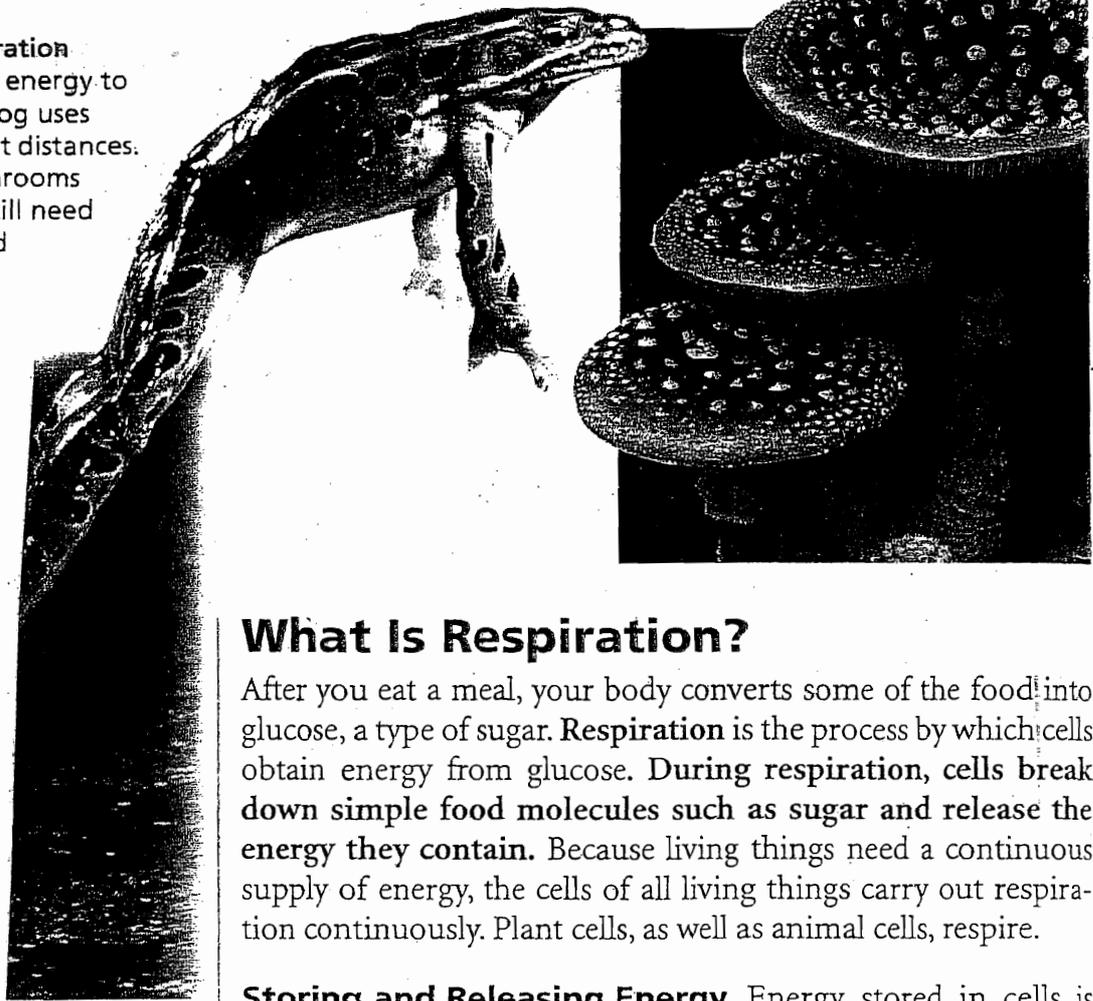


FIGURE 6

Energy From Respiration

All organisms need energy to live. The leopard frog uses energy to leap great distances. Although the mushrooms don't move, they still need energy to grow and reproduce.



What Is Respiration?

After you eat a meal, your body converts some of the food into glucose, a type of sugar. **Respiration** is the process by which cells obtain energy from glucose. **During respiration, cells break down simple food molecules such as sugar and release the energy they contain.** Because living things need a continuous supply of energy, the cells of all living things carry out respiration continuously. Plant cells, as well as animal cells, respire.

Storing and Releasing Energy Energy stored in cells is something like money you put in a savings account in a bank. When you want to buy something, you withdraw some of the money. Cells store and use energy in a similar way. During photosynthesis, plants capture the energy from sunlight and “save” it in the form of carbohydrates, including sugars and starches. Similarly, when you eat a meal, you add to your body’s energy savings account. When cells need energy, they “withdraw” it by breaking down the carbohydrates in the process of respiration.

Breathing and Respiration The term *respiration* has two meanings. You have probably used it to mean “breathing,” that is, moving air in and out of your lungs. To avoid confusion, the respiration process that takes place inside cells is sometimes called cellular respiration. The two meanings of the term *respiration* do point out a connection, however. Breathing brings oxygen, which is usually necessary for cellular respiration, into your lungs.

Lab zone Skills Activity

Predicting

During the winter months, some animals go into a state called hibernation. During hibernation, an animal does not eat and its body activities are greatly reduced. Predict what will happen to an animal’s rate of cellular respiration when the animal goes into hibernation. Explain your prediction.



Reading Checkpoint

What is respiration?

The Two Stages of Respiration Like photosynthesis, respiration is a two-stage process. The first stage takes place in the cytoplasm of the organism's cells. There, molecules of glucose are broken down into smaller molecules. Oxygen is not involved, and only a small amount of energy is released.

The second stage of respiration takes place in the mitochondria. There, the small molecules are broken down into even smaller molecules. These chemical reactions require oxygen, and they release a great deal of energy. This is why the mitochondria are sometimes called the "powerhouses" of the cell.

Trace the steps in the breakdown of glucose in Figure 7. Note that energy is released in both stages. Two other products of respiration are carbon dioxide and water. These products diffuse out of the cell. In most animals, the carbon dioxide and some water leave the body during exhalation, or breathing out. Thus, when you breathe in, you take in oxygen—a raw material for respiration. When you breathe out, you release carbon dioxide and water—products of respiration.

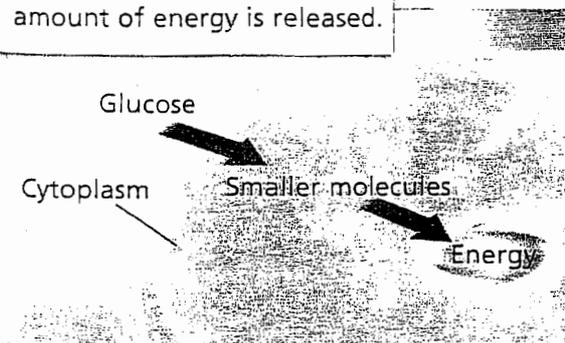
The Respiration Equation Although respiration occurs in a series of complex steps, the overall process can be summarized in the following equation:



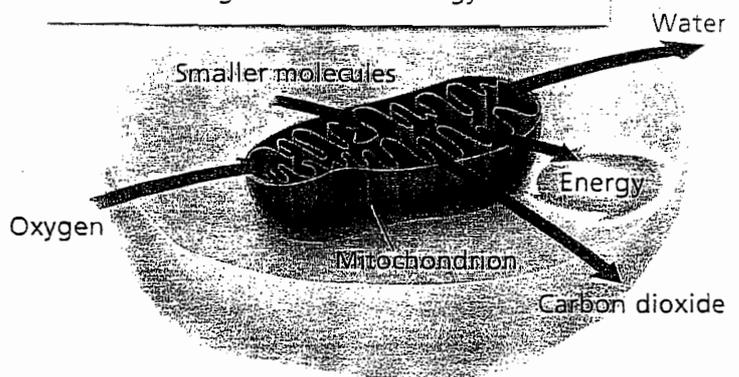
Notice that the raw materials for respiration are sugar and oxygen. Plants and other organisms that undergo photosynthesis make their own sugar. The glucose in the cells of animals and other organisms comes from the food they consume. The oxygen used in respiration comes from the air or water surrounding the organism.

FIGURE 7
Two Stages of Respiration
Respiration, like photosynthesis, takes place in two stages.
Interpreting Diagrams In which stage of respiration is oxygen used?

Stage 1 In the cytoplasm, glucose is broken down into smaller molecules. A small amount of energy is released.



Stage 2 In the mitochondria, the smaller molecules combine with oxygen to produce water and carbon dioxide. This reaction releases a large amount of energy.



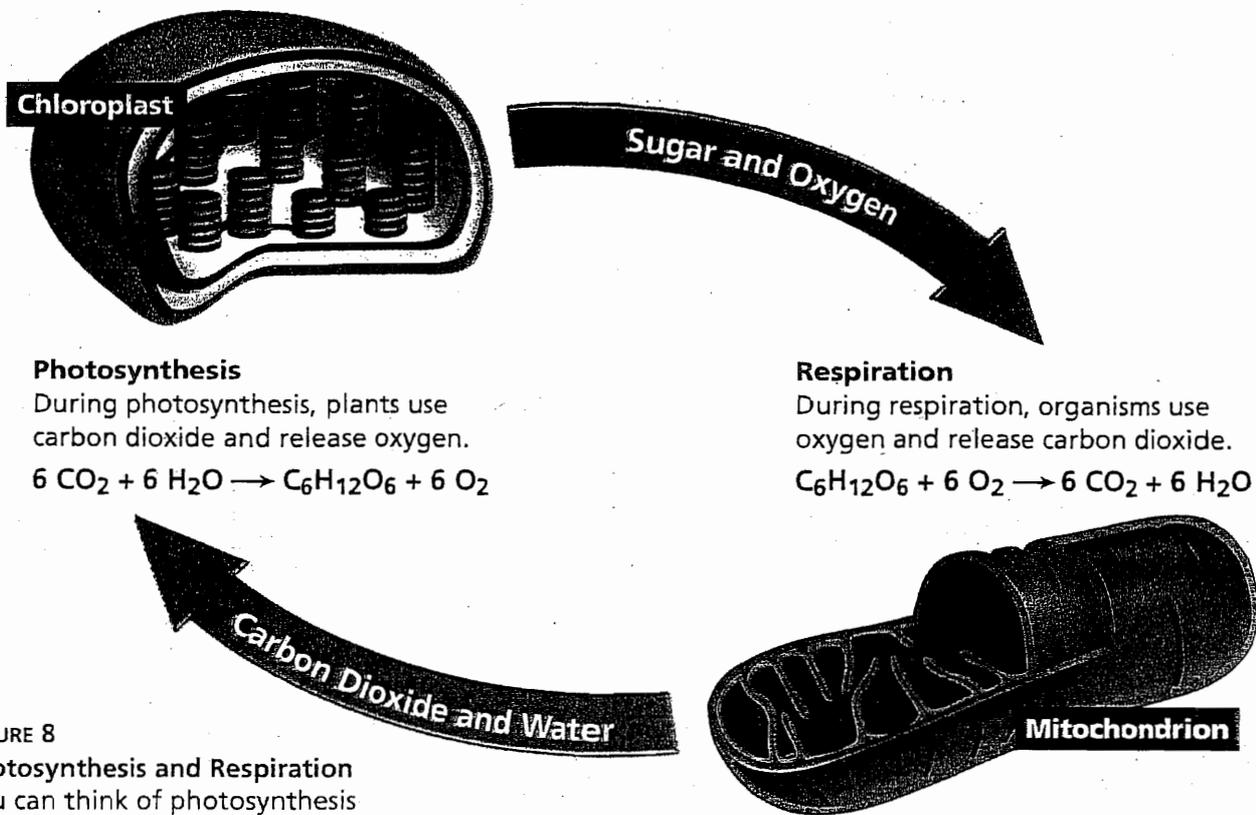


FIGURE 8
Photosynthesis and Respiration
You can think of photosynthesis and respiration as opposite processes.
Comparing and Contrasting
Which process uses oxygen? Which uses carbon dioxide?

Comparing Photosynthesis and Respiration Can you notice anything familiar about the equation for respiration? You are quite right if you said it is the opposite of the equation for photosynthesis. This is an important point. During photosynthesis, carbon dioxide and water are used to produce sugars and oxygen. During respiration, the sugar glucose and oxygen are used to produce carbon dioxide and water. Photosynthesis and respiration can be thought of as opposite processes.

Together, these two processes form a cycle that keeps the levels of oxygen and carbon dioxide fairly constant in Earth's atmosphere. As you can see in Figure 8, living things use both gases over and over again.



Reading Checkpoint

Which process—photosynthesis or respiration—produces water?

Fermentation

Some cells are able to obtain energy from food without using oxygen. For example, some single-celled organisms live where there is no oxygen, such as deep in the ocean or in the mud of lakes or swamps. These organisms obtain their energy through **fermentation**, an energy-releasing process that does not require oxygen. **Fermentation provides energy for cells without using oxygen.** The amount of energy released from each sugar molecule during fermentation, however, is much lower than the amount released during respiration.

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Alcoholic Fermentation One type of fermentation occurs when yeast and some other single-celled organisms break down sugars. This process is sometimes called alcoholic fermentation because alcohol is one of the products. The other products are carbon dioxide and a small amount of energy.

The products of alcoholic fermentation are important to bakers and brewers. The carbon dioxide produced by yeast creates air pockets in bread dough, causing it to rise. Carbon dioxide is also the source of bubbles in alcoholic drinks such as beer and sparkling wine.

Lactic Acid Fermentation Another type of fermentation takes place at times in your body. You've probably felt its effects. Think of a time when you ran as fast as you could for as long as you could. Your leg muscles were pushing hard against the ground, and you were breathing quickly.

No matter how hard you breathed, your muscle cells used up the oxygen faster than it could be replaced. Because your cells lacked oxygen, fermentation occurred. The fermentation supplied your cells with energy. One product of this type of fermentation is an acid known as lactic acid. When lactic acid builds up, you feel a painful sensation in your muscles. Your muscles feel weak and sore.



Reading
Checkpoint

Which kind of fermentation is important to bakers?

Section 2 Assessment



Target Reading Skill

Using Prior Knowledge Review your graphic organizer about respiration. List two things that you learned about respiration.

Reviewing Key Concepts

- Reviewing** What happens during respiration?
 - Reviewing** What is the equation for respiration?
 - Comparing and Contrasting** Compare the equations for respiration and photosynthesis.
 - Relating Cause and Effect** Explain why cellular respiration adds carbon dioxide to the atmosphere, but photosynthesis does not.

- Identifying** What is the process in which cells obtain energy without using oxygen?
 - Inferring** How would athletes be affected if this process could not take place?
 - Predicting** Is this process more likely to occur during a short run or a long walk? Explain your answer.

Lab
zone

At-Home Activity

Make Bread With an adult family member, follow a recipe in a cookbook to make a loaf of bread using yeast. Explain to your family what causes the dough to rise. After you bake the bread, observe a slice and look for evidence that fermentation occurred.