DIGESTIVE SYSTEM AND NUTRITION

LEARNING OUTCOMES
1. State the function of each organ of the gastrointestinal tract.
2. List the accessory organs and provide a function for each.
3. Describe the structure of the gastrointestinal tract wall.

Overview of Digestion

The organs of the digestive system are located within a tube called the gastrointestinal (GI) tract. Food 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.

Our food also contains water, salts, vitamins, and minerals that help the body function normally. The nutrients made available by digestive processes are carried by the blood to our cells. The following processes are necessary to the digestive process:

◊ ***Ingestion*** occurs when the mouth takes in food.

◊ ***Digestion*** 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. Mechanical digestion occurs primarily in the mouth by chewing and by wavelike contractions of the smooth muscles in the stomach called ***peristalsis***.

> ***Peristalsis:*** *wavelike contractions that propel substances along a tubular structure such as the esophagus.*

Chemical digestion begins in the mouth, continues in the stomach, and is completed in the small intestine. During chemical digestion digestive enzymes hydrolyze our food's macromolecules into absorbable subunits.

◊ ***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.

◊ ***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.

◊ ***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

> ***Defecation:*** *discharge of feces from the rectum through the anus.*

The wall of the GI tract has four layers. Each layer can be associated with a particular function:

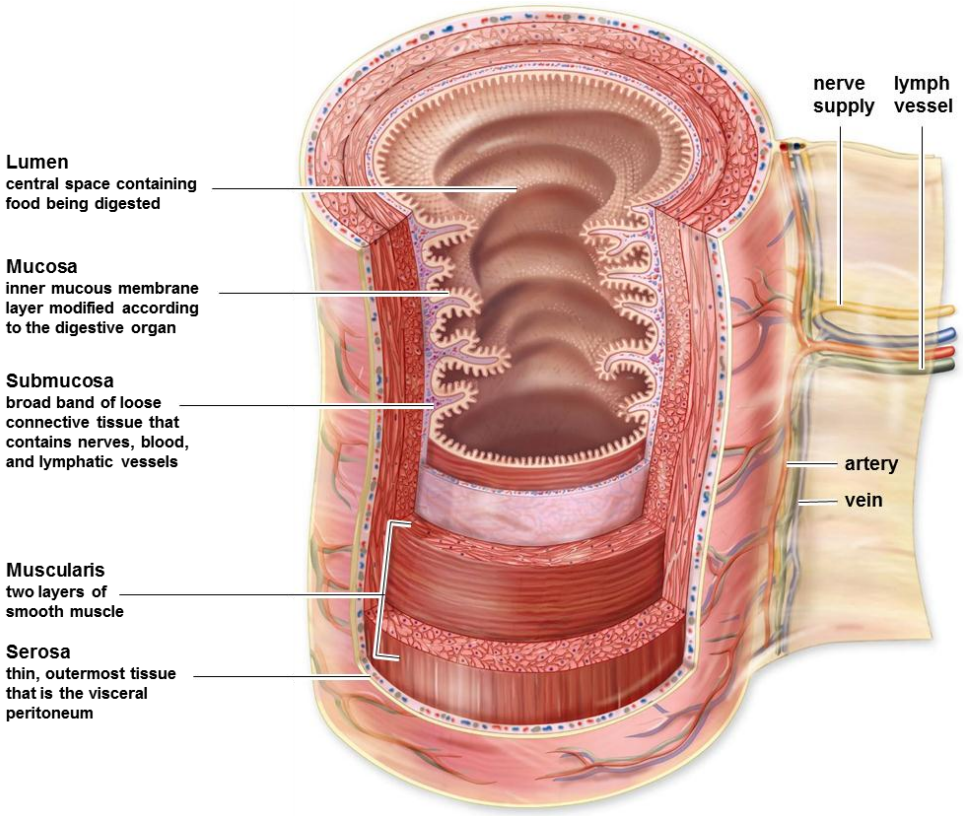
1- ***The mucosal layer*** contains cells that produce and secrete ***mucus*** used to protect all the layers of the tract from the digestive enzymes inside the lumen. Glands in the mucosa of the mouth, stomach, and small intestine also release digestive enzymes.

2- ***The submucosal:*** the second layer in the GI wall. The submucosal layer is a broad band of loose connective tissue that contains blood vessels, lymphatic vessels, and nerves. These are the vessels that will carry the nutrients absorbed by the mucosa. Lymph nodules, called ***Peyer's patches***, are also in the submucosa.

3- ***The muscularis:*** third layer contains two layers of smooth muscle. The contraction of these muscles, under nervous and hormonal control, accounts for peristalsis and subsequent movement of digested food from the esophagus to the anus.

4- ***The serosa***: (serous membrane layer) fourth and outermost layer of the tract, which secretes a lubricating fluid. The serosa is a part of the ***peritoneum***, the internal lining of the abdominal cavity.

> ***Peritoneum:*** *the serous membrane lining the abdominopelvic walls and investing the viscera.*



The Stomach:

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.

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.

Emulsification: *breaking up of fat globules into smaller droplets by the action of bile salts or any other emulsifier.*

Lipase: *enzyme that digests fat and lipids; secreted by the pancreas.*

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. Nutrients are absorbed in the Small Intestine.

Amylase: *enzyme that breaks down carbohydrate.*

Trypsin: *protein-digesting enzyme secreted by the pancreas.*

The walls of the small intestine absorb the sugar, amino acid, glycerol and fatty acid products of digestion. They have fingerlike projections called ***villi*** where nutrient molecules are absorbed into the cardiovascular and lymphatic systems. The lymphatic capillary in a villus is called a ***lacteal***. Lipoprotein molecules called ***chylomicrons*** enter lacteals. Nutrients are carried to all cells of the body by the bloodstream.

> ***Chylomicron:*** *a class of lipoprotein that transport dietary cholesterol and triglycerides from the intestine to the tissues after meals.*

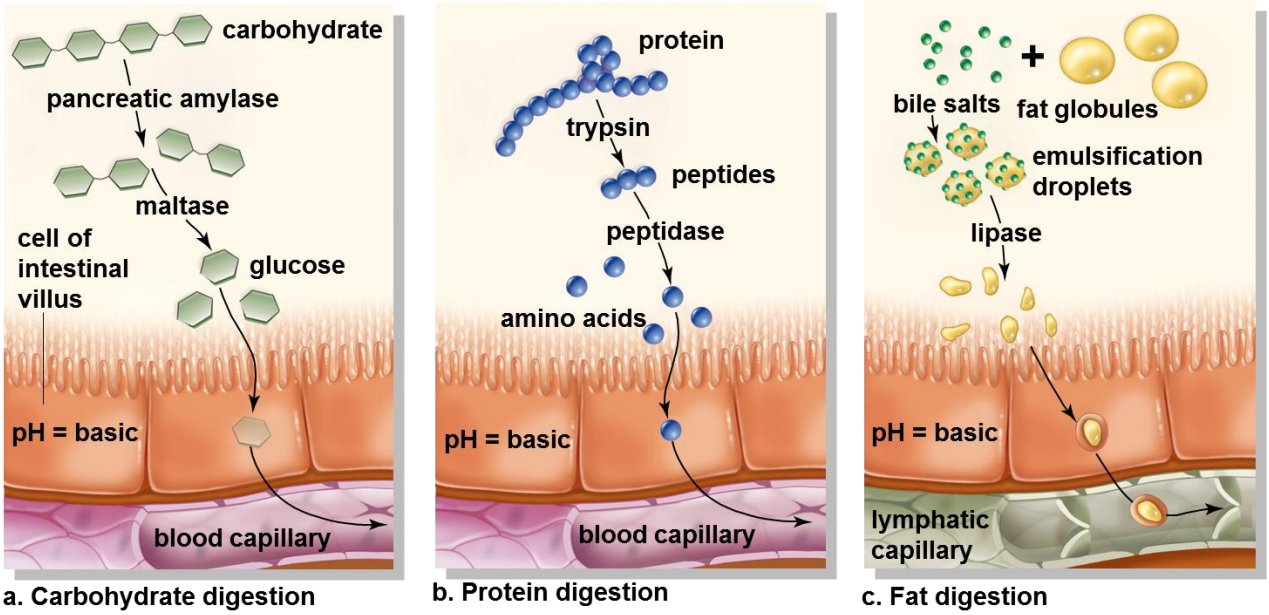


Figure Digestion and absorption of organic nutrients.

The Large Intestine

The large intestine absorbs water, salts, and some vitamins and it forms and stores feces. ***Defecation***, which is ridding the body of feces.

Three Accessory Organs

1- ***The pancreas:*** produces pancreatic juice, which contains digestive enzymes to break down carbohydrates (i.e., pancreatic amylase), proteins (i.e., trypsin), and fats (i.e., lipase).

2- ***The liver:*** produces bile, which is stored in the gallbladder. The liver receives blood from the small intestine by way of the hepatic portal vein. It has numerous important functions.

3- ***The gallbladder***: stores bile until it is sent to the duodenum.

Nutrition and Weight Control

A ***nutrient*** is defined as a component of food that performs a physiological function in the body.

Table 8.2 Functions of the Liver

1. Destroys old red blood cells; excretes bilirubin, a breakdown product of hemoglobin in bile, a liver product
2. Detoxifies blood by removing and metabolizing poisonous substances
3. Stores iron (Fe^{2+}), the water-soluble vitamin B_{12}, and the fat-soluble vitamins A, D, E, and K
4. Makes plasma proteins, such as albumins and fibrinogen, from amino acids
5. Stores glucose as glycogen after a meal, and breaks down glycogen to glucose to maintain the glucose concentration of blood between eating periods
6. Produces urea after breaking down amino acids
7. Helps regulate blood cholesterol level, converting some to bile salts

Classes of Nutrients

1- ***Carbohydrates:***

To meet energy needs, dietitians recommend consuming foods rich in complex carbohydrates like breads and pasta. Simple carbohydrates like table sugar (sucrose) are not recommended. Fiber helps regularity and may help prevent cancer.

2- ***Proteins:***

Dietary meat does assure that all the essential amino acids are acquired but this is also possible by consuming a combination of legumes, grains, vegetables, seeds, and nuts. The body can be harmed if the amount of protein in the diet is severely limited, or if it is present in an overabundance.

3- ***Lipids:***

Fats, oils, and cholesterol are lipids. Saturated fats, which are usually solid at room temperature, promote heart disease. Oils contain unsaturated fatty acids which do not promote cardiovascular disease. Linoleic and linolenic acids are essential fatty acids and must be supplied by diet.

4- ***Minerals***

Minerals are divided into major minerals and trace minerals. The major minerals are constituents of cells and body fluids and are structural components of tissues. The trace minerals are parts of larger molecules.

5- ***Vitamins:***

Vitamins are organic compounds that the body is unable to produce but needs for metabolic purposes. Many vitamins are portions of coenzymes. Vitamins are divided into fat and water soluble classes.