

Digestive System

The digestive system is made up of a tubular system and its accessory organs and is referred to as the alimentary canal or gastrointestinal tract (GI)

I. A tube traveling through the body

- A. begins at the mouth
- B. end at the anus
- C. approx. 30 feet long

II. Major function = preparation of food for cellular use

- A. ingestion - food into the mouth
- B. mastication - chewing
- C. deglutition - swallowing
- D. digestion - mechanical and chemical breakdown of food
- E. absorption - in small intestine
- F. peristalsis - contractions for propulsion of bolus
- G. defecation - discharge of waste

III. Structures of the GI tract

- A. Oral (bucal) cavity, pharynx, esophagus, stomach, small and large intestine
- B. Accessory structures - teeth, tongue, salivary glands, liver, gall bladder, and pancreas

Membranes of thorax and abdomen

Serous membrane - an epithelial membrane which lines the thoracic and abdominal cavities and covers the organs which lie in these cavities.

Thorax = pleura

Abdomen = peritoneum made of simple squamous epithelium

Parietal peritoneum - line the wall of the abdominal cavity. Comes together to form a double wall called the mesentery. The dorsal mesentery holds the small intestine and allows for freedom of movement and supports the vessels and nerves that supply the small intestine.

Visceral peritoneum - membrane over the intestines

Peritoneal cavity - area between the parietal and visceral peritoneum.

Falciform ligament - attaches the liver to the diaphragm and the anterior abdominal wall.

Lesser omentum - from the lesser curvature of the stomach and upper duodenum to the liver.

Greater omentum - from greater curvature of the stomach to the transverse colon.

Retroperitoneal - not located inside the peritoneal cavity, but rather between the parietal peritoneum and the muscle wall. Two types, 1) primarily retroperitoneal and 2) secondarily retroperitoneal.

Examples of primarily retroperitoneal structures:

- a. part of pancreas and duodenum
- b. kidneys, abdominal aorta, abdominal part of inferior vena cava

Examples of secondarily retroperitoneal structures:

Ascending and descending colon

Layers of the GI tract

4 layers, from the inside out are:

1. mucosa
2. submucosa
3. muscularis
4. serosa

Mucosa - absorptive and secretory layer, simple columnar, supported by lamina propria (CT). In the lamina propria we find many lymph nodes. The inside portion (muscularis mucosa) forms plicae circularis (permanent folds in the mucosa and submucosa).

Submucosa - vascular layer, also contains nerves

Meissner's plexus - autonomic to muscularis mucosa

Muscularis - has an inner circular layer and an outer longitudinal layer of muscle. Between these two layers of muscle we find the myenteric (Auerbach's) plexus. It is autonomic (para and symp) to the muscular layer. These muscles function to move, mulch, and churn the food.

Serosa (adventitia) binding and protective layer of loose fibrous CT.

Innervation of the digestive system

I. Vagus - parasympathetic to esophagus, stomach, pancreas, gallbladder, small intestine, and upper portion of the large intestine.

II. Parasympathetic from sacral spinal nerves to lower portion of the large intestine

parasympathetic increases movement and secretions of GI tract

III. Sympathetic from splanchnic nerves

sympathetic decreases movement and halt secretions

Mouth - oral (buccal) cavity

Contains the cheeks, lips, palates, and tongue

Frenulum midline fold

Vermilion (red margin) line between skin and oral mucosa

Tongue

moves food

taste buds

tonsils

frenulum

Anterior 2/3 of the tongue taste sensation is via the facial nerve (CN VII) whereas the posterior 1/3 is via the glossopharyngeal nerve (CN IX).

Palate - roof

palatal rugae (folds) - friction with tongue for swallowing

uvula

Arches

anterior - palatoglossal arch

posterior - palatopharyngeal arch

find the palatine tonsils between these arches

Teeth

Are really part of the skeletal system. Teeth are bones which reach down into alveoli (sockets). This forms a special type of joint known as a gomphosis.

Deciduous teeth (baby or milk teeth) = 20

Permanent teeth = 32

Parts of a tooth

crown - exposed part of the tooth above the gingiva (gum)

enamel - outer layer of the tooth. Hardest substance in the human body. Non-replaceable

root - portion of the tooth embedded in the bone

neck - connects the crown to the root

cementum - outer layer of the root. It attaches to the periodontal ligament

dentin - deep to the enamel. It forms the bulk of the tooth and surrounds the pulp cavity. The pulp cavity leads to the root canal which ends at the apical foramen. The apical foramen provides an opening for the entrance of blood vessels and nerves.

dentinal tubules - are cellular processes of odontoblasts

Salivary glands - will find some buccal glands = minor ductless glands.

3 major glands

1. parotid gland - subcutaneous, in front of ear. Has parotid duct (Stenson's duct) which enters the mouth behind 2nd upper molar. It is the gland involved with the mumps.

2. submandibular gland - covered by the mylohyoid muscle. Has submandibular (Wharton's) duct which enters the floor of the mouth on either side of the lingual frenulum.

3. Sublingual gland - found in the floor of the mouth on each side of the tongue.

innervation para = watery
 symp = viscous

Pharynx - contains constrictor muscles. (superior, middle, and inferior). These are used for swallowing.

Esophagus - connects the pharynx to the stomach. It is a muscular tube which passes through the diaphragm at the esophageal hiatus. This tube is lined with nonkeratinized stratified squamous epithelium. There is a lower esophageal sphincter which prevents the reflux of food.

Stomach - 4 regions

1. Cardia
2. fundus
3. body
4. pylorus

The muscularis layer of the stomach is subdivided into three layers:

1. outer longitudinal
2. middle circular
3. inner oblique

Within the stomach we see many gastric pits. These are tubular invaginations into the mucosa of the stomach. At the end of the gastric pit we will find the secretory portion of the gland. In the stomach the secretory glands are subdivided into two varieties of glands. These are the 1, cardiac and pyloric glands and the 2, gastric glands. The cardiac and pyloric glands are found at the bottom of the gastric pits in the cardia and pylorus regions of the stomach. The gastric glands are found at the bottom of the gastric pits throughout the stomach except in the cardia and pylorus regions.

There are 5 cell types associated with the glands of the stomach. These are:

1. Mucus cells - As their name implies they secrete a watery mucus. These are found mainly in the cardia and pylorus of the stomach. Those found in the gastric glands are referred to as mucus neck cells.
2. Regenerative cells – These cells are found at the base of the gastric pit and the neck of the gland. They rapidly divide and migrate either up into the gastric pit, or down into the gland to replace dead cells.
3. Parietal cells – Are found mainly in the gastric glands. They are found in the upper ½ of the gland and secrete HCl and intrinsic factor.
4. Chief cells – are so named because they are the chief cell type (most numerous) found in the gastric glands. In infancy they secrete rennin and lipase. They also secrete pepsinogen throughout life. This cell type is found in the gastric glands, but not in the cardiac or pyloric glands.
5. Enteroendocrine cells – These cells are found in the lower end of the glands. They secrete hormones and paracrine messengers that regulate digestion.

Intestine Small and large intestine

Small intestine (approximately 21 feet long in living body, maybe 30 feet long in cadaver) consists of the duodenum, jejunum, and ileum. It is all supported by the mesentery except for a portion of the duodenum. Functions to aid in the chemical and mechanical breakdown of food (chyme), absorption and transportation.

Duodenum- (9-12 inches) is short and C shaped. becomes retroperitoneal. Ends at the duodenal-jejunal flexure (ligament of Treitz). Receives common bile duct from the liver and gall bladder and pancreatic duct at the Ampulla of Vater (hepatopancreatic ampulla)- into duodenal papilla. This flow is controlled by the sphincter of Oddi.

Jejunum - (8 feet) Middle portion of the small intestine. Lacks fat near the intestine in the mesentery.

Ileum - (12 feet) Walls have Peyer's patches which are groups of lymph nodules. The fat in the mesentery reaches out onto the tubal portion. Ends at the ileocecal junction.

Terms and concepts related to the small intestine:

Duodenal (Brunner's) Glands: These glands are found in the wall of the duodenum. They function to secrete a bicarbonate-rich mucus which neutralizes the HCl coming from the stomach.

Intestinal crypts (of Lieberkuhn): These crypts are found throughout the small intestine at the bases of the villi. These are very similar to the gastric glands that we saw in the stomach. They are tubular invaginations that extend inward as far as the muscularis mucosa. In their upper ½ they consist of absorptive and Goblet cells. Goblet cells secrete a protective mucus. The lower ½ consists mainly of dividing epithelial cells. These epithelial cells have a 3 to 6 day lifespan during which they migrate to the tip of the villus to replace the older cells of the villus. After they die they are sloughed off and are digested. The base of the intestinal crypts also contain Paneth cells, the function of which is still unknown, but it is believed that they secrete lysozyme as a bacterial defense mechanism.

Brush border: The villus of the small intestine has a "brush border" of microvilli. This serves to increase the absorptive surface of the small intestine. The brush border also produces brush border enzymes, one of which is enterokinase, which activates pancreatic enzymes.

Peyer's Patches: Throughout the small intestine there is a large population of lymphocytes in the lamina propria and submucosa. These lymphocytes intercept pathogens before they can enter the blood.

stream/lymphatics. These lymphocytes aggregate into conspicuous nodules. In the Ileum these nodules are known as Payer's patches.

Large intestine - has little or no digestive function. Expels waste and absorbs water and electrolytes. Typically has 4 regions, the ascending, transverse, descending, and sigmoid regions of the colon. We will consider it to have 6 regions.

Cecum - beginning of the large intestine. Starts at the ileocecal junction. Here there is a valve (ileocecal valve) to prevent back flow. Attaches to the appendix. Has the beginning of the taeniae coli.

Ascending colon - ascends on the right side to end at the hepatic (right colic) flexure. Taeniae coli present

Transverse colon - travels transversely across the abdomen in front of the upper portion of the small intestine. Is supported by the transverse mesocolon. Ends at the splenic (left colic) flexure. Taeniae coli present.

Descending colon -descends down the left side to end at the sigmoid colon. Taeniae coli present.

Sigmoid colon - Passes over the psoas muscles to enter the pelvic cavity. Supported by the sigmoid mesocolon. Taeniae coli present.

Rectum -between sigmoid colon and anal canal. Storage area for feces.

Note - the entire length of the colon has three bands of longitudinal muscle (taeniae coli) for propulsion of contents. We also see saculations (haustra) and appendices epiploicae.

Liver - in upper right abdomen, protected by ribs
has four lobes;

1. large right lobe
 2. smaller left lobe
- these two lobes are separated by the Falciform ligament.
3. caudate lobe. Near Inferior Vena Cava
 4. quadrate lobe. Near gall bladder

we should see the ligamentum teres hepatis. It is the remnant of the umbilical vein of the fetus.

Porta hepatis - the doorway to the liver. Hepatic artery, portal vein, lymphatics, nerves, and hepatic ducts enter and leave here.

Functions of the liver - synthesis, storage, and release of vitamins and glycogen. Synthesis of blood proteins. Phagocytosis of old RBC's and bacteria. Removal of toxic substances. Production of bile.

Gall bladder - storage and concentration of bile. Bile is produced in the liver and then collects in bile canaliculae which empty into the right and left hepatic ducts. These join to form the common hepatic duct. This is joined by the cystic duct from the gall bladder to form the common bile duct. The bile duct will eventually be joined by the pancreatic duct. This will empty into the duodenum at the hepaticopancreatic ampulla.

Pancreas - has both endocrine and exocrine functions

1. endocrine - insulin and glucagon from the islets of Langerhans.
2. exocrine - pancreatic juice, pancreatic lipases

The pancreas has three regions, a head, body, and tail

Review the breakdown of the billiary tree.

The portal-caval system: This is the blood flow from the intestines through the liver to the inferior vena cava. Briefly blood in the portal vein - from intestine plus oxygenated blood from the hepatic artery enters the hepatic sinusoids. From here the blood drains into the central canal, then to the hepatic vein, and ultimately to the inferior vena cava. All of the functions/interaction that the liver has with the blood happens while the blood is flowing through the hepatic sinusoids.