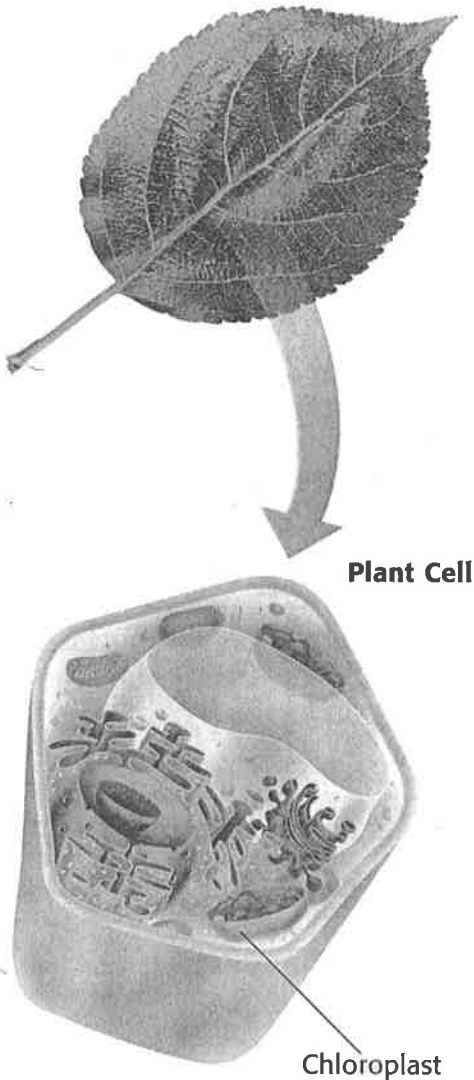


Terms to Learn

photosynthesis  
cellular respiration  
fermentation

What You'll Do

- ◆ Describe photosynthesis and cellular respiration.
- ◆ Compare cellular respiration with fermentation.

**From Sun to Cell**

Nearly all of the energy that fuels life comes from the sun. Plants are able to capture light energy from the sun and change it into food through a process called **photosynthesis**. The food that plants make supplies them with energy and also becomes a source of energy for the organisms that eat the plants. Without plants and other producers, consumers would not be able to live.

**Photosynthesis** Plants have molecules in their cells that absorb the energy of light. These molecules are called *pigments*. Chlorophyll, the main pigment used in photosynthesis, gives plants their green color. In the cells of plants, chlorophyll is found in chloroplasts, which are shown in **Figure 8**.

Plants use the energy captured by chlorophyll to change carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O) into food, the simple sugar glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>). Glucose is a carbohydrate. When plants make glucose, they are converting the sun's energy into a form of energy that can be stored. The energy in glucose is used by the plant's cells, and some of it may be stored in the form of other carbohydrates or lipids. Photosynthesis also produces oxygen (O<sub>2</sub>). Photosynthesis can be summarized by the following equation:



**Figure 8** During photosynthesis, plant cells use the energy in sunlight to make food (glucose) from carbon dioxide and water. Photosynthesis takes place in chloroplasts.

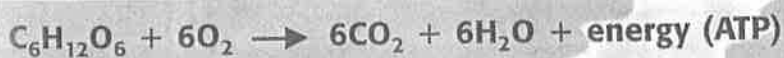
## Getting Energy from Food

The food you eat has to be broken down so that the energy it contains can be converted into a form your cells can use. In fact, all organisms must break down food molecules in order to release the stored energy. There are two ways to do this. One way uses oxygen and is called **cellular respiration**. The other way does not use oxygen and is called **fermentation**.

**Cellular Respiration** The word *respiration* means “breathing,” but cellular respiration is not the same thing as breathing. Breathing supplies your cells with the oxygen they need to perform cellular respiration. Breathing also rids your body of carbon dioxide, which is a waste product of cellular respiration.

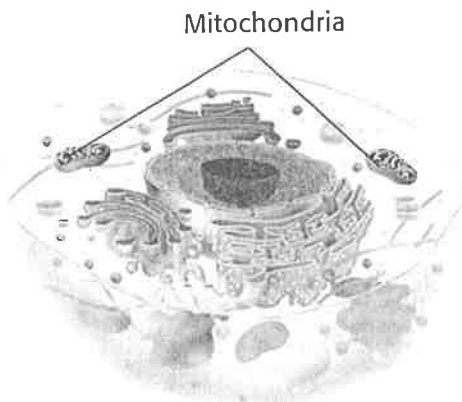
Most organisms, such as the cow in **Figure 9**, use cellular respiration to obtain energy from food. During cellular respiration, food (glucose) is broken down into  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , and energy is released. A lot of the energy is stored in the form of ATP. ATP is the molecule that supplies energy to fuel the activities of cells. Most of the energy released, however, is in the form of heat. In some organisms, including yourself, this heat helps to maintain the body’s temperature.

In the cells of eukaryotes, cellular respiration takes place in mitochondria. The process of cellular respiration is summarized in the equation below. Does this equation remind you of the equation for photosynthesis? The diagram on the next page shows how photosynthesis and respiration are related.



Glucose    Oxygen    Carbon dioxide    Water

Animal Cell



## Chemistry CONNECTION

When the Earth was young, its atmosphere lacked oxygen. The first forms of life used fermentation to gain energy. After organisms evolved the ability to photosynthesize, about 3 billion years ago, the oxygen they produced was added to the atmosphere.



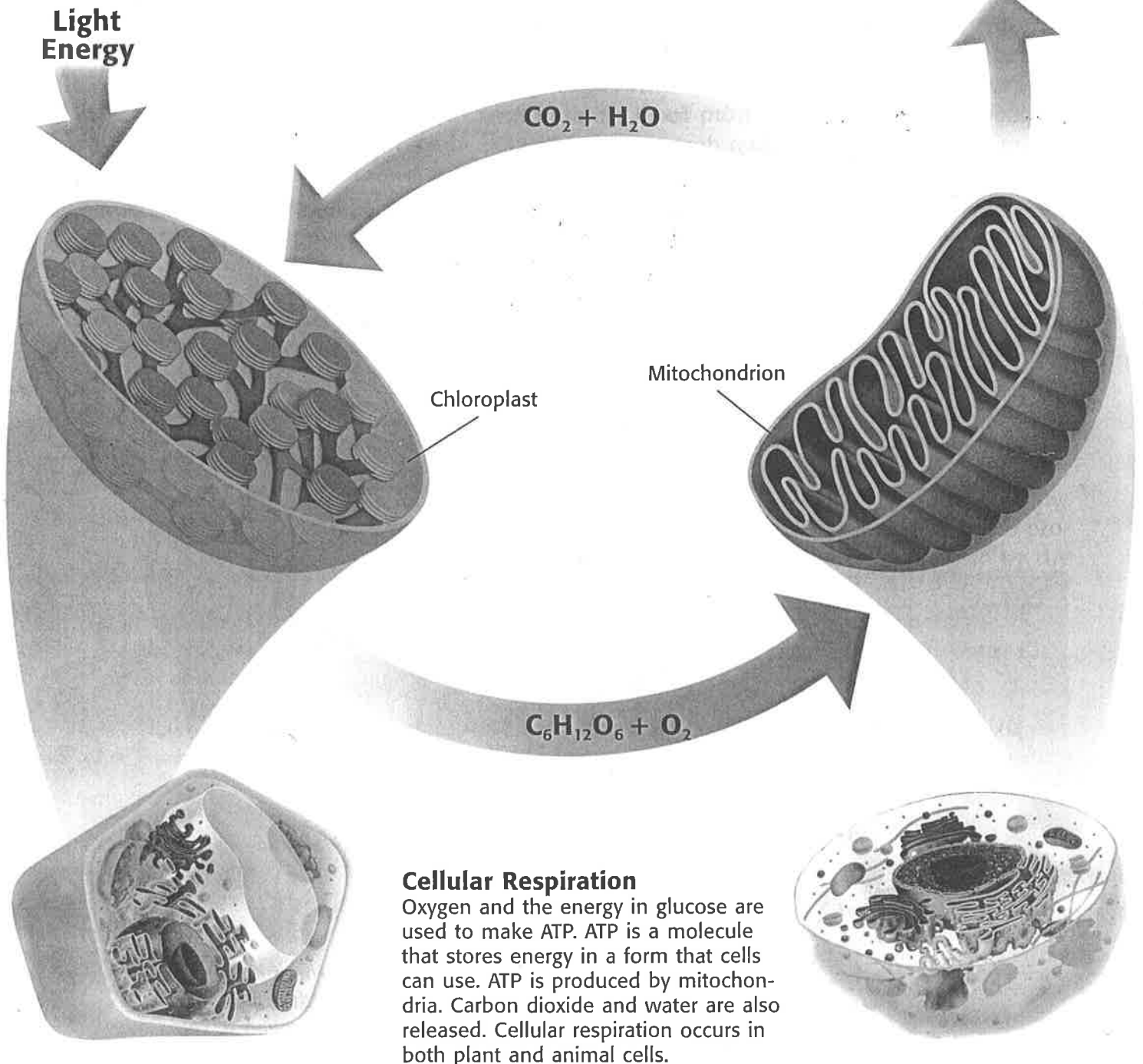
**Figure 9** The mitochondria in the cells of this cow will use cellular respiration to release the energy stored in the grass.

# Photosynthesis and Respiration: What's the Connection?

## Photosynthesis

Light energy, carbon dioxide, and water are used to make glucose in chloroplasts. Oxygen is released.

ATP

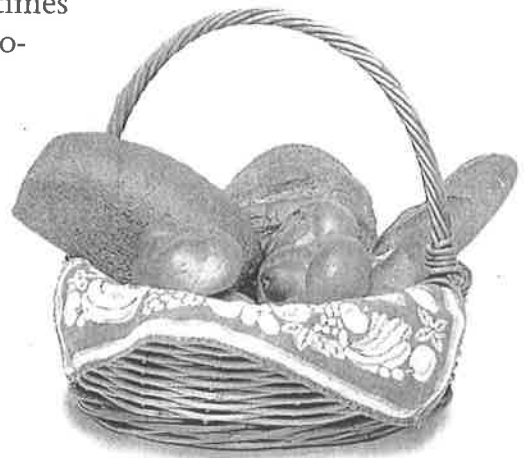


## Cellular Respiration

Oxygen and the energy in glucose are used to make ATP. ATP is a molecule that stores energy in a form that cells can use. ATP is produced by mitochondria. Carbon dioxide and water are also released. Cellular respiration occurs in both plant and animal cells.

**Fermentation** Have you ever run so far that you started to feel a burning sensation in your muscles? Well, sometimes your muscle cells can't get the oxygen they need to produce ATP by cellular respiration. When this happens, they use the process of fermentation. Fermentation leads to the production of a small amount of ATP and products from the partial breakdown of glucose.

There are two major types of fermentation. The first type occurs in your muscles. It produces lactic acid, which contributes to muscle fatigue after strenuous activity. This type of fermentation also occurs in the muscle cells of other animals and in some types of fungi and bacteria. The second type of fermentation occurs in certain types of bacteria and in yeast. This type of fermentation is described in **Figure 10**.

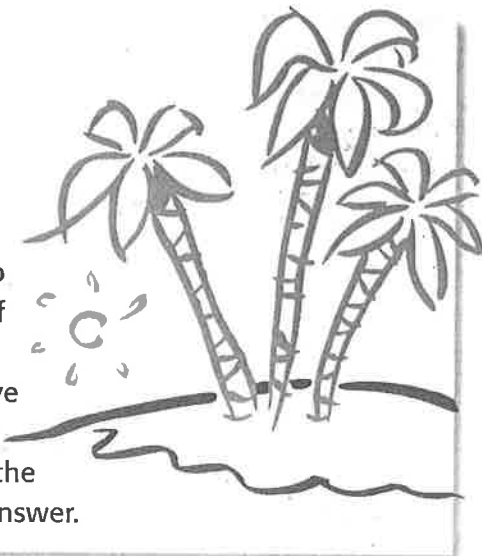


**Figure 10** Yeast cells make carbon dioxide and alcohol during the fermentation of sugar. The carbon dioxide causes bubbles to form in bread.

## APPLY

### Fantasy Island

You have been given the assignment of restoring life to a barren island. What types of organisms would you put on the island? If you want to have animals on the island, what other organisms must be on the island as well? Explain your answer.



## REVIEW

1. Why are producers important to the survival of all other organisms?
2. How do the processes of photosynthesis and cellular respiration relate to each other?
3. What does breathing have to do with cellular respiration?
4. How are respiration and fermentation similar? How are they different?
5. **Identifying Relationships** In which cells would you expect to find the greater number of mitochondria: cells that are very active or cells that are not very active? Why?

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