● Before You Read

Have you ever had food “go down the wrong pipe”? On the lines below, describe how your body responded. Explain what purpose you think your body’s response serves. Then read the section to learn about reflexes in the digestive process.

● Read to Learn

Functions of the Digestive System

The digestive system performs three main functions. It takes in food. Then it breaks down food so nutrients can be absorbed. Finally, it gets rid of what cannot be digested.

What are mechanical and chemical digestion?

Mechanical digestion is the action of breaking down food into smaller pieces by chewing and by the mixing action of smooth muscles in the stomach and small intestine. Chemical digestion is the action of breaking down larger molecules into smaller molecules that cells can absorb by digestive enzymes. Amylase (AM uh lays), an enzyme in saliva, starts chemical digestion by breaking down starches into sugars.

How is food forced through the esophagus?

The tongue pushes chewed food to the back of the mouth which stimulates the swallowing reflex. Chewed food enters the esophagus (ih SAH fuh gus), a muscular tube that connects the pharynx, or throat, to the stomach. Smooth muscles that line the esophagus contract in a rhythm to move food through the digestive system in a process called peristalsis (per uh STAHL sus).
What is the function of the epiglottis?

The epiglottis is a small plate of cartilage that covers the opening to the trachea. If the opening is not closed, food can enter the trachea, which will trigger a coughing reflex. The body coughs to keep the food from entering the lungs.

How does digestion continue in the stomach?

Refer to the figure below as you follow the path of food through the digestive system. Food moves through the esophagus, passes through a circular muscle called a sphincter and into the stomach. The stomach walls are made of three layers of smooth muscle. During mechanical digestion, these smooth muscles contract. These contractions, called peristalsis, break food into smaller pieces and mix food with acid that is secreted by stomach glands, called gastric glands. The condition commonly known as heartburn is the result of some acid leaking through the sphincter back into the esophagus.

The acidic environment in the stomach aids the action of pepsin, an enzyme involved in the chemical digestion of proteins. Mucus secreted by the lining of the stomach helps protect the stomach from the acid and pepsin.

Contractions of the muscular walls of the stomach push food farther along the digestive tract. Food passes through the pyloric sphincter at the lower end of the stomach and enters the small intestine.

Think it Over

2. Draw Conclusions
What part of the digestive tract could be damaged by constant heartburn?

Picture This

3. Circle the structures that secrete digestive juices but do not hold food on its way through the body.
What is the role of the small intestine?

The **small intestine** is a muscular tube that connects the stomach and the large intestine. Smooth muscles in the wall of the small intestine continue mechanical digestion and move food farther along the digestive tract.

The small intestine completes chemical digestion with the help of the pancreas, liver, and gallbladder, as illustrated in the figure below. The pancreas makes enzymes that digest carbohydrates, proteins, and fats. It also makes hormones, which you will learn about later. The **liver** is the organ that makes bile. Bile helps break down fats. Extra bile is stored in the gallbladder to be released into the small intestine when needed.

The small intestine is lined with fingerlike structures called **villi** (VIH li) (singular, villus). Chemical digestion is completed and most of the nutrients from food are absorbed through the villi. Villi increase the surface area of the small intestine. Food that cannot be digested moves into the large intestine as a thick liquid substance called chyme (KIME).

What is the main function of the large intestine?

The **large intestine** is the end part of the digestive tract. It includes the colon, rectum, and appendix. The appendix is a saclike structure that has no known function.

Some bacteria normally live in the colon. They make vitamin K and certain B vitamins that the body can use.

The main function of the colon is to absorb water from the chyme. The remaining material is a more solid material called feces. Smooth muscle contractions, called peristalsis, move feces toward the rectum. Feces exit the body through the anus.

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**Picture This**

4. **Label** the structure that produces bile and the structure that stores bile.

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**Reading Check**

5. **Explain** the function of the colon.

   ________________

   ________________
The body needs certain nutrients to function properly.

What You’ll Learn

- how proteins, carbohydrates, and fats are broken down
- roles of vitamins and minerals in homeostasis
- how to eat healthfully

Before You Read

On the lines below, describe foods that are healthful. In this section you will learn how to use the food pyramid and food labels to help you choose nutritious foods.

Read to Learn

Calories

Nutrition is the process of taking in and using food. Food supplies building materials and energy for the body. A Calorie (with a capital C) is the unit used to measure the energy content of foods. A calorie (with a lowercase c) is a measure of heat. One Calorie equals 1000 calories.

The energy content of food can be measured by burning the food to change the stored energy to heat. Different foods have different energy content. For example, one gram of carbohydrate or protein contains four Calories. One gram of fat contains nine Calories. You can stay at the same body weight by taking in the same number of Calories that you use each day. To lose weight, you need to use more Calories than you eat. The table below compares Calorie usage in different activities. Physical activity is a key part of good health.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Calories Used per Hour</th>
<th>Activity</th>
<th>Calories Used per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>baseball</td>
<td>282</td>
<td>hiking</td>
<td>564</td>
</tr>
<tr>
<td>basketball</td>
<td>564</td>
<td>jogging</td>
<td>740–920</td>
</tr>
<tr>
<td>bicycling</td>
<td>240–410</td>
<td>skating</td>
<td>300</td>
</tr>
<tr>
<td>football</td>
<td>540</td>
<td>soccer</td>
<td>540</td>
</tr>
</tbody>
</table>
Carbohydrates

Sugars such as glucose, fructose, and sucrose are simple carbohydrates. They are found in fruits and candy. Complex carbohydrates such as starches are long chains of sugars. Foods such as potatoes, cereals, and bread are starches.

During digestion, complex carbohydrates are broken down into simple sugars. Simple sugars are absorbed through villi in the small intestine into blood capillaries and then circulated to provide energy for cells. Extra glucose is stored in the liver.

Cellulose, or dietary fiber, is also a complex carbohydrate found in plants. Fiber is important in the diet, even though humans cannot digest it. Fiber helps keep food moving through and out of the digestive tract. Bran, whole-grain breads, and beans are good sources of fiber.

Fats

Fats are the most concentrated energy source. In proper amounts, fats are needed in a healthful diet. Fats are broken down in the small intestines into fatty acids and glycerol. Fatty acids are absorbed and circulated in the blood through the body for energy. Fats help maintain homeostasis by providing energy and by storing and transporting vitamins.

Not all fats are healthful. Recall that fats are either saturated or unsaturated. Meats, cheeses, and other dairy products contain saturated fats. Plants are the main source of unsaturated fats.

A diet high in saturated fats might result in high blood levels of cholesterol. This can lead to high blood pressure and other heart problems.

Proteins

During digestion, proteins in foods are broken down into amino acids. Amino acids are absorbed into the bloodstream and carried to the cells. By a process called protein synthesis, the cells assemble the amino acids into proteins needed for body structures and functions.

Twenty amino acids are needed by the body for protein synthesis. The body can make 12 of the amino acids. The other eight, known as essential amino acids, need to come from foods. Animal products such as meat, fish, eggs, and dairy products provide all eight essential amino acids. Vegetables, fruits, and grains do not contain all eight. However, they can be combined to provide all eight essential amino acids.
4. Identify the three food groups that should make up the largest portion of your diet.

Food Pyramid

In 2005, the Department of Agriculture published MyPyramid, shown in the figure below. This diagram provides general guidelines for a healthful diet. Notice that the bands representing food groups are not the same width. The message is that people need more nutrients from grains and vegetables than from meats and oils.

Vitamins and Minerals

Vitamins are organic compounds that are needed in small amounts for metabolism. Many vitamins help enzymes function. Vitamin D is made by cells in skin. Bacteria living in the large intestines make vitamin K and certain B vitamins. However, most vitamins need to come from a balanced diet.

Fat-soluble vitamins can be stored in the liver and fatty tissues. Water-soluble vitamins cannot be stored. They need to be eaten regularly.

Minerals are inorganic compounds used as building materials and are involved in metabolism. For example, iron is used to make hemoglobin. Calcium is in bones and is involved in muscle and nerve function.

What information do nutrition labels provide?

The FDA requires food labels to list the name of the food; product’s weight or volume; name and address of the manufacturer, distributor, or packager; ingredients; and nutrition content. The percent daily values are based on an individual serving, not the entire package. Use the daily requirement percentages as a guide.
Before You Read

On the lines below, describe how your body felt during a stressful situation. Then read the section to learn how the endocrine system participates in the fight or flight response.

Read to Learn

Action of Hormones

The endocrine system is composed of glands and works as a communication system. Endocrine glands produce hormones, which are released into the bloodstream and distributed to body cells. A hormone acts on certain target cells and tissues to produce a specific response.

Hormones are classified as steroid hormones and nonsteroid, or amino acid, hormones based on their structure and how they do their job.

How do steroid hormones produce a response?

All steroid hormones cause target cells to start protein synthesis. Steroid hormones diffuse through the plasma membrane of target cells and bind to receptors inside the cell. The hormones and receptors move together into the cell nucleus, where they bind to DNA, activating certain genes.

How do amino acid hormones work?

Nonsteroid hormones are made of amino acids. They cannot diffuse into a cell. Instead, they bind with receptors on the plasma membrane of target cells, activating an enzyme inside the membrane that produces the desired response.
Negative Feedback

An internal feedback process called negative feedback maintains homeostasis in the body. When a body system is too different from a set point, negative feedback returns the system to the set point.

For example, parathyroid hormone maintains the proper amount of calcium in the blood. If blood calcium drops below a certain level, the parathyroid glands respond by releasing more hormone. The hormone causes calcium to be released from the bones. This raises the amount of calcium in the blood. If the amount of calcium in the blood rises too high, parathyroid glands stop making the hormone, causing the opposite effect.

Endocrine Glands and Their Hormones

The endocrine system includes all the glands that secrete hormones. The locations of these glands are shown in the figure on the next page.

1. **Apply** What happens to the blood calcium level when the parathyroid glands produce more hormones? (Circle your answer.)
   a. increases
   b. decreases
   c. stays the same

2. **Identify** the gland that produces more hormones when blood calcium levels are too high.

   - Parathyroid hormone increases blood calcium levels by stimulating the bones to release calcium. They also cause the kidneys to reabsorb more calcium and the intestines to absorb more calcium from food. The hormones of the thyroid and parathyroid work together to maintain homeostasis.
What hormones does the pancreas secrete?
The pancreas secretes insulin and glucagon, which work together to maintain homeostasis. When blood glucose levels are high, the pancreas secretes insulin. **Insulin** signals body cells to convert more glucose to glycogen, which is stored in the liver. When blood glucose levels are low, the pancreas secretes glucagon. **Glucagon** (GLEW kuh gahn) signals liver cells to convert glycogen to glucose and release the glucose into the blood. The process is shown in the figure below.

![Diagram showing the interaction between insulin and glucagon](image)

What do adrenal hormones affect?
The adrenal glands are located just above the kidneys. The adrenal cortex, or outer part, makes steroid hormones. The hormone **aldosterone** (al DAWS tuh rohn) affects the kidneys and aids sodium reabsorption. **Cortisol** raises blood glucose levels and reduces inflammation.

How do adrenal glands respond to stress?
During a stressful situation, the adrenal glands create a sudden burst of energy. The inner part of the adrenal glands secretes epinephrine (eh puh NEH frun), also called adrenaline, and norepinephrine. These hormones work together to increase heart rate, blood pressure, breathing rate, and blood sugar levels. All of these responses increase the activity of body cells as part of the fight or flight response.
**Link to the Nervous System**

Both the nervous and endocrine systems regulate the activities of the body and help maintain homeostasis. The hypothalamus, located in the brain, serves as a link between the nervous system and the endocrine system. The hypothalamus produces two hormones—antidiuretic hormone (ADH) and oxytocin (ahk sih TOH sun). You will learn about oxytocin in Chapter 36.

The antidiuretic (AN ti DY yuh REH tic) hormone (ADH) controls water balance. ADH affects collecting tubules in the kidneys.

Cells in your hypothalamus detect when the level of water in your blood drops too low. The hypothalamus responds by releasing ADH. The figure below illustrates how ADH works. ADH travels in the blood to the kidneys. There, it binds with receptors on certain kidney cells. This causes the kidneys to reabsorb more water and decrease the amount of water leaving the body as urine.

If the level of water in your blood rises too high, the hypothalamus releases less ADH. This causes the kidneys to reabsorb less water and increases the amount of water leaving the body as urine.

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### Reading Check

**6. Decide** What two hormones are produced by the hypothalamus?

- [ ] calcium
- [ ] glucose
- [ ] water

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### Picture This

**7. Identify** ADH helps maintain homeostasis by controlling the balance of which important substance in the body? (Circle your answer.)

- [ ] a. calcium
- [ ] b. glucose
- [ ] c. water