

Respiration

Reading Preview

Key Concepts

- What events occur during respiration?
- What is fermentation?

Key Terms

- respiration
- fermentation

Target Reading Skill


Using Prior Knowledge Your prior knowledge is what you already know before you read about a topic. Before you read, write a definition of respiration in a graphic organizer like the one below. As you read, revise your definition based on what you learn.

What You Know
1. Definition of respiration:
What You Learned
1.

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Discover Activity

What Is a Product of Respiration?

1.  Put on your goggles. Fill two test tubes half full of warm water. Add 5 mL of sugar to one of the test tubes. Put the tubes in a test-tube rack.
2. Add 0.5 mL of dried yeast (a single-celled organism) to each tube. Stir the contents of each tube with a straw. Place a stopper snugly in the top of each tube.
3. Observe the two test tubes over the next 10 to 15 minutes.

Think It Over

Observing How can you account for any changes you observed?

You've been hiking all morning, and you are hungry. You get out the sandwich you packed and begin munching. Why does your body need food?

What Is Respiration?

Food supplies your body with glucose, an energy-rich 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.**

Storing and Releasing Energy Energy stored in cells is something like money in a savings account. During photosynthesis, plants capture energy from sunlight and “save” it in the form of carbohydrates, including sugars and starches. Similarly, when you eat, 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.

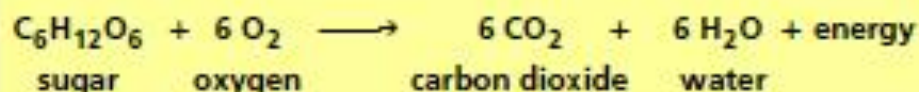
Breathing and Respiration The term *respiration* has two meanings. You have probably used it to mean “breathing,” that is, moving air in and out of your lungs. To avoid confusion, the respiration process that takes place inside cells is sometimes called cellular respiration. Breathing brings oxygen,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

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 16. 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.

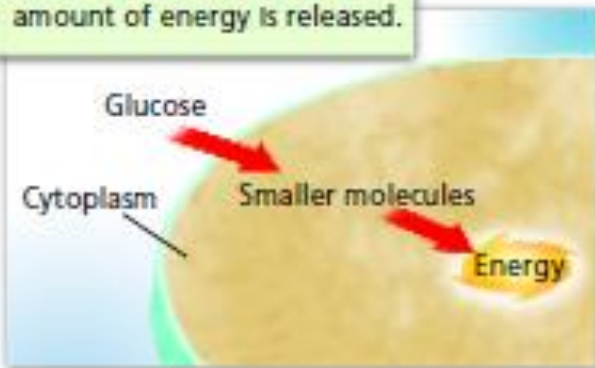
FIGURE 16

Two Stages of Respiration

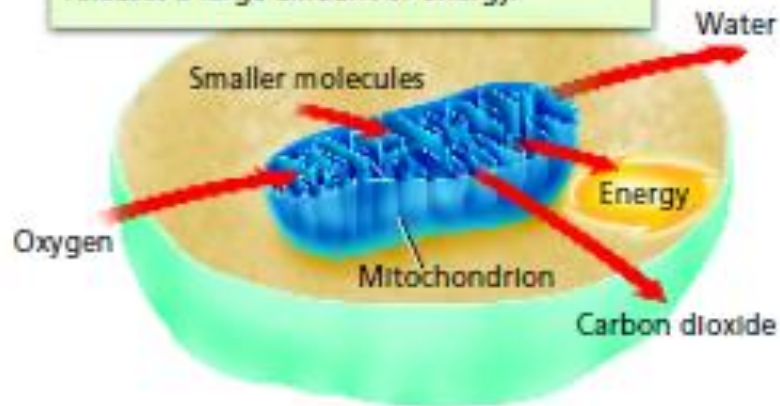
Respiration, like photosynthesis, takes place in two stages.

Interpreting Diagrams In which stage 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.



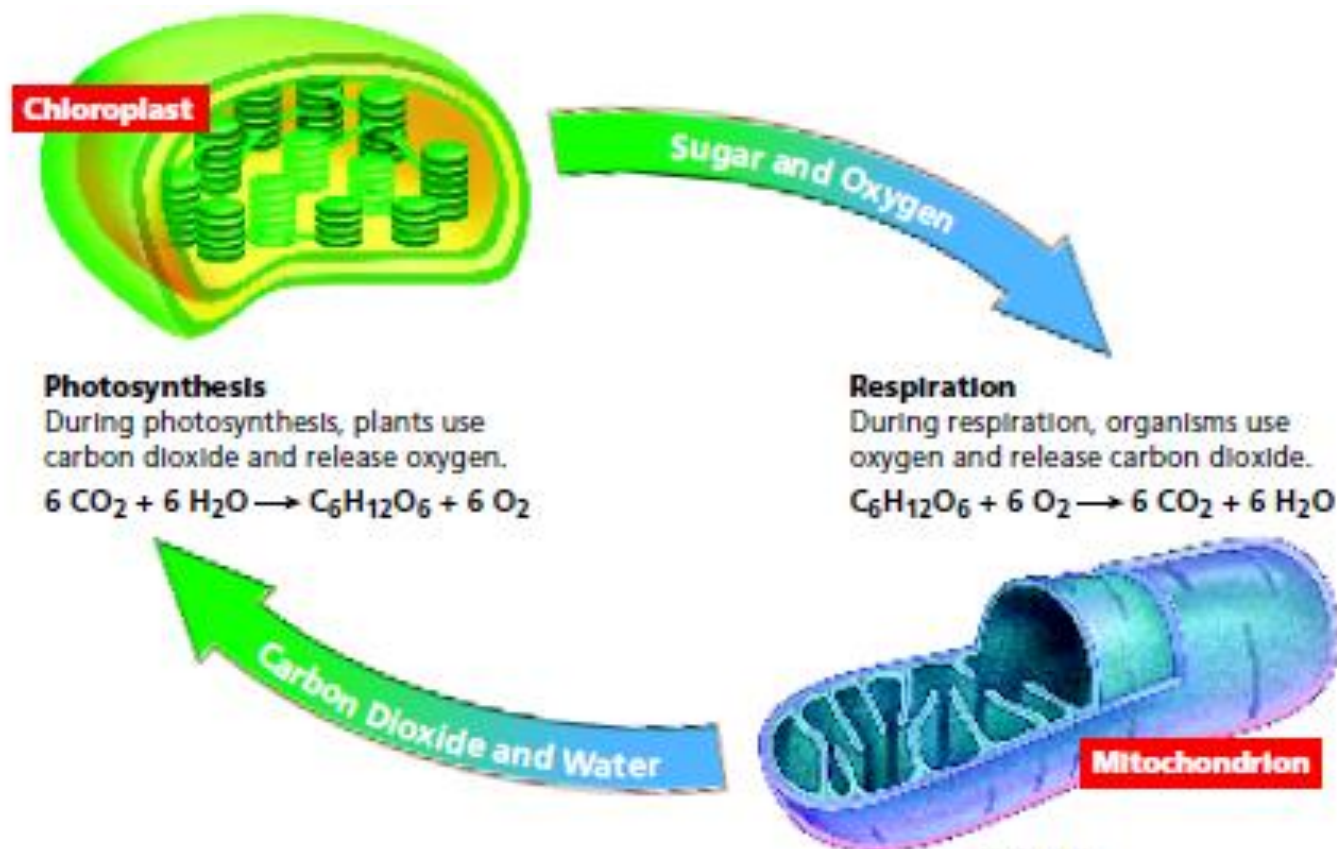


FIGURE 17

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 17, living things use both gases over and over again.



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.



FIGURE 18
Lactic Acid Fermentation
When an athlete's muscles run out of oxygen, lactic acid fermentation supplies the cells with energy.

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.

Alcoholic fermentation is 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.

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.

Section 4 Assessment

Target Reading Skill

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

Reviewing Key Concepts

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

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

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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.