Lesson 7: Oxygen Production and Life

☐ Getting Started

In Lesson 6, you learned about three major cycles — water, nitrogen, and carbon. In this lesson, you will look at oxygen and at the role of plant and animal processes that are important for the survival of an ecosystem. Oxygen is located in three **reservoirs** (places where something is kept in store): the atmosphere (air), all biological matter, and the Earth's crust. While each of these reservoirs is significant, this lesson will focus primarily on oxygen in the atmosphere. The major source of atmospheric oxygen is photosynthesis.

In this lesson, you will begin to see how oxygen, which is necessary for life, is produced at the levels required for all organisms to survive. In order to understand oxygen's significance, you will have to consider two important processes in living organisms — photosynthesis and cellular respiration — which both require oxygen. Respiration requires oxygen to break chemical bonds and release energy. Photosynthesis produces oxygen as a by-product. As you go through this lesson, consider how there always seems to be enough oxygen. Ask this question: if oxygen is constantly being used, how is enough present for all living things?

Stuff You Need

- ✓ scissors* (Activity 1 - Option 2)

Ideas to Think About

- How do relationships between living and non-living components of an ecosystem enable the system to sustain itself?
- How do Earth cycles ensure the survival of an ecosystem?

Things to Know

- A **reservoir** is a place where something is kept in store.
- A **depletion** is a serious decrease or exhaustion of the abundance or supply of something.
- **Cellular respiration** is a process in all living things where stored energy is released by the breaking of chemical bonds to produce energy for survival.
- **Glucose** is an energy source produced by the process of photosynthesis. Glucose contains carbon, hydrogen, and oxygen.

☐ Reading and Questions

Review pp. 8-10 in the *Exploring Ecology* booklet. As you read, pay attention to the roles of oxygen and carbon dioxide in photosynthesis. A common idea is that plants ar the primary producers of energy. While this is true, plants also release oxygen and water back into the environment. As you read, consider the important role that plants play in releasing oxygen and water into the environments in which they are found.

1. By what process do plants utilize carbon dioxide and water and release oxygen?

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2. What will happen if the process of photosynthesis stops in a plant? In all plants?

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3. In what way might the release of oxygen back into the environment be harmful to a plant that is found in a dry region (HINT: Consider how a plant produces oxygen)?

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4. Consider the energy pyramid (p. 10). Why do you think it is important that the base of the pyramid (plants) contain the most abundant organisms? How does this relate to the cycling of oxygen?

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Exploring Ecology
www.movingbeyondthepage.com/link/4972/

Activities

☐ Activity 1: Necessary and Interdependent

In this activity, you will explore the importance of photosynthesis and **cellular respiration** and the relationships between them. Ask your parent which option to complete.

Option 1

Consider the following equations. To help reinforce the contents of each equation, write them on the "Equations" page. Next, answer the questions at the top of the "Questions to Consider and Scenario Response" page and then read the scenario at the bottom of the page and answer that question. Part of this activity will require you to make connections based on the information in the equations, so use the "Equations" page if you need to refer to either equation. Feel free to refer back to the readings to answer the questions for this lesson.

As you consider the questions, it is important for you to recognize that the questions are designed for you to take the basic knowledge you have about respiration and photosynthesis and analyze it to find answers to the questions. It may seem difficult, yet press on. The goal of the questions is to make you think critically, so the answers may not be obvious based only on the reading.

Photosynthesis
Carbon Dioxide + Water + Sunlight —> Glucose + Oxygen

Cellular Respiration
Glucose + Oxygen —> Water + Carbon Dioxide + Energy

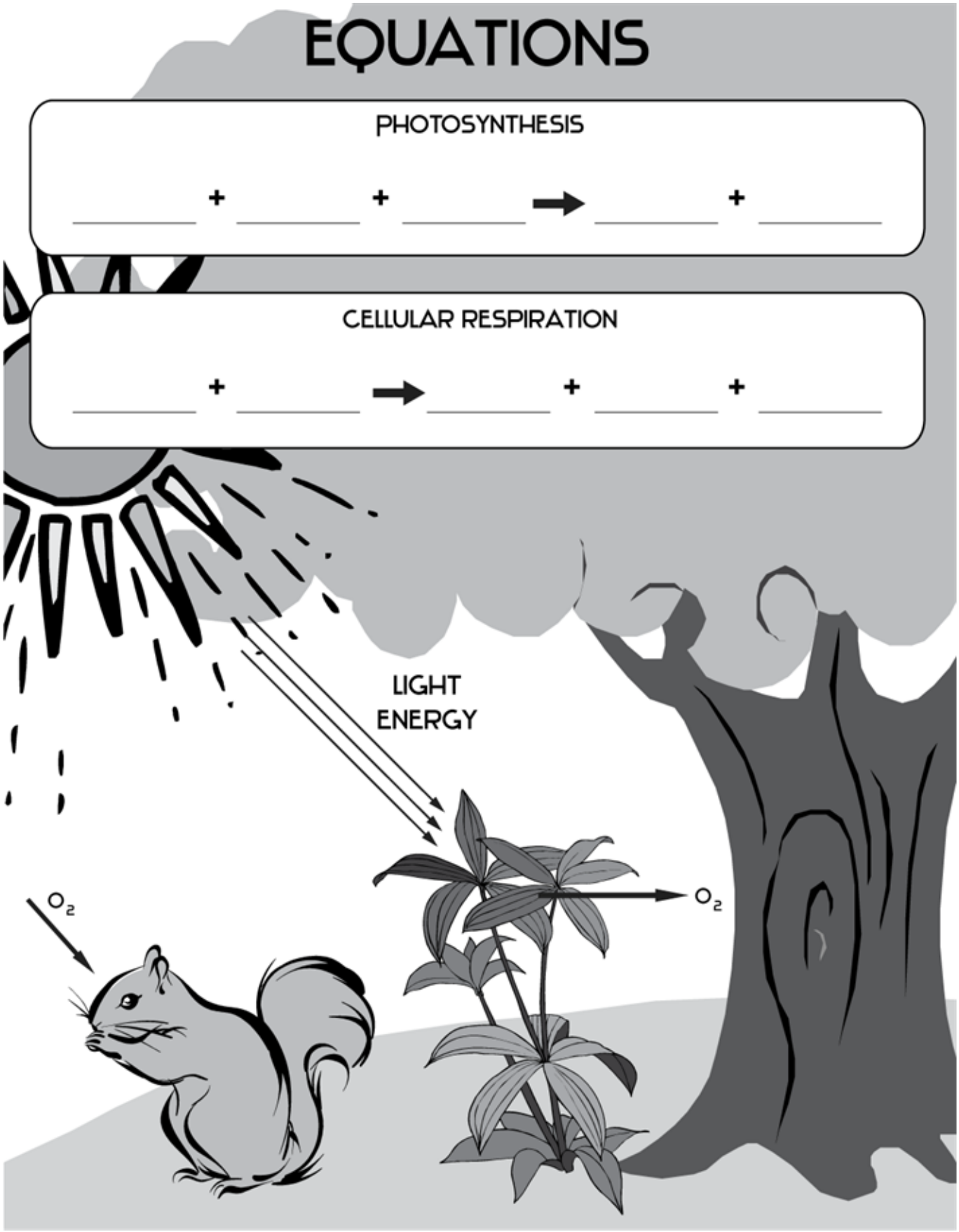
Option 2

In this option, you will organize drawings and use them to answer questions regarding the importance of photosynthesis and its products for life. First, read the scenario on the "Photosynthesis Description" page. Next, cut out the drawings from the "Photosynthesis Drawings" sheet, and then feel free to manipulate them to help you answer questions effectively. (The questions are located at the bottom of the "Photosynthesis Description" page.)

☐ Wrapping Up

Review the equations that you worked with and consider the importance of each component and the importance of both photosynthesis and respiration for all life. Imagine what would happen if the the Sun didn't rise in the morning or plants couldn't absorb oxygen, carbon dioxide, and water. Would the energy-storing molecule glucose or the structural molecule cellulose even exist? How long would organisms that depend on the by-products of photosynthesis and respiration (oxygen) continue to exist?

Consider the importance of both photosynthesis, which produces glucose and cellulose, and oxygen and how important water is for this process. Consider the by-product of cellular respiration, oxygen, and how important and necessary it is for all living organisms — without oxygen, they cannot respire (break down energy molecules) and will not have the energy necessary for survival. As you review the processes of photosynthesis and cellular respiration, keep in mind that every part of the process is important for all living organisms. If one process or even one part of it is removed — whether it is oxygen, carbon dioxide, water, or sunlight — organisms cannot survive.



QUESTIONS TO CONSIDER

1. How are the two processes interdependent?

2. Given the fact that both plants and animals require energy for survival, yet it is only plants that produce their own food, how does the environment produce enough stored energy for all organisms?

3. Respiration requires oxygen and photosynthesis produces oxygen. Both plants and animals carry out cellular respiration, yet only plants photosynthesize. Why do you think there is enough oxygen to meet the needs of all living organisms?

Challenging Question: How might an abundance of carbon dioxide be beneficial for the environment?

SCENARIO RESPONSE

Directions: Read the following fictional excerpt and decide what you would do.

As a scientist and world traveler you have been invited to the city of Sustain in the small country of Ability. Upon arriving in Sustain, you are taken to a local water supply and told about a recent occurrence. Autotrophic organisms have stopped producing oxygen. Since the water supply is used for fishing, what would be the two biggest concerns of people who live in Sustain and Ability?

PHOTOSYNTHESIS DESCRIPTION

Directions: Use the following description to help you organize the squares on the "Photosynthesis Drawings" page:

The Sun rises early in the morning and plants begin to absorb their energy into special parts called chloroplasts. The plant also absorbs from the atmosphere and soil the following: diatomic oxygen, carbon dioxide, and water. These components, along with the Sun's energy, are then used to make energy-storing molecules and structural molecules known as carbohydrates. The energy-storing molecule is known as glucose. The structural molecule is known as cellulose. The plant grows daily and is located in a field where it goes through the process of photosynthesis daily. The field is often visited by consumers such as deer. Eventually it is consumed by a doe who will give birth in the future. The glucose from the plant is broken down and used for energy by the doe and the new life growing within it. By-products from the breakdown of glucose including carbon dioxide and water are released back into the environment as the doe breathes in the oxygen necessary for respiration.

After you have organized the drawings, use them and the information you've learned so far to help you answer the following questions:

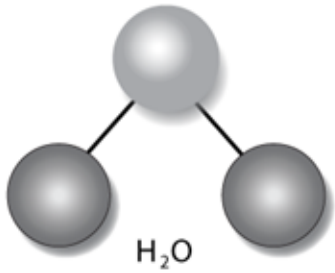
1. How are photosynthesis and respiration interdependent?

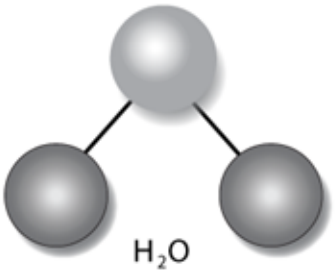
2. Given the fact that both plants and animals require energy for survival, yet it is only plants that produce their own food, how does the environment produce enough stored energy for all organisms?

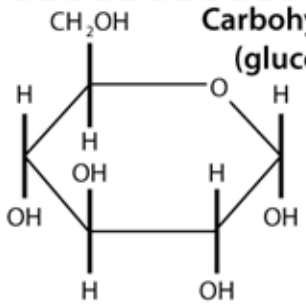
3. Respiration requires oxygen and photosynthesis produces oxygen. Both plants and animals carry out cellular respiration, yet only plants photosynthesize. Why do you think there is enough oxygen to meet the needs of all living organisms?

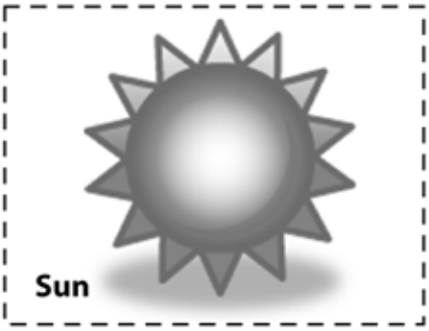
Challenging Question: How might an abundance of carbon dioxide be beneficial for the environment?

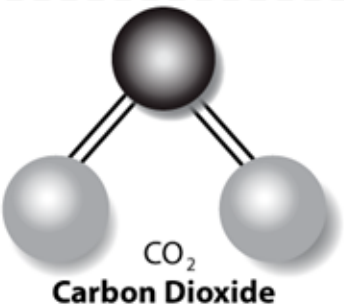
PHOTOSYNTHESIS DRAWINGS

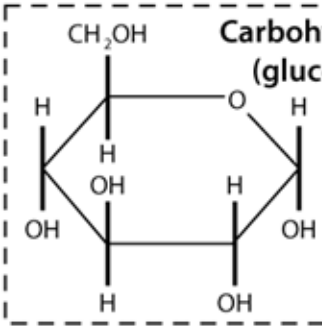


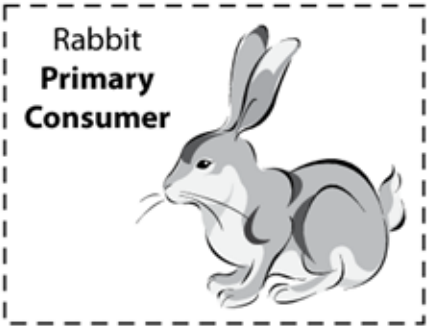


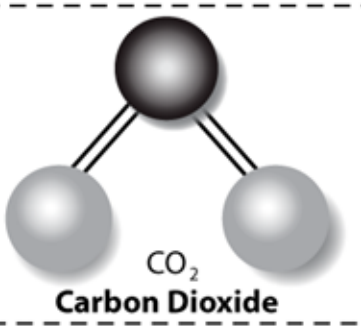


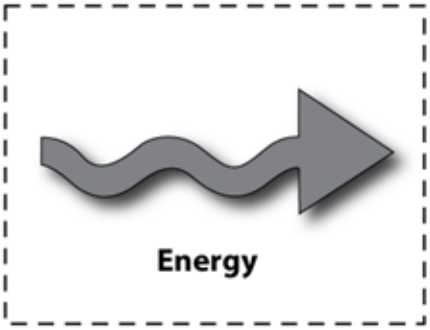


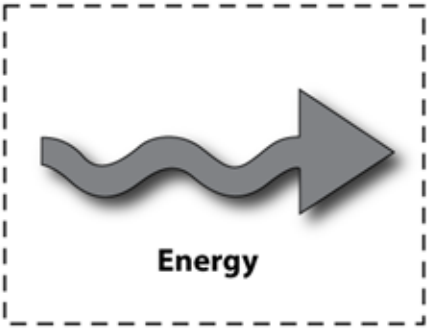


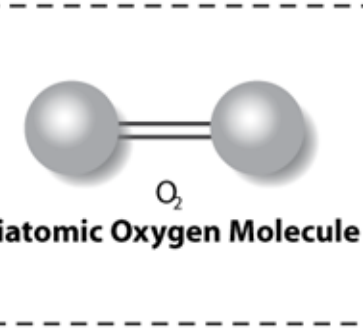


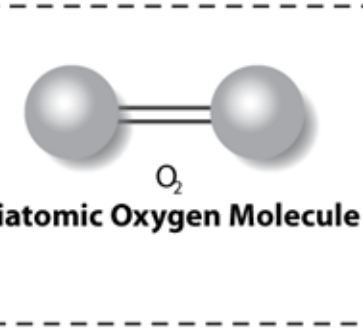












Parent Overview

Lesson 7: Oxygen Production and Life

Getting Started

? Big Ideas

- How do relationships between living and non-living components of an ecosystem enable the system to sustain itself?
- How do Earth cycles ensure the survival of an ecosystem?

🕮 Facts and Definitions

- A **reservoir** is a place where something is kept in store.
- A **depletion** is a serious decrease or exhaustion of the abundance or supply of something.
- **Cellular respiration** is a process in all living things where stored energy is released by the breaking of chemical bonds to produce energy for survival.
- **Glucose** is an energy source produced by the process of photosynthesis. Glucose contains carbon, hydrogen, and oxygen.

⦿ Skills

- Know that the major source of atmospheric oxygen is photosynthesis. (S)
- Know that photosynthesis is a process carried on by green plants and other organisms containing chlorophyll. (S)

Introducing the Lesson

In this lesson, your child will work with the components of photosynthesis either visually or mathematically. The goal of the lesson is to see how important each component of photosynthesis and respiration is and, in an abstract way, learn exactly where the oxygen on the planet goes and where it comes from. Your child has already been exposed to cycles in the Earth's systems, and through today's activity she will be able to take a closer look at how important these cycles are for life.

Reading and Questions (Answers)

1. By what process do plants utilize carbon dioxide and water and release oxygen?
    - Photosynthesis.
2. What will happen if the process of photosynthesis stops in a plant? In all plants?
    - Because photosynthesis stores energy and produces the carbohydrates necessary for growth, the plant would no longer have the energy necessary for survival. Also, the plant would stop growing. If one plant stops photosynthesizing, the lack of oxygen production would not be dangerous. If all plants were to stop photosynthesizing, oxygen in the environment would be quickly depleted.
3. In what way might the release of oxygen back into the environment be harmful to a plant that is found in a dry region (HINT: Consider how a plant produces oxygen)?
    - Like all plants, plants found in arid lands produce energy via photosynthesis. This requires water, carbon dioxide, and oxygen. Water is a precious commodity, and if a plant fails to keep the water necessary for producing carbohydrates, a product of photosynthesis, it will eventually die. Also, one of the products of photosynthesis is oxygen, along with water and energy released for the plant to survive. When a plant produces an abundance of oxygen, it is also producing the by-product of water. If this water is also lost, especially in an arid region, the plant may not survive.

4. Consider the energy pyramid (p. 10). Why do you think it is important that the base of the pyramid (plants) contain the most abundant organisms? How does this relate to the cycling of oxygen?

- Primary consumers depend on producers for food. Due to the energy lost between levels, the primary consumers require a lot of producers to survive. In addition, producers provide oxygen, which organisms at the higher trophic levels (and decomposers) require to survive.

Outline of Activities and Answer Keys

Activity 1: Necessary and Interdependent

There are two options for this activity. The first is ideally better for the logical/mathematical/analytical thinker, and the second is preferable for the visual or creative learner and is intended to help in answering the questions. Both options essentially require the same level of analytical thinking and the same level of comprehension with the primary difference being the way in which the thought processes are engaged to appeal to various learning styles.

Option 1

"Questions to Consider" Answer Key:

- *How are the two processes interdependent?* Oxygen is a by-product of photosynthesis and is required for cellular respiration to occur. By-products of respiration are carbon dioxide and water, which are necessary for photosynthesis.
- *Given the fact that both plants and animals require energy for survival, yet it is only plants that produce their own food, how does the environment have enough energy for all organisms?* Plants in general are the most abundant organism on the planet. By sheer mass, enough energy is produced and stored by plants to ensure that the ecosystem survives. Plants are not mobile and while they do require energy for survival, there is a point in their life cycles that does not require large amounts of energy for growth or survival. Basically, plants produce an excess of energy. Also, it is of equal importance to recognize that organisms such as animals require a lot more energy for survival and for movement where plants do not.
- *Respiration requires oxygen and photosynthesis produces oxygen. Both plants and animals carry out cellular respiration, yet only plants photosynthesize. Why do you think there is enough oxygen to meet the needs of all living organisms?* The answer is similar to the previous question. The abundance of photosynthesizing organisms ensures that enough oxygen is produced to sustain an environment under normal conditions. Earth has reservoirs of oxygen as well, ensuring that an abundance of oxygen is present.
- *How might an abundance of carbon dioxide be beneficial for the environment?* Higher amounts of carbon dioxide could promote plant growth and the production of excess energy and oxygen. While more than just carbon dioxide is required (consider the need for nitrogen and oxygen), if plant growth increases, oxygen does as well. (NOTE: The element that would limit the development of greater amounts of plant growth would be nitrogen.)

Review and discuss your child's answer to the scenario at the end of the activity. Answers will vary, but below is a sample answer.

Individuals in the city and the overall country would have the following concerns. One would be that the failure to produce oxygen means that the oxygen in the water would eventually be depleted. (It would not disappear because oxygen is present in the atmosphere and would eventually diffuse into the water.) The second concern would be that a major food source would dwindle. Without oxygen being replenished by plants in the water, the fish and the plants themselves would be unable to carry out cellular respiration.

Option 2

In this option, your child will manipulate drawings and use them to answer questions regarding the importance of photosynthesis and its products for life. The diagram should show a combination of carbon dioxide, water, and sunlight producing carbohydrates and oxygen. When the carbohydrate is broken down, the diagram should include a carbohydrate and oxygen producing water, carbon dioxide, and energy.

Review your child's answers to the following questions:

- *How are photosynthesis and respiration interdependent?*
  Both photosynthesis and respiration (the breakdown of the carbohydrate) have as a central element glucose. Glucose, a carbohydrate, is produced when carbon dioxide and water are combined by using energy. As a result of the process, oxygen is also released. Glucose, when broken down, produces carbon dioxide and water. In essence, photosynthesis utilizes the products of respiration, and respiration cannot occur without the primary product of photosynthesis, glucose.
- *Given the fact that both plants and animals require energy for survival, yet it is only plants that produce their own food, how does the environment produce enough stored energy for all organisms?*
  In a healthy ecosystem, one that sees organisms surviving and reproducing, there will always be an adequate number of producers. These producers are the foundation of the food chain and without them, other organisms that have to capture or eat food for energy cannot survive. The abundance of producers ensures that the ecosystem has appropriate amounts of energy. The producers are abundant; when producers decrease, the number of organisms will also do the same.
- *Respiration requires oxygen and photosynthesis produces oxygen. Both plants and animals carry out cellular respiration, yet only plants photosynthesize. Why do you think there is enough oxygen to meet the needs of all living organisms?*
  There is a lot of oxygen in the atmosphere plus oxygen that is in the hydrosphere and stored in carbohydrates. Also, the Earth is a giant ecosystem that sustains itself.
- *Challenging Question: How might an abundance of carbon dioxide be beneficial for the environment?*
  Plants utilize carbon dioxide to produce carbohydrates that are beneficial for energy and for growth. With an abundance of carbon dioxide, plant growth is encouraged. Also, increased plant life insures an oxygen-rich environment.

Wrapping Up

Things to Review

- Photosynthesis is the primary source of atmospheric oxygen.
- Cellular respiration occurs in all living organisms.
- Cellular respiration requires oxygen.
- Interruption of the process of photosynthesis will have a major impact on the photosynthesizing organism and its immediate environment.