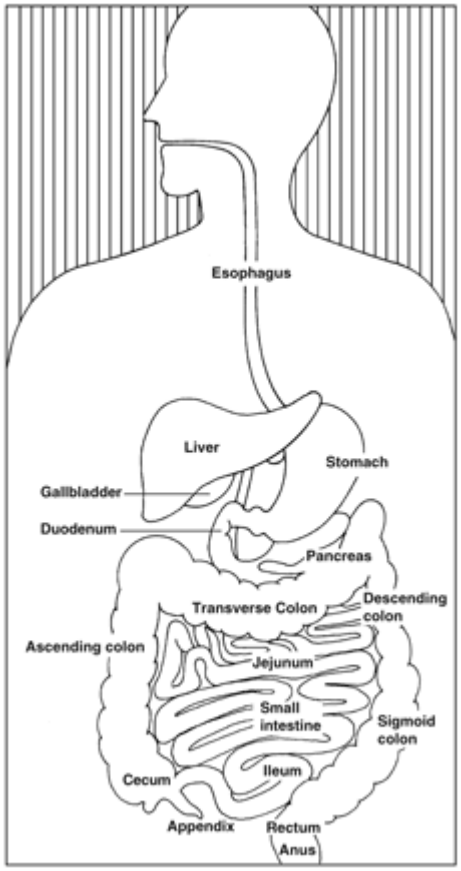
Your Digestive System and How It Works

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 (see figure).

Organs that make up the digestive tract are the mouth, esophagus, stomach, small intestine, large intestine—also called the colon—rectum, and anus. Inside these hollow organs is a lining called the mucosa. In the mouth, stomach, and small intestine, the mucosa contains tiny glands that produce juices to help digest food. 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. The gallbladder stores the liver’s digestive juices until they are needed in the intestine. Parts of the nervous and circulatory systems also play major roles in the digestive system.



The digestive system.

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.

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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.

Movement of Food Through the System

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. At the junction of the esophagus and stomach, there is a ringlike valve, called the pyloric valve, closing the passage between the two organs. As food approaches the closed valve, the surrounding muscles relax and allow the food to pass through to the stomach.

The stomach has three mechanical tasks. First, it stores the swallowed food and liquid. To do this, the muscle of the upper part of the stomach relaxes to accept large volumes of swallowed material. The second job is to mix up the food, liquid, and digestive juice produced by the stomach. The lower part of the stomach mixes these materials by its muscle action. The third task of the stomach is to empty its contents slowly into the small intestine.

Several factors affect emptying of the stomach, including the kind of food and the degree of muscle action of the emptying stomach and the small intestine. Carbohydrates, for example, spend the least amount of time in the stomach, while protein stays in the stomach longer, and fats the longest. As the food dissolves into the juices from the pancreas, liver, and intestine, the contents of the intestine are mixed and pushed forward to allow further digestion.

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 mucosa. These materials are pushed into the colon, where they remain until the feces are expelled by a bowel movement.

Production of Digestive Juices

The digestive glands that act first are in the mouth—the salivary glands. Saliva produced by these glands contains an enzyme 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. They produce stomach acid and an enzyme that digests protein. A thick mucus layer coats the mucosa and helps keep the acidic digestive juice from

dissolving the tissue of the stomach itself. In most people, the stomach mucosa is able to resist the juice, although food and other tissues of the body cannot.

After the stomach empties the food and juice mixture into the small intestine, the juices of two other digestive organs mix with the food. One of these organs, the pancreas, produces a juice that contains a wide array of enzymes to break down the carbohydrate, fat, and protein in food. Other enzymes that are active in the process come from glands in the wall of the intestine.

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. After fat is dissolved, it is digested by enzymes from the pancreas and the lining of the intestine.

Absorption and Transport of Nutrients

Most digested molecules of food, as well as water and minerals, are absorbed through the small intestine. The mucosa 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 can be absorbed. Specialized cells allow absorbed materials to cross the mucosa 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.

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, in juice produced by the pancreas, and in the lining of the small intestine. Starch is digested in two steps. First, an enzyme in the saliva and pancreatic juice breaks the starch into molecules called maltose. Then an enzyme in the lining of the small intestine splits the maltose into glucose molecules that can be absorbed into the blood. Glucose is carried through the bloodstream to the liver, where it is stored or used to provide energy for the work of the body.

Sugars are digested in one step. An enzyme in the lining of the small intestine digests sucrose, also known as table sugar, into glucose and fructose, which are absorbed through the intestine into the blood. Milk contains another type of sugar, lactose, which is changed into absorbable molecules by another enzyme in the intestinal lining.

Fiber is undigestible and moves through the digestive tract without being broken down by enzymes. Many foods contain both soluble and insoluble fiber. Soluble fiber dissolves easily in water and takes on a soft, gel-like texture in the intestines. Insoluble fiber, on the other hand, passes essentially unchanged through the intestines.

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. The bile acids combine with the fatty acids and cholesterol and help these molecules move into the cells of the mucosa. In these cells the small molecules are formed back into large ones, most of which pass into vessels called lymphatics near the intestine. These small vessels carry the reformed fat to the veins of the chest, and the blood carries the fat to storage depots in different parts of the body.

Vitamins. Another vital part of food that is absorbed through the small intestine are vitamins. The two types of vitamins are classified by the fluid in which they can be dissolved: water-soluble vitamins (all the B vitamins and vitamin C) and fat-soluble vitamins (vitamins A, D, E, and K). Fat-soluble vitamins are stored in the liver and fatty tissue of the body, whereas water-soluble vitamins are not easily stored and excess amounts are flushed out in the urine.

Water and salt. Most of the material absorbed through the small intestine is water in which salt is dissolved. The salt and water come from the food and liquid you swallow and the juices secreted by the many digestive glands.

How is the digestive process controlled?

Hormone Regulators

The major hormones that control the functions of the digestive system are produced and released by cells in the mucosa of the stomach and small intestine. These hormones are released into the blood of the digestive tract, travel back to the heart and through the arteries, and return to the digestive system where they stimulate digestive juices and cause organ movement.

The main hormones that control digestion are gastrin, secretin, and cholecystokinin (CCK):

- **Gastrin** causes the stomach to produce an acid for dissolving and digesting some foods. Gastrin is also necessary for normal cell growth in the lining of the stomach, small intestine, and colon.
- **Secretin** causes the pancreas to send out a digestive juice that is rich in bicarbonate. The bicarbonate helps neutralize the acidic stomach contents as they enter the small intestine. Secretin also stimulates the stomach to produce pepsin, an enzyme that digests protein, and stimulates the liver to produce bile.
- **CCK** causes the pancreas to produce the enzymes of pancreatic juice, and causes the gallbladder to empty. It also promotes normal cell growth of the pancreas.

Additional hormones in the digestive system regulate appetite:

- **Ghrelin** is produced in the stomach and upper intestine in the absence of food in the digestive system and stimulates appetite.
- **Peptide YY** is produced in the digestive tract in response to a meal in the system and inhibits appetite.

Both of these hormones work on the brain to help regulate the intake of food for energy. Researchers are studying other hormones that may play a part in inhibiting appetite, including glucagon-like peptide-1 (GPL-1), oxyntomodulin (OXM), and pancreatic polypeptide.

Nerve Regulators

Two types of nerves help control the action of the digestive system.

Extrinsic, or outside, nerves come to the digestive organs from the brain or the spinal cord. They release two chemicals, acetylcholine and adrenaline. Acetylcholine causes the muscle layer of the digestive organs to squeeze with more force and increase the "push" of food and juice through the digestive tract. It also causes the stomach and pancreas to produce more digestive juice. Adrenaline has the opposite effect. It relaxes the muscle of the stomach and intestine and decreases the flow of blood to these organs, slowing or stopping digestion.

The intrinsic, or inside, nerves make up a very dense network embedded in the walls of the esophagus, stomach, small intestine, and colon. The intrinsic nerves are triggered to act when the walls of the hollow organs are stretched by food. They release many different substances that speed up or delay the movement of food and the production of juices by the digestive organs.

Together, nerves, hormones, the blood, and the organs of the digestive system conduct the complex tasks of digesting and absorbing nutrients from the foods and liquids you consume each day.

For More Information

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The National Digestive Information Clearinghouse collects resource information about digestive diseases for the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) Reference Collection. This database provides titles, abstracts, and availability information for health information and health education resources. The NIDDK Reference Collection is a service of the National Institutes of Health.

You may view the results of the automatic search on Your Digestive System and How It Works.

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