جامعة الانبار

كلية : الصيدلة

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اسم المادة باللغة العربية: بايولوجيا الانسان

اسم المدة باللغة الإنكليزية: **Human Biology**

المرحلة: الاولى

التدريسي: أ.م.د. مهند عبدالمجيد محمد

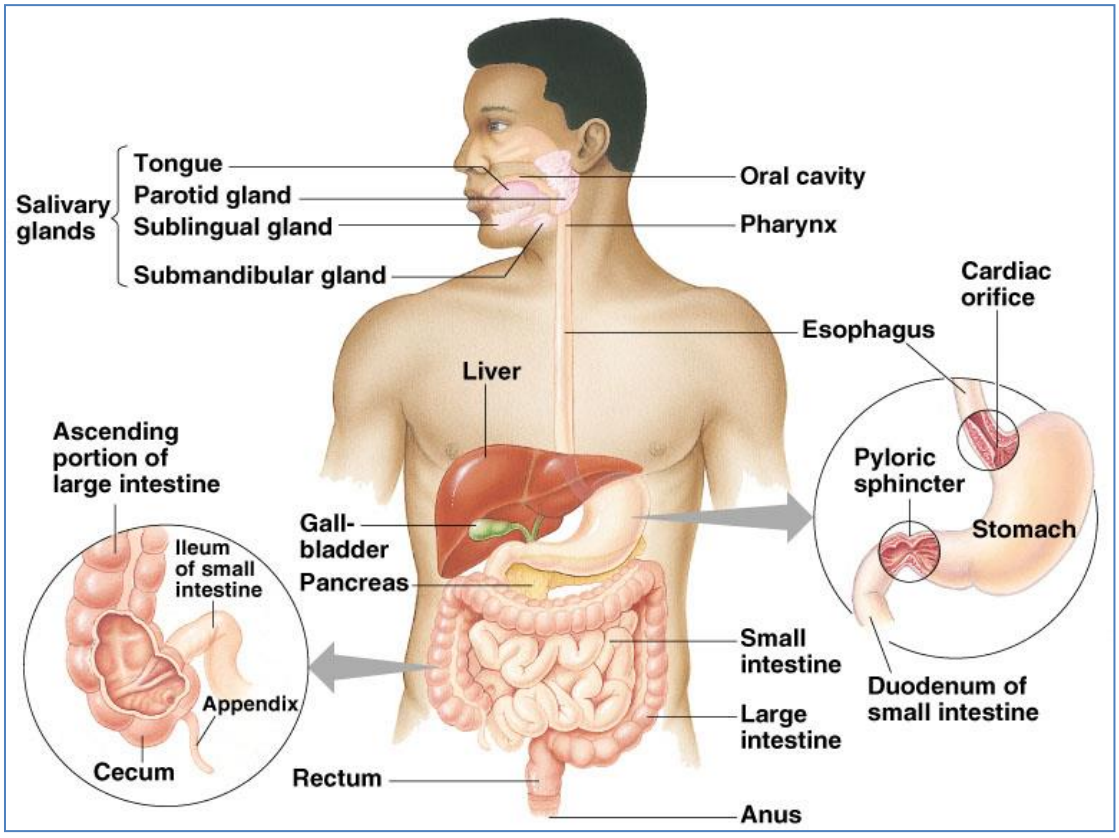
عنوان المحاضرة باللغة العربية: التغذية وجهاز الهظمي

عنوان المحاضرة باللغة الإنكليزية: **Digestive system and Nutrition**

محتوى المحاضرة:

DIGESTIVE SYSTEM AND NUTRITION

Digestive system: The organs of the digestive system are located within a tube called the gastrointestinal (GI) tract, which is depicted in Figure below. Food, whether it is a salad or a cheeseburger, consists of the organic macromolecules: carbohydrates, fats, and proteins. These molecules are too big to cross plasma membranes. The **purpose** of digestion is to **hydrolyze**- or break down using water- these macromolecules to their subunit molecules. The subunit molecules, mainly monosaccharides, amino acids, fatty acids, and glycerol, can cross plasma membranes.



***<u>**There are five processes are necessary to the digestive process**</u>**:**

<u>**1- Ingestion**</u> Process of taking food into the digestive system through the mouth, so that it may be hydrolized or digested. The expression "You are what you eat" recognizes that our diet is very important to our health.

<u>**2- Digestion**</u> can be mechanical or chemical. **Mechanical** digestion occurs when large pieces of food are divided into smaller pieces that can be acted on by the digestive enzymes. Cutting up our food prior to ingestion aids mechanical digestion. Mechanical digestion occurs primarily in the mouth by chewing and by wavelike contractions of the smooth muscles in the stomach called **peristalsis.** During **chemical** digestion digestive enzymes hydrolyze our food's macromolecules into absorbable subunits. **Chemical** digestion begins in the mouth, continues in the stomach, and is completed in the small intestine.

3- **Movement** of GI tract contents along the digestive tract is very important for the tract to fulfill its other functions. For example, food must be passed along from one organ to the next, normally by peristalsis, and indigestible remains must be expelled.

4- Absorption occurs as subunit molecules produced by chemical digestion (i.e., nutrients) cross the wall of the GI tract and enter the cells lining the tract. From there, the nutrients enter the **blood** for delivery to the cells.

5- Elimination: Molecules that cannot be digested need to be eliminated from the body. The removal of indigestible wastes through the anus is termed ***defecation***.

Wall of the Digestive Tract:

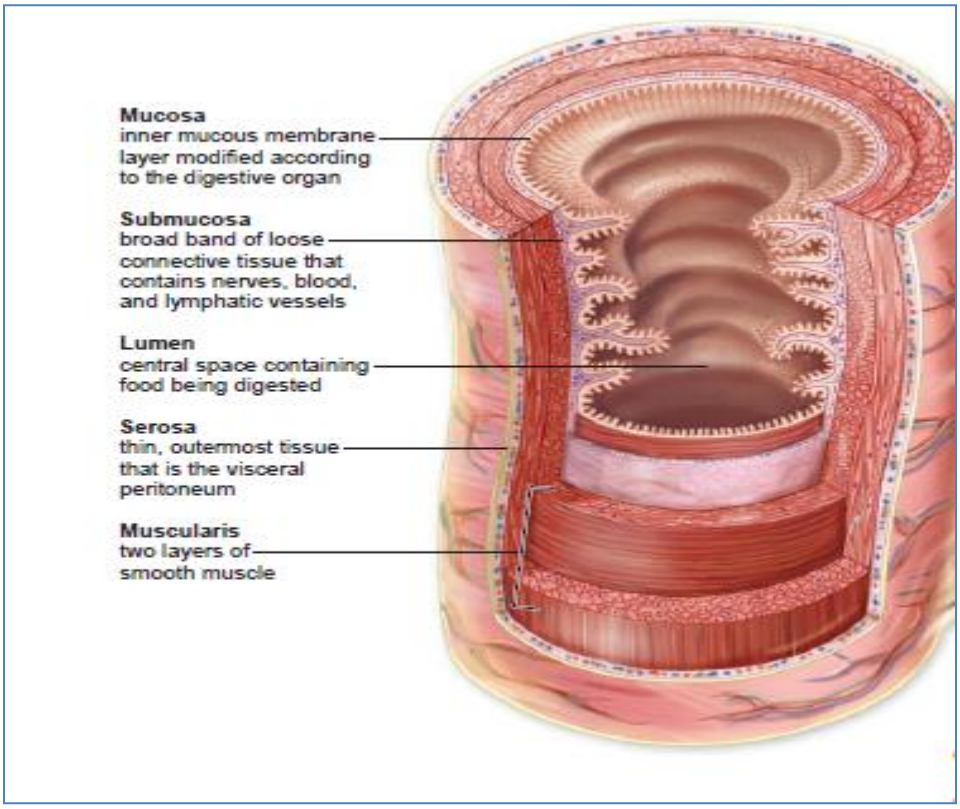
The walls of the alimentary canal organs from the esophagus to the large intestine have four characteristic layers as following:

1- The inner layer of the wall next to the lumen is called the **mucosa.** The mucosal layer contains cells that produce and secrete mucus used to protect all the layers of the tract from the digestive enzymes inside the lumen. Glands in the mucosa of the mouth, stomach, and small intestine also release digestive enzymes. **Hydrochloric acid**, an important digestive enzyme, is produced by glands in the mucosa of the stomach.

2- The second layer in the GI wall is called the **submucosa.** The submucosal layer is a broad band of loose connective tissue that contains blood vessels, lymphatic vessels, and nerves.

3- The third layer is termed the **muscularis,** and it contains two layers of smooth muscle. The inner, circular layer encircles the tract. The outer, longitudinal layer lies in the same direction as the tract.

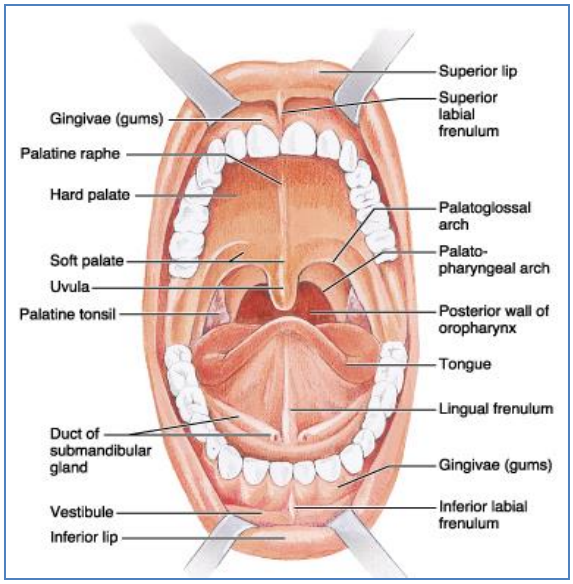
4- The fourth and outermost layer of the tract is the **serosa** (serous membrane layer), which secretes a lubricating fluid. The serosa is a part of the peritoneum, the internal lining of the abdominal cavity. The **appendix** is a worm-shaped blind tube projecting from the first part of the large intestine on the lower right side of the abdomen.



The digestive system parts:

1- The Mouth:

The mouth (also called the *oral cavity*) receives food and begins the process of mechanical and chemical digestion. The mouth is bounded externally by the lips and cheeks. The lips



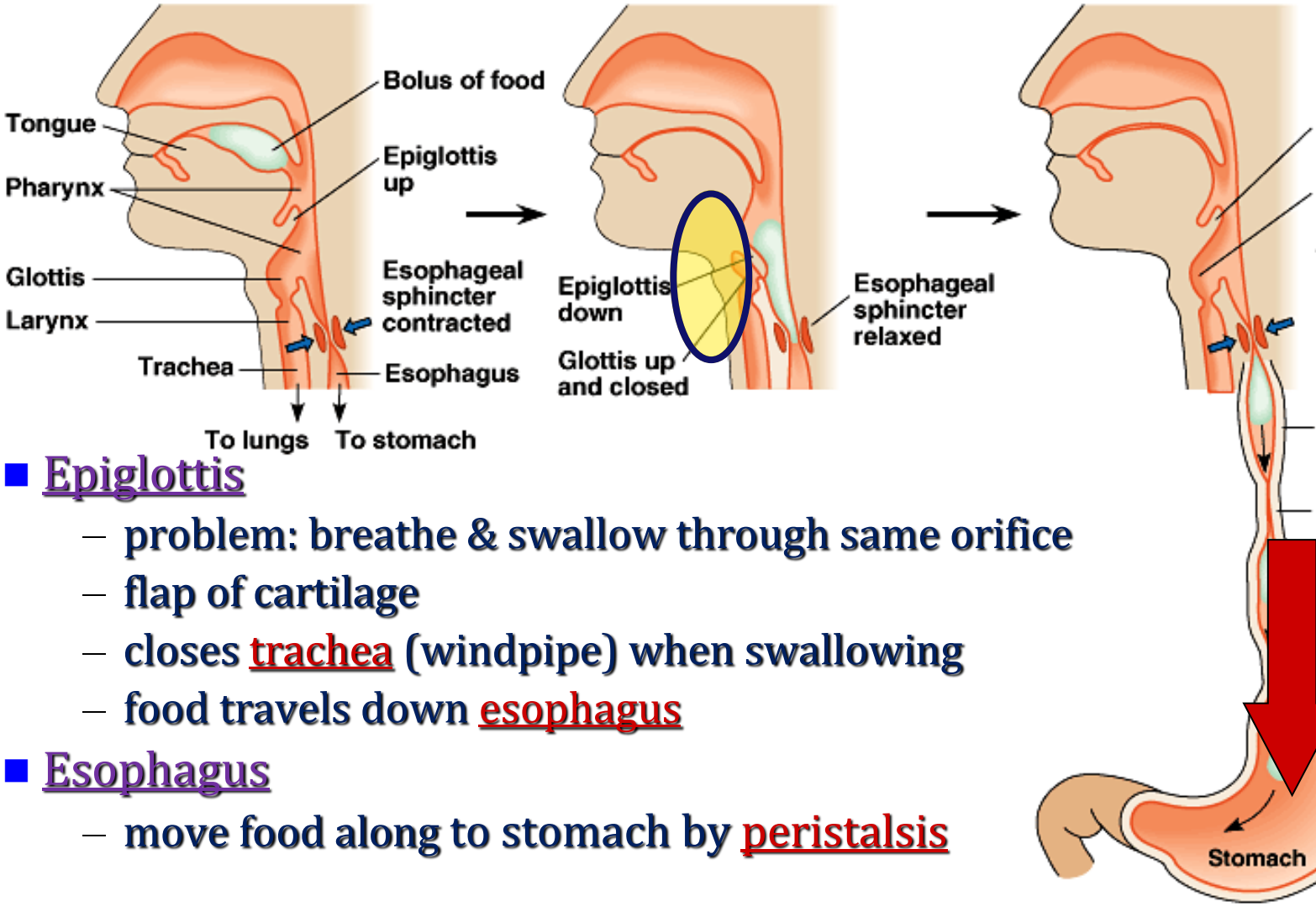
extend from the base of the nose to the start of the chin. The roof has two parts: an anterior (toward the front) **hard palate** and a posterior (toward the back) **soft palate** (See the Figure). Three pairs of **salivary glands** send secretions (**saliva**) by way of ducts to the mouth. One pair of salivary glands lies at the side of the face immediately below and in front of the ears. Saliva is a solution of mucus and water. Saliva also contains **salivary amylase,** an enzyme that begins the chemical digestion of starch, as well as bicarbonate and the antimicrobial compound called lysozyme.

2- The Pharynx and Esophagus:

Both the mouth and the nasal passages lead to the **pharynx,** a hollow space at the back of the throat. In turn, the pharynx opens into both the food passage (**esophagus**) and air passage (trachea, or windpipe). These two tubes are parallel to each other, with the trachea anterior to (in front of) the esophagus.

****Swallowing:*** Swallowing has a voluntary phase; however, once food or drink is pushed back far enough into the pharynx, swallowing becomes a reflex action performed automatically or involuntarily. During swallowing, food normally enters the esophagus, a muscular tube that moves food into the stomach, because other possible avenues are blocked.

The soft palate moves back to close off the nasal passages and the trachea moves up under the **epiglottis** to cover the glottis. The **glottis** is the opening to the larynx (voice box) and, therefore, the air passage. We do not breathe when we swallow. The up-and-down movement of the Adam's apple, the front part of the larynx, is easy to observe when a person swallows. Sometimes, the epiglottis does not cover the glottis fast enough or completely enough and food or liquid can end up in the trachea instead of the esophagus. When this occurs, the muscles around the lungs contract and force a cough that will bring the food back up the trachea
and into the pharynx.



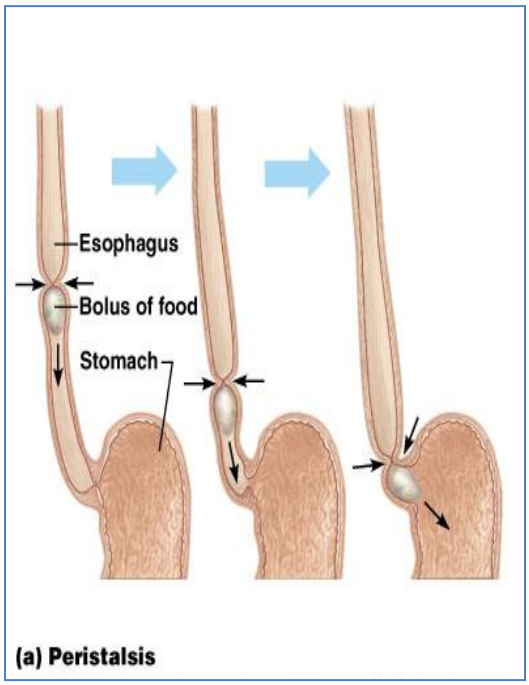
- **Epiglottis**
  - problem: breathe & swallow through same orifice
  - flap of cartilage
  - closes trachea (windpipe) when swallowing
  - food travels down esophagus
- **Esophagus**
  - move food along to stomach by peristalsis

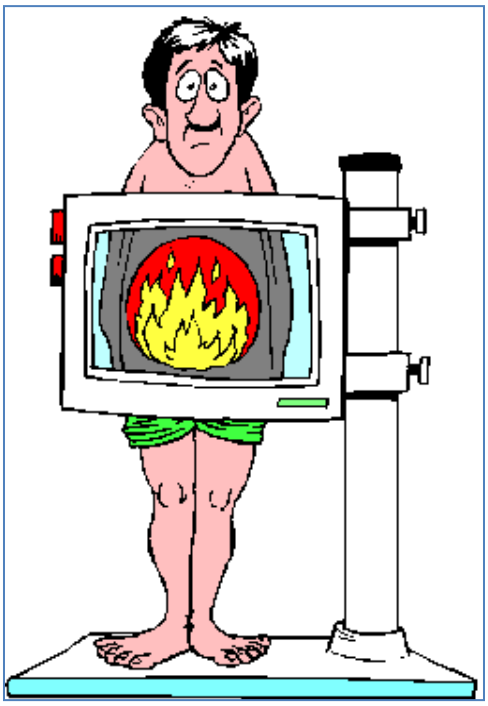
*****Peristalsis:***

Peristalsis pushes food through the esophagus. The peristaltic contractions continue in the stomach and intestines. The esophagus plays no role in the chemical digestion of food. Its sole purpose is to move the food bolus from the mouth to the stomach. A constriction called the ***lower gastroesophageal sphincter*** marks the entrance of the esophagus to the stomach. **Sphincters**

are muscles that encircle tubes and act as valves. The tubes close when the sphincters contract and they open when the sphincters relax.

When food or saliva is swallowed, the sphincter relaxes for a moment to allow the food or saliva to enter the stomach. The sphincter then contracts, preventing the acidic stomach contents from backing up into the esophagus. When the lower esophageal sphincter fails to open and allow food into the stomach, or when the sphincter is opened and food moves from the stomach back to the esophagus, **heartburn** occurs. As discussed in the Health Focus, *Heartburn*, this condition can lead to damage of the esophagus and lower esophageal sphincter. Vomiting occurs when strong contractions of the abdominal muscles and the **diaphragm** (the muscle separating the thoracic and abdominal cavities) force the contents of the stomach into the esophagus and into the oral cavity.

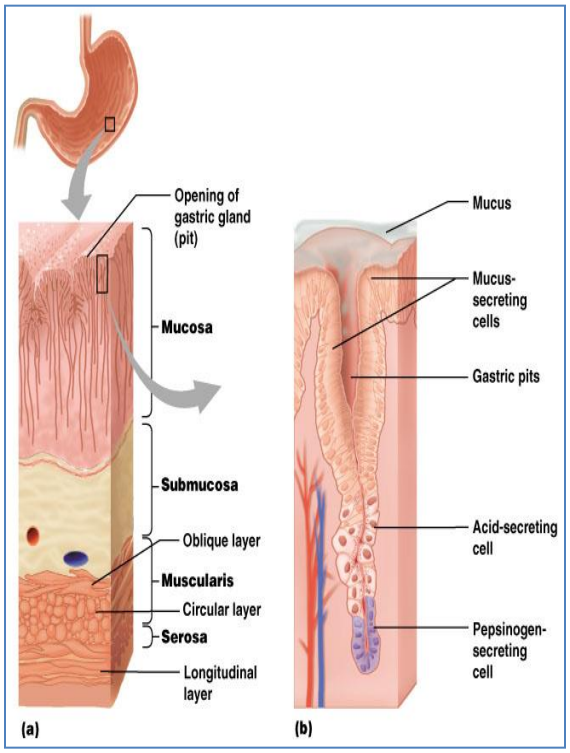


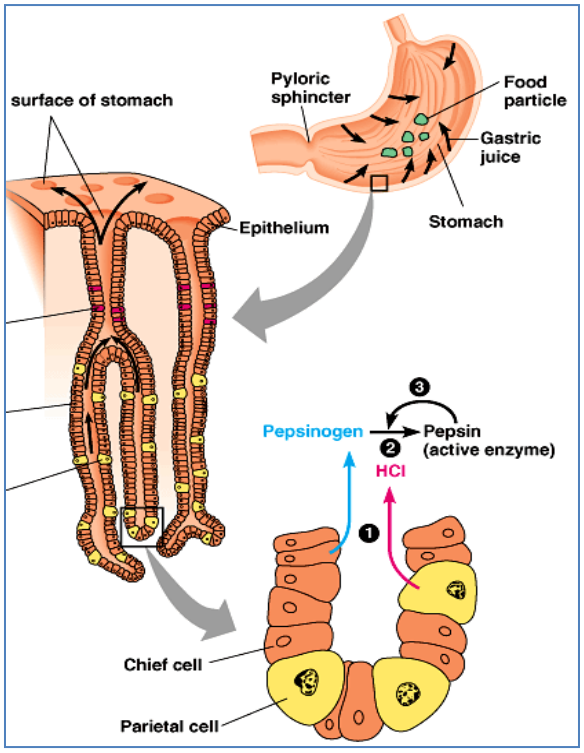


3- The Stomach:

The **stomach** is a thick-walled, J-shaped organ that lies on the left side of the body beneath the diaphragm. The stomach is continuous with the esophagus above and the duodenum of the small intestine below. The stomach stores food, initiates the digestion of protein, and controls the movement of food into the small intestine. Nutrients are not absorbed by the stomach. However, it does absorb alcohol, because alcohol is fat soluble and can pass

through membranes easily. The stomach wall has the usual four layers, but two of them are modified for particular functions.
The mucosa of the stomach has millions of gastric pits, which lead into **gastric glands**. The gastric glands produce gastric juice. Gastric juice contains an enzyme called **pepsin,** which digests protein, plus hydrochloric acid (HCl) and mucus. HCl causes the stomach to be very acidic with a pH of about 2. This acidity is beneficial because it kills most bacteria present in food. Although HCl does not digest food, it does break down the connective tissue of meat and activates pepsin.





4- The Small Intestine:

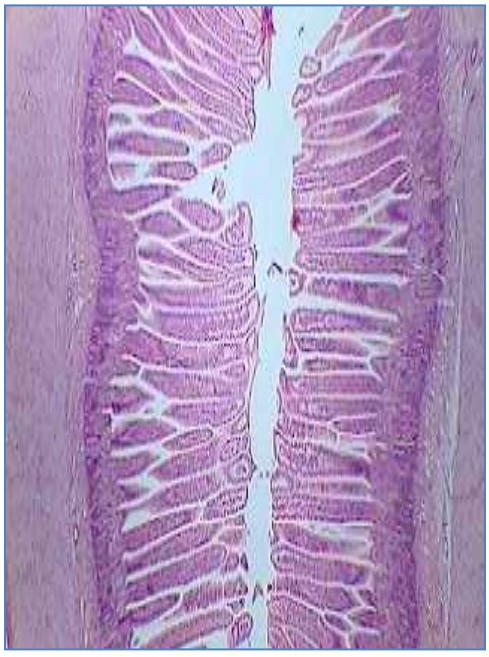
The **small intestine** is named for its small diameter compared with that of the large intestine. The small intestine is very long, averaging about 6 m (18 ft) in length, compared with the large intestine, which is about 1.5 m in length. There are three sections of small intestine, **duodenum** most digestion, **jejunum** absorption of nutrients and water and **ileum** the same function of jejunum.

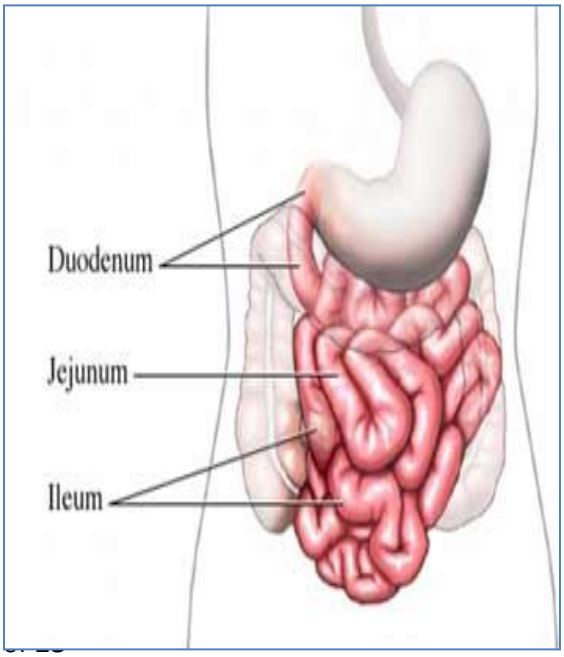
Digestion is completed in the Small Intestine: The small intestine contains enzymes to digest all types of foods, primarily carbohydrates, proteins, and fats. Most of these enzymes are secreted by the pancreas

and enter via a duct at the **duodenum** (the name for the first 25 cm of the small intestine). Another duct brings bile from the liver and gallbladder into the duodenum. **Bile** emulsifies fat. Emulsification causes fat droplets to disperse in water. After fat is mechanically broken down to fat droplets by bile, it is hydrolyzed to monoglycerides and fatty acids by the enzyme **lipase** present in pancreatic juice. Pancreatic amylase begins the digestion of carbohydrates. An intestinal enzyme completes the digestion of carbohydrates to glucose. Similarly, pancreatic trypsin begins and intestinal enzymes finish the digestion of proteins to amino acids. The intestine has a slightly basic pH because pancreatic juice contains sodium bicarbonate (NaHCO3), which neutralizes chyme.

Nutrients Are Absorbed in the Small Intestine:

The wall of the small intestine absorbs the molecules-namely, sugars, amino acids, fatty acids, and glycerol-that were the products of the digestive process. The mucosa of the small intestine is modified for absorption. It has been suggested that the surface area of the small intestine is approximately that of a tennis court. This great surface area functions to absorb more nutrients than a smaller area would. The mucosa of the small intestine contains fingerlike projections called **villi** (sing., **villus**), which give the intestinal wall a soft, velvety appearance. A villus has an outer layer of columnar epithelial cells, and each of these cells has thousands of microscopic extensions called microvilli.





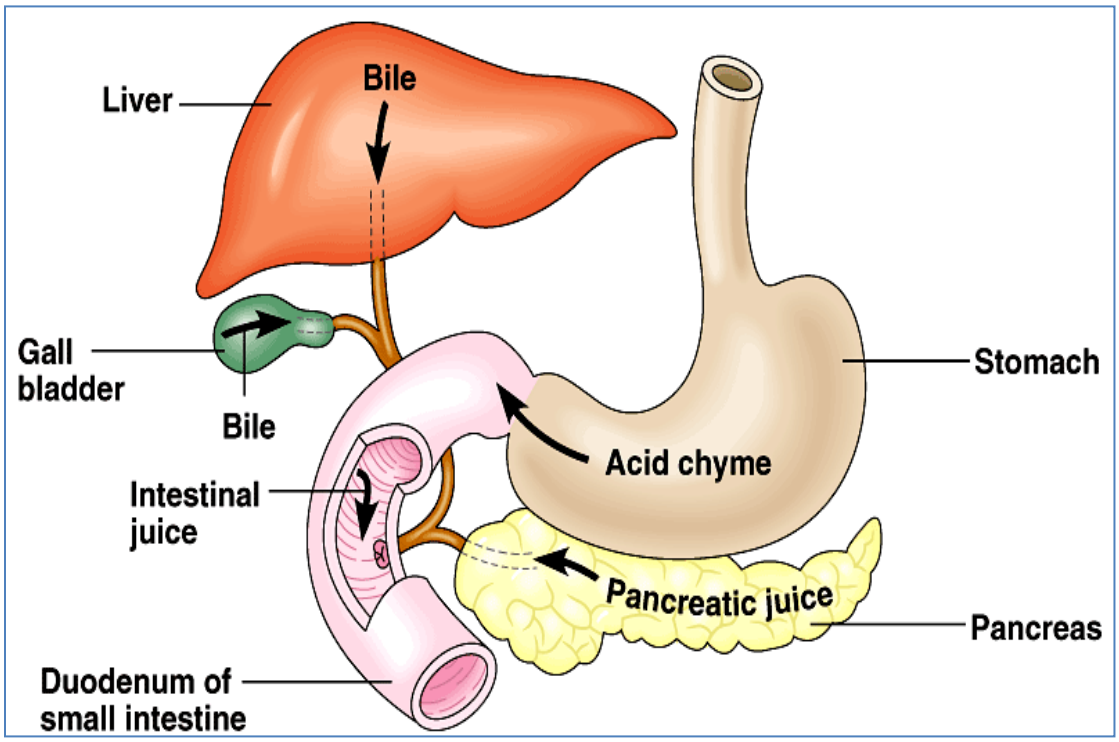
The Accessory Organs

The **pancreas** is a fish-shaped, spongy, grayish-pink organ that stretches across the back of the abdomen behind the stomach. Most pancreatic cells produce pancreatic juice, which enters the duodenum via the pancreatic duct. Pancreatic juice contains sodium bicarbonate (NaHCO3) and digestive enzymes for all types of food. Sodium bicarbonate neutralizes acid chime from the stomach. **Pancreatic amylase** digests starch, **trypsin** digests protein, and pancreatic lipase digests fat.

The pancreas is also an endocrine gland that secretes the hormone insulin into the blood. A **hormone** is a protein or steroid produced by a cell that affects the function of a different cell, the so-called target cell. When the blood glucose level rises rapidly, the pancreas produces an overload of insulin to bring the level under control and back to homeostasis. Type 1 diabetes occurs when the pancreas does not manufacture sufficient amounts of insulin. This condition is normally diagnosed in childhood. Type 2 diabetes occurs when the pancreas does not make enough insulin or when the body's cells have become insulin-resistant. Type 2 diabetes normally occurs in adulthood with risk factors such as obesity, inactivity, and a family history of the disease.

The largest gland in the body, the **liver,** lies mainly in the upper right section of the abdominal cavity, under the diaphragm. The liver is a major metabolic gland with approximately 100,000 lobules that serve as its structural and functional units. The hepatic portal vein brings blood to the liver from the GI tract capillary bed. Capillaries of the lobules filter this blood. In a sense, the liver acts like a sewage treatment plant when it removes poisonous substances from the blood and detoxifies them. The liver is also a storage organ. It removes iron and the vitamins A, D, E, K, and B12 from blood and stores them. The liver is also involved in blood glucose homeostasis. In the presence of insulin, the liver stores glucose as glycogen. When blood glucose becomes low, the liver releases glucose by breaking down glycogen. If need be, the liver converts glycerol (from fats) and amino acids to glucose molecules. As amino acids are converted to glucose, the liver combines their amino groups with carbon dioxide to form **urea,** the usual nitrogenous waste product in humans. Plasma proteins needed in the blood are also made by the liver. The liver helps regulate blood **cholesterol** levels as well. Some cholesterol is converted to bile salts

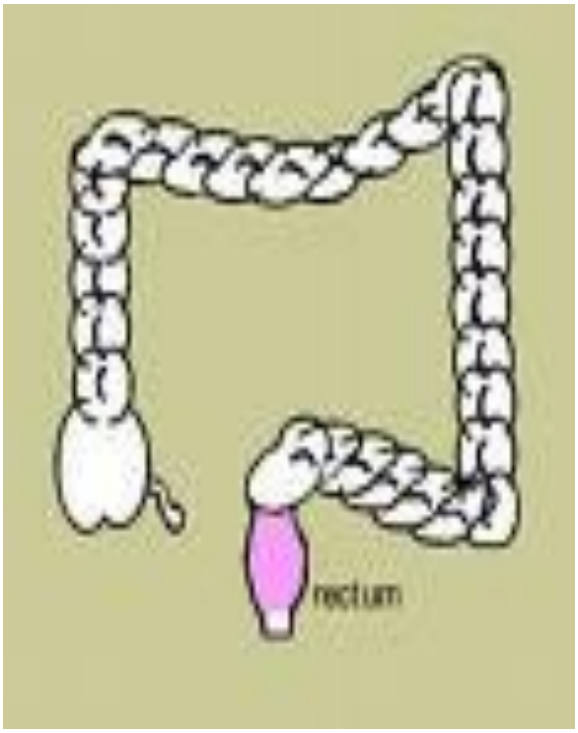
by the liver. **Bile** is a solution of bile salts, water, cholesterol, and bicarbonate. It has a yellowish-green color because it also contains bilirubin, a pigment protein formed during the breakdown of hemoglobin,
which is a process also performed by the liver. Bile is stored in the **gallbladder,** a pear-shaped organ just below the liver, until it is sent via the bile ducts to the duodenum. **Gallstones** form when liquid stored in the gallbladder hardens into pieces of stonelike material. In the small intestine, bile salts emulsify fat. When fat is emulsifi ed, it breaks up into droplets. The droplets provide a large surface area that can be acted upon by digestive enzymes.

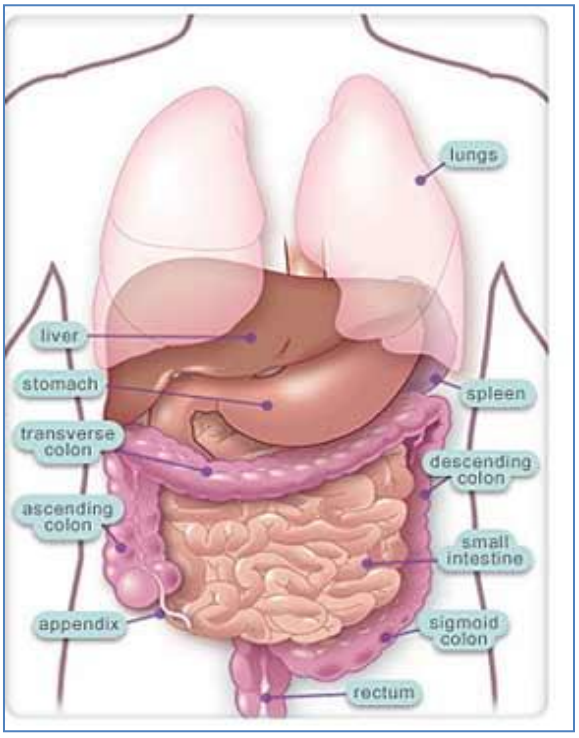


5- **The Large Intestine**:

The **large intestine** includes the cecum, the colon, the rectum, and the anal canal. The large intestine is larger in diameter than the small intestine (6.5 cm compared with 2.5 cm), but it is shorter in length. The **cecum** is the first portion of the large intestine joining the end of the small intestine. The

cecum usually has a small projection called the **vermiform appendix** (*vermiform* means "wormlike"). In humans, the appendix is thought to aid in fighting infections. Scientists have recently proposed that the appendix may also contribute to the population of needed bacteria in the large intestine. 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 last 20 cm of the large intestine. The rectum opens at the **anus,** where **defecation,** the expulsion of feces, occurs.





Functions of the Large Intestine:

The large intestine does not produce any digestive enzymes, and it does not absorb any nutrients. The function of the large intestine is to absorb water, an important process to prevent dehydration of the body and maintain homeostasis. The large intestine can absorb vitamins produced by intestinal flora, the bacteria that inhabit the intestine and aid in keeping us healthy. For many years, it was believed that *Escherichia coli* were the major inhabitants of the colon, but culture methods now show that over 99% of the colon

bacteria are other types of bacteria. The bacteria in the large intestine break down indigestible material and also
produce B-complex vitamins and most of the vitamin K needed by our bodies. The large intestine forms feces. The consistency of normal feces is usually three-fourths water and one-fourth solid wastes. Bacteria, dietary **fiber** (indigestible remains), and other indigestible materials make up the solid wastes. Bacterial action on indigestible materials causes the odor of feces and also accounts for the presence of gas. Stercobilin , which is a breakdown product of **bilirubin** (the yellow-orange bile pigment produced from the breakdown of hemoglobin) , and oxidized iron cause the brown color of feces.