SECTION 1

Cell Energy

Key Concept All cells need energy to carry out cell functions. However, cells may obtain and process energy in different ways.

What You Will Learn

- In plant cells, chloroplasts capture energy from the sun in order to make food during photosynthesis.
- Cells release energy from food through either cellular respiration or fermentation.

Why It Matters

Understanding the differences in how plants and animals obtain energy is an important part of cell biology.

Vocabulary

- photosynthesis
- cellular respiration
- fermentation

READING STRATEGY

Graphic Organizer In your **Science Journal,** create a Cause-and-Effect Map about fermentation.

photosynthesis
(FOHT oh SIN thuh sis) the process by which plants, algae, and some bacteria use sunlight, carbon dioxide, and water to make food
Wordwise The root *phot-* means "light."

Wordwise **chloroplast**
The root *chlor-* means "green." The root *plast-* means "to form."

Why do you get hungry? Feeling hungry is your body's way of telling you that your cells need energy. All cells need energy to live, grow, and reproduce. Plant cells get their energy from the sun. Many animal cells get their energy from food.

From Sun to Cell

Nearly all of the energy that fuels life comes from the sun. Plants absorb energy from the sun and change the energy into food through a process called **photosynthesis.** The food that plants make gives them energy. This food also becomes a source of energy for the organisms that eat the plants.

Photosynthesis

Plant cells have molecules that absorb light energy. These molecules are called *pigments*. Chlorophyll (KLAWR uh FIL), the main pigment used in photosynthesis, gives plants their green color. Chlorophyll is found in *chloroplasts*.

Plants cannot use energy directly from the sun to perform life processes. Instead, they use the sun's energy to change carbon dioxide and water into food. The food is in the form of the simple sugar glucose. Glucose can be stored and used by the plant's cells. Photosynthesis also produces oxygen. The chemical equation for photosynthesis is shown in **Figure 1.**

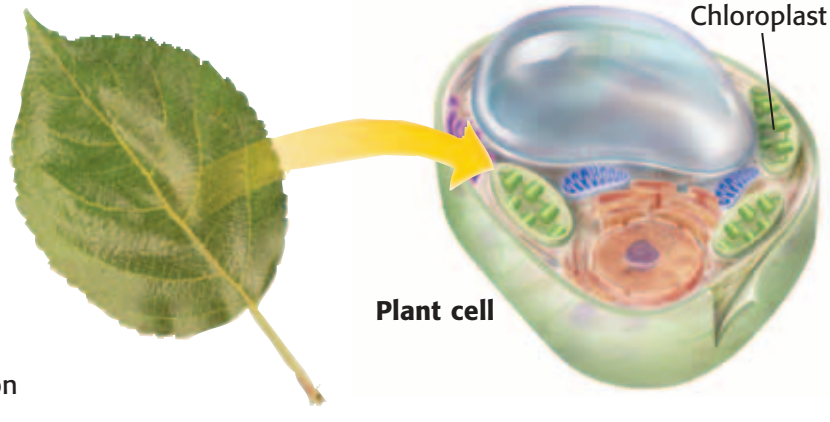
Standards Check What kind of cell has chloroplasts? 7.1.b

Figure 1 *Photosynthesis takes place in chloroplasts. Chloroplasts are found inside plant cells.*

Photosynthesis

$$6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Carbon dioxide — Water — Glucose — Oxygen



7.1.b Students know the characteristics that distinguish plant cells from animal cells, including chloroplasts and cell walls.
7.1.d Students know that mitochondria liberate energy for the work that cells do and that chloroplasts capture sunlight energy for photosynthesis.

Getting Energy from Food

Animal cells cannot make their own food. Animals must eat to get food. No matter how an organism gets food, the food must be broken down in the organism's cells in order to free the energy stored in the food. Even plant cells must break down the food that they make during photosynthesis.

Cells can break down food in two ways. The first way is **cellular respiration,** a process that uses oxygen. The second way does not use oxygen. This process is called **fermentation.** Cellular respiration releases more energy from food than fermentation does. Most complex organisms, such as plants and animals, get most of their energy through cellular respiration.

Cellular Respiration

The word *respiration* means "breathing," but cellular respiration is different from breathing. Cellular respiration is a chemical process that happens in cells. In prokaryotic cells, cellular respiration happens in the cell membrane. In eukaryotic cells, cellular respiration takes place mostly in the mitochondria.

During cellular respiration, food (such as glucose) is broken down into CO_2 and H_2O, and energy is liberated, or freed. In animals, most of the freed energy is used to keep a constant body temperature. Some of the energy is used to form **a**denosine **tri**phosphate (ATP). Molecules of ATP supply readily available energy that fuels cell activities, such as growth.

The process of cellular respiration is shown in **Figure 2.** Does the equation in the figure remind you of the equation for photosynthesis? On the next page, **Figure 3** shows how photosynthesis and respiration are related.

Standards Check **Where does the process of cellular respiration take place in eukaryotes, such as plants and animals?** 7.1.d

Quick Lab

Currency of the Cell

7.1.d

1. Some of the energy in food is converted into ATP, which can be used to perform cell functions. Examine the table that your teacher has drawn.
2. Use the chart's data to explain why ATP is referred to as the *energy currency of the cell.*
3. Why do you think that the number of ATP molecules varies so much?
4. If each glucose molecule can produce 36 ATP, how many molecules of glucose are needed to produce enough ATP to assemble the protein molecule in the chart?

10 min

cellular respiration (SEL yoo luhr RES puh RAY shuhn) the process by which cells use oxygen to produce energy from food

fermentation (fuhr muhn TAY shuhn) the breakdown of food without the use of oxygen

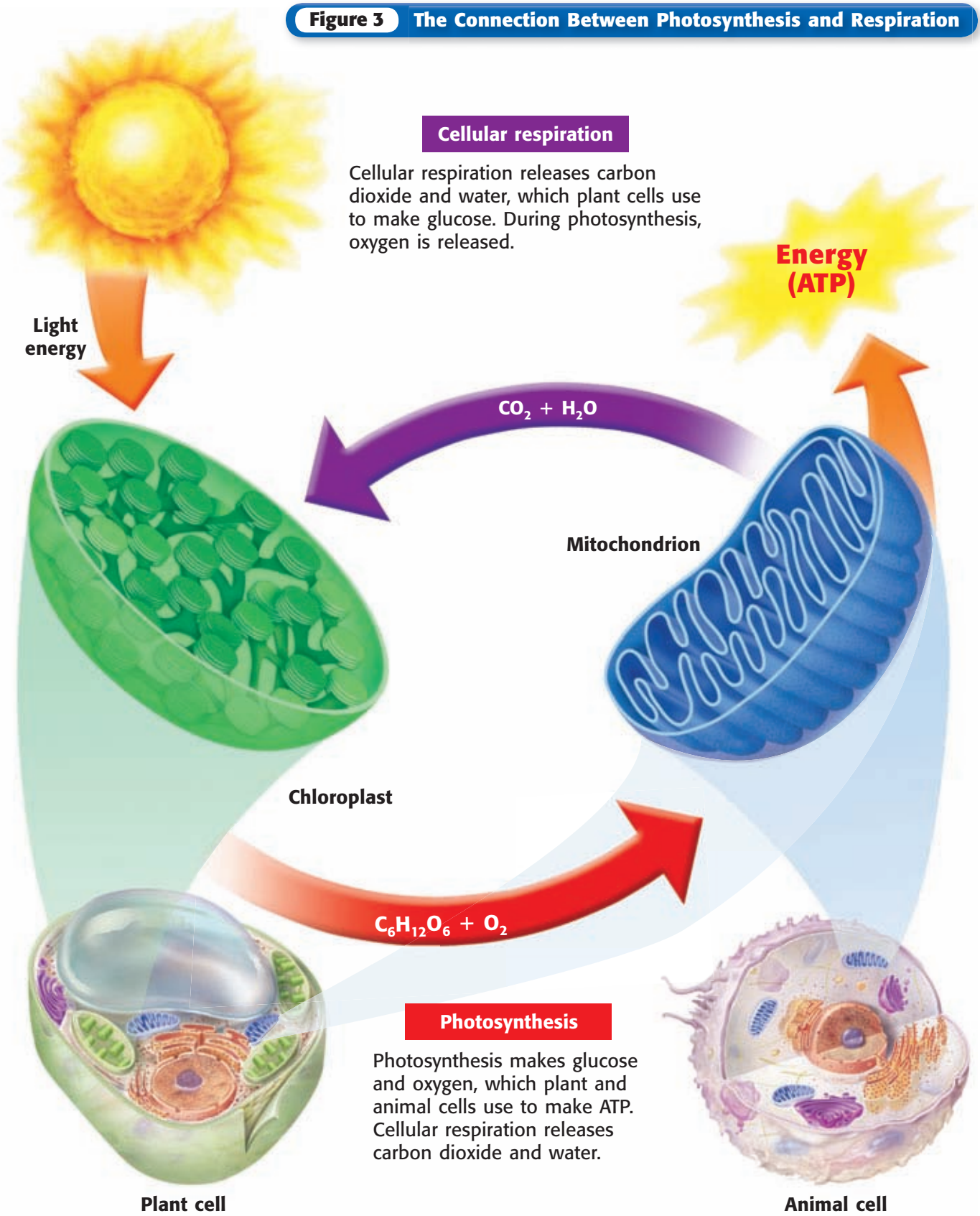
Cellular respiration

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ energy (ATP)

Glucose — Oxygen — Carbon dioxide — Water

Figure 2 *The mitochondria in the cells of this cow will use cellular respiration to release the energy stored in the grass.*

Figure 3 The Connection Between Photosynthesis and Respiration



Connection Between Photosynthesis and Respiration

As shown in **Figure 3,** photosynthesis changes CO_2 and H_2O into glucose. During photosynthesis, cells use energy from the sun to make glucose. The process also releases O_2. During cellular respiration, cells use O_2 to break down glucose and to free energy and CO_2. Each process makes the materials that are needed for the other process to occur.

Standards Check **List the products of cellular respiration.** 7.1.d

Fermentation

Have you ever had a burning feeling in your leg muscles while you were running? You may have these feelings during short, fast races. When muscle cells cannot get the oxygen that they need for cellular respiration, they use the process of fermentation to get energy. One kind of fermentation takes place in your muscles and makes lactic acid. The buildup of this acid leads to muscle fatigue and causes a burning feeling. This kind of fermentation also happens in the muscle cells of other animals and in some fungi and bacteria.

SCHOOL to HOME

Calories and Energy

Mitochondria in your cells change energy from the food that you eat into ATP. Packaged food lists the energy in food but not in units of ATP. Instead, the energy is listed as Calories. Ask an adult to help you find the number of Calories in each serving of your favorite food.

ACTIVITY

SECTION Review

7.1.b, 7.1.d

Summary

- Most of the energy that fuels life comes from the sun.
- The sun's energy is changed into food by the process of photosynthesis, which occurs in the chloroplasts of plant cells.
- Cellular respiration breaks down glucose into water, carbon dioxide, and energy.
- Cellular respiration takes place in the mitochondria of plant and animal cells.
- Fermentation is a way that cells get energy from their food without using oxygen.

Using Vocabulary

1. Write an original definition for *cellular respiration*.

Understanding Concepts

2. **Applying** How are photosynthesis and cellular respiration related?
3. **Concluding** What type of cell has chloroplasts? How do chloroplasts affect the functions of the cell?

Critical Thinking

4. **Analyzing Relationships** Why are plants important for the survival of other organisms?
5. **Predicting Consequences** What would happen to an animal if all of its mitochondria disappeared?

Math Skills

6. **Making Conversions** Cells of plant A make 120 molecules of glucose per hour. Cells of plant B make half as many molecules of glucose as cells of plant A do. How many molecules of glucose does plant B make per minute?

Challenge

7. **Applying Concepts** Your classmate suggests that chlorophyll is not the only pigment contained in plant cells. Is your classmate correct? Explain your answer.

Internet Resources

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Cell Energy; Photosynthesis

SciLinks code: HY70237; HY71140