Baida Almusawy The gastrointestinal system

Lecture (7)

The **Gastrointestinal System** is responsible for the breakdown and absorption of various foods and liquids needed to sustain life. Many different organs have essential roles in the digestion of food, from the mechanical disrupting by the teeth to the creation of bile (an emulsifier) by the liver. Bile production of the liver plays a important role in digestion: from being stored and concentrated in the gallbladder during fasting stages to being discharged to the small intestine.

In order to understand the interactions of the different components we shall follow the food on its journey through the human body. During digestion, two main processes occur at the same time.

• **Mechanical Digestion**: larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion. Mechanical digestion starts in the mouth and continues in to the stomach.

• **Chemical Digestion**: several different enzymes break down macromolecules into smaller molecules that can be more efficiently absorbed. Chemical digestion starts with saliva and continues into the intestines.

The GI tract starts with the mouth and proceeds to the esophagus, stomach, small intestine (duodenum, jejunum, ileum), and then to the large intestine (colon), rectum, and terminates at the anus. You could probably say the human body is just like a big donut. The GI tract is the donut hole. We will also be discussing the pancreas and liver, and accessory organs of the gastrointestinal system that contribute materials to the small intestine.

Layers of the GI Tract

Mucosa

(mucous membrane layer) Alayer of epithelium supported by connective tissue and smooth muscle lines the lumen (central cavity) and contains glandular epithelial cells that secrete digestive enzymes and goblet cells that secrete mucus.

Submucosa

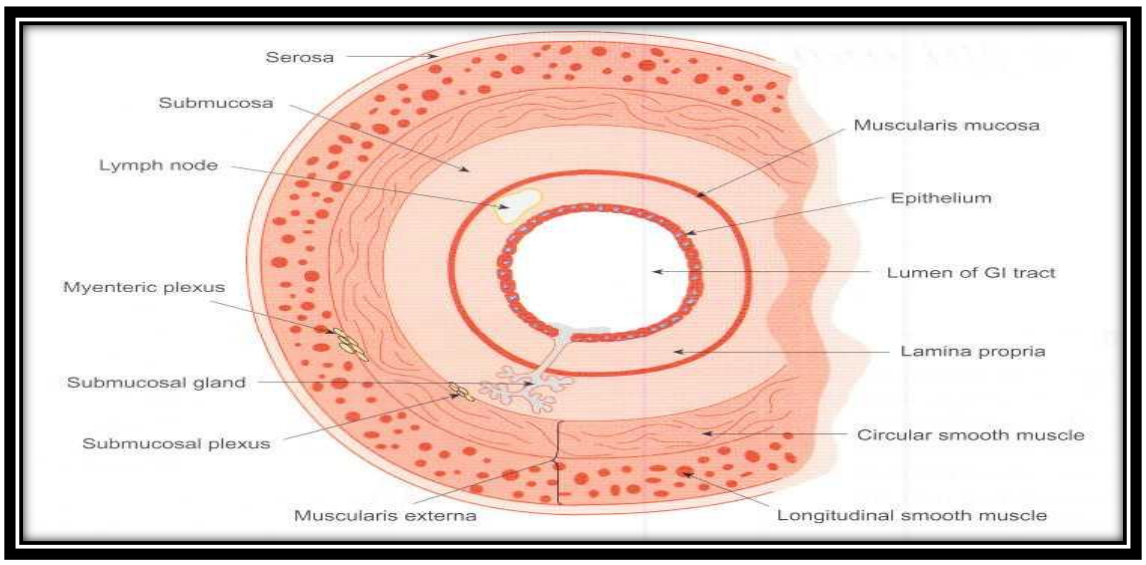
(submucosal layer) A broad band of loose connective tissue that contains blood vessels lies beneath the mucosa. Lymph nodules, called Peyer’ s patches, are in the submucosa. Like the tonsils, they help protect us from disease.

Muscularis

(smooth muscle layer) Two layers of smooth muscle make up this section. The inner, circular layer encircles the gut; the outer, longitudinal layer lies in the same direction as the gut. (The stomach also has oblique muscles.)

Serosa

(serous membrane layer) Most of the digestive tract has a serosa, a very thin, outermost layer of squamous epithelium supported by connective tissue. The serosa secretes a serous fluid that keeps the outer surface of the intestines moist so that the organs of the abdominal cavity slide against one another. The esophagus has an outer layer composed only of loose connective tissue called the adventitia.



The Mouth

The mouth, which receives food, is bounded externally by the lips and cheeks. The lips extend from the base of the nose to the start of the chin. Sensory receptors called taste buds found on the tongue, and when these are activated by the presence of food, nerve impulses travel by way of cranial nerves to the brain. The roof of the mouth separates the nasal cavities from the oral cavity. The roof has two parts: an anterior hard palate contains several bones and a posterior soft palate is composed entirely of muscle. Three pairs of salivary glands send saliva by way of ducts to the mouth. One pair of salivary glands lies at the sides of the face immediately below and in front of the ears called Parotid gland. Another pair of salivary glands lies beneath the tongue called sublingual gland, and still another pair lies beneath the floor of the oral cavity. The ducts from these salivary glands open under the tongue called submandibular gland.

The Teeth

With our teeth we chew food into pieces convenient for swallowing. During the first two years of life, the smaller 20 deciduous, or baby teeth appear. These are eventually replaced by 32 adult teeth .The third pair of molars, called the wisdom teeth.

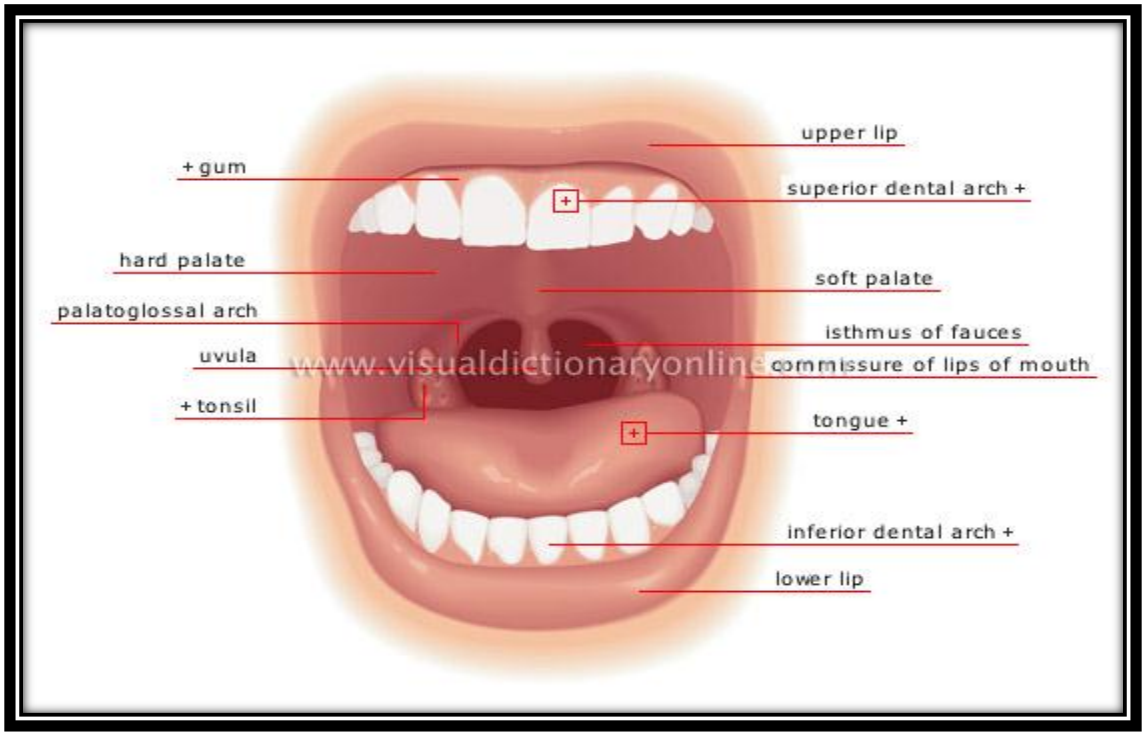


Table Path of Food

Organ	function	special	Function of special
Oral cavity	Receives food; starts digestion of starch	Teeth Tongue	Chew food Form bolus
Esophagus	Passageway	--------	----------
Stomach	Storage of food; acidity kills bacteria; starts digestion of protein	Gastric glands	Release gastric juices
Small intestine	Digestion of all foods; absorption of nutrients	Intestinal glands Villi	Release fluids Absorb nutrients
Large intestine	Absorption of water storage of indigestible remains	---------	----------

The Pharynx

The pharynx is a region that receives food from the mouth and air from the nasal cavities. The food passage and air passage cross in the pharynx because the trachea is ventral to the esophagus, a long muscular tube that takes food to the stomach.

Esophagus

The **esophagus** (also spelled oesophagus/esophagus) or gullet is the muscular tube in vertebrates through which ingested food passes from the throat to the stomach. the food moves into the esophagus and is pushed down into the stomach by the process of ***peristalsis***. At the end of the esophagus there is a sphincter that allows food into the stomach then closes back up so the food cannot travel back up into the esophagus.

Stomach

The **stomach** a thick walled organ that lies between the esophagus and the first part of the small intestine (the duodenum). It is on the left side of the abdominal cavity; the fundus of the stomach lying against the diaphragm. Lying beneath the stomach is the pancreas. The secretion of gastric juices occurs in three phases: cephalic, gastric, and intestinal. The cephalic phase is activated by the smell and taste of food and swallowing. The gastric phase is activated by the chemical effects of food and the distension of the stomach. The intestinal phase blocks the effect of the cephalic and gastric phases. Gastric juice also contains an enzyme named **pepsin**, which digests proteins, hydrochloric acid and mucus. Hydrochloric acid causes the stomach to maintain a pH of about 2, which helps kill off bacteria that comes into the digestive system via food. The stomach is **divided into four sections**, each of which has different cells and functions. The sections are:

1) Cardiac region, where the contents of the esophagus empty into the stomach,

2) Fundus, formed by the upper curvature of the organ,.

3) Body, the main central region.

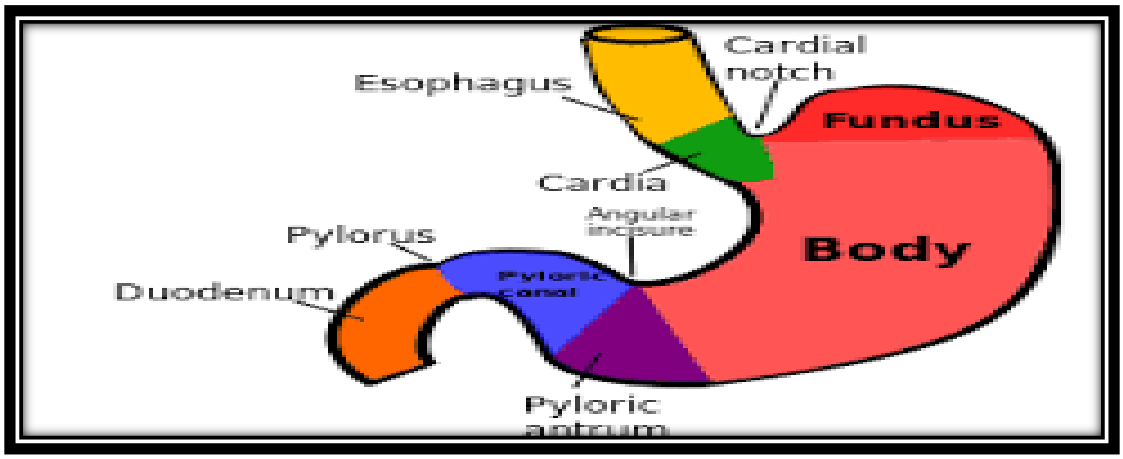
4) Pylorus or atrium, the lower section of the organ that facilitates emptying the contents into the small intestine.

Water, alcohol, salt, and simple sugars can be absorbed directly through the stomach wall. However, most substances in our food need a little more digestion and must travel into the intestines before they can be absorbed. When the stomach is empty it is about the size of one fifth of a cup of fluid. When stretched and expanded, it can hold up to eight cups of food after a big meal.

Gastric Glands

There are many different gastric glands and they secret many different chemicals. **Parietal cells** secrete hydrochloric acid; **chief cells** secrete pepsinogen; **goblet**

cells secrete mucus; **argentaffin cells** secrete serotonin and histamine; and **G cells** secrete the hormone gastrin.



Mastication

Digestion begins in the mouth. A brain reflex triggers the flow of saliva when we see or even think about food. Saliva moistens the food while the teeth chew it up and make it easier to swallow. Amylase, which is the digestive enzyme found in saliva, starts to break down starch into simpler sugars before the food even leaves the mouth. The nervous pathway involved in salivary excretion requires stimulation of receptors in the mouth, sensory impulses to the brain stem, and parasympathetic impulses to salivary glands. Swallowing your food happens when the muscles in your tongue and mouth move the food into your **pharynx**. The pharynx, which is the passageway for food and air, epiglottis closes over the pharynx to prevent food from entering the trachea and thus choking.

Enzyme	Produced In	Site of Release	pH Level
Carbohydrate Digestion			
Salivary amylase	Salivary glands	Mouth	Neutral
Pancreatic amylase	Pancreas	Small intestine	Basic
Maltase	Small intestine	Small intestine	Basic
Protein Digestion			

Pepsin	Gastric glands	Stomach	Acidic
Trypsin	Pancreas	Small intestine	Basic
Peptidases	Small intestine	Small intestine	Basic
Nucleic Acid Digestion			
Nuclease	Pancreas	Small intestine	Basic
Nucleosidases	Pancreas	Small intestine	Basic
Fat Digestion			
Lipase	Pancreas	Small intestine	Basic

Small Intestine

The small intestine is the site where most of the chemical and mechanical digestion is carried out. Tiny projections called **villi** line the small intestine which absorbs digested food into the capillaries. Most of the food absorption takes place in the jejunum and the ileum.

The functions of Nutrients are absorbed into the vessels of a villus. A villus contains blood capillaries and a small lymphatic capillary, called a lacteal. Sugars and amino acids enter the blood capillaries of a villus. Fats are digested to glycerol and fatty acids, And digestion of proteins into peptides and amino acids principally occurs in the stomach but some also occurs in the small intestine. Peptides are degraded into amino acids and carbohydrates are degraded into simple sugars.

The Duodenum

the first and shortest part of the small intestine.

The Jejunum

The *Jejunum* is a part of the small bowel, The inner surface of the jejunum, its mucous membrane, is covered in projections called villi, which increase the surface area of tissue available to absorb nutrients from the gut contents.

The Ileum

Its function is to absorb vitamin B12 and bile salts. The wall itself is made up of folds, each of which has many tiny finger-like projections known as villi, on its surface. In turn, the epithelial cells which line these villi possess even larger numbers of micro villi.

Large Intestine

The large intestine (colon) extends from the end of the ileum to the anus. It is about 5 feet long, being one-fifth of the whole extent of the intestinal canal. There are trillions of bacteria, yeasts, and parasites living in our intestines, mostly in the colon. The colon includes the ascending colon, which goes up the right side of the body to the level of the liver; the transverse colon, which crosses the abdominal cavity just below the liver and the stomach; the descending colon, which passes down the left side of the body; and the sigmoid colon, which enters the rectum, The rectum opens at the anus, where defecation,the expulsion of feces.. Most of these are very helpful to our health, while the minority are harmful. Helpful organisms *synthesize* vitamins, like *B12*, *biotin*, and *vitamin K*. They breakdown toxins and stop proliferation of harmful organisms. They stimulate the immune system and produce short chain fatty acids (SCFAs) that are required for the health of colon cells and help prevent colon cancer. There are many beneficial bacteria but some of the most common and important are *Lactobacillus Acidophilus* and various species of *Bifidobacterium.* These are available as "probiotics" from many sources.

The Pancreas

The pancreas lies deep in the abdominal cavity, endocrine and an exocrine function. As an endocrine gland, it secretes insulin and glucagon, hormones that help keep the blood glucose level within normal limits. In this chapter, we are interested in its exocrine function. whereas pepsin acts best in an acid pH of the

stomach, pancreatic enzymes require a slightly basic pH. Pancreatic amylase digests starch, trypsin digests protein, and lipase digests fat.

Liver

The liver, which is the largest gland in the body, The liver has two main lobes, the right lobe and the smaller left lobe, these three structures are located between the lobules: a bile duct that takes bile away from the liver; it removes poisonous substances and detoxifies them. The liver also removes nutrients and works to keep the contents of the blood constant. It removes and stores iron and the fat-soluble vitamins A, D, E, and K. The liver makes the plasma proteins from amino acids and it helps regulate the quantity of cholesterol in the blood.

• The liver performs several roles in carbohydrate metabolism:

• gluconeogenesis (the formation of glucose from certain amino acids, lactate or glycerol)

• Glycogenolysis (the formation of glucose from glycogen)

• Glycogenesis (the formation of glycogen from glucose)

• The breakdown of insulin and other hormones

• The liver is responsible for the mainstay of protein metabolism.

• The liver also performs several roles in lipid metabolism:

• cholesterol synthesis

• The production of triglycerides (fats)

• The liver produces coagulation factors I (fibrinogen), II (prothrombin),

Gallbladder

The gallbladder is a pear-shaped, muscular sac attached to the surface of the liver, The gallbladder is a pear shaped organ that stores about 50 ml of bile (or "gall") until the body needs it for digestion. The gallbladder is connected to the main bile duct through the gallbladder duct (cystic duct). The main biliary tract runs from the liver to the duodenum, and the cystic duct is effectively a "cul de sac", serving as entrance and exit to the gallbladder. The gallbladder is a pear

shaped organ that stores about 50 ml of bile (or "gall") until the body needs it for digestion.

The gallbladder stores bile, which is released when food containing fat enters the digestive tract, stimulating the secretion of cholecystokinin (CCK). The bile emulsifies fats and neutralizes acids in partly digested food. After being stored in the gallbladder, the bile becomes more concentrated than when it left the liver, increasing its potency and intensifying its effect in fats.

Anus

The human anus is situated between the buttocks, posterior to the perineum. Role of the anus is when the rectum is full, the increase in intra-rectal pressure forces the walls of the anal canal apart allowing the fecal matter to enter the canal. The rectum shortens as material is forced into the anal canal and peristaltic waves propel the feces out of the rectum. The internal and external sphincters of the anus allow the feces to be passed by muscles pulling the anus up over the exiting feces.