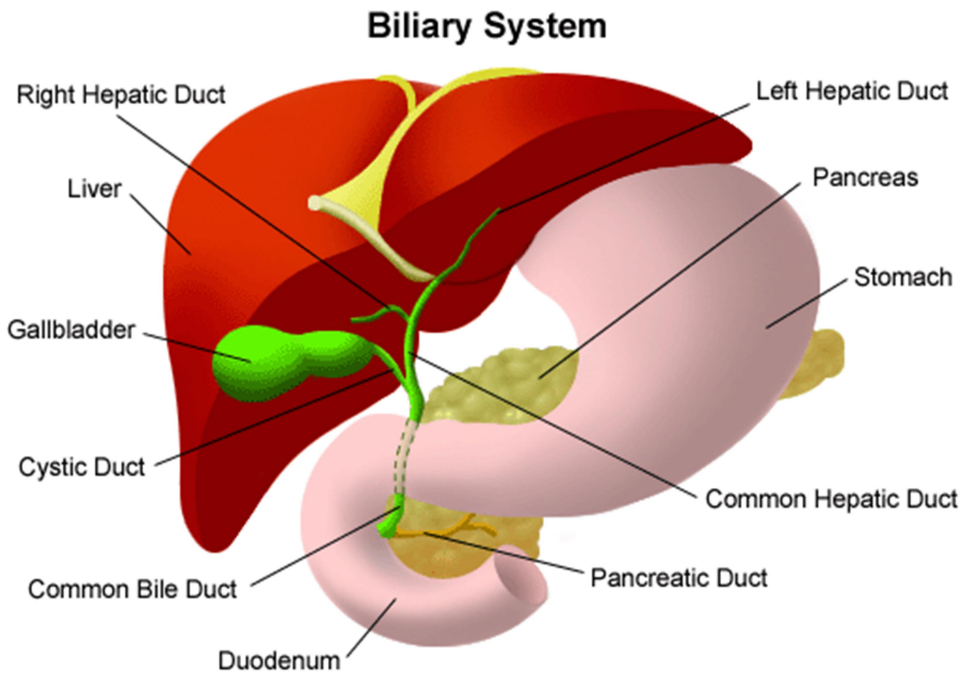


Figure: The large intestine.

Liver

The liver is the largest gland in the body ,it has four lobes right, left, caudate, and quadrate. The falciform ligament separates the right and left lobes anteriorly and suspends the liver from the diaphragm and anterior abdominal wall. The liver virtually fill the right upper quadrant of the abdomen and extend partially into the left upper quadrant directly inferior to the diaphragm. The liver forms a substance called bile, which emulsifies, or mechanically breaks down, fats into smaller particles so that they can be chemically digested. Bile is released from the liver through the right and left hepatic ducts, which join to form the common hepatic duct. The cystic duct carries bile to and from the gallbladder. When the hepatic and cystic ducts merge, they form the common bile duct, which empties into the duodenum. The liver is supplied with blood through two vessels: the portal vein and the hepatic artery. The hepatic artery carries oxygenated blood, whereas the venous portal system carries blood that is rich in digestive end products.



Function of the liver

Liver has many functions that affect digestion, metabolism, blood composition, and elimination of waste. Some of its major activities are:

- manufacture of bile, needed for the digestion of fats.
- storage of glucose (simple sugar) in the form of glycogen.

When the blood sugar level falls below normal, liver cells convert glycogen to glucose, which is released into the blood restoring the normal blood sugar concentration.

- modification of fats so that they can be used more efficiently by cells all over the body.
- storage of some vitamins and iron.
- formation of blood plasma proteins, such as albumin, globulins, and clotting factors.
- The destruction of old red blood cells and the recycling or elimination of their breakdown products. One byproduct, a pigment called bilirubin , is eliminated in bile and gives the stool its characteristic dark color.
- The synthesis of urea, a waste product of protein metabolism. Urea is released into the blood and transported to the kidneys for elimination.
- The detoxification (removal of the poisonous properties) of harmful substances, such as alcohol and certain drugs.

Composition of Bile

The bile is yellow-green, alkaline solution containing

- bile salts,
- bile pigments,
- cholesterol,
- neutral fats,
- phospholipids, and electrolytes.

The main function of bile are :

- Emulsify fat
- Facilitate fat and cholesterol absorption

The gallbladder

The gallbladder, a small thin-walled, green muscular sac on the ventral surface of the liver. it stores and concentrates bile by absorbing its water and ions from bile. When fatty food enters the duodenum, a hormone called cholecystokinin is secreted, causing a contraction of the gallbladder and move bile out into the duodenum.

The pancreas

The pancreas is a complex gland located in the upper left quadrant, it composed of both endocrine and exocrine tissues. The endocrine part of the pancreas consists of pancreatic islets (islets of Langerhans). The islet cells produce insulin and glucagon, which are very important in controlling blood levels of nutrients such as glucose and amino acids. The exocrine part of the pancreas is a compound acinar gland. The acini produce digestive enzymes involved in the digestion of the three types of food molecules: carbohydrates, proteins, and lipids. Clusters of acini are connected by small ducts, which join to form larger ducts, and the larger ducts join to form the pancreatic duct. The pancreatic duct joins the common bile duct and empties into the duodenum.

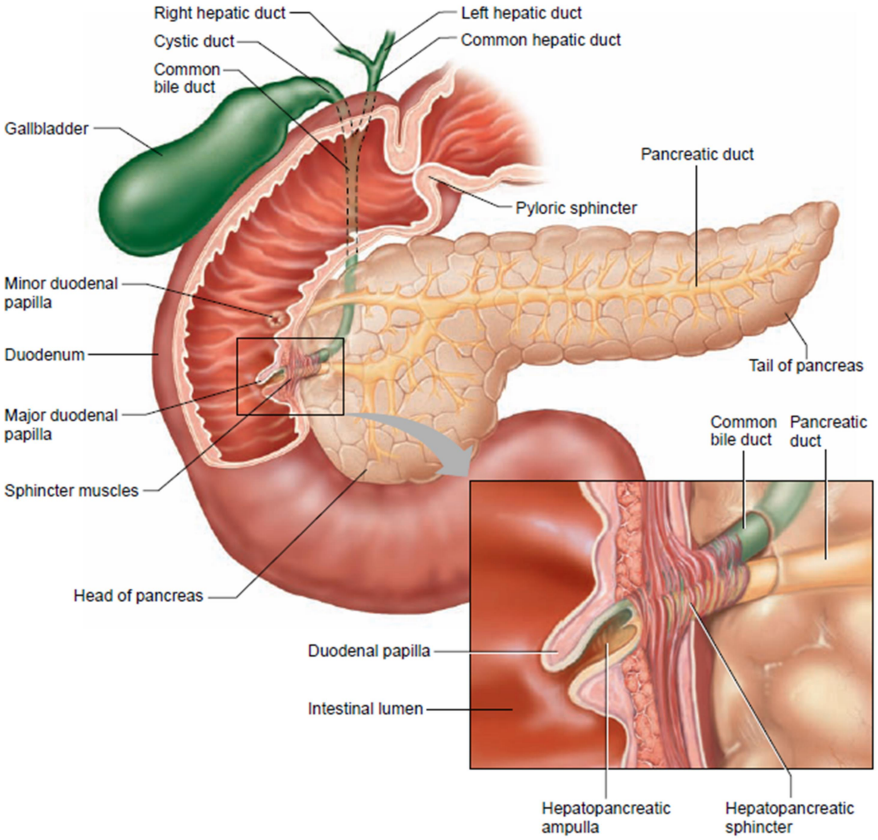


Figure: The pancreas