

# Cycles of Matter

## Reading Preview

### Key Concepts

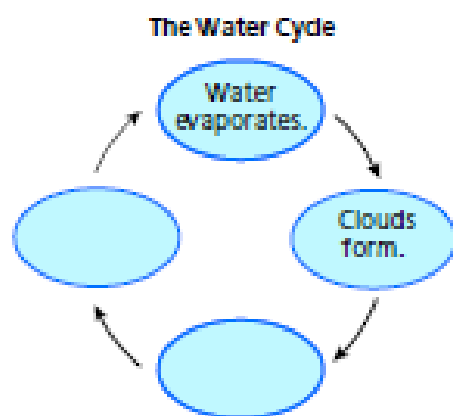
- What processes are involved in the water cycle?
- How are carbon and oxygen recycled in ecosystems?
- What is the nitrogen cycle?

### Key Terms

- water cycle • evaporation
- condensation • precipitation
- nitrogen fixation

## Target Reading Skill

**Sequencing** A sequence is the order in which a series of events occurs. As you read, make a cycle diagram that shows the water cycle. Write each event of the water cycle in a separate oval.

Lab  
zone

## Discover Activity

### Are You Part of a Cycle?

1. Hold a small mirror a few centimeters from your mouth.
2. Exhale onto the mirror.
3. Observe the surface of the mirror.

### Think It Over

**Inferring** What is the substance that forms on the mirror? Where did this substance come from?



A pile of crumpled cars is ready for loading into a giant compactor. The aluminum and copper pieces have already been removed so that they can be recycled, or used again. Now the steel will be reclaimed at a recycling plant. Earth has a limited supply of aluminum, copper, and the iron used in steel. Recycling old cars is one way to ensure a steady supply of these materials.

Like the supply of metal for building cars, the supply of matter in an ecosystem is limited. Matter in an ecosystem includes water, carbon, oxygen, nitrogen, and many other substances. If matter could not be recycled, ecosystems would quickly run out of the raw materials necessary for life. In this section, you will learn about some cycles of matter: the water cycle, the carbon and oxygen cycles, and the nitrogen cycle.

To understand how these substances cycle over and over through an ecosystem, you need to know a few basic terms that describe the structure of matter. Matter is made up of tiny particles called atoms. Two or more atoms that are joined and act as a unit make up a molecule. For example, a water molecule consists of two hydrogen atoms and one oxygen atom.

## The Water Cycle

Water is essential for life. To ensure a steady supply, Earth's water must be recycled. The **water cycle** is the continuous process by which water moves from Earth's surface to the atmosphere and back. **The processes of evaporation, condensation, and precipitation make up the water cycle.** As you read about these processes, follow the cycle in Figure 5.

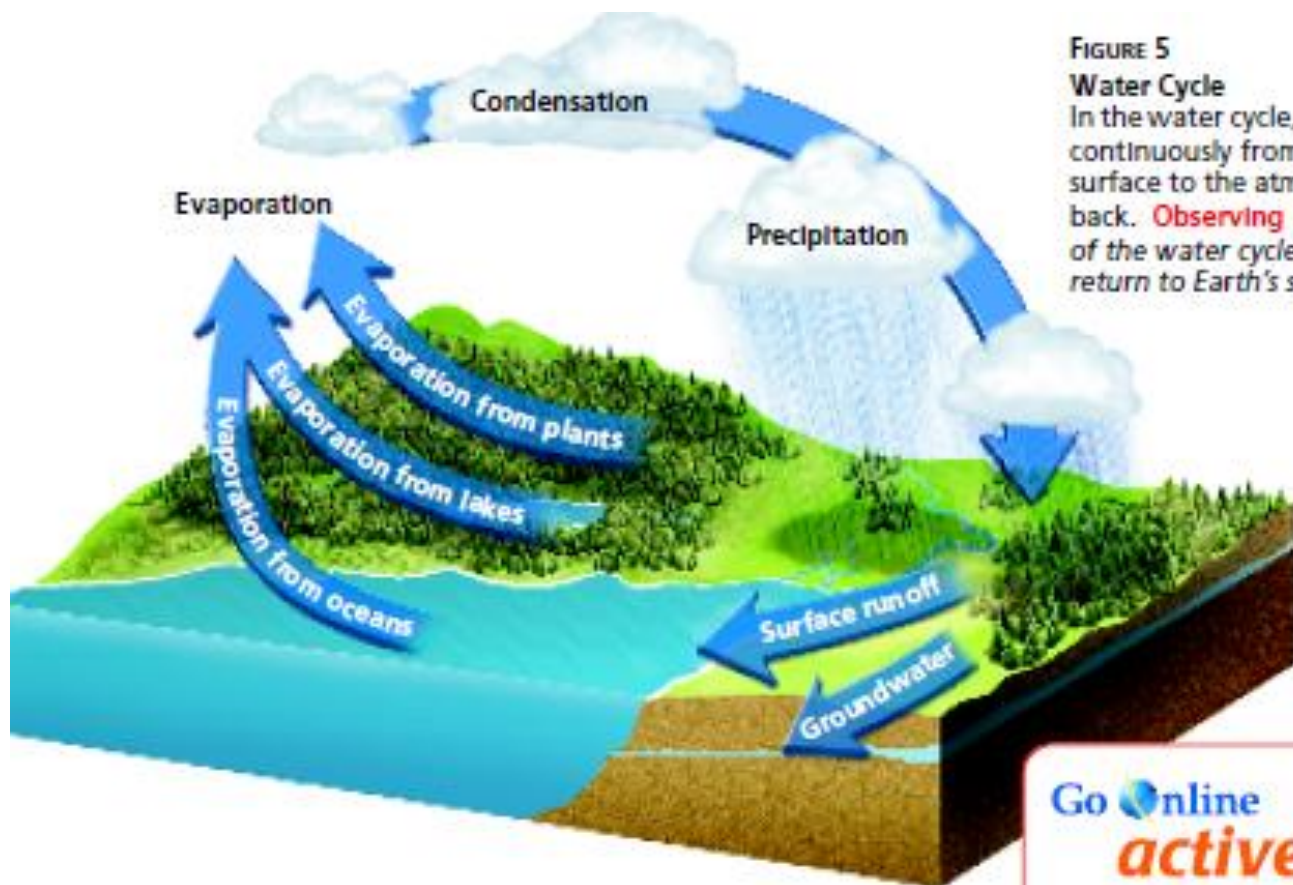


FIGURE 5

### Water Cycle

In the water cycle, water moves continuously from Earth's surface to the atmosphere and back. **Observing** In which step of the water cycle does water return to Earth's surface?

Go **online**  
**active art**

For: Water Cycle activity  
Visit: [PHSchool.com](http://PHSchool.com)  
Web Code: cfp-4024

**Evaporation** The process by which molecules of liquid water absorb energy and change to a gas is called **evaporation**. In the water cycle, liquid water evaporates from oceans, lakes, and other surfaces and forms water vapor, a gas, in the atmosphere. The energy for evaporation comes from the heat of the sun.

Living things also give off water. For example, plants release water vapor from their leaves. You release liquid water in your wastes and water vapor when you exhale.

**Condensation** As the water vapor rises higher in the atmosphere, it cools down. The cooled vapor then turns back into tiny drops of liquid water. The process by which a gas changes to a liquid is called **condensation**. The water droplets collect around particles of dust, eventually forming clouds.

**Precipitation** As more water vapor condenses, the drops of water in the cloud grow larger. Eventually the heavy drops fall back to Earth as **precipitation**—rain, snow, sleet, or hail. Most precipitation falls back into oceans or lakes. The precipitation that falls on land may soak into the soil and become groundwater. Or the precipitation may run off the land, eventually flowing back into a river or ocean.



What process causes water from the surface of the ocean to enter the atmosphere as water vapor?


### Lab zone Skills Activity

#### Developing Hypotheses

You've decided to have cocoa at a friend's house on a cold, rainy day. As your friend boils some water, you notice that the inside of a window near the stove is covered with water droplets. Your friend thinks the window is leaking. Using what you know about the water cycle, can you propose another explanation for the water droplets?

## Carbon and Oxygen Blues

This activity explores the role of producers in the carbon and oxygen cycles.

1.  Your teacher will provide you with two plastic cups containing bromthymol blue solution. Bromthymol blue solution appears blue in the absence of carbon dioxide and appears yellow in the presence of carbon dioxide. Note the color of the solution.
2. Place two sprigs of an *Elodea* plant into one of the cups. Do not put any *Elodea* into the second cup. Cover both cups with plastic wrap. Wash your hands.
3. Place the cups where they will not be disturbed. Observe the two cups over the next few days. Note any color changes.

**Inferring** What do your observations indicate about the role of producers in the carbon and oxygen cycles?

## The Carbon and Oxygen Cycles

Two other substances necessary for life are carbon and oxygen. Carbon is an essential building block in the bodies of living things. Most organisms use oxygen for their life processes. In ecosystems, the processes by which carbon and oxygen are recycled are linked. Producers, consumers, and decomposers play roles in recycling carbon and oxygen.

**The Carbon Cycle** Producers take in carbon dioxide gas from the air during photosynthesis. They use carbon from the carbon dioxide to make food molecules—carbon-containing molecules such as sugars and starches. When consumers eat producers, they take in the carbon-containing food molecules. When consumers break down these food molecules to obtain energy, they release carbon dioxide and water as waste products. When producers and consumers die, decomposers break down their remains and return carbon compounds to the soil. Some decomposers also release carbon dioxide as a waste product.

**The Oxygen Cycle** Like carbon, oxygen cycles through ecosystems. Producers release oxygen as a result of photosynthesis. Most organisms take in oxygen from the air and use it to carry out their life processes.

**Human Impact** Human activities also affect the levels of carbon and oxygen in the atmosphere. When humans burn oil and other fuels, carbon dioxide is released into the atmosphere. When humans clear forests for lumber, fuel, and farmland, carbon dioxide levels also rise. As you know, producers take in carbon dioxide during photosynthesis. When trees are removed from the ecosystem, there are fewer producers to absorb carbon dioxide. There is a greater effect if trees are burned down to clear a forest. If trees are burned down to clear a forest, additional carbon dioxide is released in the burning process.



What role do producers play in the carbon and oxygen cycles?

**FIGURE 6**  
**Rising Carbon Dioxide Levels**  
When forests burn, large amounts of carbon dioxide are released into the air. In addition, there are fewer trees available to absorb carbon dioxide from the air.



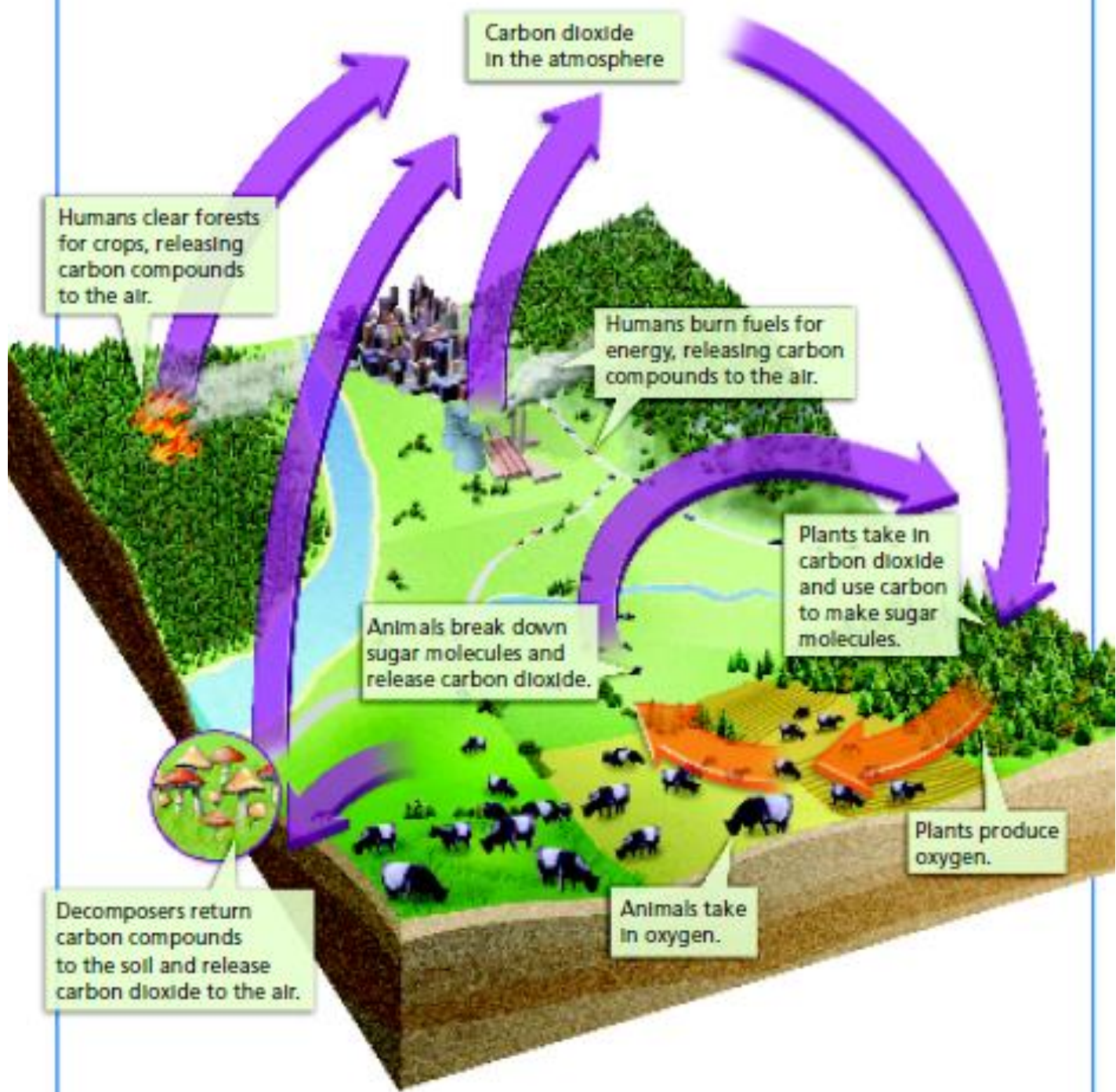


FIGURE 7

## Carbon and Oxygen Cycles

This scene shows how the carbon and oxygen cycles are linked. Producers, consumers, and decomposers all play a role in recycling these two substances.

**Interpreting Diagrams** How do human activities affect the carbon and oxygen cycles?





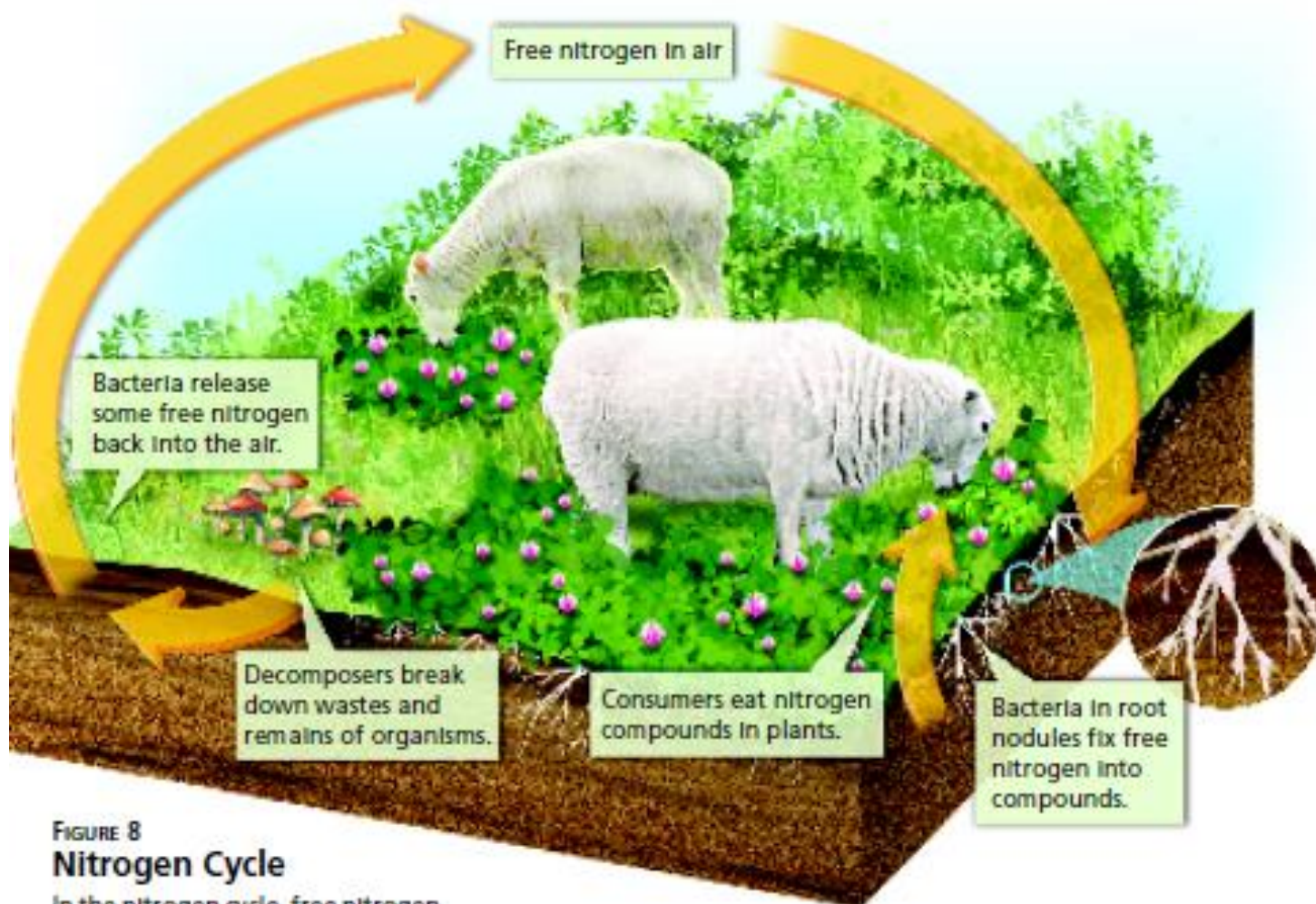


FIGURE 8  
**Nitrogen Cycle**

In the nitrogen cycle, free nitrogen from the air is fixed into compounds. Consumers can then use these nitrogen compounds in carrying out their life processes.

**Relating Cause and Effect** How does nitrogen get returned to the environment?

## The Nitrogen Cycle

Like carbon, nitrogen is a necessary building block in the matter that makes up living things. **In the nitrogen cycle, nitrogen moves from the air to the soil, into living things, and back into the air.** You can follow this process in Figure 8.

Since the air around you is about 78 percent nitrogen gas, you might think that it would be easy for living things to obtain nitrogen. However, most organisms cannot use nitrogen gas. Nitrogen gas is called “free” nitrogen because it is not combined with other kinds of atoms.

**Nitrogen Fixation** Most organisms can use nitrogen only once it has been “fixed,” or combined with other elements to form nitrogen-containing compounds. The process of changing free nitrogen into a usable form of nitrogen is called **nitrogen fixation**. Most nitrogen fixation is performed by certain kinds of bacteria. Some of these bacteria live in bumps called nodules (NAHJ oolz) on the roots of certain plants. These plants, known as legumes, include clover, beans, peas, alfalfa, and peanuts.



The relationship between the bacteria and the legumes is an example of mutualism. Both the bacteria and the plant benefit from this relationship: The bacteria feed on the plant's sugars, and the plant is supplied with nitrogen in a usable form.

### Return of Nitrogen to the Environment

Once nitrogen has been fixed, organisms can use it to build proteins and other complex compounds. Decomposers, in turn, break down these complex compounds in animal wastes and the bodies of dead organisms. Decomposition returns simple nitrogen compounds to the soil. Nitrogen can cycle from the soil to producers and consumers many times. At some point, however, bacteria break down the nitrogen compounds completely. These bacteria then release free nitrogen back into the air. The cycle continues from there.

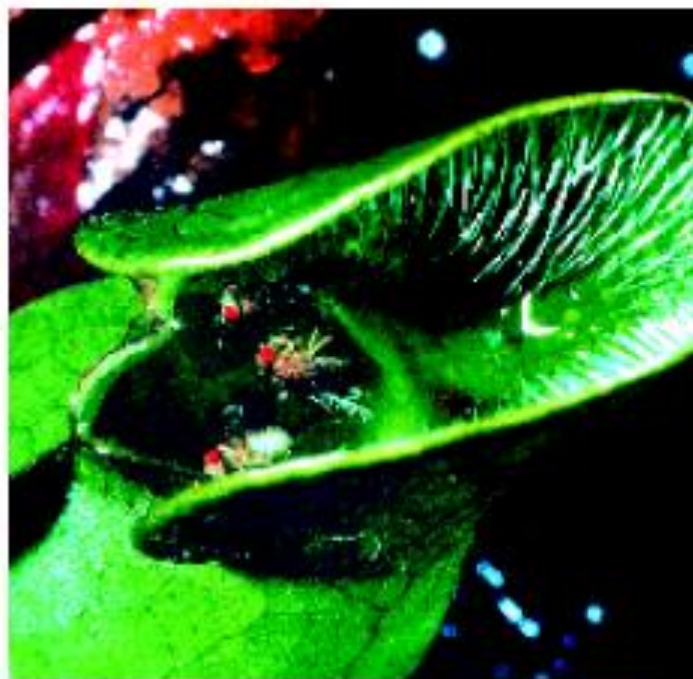


Where do some nitrogen-fixing bacteria live?

FIGURE 9

### Growth in Nitrogen-Poor Soil

Pitcher plants can grow in nitrogen-poor soil because they have another way of obtaining nitrogen. Insects become trapped in the plant's tube-shaped leaves. The plant then digests the insects and uses their nitrogen compounds for its functions.



## Section 2 Assessment

**Target Reading Skill Sequencing** Refer to your cycle diagram about the water cycle as you answer Question 1.

### Reviewing Key Concepts

1. a. **Defining** Name and define the three major processes that occur during the water cycle.  
b. **Making Generalizations** Defend this statement: The sun is the driving force behind the water cycle.
2. a. **Reviewing** Which two substances are linked in one recycling process?  
b. **Comparing and Contrasting** What role do producers play in the carbon and oxygen cycles? What role do consumers play in these cycles?  
c. **Developing Hypotheses** How might the death of all the producers in a community affect the carbon and oxygen cycles?
3. a. **Reviewing** Why do organisms need nitrogen?  
b. **Sequencing** Outline the major steps in the nitrogen cycle.  
c. **Predicting** What might happen in a community if all the nitrogen-fixing bacteria died?

### Writing in Science

**Comic Strip** Choose one of the cycles discussed in this section. Then draw a comic strip with five panels that depicts the important events in the cycle. Remember that the last panel must end with the same event that begins the first panel.