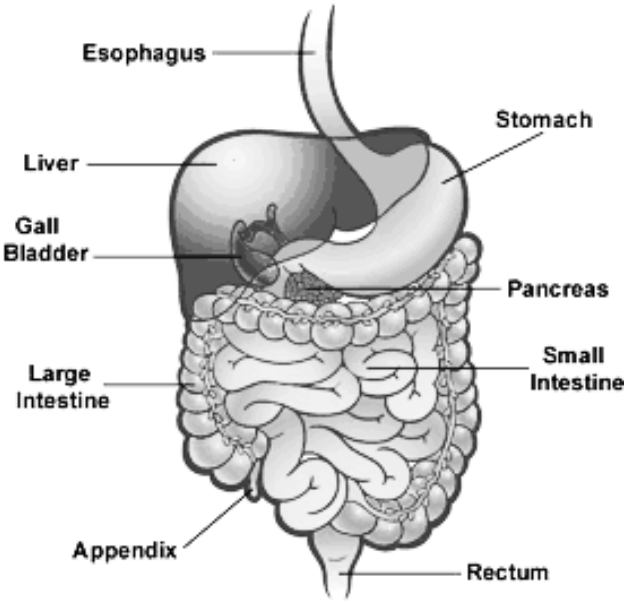
“Digestive System”

The digestive system is made up of the digestive tract—a series of hollow organs joined in a long, twisting tube from the mouth to the anus—and other organs that help the body break down and absorb food. Organs that make up the digestive tract are the mouth, esophagus, stomach, small intestine, large intestine—also called the colon—rectum, and anus. The digestive tract also contains a layer of smooth muscle that helps break down food and move it along the tract. Two “solid” digestive organs, the liver and the pancreas, produce digestive juices that reach the intestine through small tubes called ducts.



Why is digestion important?

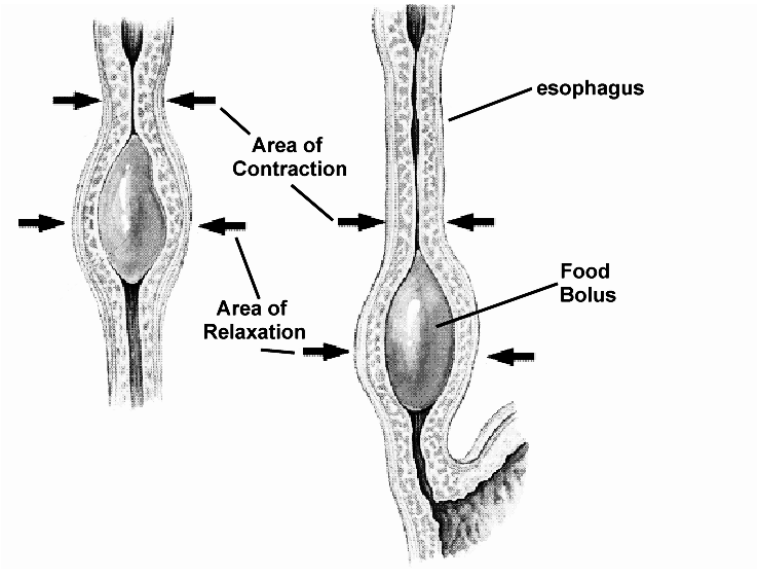
When you eat foods—such as bread, meat, and vegetables—they are not in a form that the body can use as nourishment. Food and drink must be changed into smaller molecules of nutrients before they can be absorbed into the blood and carried to cells throughout the body. Digestion is the process by which food and drink are broken down into their smallest parts so the body can use them to build and nourish cells and to provide energy.

How is food digested?

Digestion involves mixing food with digestive juices, moving it through the digestive tract, and breaking down large molecules of food into smaller molecules. Digestion begins in the mouth, when you chew and swallow, and is completed in the small intestine.

Physical Digestion and Movement

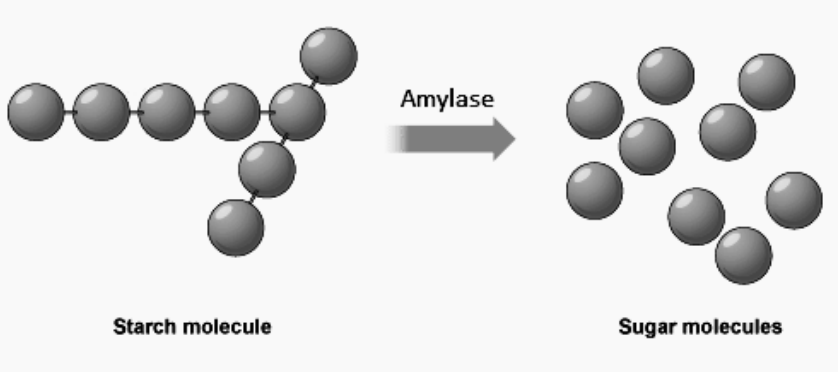
The large, hollow organs of the digestive tract contain a layer of muscle that enables their walls to move. The movement of organ walls can propel food and liquid through the system and also can mix the contents within each organ. Food moves from one organ to the next through muscle action called peristalsis. Peristalsis looks like an ocean wave traveling through the muscle. The muscle of the organ contracts to create a narrowing and then propels the narrowed portion slowly down the length of the organ. These waves of narrowing push the food and fluid in front of them through each hollow organ.



The first major muscle movement occurs when food or liquid is swallowed. Although you are able to start swallowing by choice, once the swallow begins, it becomes involuntary and proceeds under the control of the nerves. Swallowed food is pushed into the esophagus, which connects the throat above with the stomach below. The stomach has the mechanical tasks of churning and storing ingested food.

Finally, the digested nutrients are absorbed through the intestinal walls and transported throughout the body. The waste products of this process include undigested parts of the food, known as fiber, and older cells that have been shed from the lining of the digestive tract. These materials are pushed into the colon, where they remain until the feces are expelled by a bowel movement.

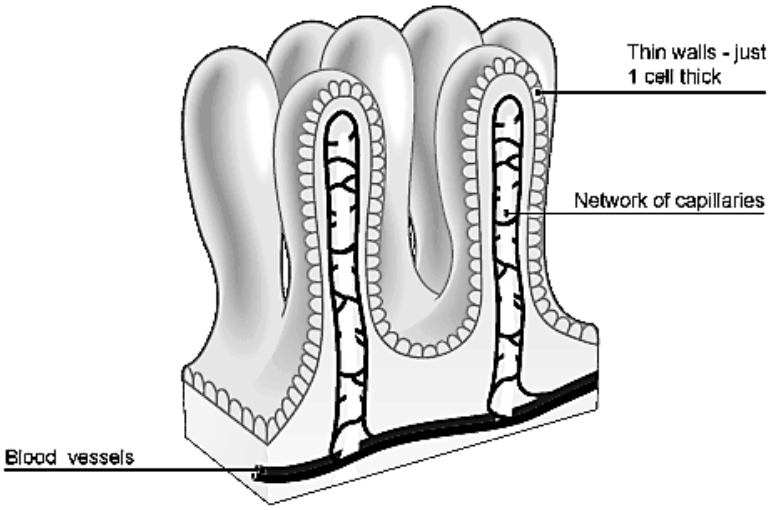
Chemical Digestion



The digestive glands that act first are in the mouth—the salivary glands. Saliva produced by these glands contains an enzyme called amylase that begins to digest the starch from food into smaller molecules. An enzyme is a substance that speeds up chemical reactions in the body. The next set of digestive glands is in the stomach lining. Glands in the lining of your stomach secrete acids and enzymes that chemically break down food into smaller molecules. The acids help first break down proteins, with the help of enzymes that cause the hydrolysis of proteins into amino acids. Additionally, the stomach secretes a bicarbonate buffer, or a chemical that resists a change in PH or acidity.

The second organ, the liver, produces yet another digestive juice—bile. Bile is stored between meals in the gallbladder. At mealtime, it is squeezed out of the gallbladder, through the bile ducts, and into the intestine to mix with the fat in food. The bile acids dissolve fat into the watery contents of the intestine, much like detergents that dissolve grease from a frying pan.

Absorption and Transport of Nutrients



Most digested molecules of food, as well as water and minerals, are absorbed through the small intestine. The lining of the small intestine contains many folds that are covered with tiny fingerlike projections called villi. In turn, the villi are covered with microscopic projections called microvilli. These structures create a vast surface area through which nutrients and water can be absorbed. Specialized cells allow absorbed materials to cross the lining of the intestine into the blood, where they are carried off in the bloodstream to other parts of the body for storage or further chemical change. This part of the process varies with different types of nutrients. After the nutrients are absorbed in the small intestine the food is transferred into the large intestine. The main function of the large intestine is to absorb water from the indigestible food then excrete waste to finish the digestion process. Many bacteria reside in large intestine that produce beneficial vitamins by breaking down our waste.

<u>Digestive System Anatomy</u>

Mouth
Food begins its journey through the digestive system in the mouth, also known as the oral cavity. Inside the mouth are many accessory organs that aid in the digestion of food—the tongue, teeth, and salivary glands. Saliva lubricates the food and also contains an enzyme called amylase that hydrolyzes or breaks down carbohydrates. Teeth chop food into small pieces, which are moistened by saliva before the tongue and other muscles push the food into the pharynx.

Esophagus
The esophagus is a muscular tube connecting the pharynx, or back of the throat, to the stomach. It carries swallowed masses of chewed food along its length. The food is moved by peristalsis, the contraction of the muscular walls of the digestive system. At the end of the esophagus is a muscular ring called the lower esophageal sphincter which keeps food and stomach acids from going up the esophagus towards the mouth.

Stomach
The stomach is a muscular sac that is located on the left side of the abdominal cavity, just below the diaphragm. In an average person, the stomach is about the size of their two fists placed next to each other. This major organ acts as a storage tank for food so that the body has time to digest large meals properly. The stomach also contains hydrochloric acid and digestive enzymes that continue the digestion of food that began in the mouth. In addition to the chemical digestion of food, the muscular walls to the stomach churn to physically break down food into smaller pieces which provides more surface area to react with the stomach enzymes and acids. The pepsin enzyme located in the stomach begins the chemical digestion of proteins. Pepsin hydrolyzes proteins into amino acids.

Small Intestine
The small intestine is a long, thin tube about 1 inch in diameter and about 10 feet long. A variety of enzymes in the small intestine break down, or hydrolyze proteins, lipids and carbohydrates. The organ is located just below to the stomach and takes up most of the space in the abdominal cavity. The entire small intestine is coiled like a hose and the inside surface is full of many ridges and folds. Projections called villi line the small intestine area to increase the surface area where nutrients can be absorbed. By the time food leaves the small intestine, around 90% of all nutrients have been extracted from the food that entered it.

Liver and Gallbladder
The **liver** is a roughly triangular organ of the digestive system located to the right of the stomach, and above the small intestine. The liver weighs about 3 pounds and is the second largest organ in the body. The liver has many different functions in the body, but the main function of the liver in digestion is the production of bile and its secretion into the small intestine. The gallbladder is a small, pear-shaped organ located just posterior to the liver. The gallbladder is used to store and recycle excess bile from the small intestine so that it can be reused for the digestion of subsequent meals.

Pancreas
The pancreas is a large gland located just inferior and posterior to the stomach. It is about 6 inches long and shaped like short, lumpy snake with its “head” connected to the duodenum and its “tail” pointing to the left wall of the abdominal cavity. The pancreas secretes digestive enzymes into the small intestine to complete the chemical digestion of foods. In addition, the pancreas produces insulin to control blood glucose levels.

Digestion of Biological Molecules

Carbohydrates

The *Dietary Guidelines for Americans 2005* recommend that 45 to 65 percent of total daily calories be from carbohydrates. Foods rich in carbohydrates include bread, potatoes, dried peas and beans, rice, pasta, fruits, and vegetables. Many of these foods contain both starch and fiber. The digestible carbohydrates—starch and sugar—are broken into simpler molecules by enzymes in the saliva (amylase) along with juice produced by the pancreas, and in the lining of the small intestine. The pancreas also produces insulin to aid in the absorption of sugar from the blood stream.

Protein

Foods such as meat, eggs, and beans consist of giant molecules of protein that must be digested by enzymes before they can be used to build and repair body tissues. An enzyme in the juice of the stomach starts the digestion of swallowed protein. Then in the small intestine, several enzymes from the pancreatic juice and the lining of the intestine complete the breakdown of huge protein molecules into small molecules called amino acids. These small molecules can be absorbed through the small intestine into the blood and then be carried to all parts of the body to build the walls and other parts of cells.

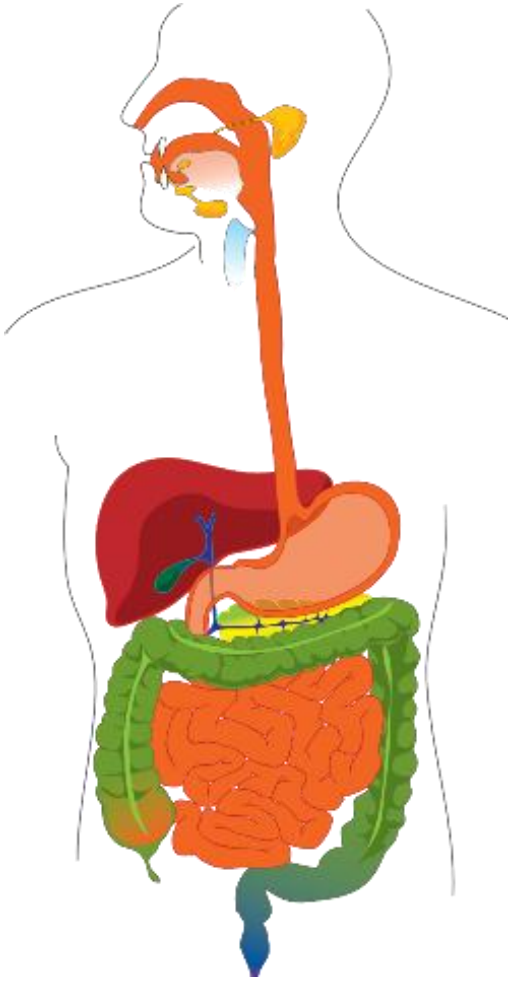
Fats

Fat molecules are a rich source of energy for the body. The first step in digestion of a fat such as butter is to dissolve it into the watery content of the intestine. The bile acids produced by the liver dissolve fat into tiny droplets and allow pancreatic and intestinal enzymes to break the large fat molecules into smaller ones. Some of these small molecules are fatty acids and cholesterol.

“Digestive System Guided Questions”

1. Label the sketch of the digestive system and label the following components. Include a one sentence description of the function for each part of the digestive system.

>Mouth, Esophagus, Gallbladder, Stomach, Pancreas, Small Intestine, Large Intestine, Liver



Functions of the Digestive System Components

Structure	**Function**
Gallbladder	
Mouth	
Stomach	
Large Intestine	
Small Intestine	
Liver	
Pancreas	
Esophagus	

2. Describe how peristalsis physically digests food and moves it along the digestive tract.

3. Describe the location function of the enzyme amylase in the digestive system. Would you classify amylase an enzyme that performs hydrolysis or dehydration synthesis?

4. Compare and contrast chemical and physical digestion.

5. Which digestive organ is the first to breakdown protein? Proteins or polypeptides are broken down into what smaller molecules?

6. Explain how do the liver and gallbladder work together to digest fats?

7. List three types of molecules that are broken down in the small intestine.

8. Compare and contrast the functions of the large and small intestines.

9. What role does hydrolysis play in digestion?