SECTION 1

Photosynthesis

Key Concept Plants make food during photosynthesis and use the energy in the food during cellular respiration.

What You Will Learn

- Chloroplasts capture sunlight energy for photosynthesis.
- Photosynthesis is the process by which most plants make food.
- Mitochondria release the energy that cells use to do work.
- Cellular respiration allows living things, including plants, to use the products of photosynthesis.

Why It Matters

Most living things depend on the products of photosynthesis.

Vocabulary

- photosynthesis
- chlorophyll
- cellular respiration
- stoma
- transpiration

READING STRATEGY

Brainstorming The main idea of this section is that photosynthesis is a complicated but important process. Brainstorm words and phrases related to photosynthesis. Record your work in your **Science Journal.**

Plants do not have lungs. But like you, plants need air. Air contains oxygen, carbon dioxide, and other gases. Your body needs oxygen, and plants need oxygen. But what other gas is important to plants?

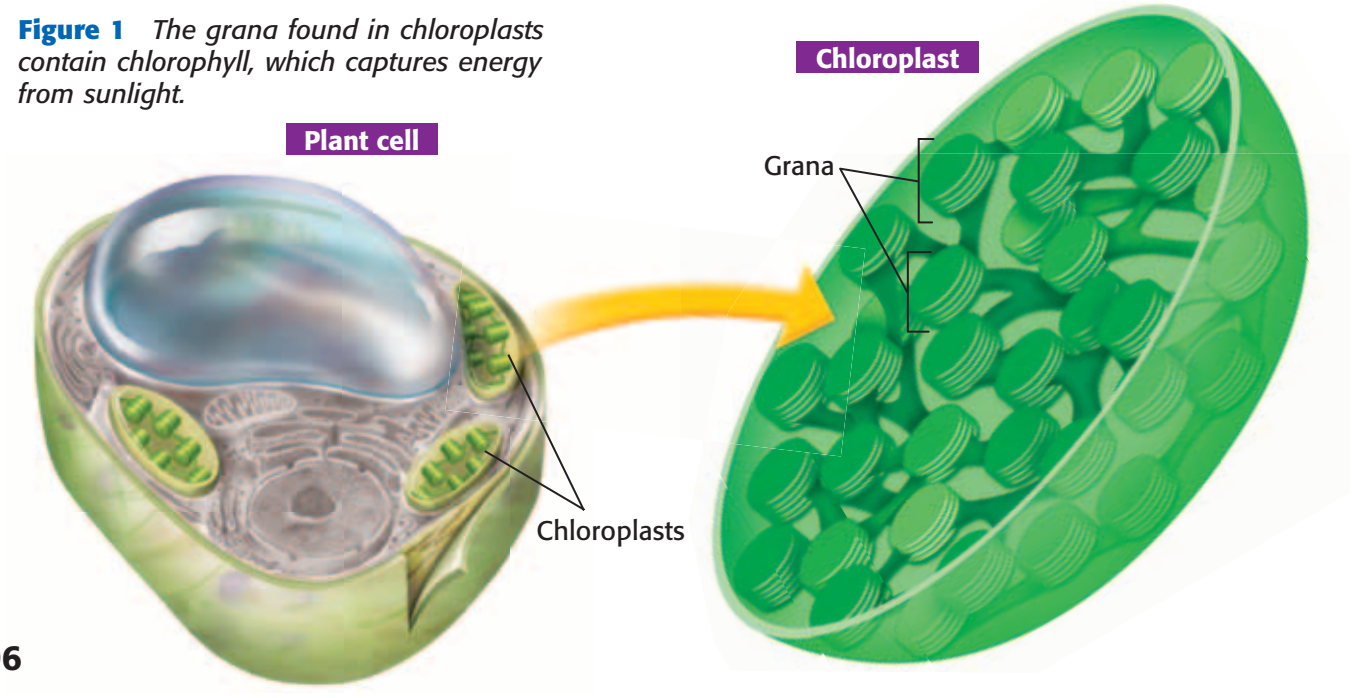
If you guessed *carbon dioxide,* you are correct. Plants use carbon dioxide for photosynthesis. **Photosynthesis** is the process by which plants make their own food. Plants capture energy from sunlight during photosynthesis. This energy is used to make the sugar glucose, $C_6H_{12}O_6$, from carbon dioxide, CO_2, and water, H_2O.

Capturing Light Energy

Plant cells have organelles called *chloroplasts* (KLAWR uh PLASTS), shown in **Figure 1.** Chloroplasts are the parts of plant cells that capture energy from sunlight for photosynthesis. Two membranes surround each chloroplast. Inside the chloroplast, another membrane forms stacks called *grana* (GRAY nuh). Grana contain **chlorophyll,** a green pigment that absorbs light energy. Because it reflects the green wavelengths of sunlight, chlorophyll looks green. Every green part of a plant looks green because of the presence of chloroplasts and the pigment chlorophyll.

Standards Check **What organelle captures energy from sunlight? Is this organelle present in animal cells?** 7.1.b, 7.1.d

Figure 1 *The grana found in chloroplasts contain chlorophyll, which captures energy from sunlight.*



Making Sugar

The light energy captured by chlorophyll is used to help form glucose molecules. Glucose is a simple sugar that plants use for food. In turn, plant cells give off oxygen gas, O_2. Photosynthesis is a complicated process made up of many steps. But it can be summarized by the following chemical equation:

$$6CO_2 + 6H_2O \xrightarrow{\textit{light energy}} C_6H_{12}0_6 + 6O_2$$

Six molecules of carbon dioxide and six molecules of water are needed to form one molecule of glucose and six molecules of oxygen. **Figure 2** shows where plants get the materials for photosynthesis.

photosynthesis (FOHT oh SIN thuh sis) the process by which plants, algae, and some bacteria use sunlight, carbon dioxide, and water to make food

chlorophyll (KLAWR uh FIL) a green pigment that captures light energy for photosynthesis

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

Getting Energy from Sugar

Glucose molecules store energy. Plant cells use this energy for their life processes. Mitochondria release the energy stored in glucose, which plant cells use to do work. To get energy, mitochondria in plant cells break down glucose and other food molecules in a process called **cellular respiration.** During this process, plant cells use oxygen and give off carbon dioxide and water. Excess glucose is converted into another sugar called *sucrose* or is stored as starch.

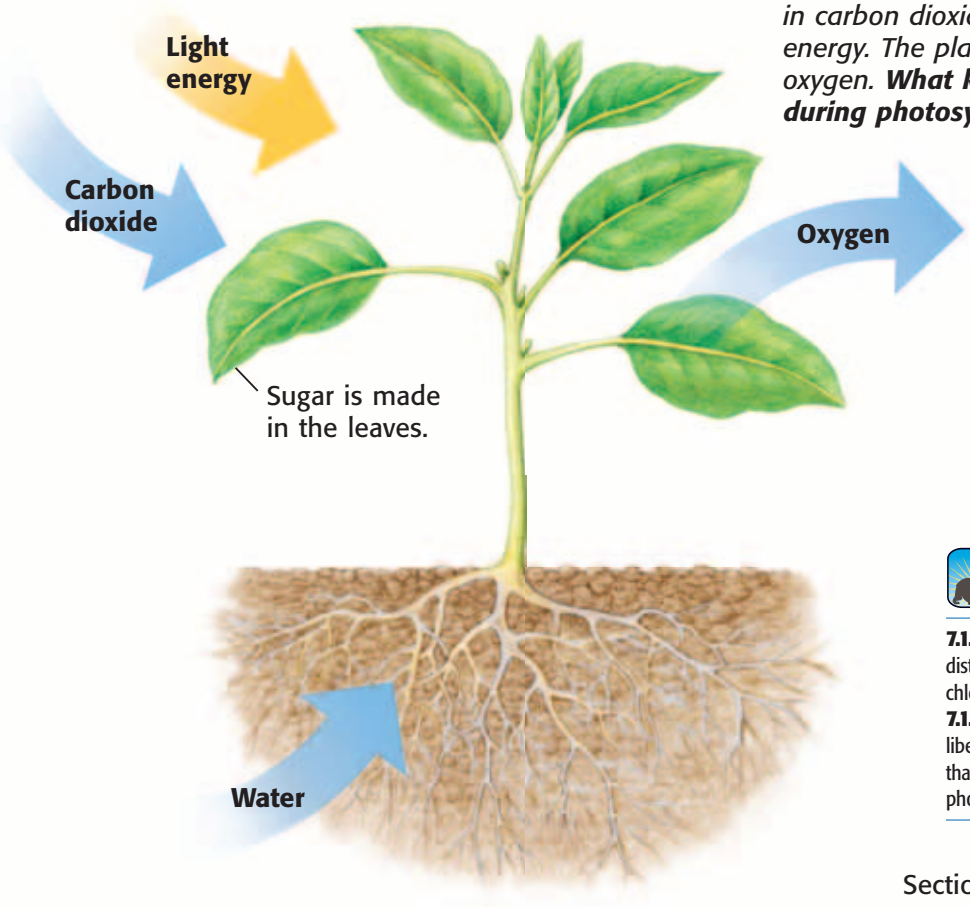
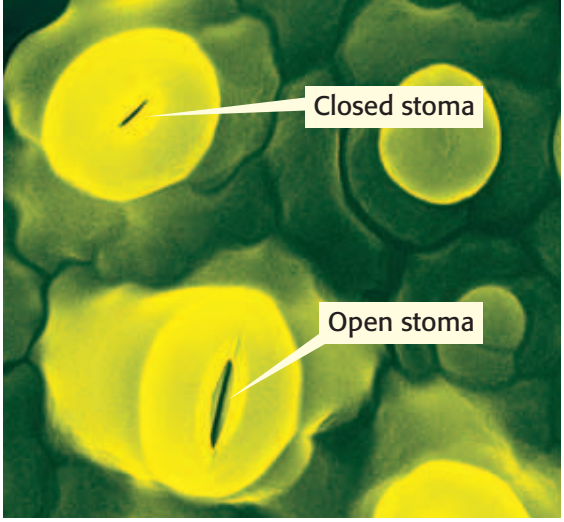


Figure 2 *During photosynthesis, plants take in carbon dioxide and water and absorb light energy. The plants make sugar and release oxygen.* ***What kind of sugar do plants make during photosynthesis?***

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.



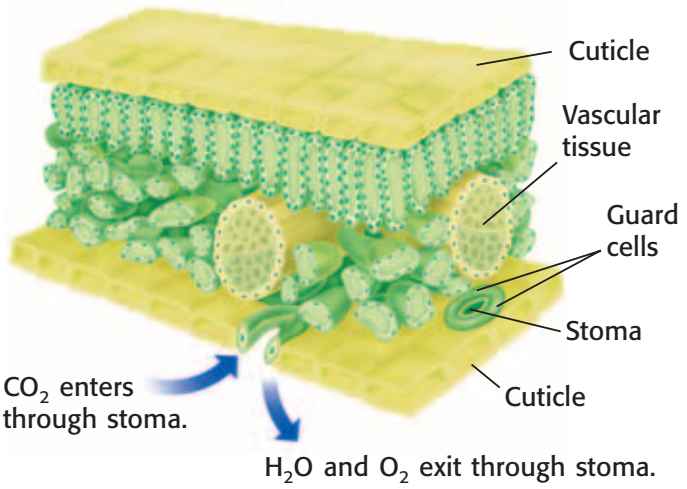


Figure 3 *When light is available for photosynthesis, the stomata are usually open. At nighttime, the stomata close to conserve water.*

Gas Exchange

A waxy cuticle covers much of the above-ground outer surfaces of a plant. The cuticle protects the plant from water loss. How does a plant get carbon dioxide through this barrier? Carbon dioxide enters the plant's leaves through stomata (singular, *stoma*). A **stoma** is an opening in the epidermis and cuticle of a leaf. Each stoma is surrounded by two *guard cells*. The guard cells act like double doors by opening and closing the stoma. Stomata are shown in **Figure 3.**

stoma (STOH muh) one of many openings in a leaf or a stem of a plant that enable gas exchange to occur (plural, *stomata*)

transpiration (TRAN spuh RAY shuhn) the process by which plants release water vapor into the air through stomata

When stomata are open, carbon dioxide enters the leaf. The oxygen produced during photosynthesis exits the leaf through the stomata. Water vapor also exits the leaf in this way. The loss of water through leaves is called **transpiration.** Most of the water absorbed by a plant's roots replaces the water lost during transpiration. Sometimes, the amount of water lost through a plant's leaves is greater than the amount of water absorbed by the plant's roots. As a result, the plant wilts.

Quick Lab

Measuring Gas Exchange in Plants

7.1.d
7.7.c

1. Obtain **4 jars** from your teacher. Label two of the jars with your last name and the letter *A.* Label the other 2 jars with your last name and the letter *B.*
2. Fill each jar with **bromothymol-blue (BTB) solution.**
3. Place a **small piece of elodea** in one of the jars labeled "A" and one of the jars labeled "B."
4. Carefully place the lids on the jars so that no air bubbles form.
5. Place the two jars labeled "A" in a dark place.
6. Place the two jars labeled "B" in a sunny place.
7. The next day, observe your jars. Record your observations.
8. When it turns yellow, BTB indicates the presence of carbon dioxide. Use this fact to explain what happened inside the jars.
9. What role did the jars without elodea play in this experiment?

15 min plus follow-up

The Importance of Photosynthesis

Plants and other photosynthetic organisms, such as some bacteria and many protists, form the base of nearly all food chains on Earth. An example of one food chain is shown in **Figure 4.** During photosynthesis, plants store light energy as chemical energy. Some animals use this chemical energy when they eat plants. Other animals get energy from plants indirectly. These animals eat animals that eat plants. Most organisms could not survive without photosynthetic organisms.

Plants, animals, and most other organisms depend on cellular respiration to get energy. Cellular respiration requires oxygen. Oxygen is a byproduct of photosynthesis. So, photosynthesis provides the oxygen that animals and plants need for cellular respiration.

Standards Check **What are two ways in which the products of photosynthesis are important?** 7.1.d

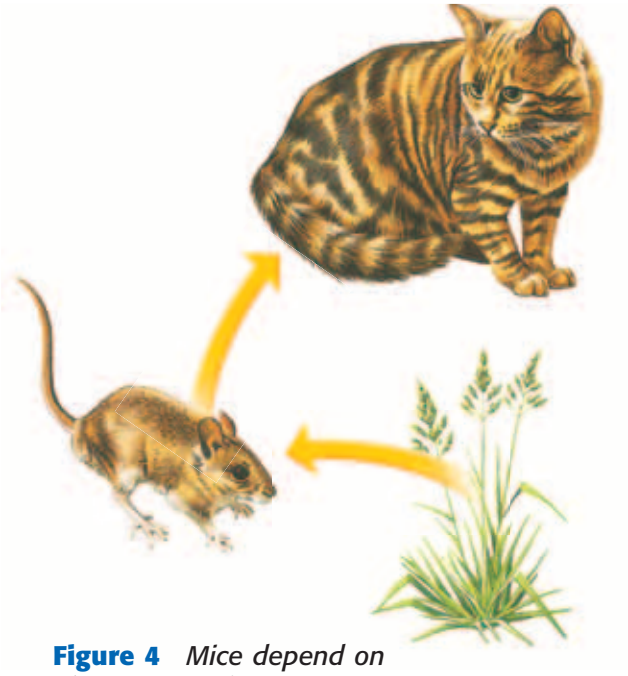


Figure 4 *Mice depend on plants for food. In turn, cats get energy from mice.*

SECTION **Review**

7.1.b, 7.1.d

Summary

- Chloroplasts and mitochondria are important organelles in plant cells.
- During photosynthesis, plants use energy from sunlight, carbon dioxide, and water to make glucose and oxygen.
- Plants get energy from food by cellular respiration, which uses oxygen and releases carbon dioxide and water.
- Transpiration, or the loss of water through the leaves of plants, occurs when stomata are open.

Understanding Concepts

1. **Describing** What do chloroplasts and mitochondria do?
2. **Comparing** What is the relationship between cellular respiration and photosynthesis?
3. **Identifying** How do plants take in and give off gases?

Critical Thinking

INTERPRETING GRAPHICS Use the image below to answer the next question.

4. **Predicting Consequences** What would happen if the structure above was not present in plant cells?
5. **Predicting Consequences** Predict what might happen if plants and other photosynthetic organisms disappeared.
6. **Applying Concepts** Why are animals not able to perform photosynthesis? In what ways do animals depend on plants?

Math Skills

7. **Solving Problems** Plants use 6 carbon dioxide molecules and 6 water molecules to make 1 glucose molecule. How many carbon dioxide and water molecules are needed to make 12 glucose molecules?

Internet Resources

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

Topic: Photosynthesis

SciLinks code: HY71140