

Al-Mustaqbal University
College of Engineering and Technologies
Biomedical Engineering Department



Systemic Physiology I

Lecture: 6

Digestive System Physiology

Prepared by:

Dr. Asma'a Hassan Mohamed

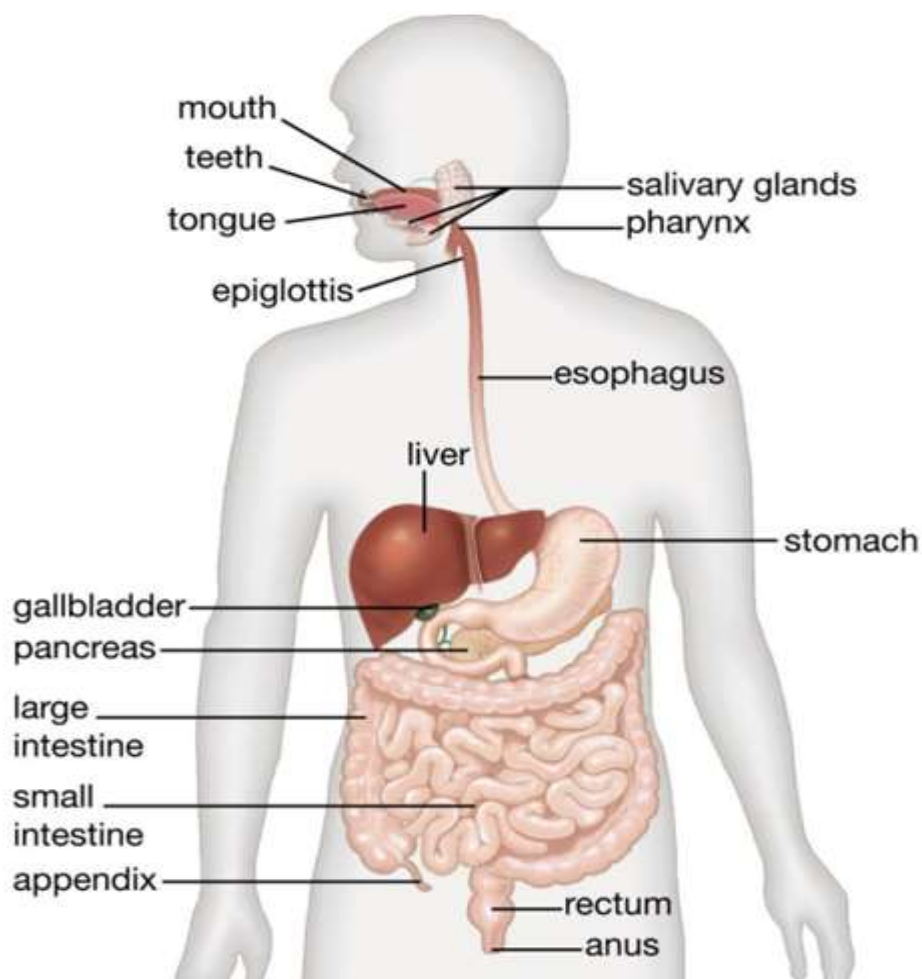
Digestive System Physiology

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

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

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

Digestion: Refer to All those processes involved in breaking down large, complex, insoluble molecules into simple, soluble so that these substances can be absorbed quickly into the blood for transport to the cells that utilize them.



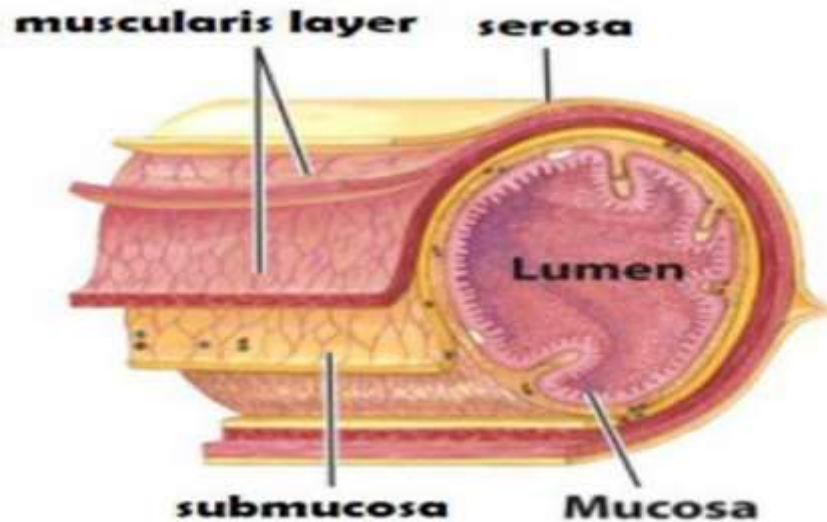
Functions of Digestive System

1. Ingestion, taking food into the digestive tract.
2. Propulsion – swallowing and peristalsis.
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 the esophagus to the anal canal, the walls of the GI tract have the same four compositions:

- 1. Mucosa**, which secretes gastric juices, absorbs nutrients, and protects the tissue through mucus production. It consists of a single layer of epithelial tissue attached to the lamina propria (a layer of connective tissue).
- 2. Submucosa** holds blood, lymphatic, and nervous tissues that serve to nourish, protect, and communicate.
- 3. muscular layer** consists of circular and longitudinal muscle that contract and relax and make a wavelike movement termed peristalsis.
- 4. Serosa** is the outermost layer, which consists of connective tissue covered by squamous epithelium.



Gastrointestinal Tract (GIT).

Salivary glands: 3- pairs of salivary glands empty their secretions into the mouth:

1. The parotid glands (large glands lies anterior to the ear).
2. The submandibular gland.
3. Small sublingual gland.

The function of salivary glands is to secrete saliva into the floor of the mouth. **1.0 - 1.5 liters** of saliva secreted per day:

1. 25% by parotid glands,
2. 5% by sublingual glands, and
3. 70% by submandibular glands.

The salivary glands are controlled by the two divisions of the autonomic nervous system, the sympathetic and the parasympathetic.

Composition of the Saliva

- Water 99.4%.
- Electrolytes (Na^+ , Cl^- , HCO_3^-) to regulate osmotic pressure.

- Buffers keep pH near (7.0)
- Glycoprotein.
- Antibody (IgA) and lysozyme.
- Enzyme –amylase to digest carbohydrates.
- A waste product like urea.

Function of saliva

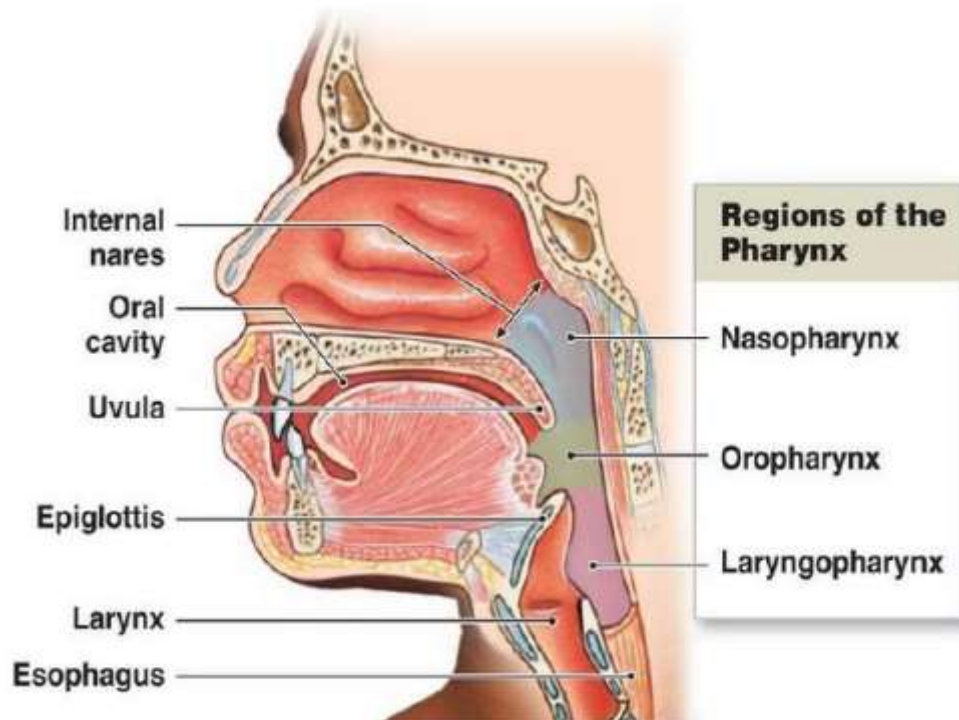
1. Contain bactericidal agents to Cleanses the mouth.
2. Facilitate swallowing (lubricant).
3. Contains amylase enzymes that break down starch.
4. Aid speech by facilitating the movement of the lips and tongue.
5. The saliva PH ranges between 6-7, which helps neutralize gastric acid and relieve heartburn when regurgitation from the stomach to the esophagus.

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
- The hypopharynx.

The pharynx has two skeletal muscle layers lined with stratified squamous epithelium and allows passage of food and fluids to the esophagus and air to the trachea.



Esophagus

The esophagus is a muscular tube going from the laryngopharynx to the stomach. Travels through the mediastinum and the diaphragm, join the stomach at the cardiac orifice, guarded by the gastro-esophageal sphincter or the cardiac sphincter. It transports food to the stomach.



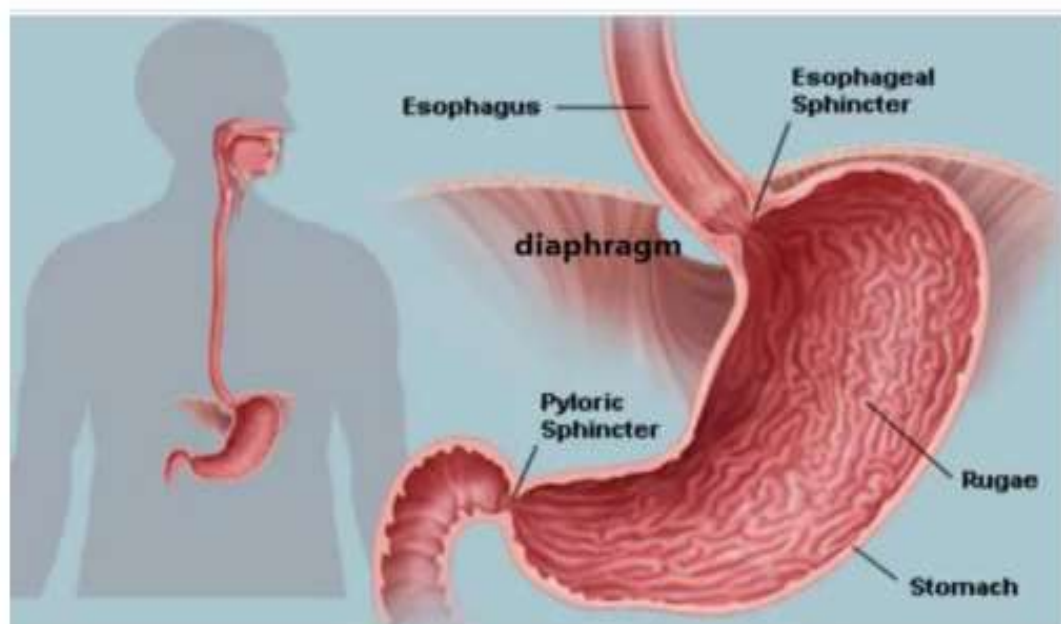
The stomach

The stomach lies below the diaphragm in the upper left region of the abdominal cavity.

Functions of the stomach

1. receive food from the esophagus, mix food with gastric juice.
2. Start protein digestion.
3. Move food into the small intestine.

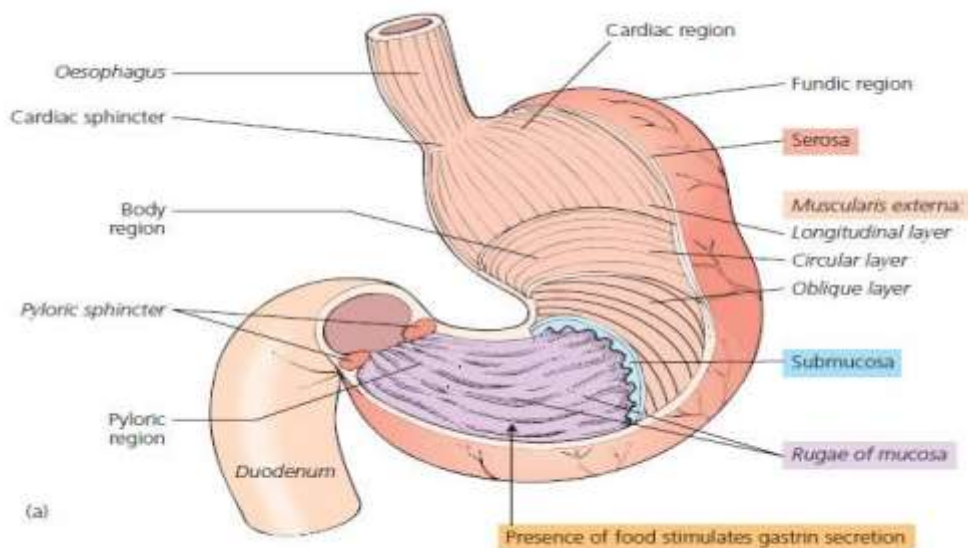
The beginning portion of the stomach that is attached to the esophagus is called the cardiac region. The portion of the stomach that balloons over the cardiac portion are called the **fundic region**, or fundus. The central part of the stomach is called the body, and the narrow portion that is connected to the small intestine is called the **pyloric region** or **pylorus**. A sphincter called the pyloric sphincter controls substances from the pyloric region of the stomach into the small intestine.



Histologic Structure of the Stomach

Gastric glands: found in the fundus and body of the stomach and composed of the following cells:

- 1. Mucous cells:** Produce alkaline mucous, which protects the stomach wall itself from being damaged by the acid.
- 2. Parietal cells:** Produce HCL – hydrochloric acid, which makes the stomach content acidic.
- 3. Chief cells:** Produce enzymes, mostly pepsinogen.
- 4. G-cells:** Produce Gastrin hormone.
- 5. D-cells:** Secrete Somatostatin.



Small intestine

The **small intestine** or **small bowel** is an organ in the gastrointestinal tract where most of the absorption of nutrients and minerals from food occurs. Receives bile and pancreatic juice through the pancreatic duct to aid in digestion.

The small intestine has three distinct regions – the duodenum, jejunum, and ileum.

- The duodenum, the shortest part, is where preparation for absorption through small finger-like lumps called villi.
- The jejunum is specialized for the absorption of small nutrient particles previously digested by enzymes in the duodenum through its lining by enterocytes.

Enterocytes or intestinal absorptive cells (are simple columnar epithelial cells that line the inner surface of the small and large intestines).

- The primary function of the ileum is to absorb vitamin B12, bile salts, and whatever products of digestion were not absorbed by the jejunum.
- Digestive Hormones that secreted from the small intestine and their functions.

Hormone	Origin	Function
Cholecystokinin (CCK)	Duodenum	contraction of gallbladder
Gastric inhibitory peptide (GIP)	Duodenum	Stimulate the release of insulin
Gastrin	Stomach	Stimulate the production of acid and enzyme
Secretin	Duodenum	increase bile secretion

Large Intestine

The large intestine, also known as the large bowel, is the last part of the gastrointestinal tract and the digestive system in humans. Water is absorbed here, and the remaining waste material is stored as feces before being removed by defecation.

The colon is the largest portion of the large intestine, so many mentions of the large intestine and colon have similarities in meaning whenever accuracy is not the focus. Most sources define the large intestine as

combining the cecum, colon, rectum, and anal canal. Some other sources exclude the anal canal.

The colon composition of the ascending colon, transverse colon, and then descending to the rectum and its endpoint at the anal canal.

Functions of Large Intestine

1. Absorptions of less than 10% of the nutrients in the large intestine.
2. Large intestine prepares fecal material for ejection from the body.
3. Reabsorption of water and other substances such as bile salts, vitamins, toxins of bacteria.

Bacteria in the colon produce three vitamins:

- Vitamin K.
- Biotin.
- Vitamin B5.

Liver

The liver is an organ only found in vertebrates which detoxifies various metabolites, synthesizes proteins, and produces biochemicals necessary for digestion and growth.

Functions of the liver:

1. Formation and secreted of bile.
2. Nutrients and vitamin metabolism.
3. Inactivated some substances (toxins, steroid, and other hormones)
4. Synthesis of plasma proteins.
5. Contributes with immunity.

The **gall bladder** is a small sac:

Function: storage of bile.

- Produces bile that leaves the liver through the common hepatic duct and enters the duodenum through the common bile duct.
- Bile is a yellow-to-green watery solution containing bile salts, bile pigments, cholesterol, phospholipids, and various electrolytes.
- Bile Functions: Bile secretion contain bile salts and phospholipids, which break the fat, in the process called "Emulsification."

Pancreas

The pancreas is an organ of the digestive system and endocrine system. The pancreas has both an endocrine and an exocrine digestive function. It mainly regulates blood sugar levels as an endocrine gland, secreting the hormones insulin, glucagon, somatostatin, and pancreatic polypeptide.

Exocrine tissue (pancreatic acini):

1. Secrete pancreatic digestive enzymes.
2. The pancreatic enzymes secreted into the duodenum are alkaline fluid (pH 8), which neutralizes the acidic chyme coming from the stomach.
3. The acini glands of the exocrine pancreas produce 1-1.5 L of pancreatic juice daily.

Pancreatic juice consists of the following enzymes:

1. Amylase: which digests carbohydrates.
2. Lipase: which digests of fat.
3. Trypsin, chymotrypsin, digests protein.