Lesson 2: An Isolated Plant

Introduction

In the last lesson, you explored a terrarium system that has been sealed from the outside world, yet the plant inside the terrarium has continued to grow and fill the bottle with healthy leaves. In this lesson, you will continue to think about how the plant interacts with its environment to stay alive.

Lesson Question

Process and Procedure

1. Write your best ideas about the lesson focus question in the space below. Leave space to revise your ideas as you learn throughout this lesson. As you have new ideas, record them in a different color.

A Plant as a System

2. Just as the terrarium can be considered a system, a plant can be considered a system. Thinking about the plant sealed in the terrarium as a system can help us figure out how it has stayed alive for so long.

   In the table below, write your ideas about how the terrarium plant can be considered a system

Feature of a System	Feature of a Plant
Boundary	
Components	
Processes	
Inputs and Outputs	

   Add ideas from the class discussion in the space below.

3. To stay alive, a plant requires inputs of carbon dioxide (CO_2) and water (H_2O) from its environment. Because carbon dioxide is a clear gas, it is impossible to observe directly, so we will use an indicator to detect its presence or absence in the system. The indicator we will use is bromothymol blue (BTB), which changes color in the presence of carbon dioxide.

   Observe the demonstration and record the color of the indicator in the table below.

Color of Bromothymol Blue (BTB) in the Presence of Carbon Dioxide (CO_2)

	Carbon dioxide (CO_2) Absent	**Carbon dioxide (CO_2) Present Low Concentration**	**Carbon dioxide (CO_2) Present High Concentration**
Color			

4. Follow your teacher's directions to observe how a common aquatic plant, *Elodea*, uses carbon dioxide as an input of matter. Draw a labeled diagram of the investigation setup in the space below.

   On the diagram above, use a different color to show the results of the investigation.

   Use the space below to record important ideas from your class discussion.

5. Read and annotate *Where Does the Carbon Go?* to learn more about how a plant uses carbon dioxide. As you read, stop and discuss the questions with your group.

Where Does the Carbon Go?

Carbon dioxide is a colorless, odorless gas that is present in the Earth's atmosphere. A single molecule of carbon dioxide, CO_2, is composed of two oxygen atoms attached to one carbon atom by chemical bonds. Carbon dioxide (CO_2) can dissolve in water (H_2O) to form carbonic acid (H_2CO_3). As its name suggests, carbonic acid is an acid. Acids have a pH value less than the neutral value of 7.0. The pH of a substance can be determined by the use of an indicator such as Bromothymol Blue (BTB).

Stop and Think
In the demonstration you observed, why did the Bromothymol Blue solution change color when air was bubbled through it by blowing through a straw? Why did the Bromothymol Blue solution change color when *Elodea* was added, and the test tube left in the light?

Plants use carbon dioxide in the process of photosynthesis. Photosynthesis is a series of chemical reactions in which the atoms of carbon dioxide (CO_2) and water (H_2O) molecules are separated and recombined to form glucose ($C_6H_{12}O_6$) and oxygen (O_2) molecules. Carbon dioxide in the air enters a plant through small openings in their leaves called stomata. In a cycle of chemical reactions, carbon dioxide molecules are separated into carbon and oxygen atoms. These atoms then form chemical bonds with hydrogen atoms to make glucose. Glucose is a type of sugar that a plant can use to form other molecules such as starch, proteins, and nucleic acids. Plants also use glucose as fuel in other chemical reactions.

Stop and Think
Elodea is an aquatic plant that lives underwater. Where does *Elodea* get the carbon dioxide it needs for photosynthesis?

6. Draw a diagram showing the important ideas in the article.

In the last investigation, you explored how a plant uses inputs of carbon dioxide and water to produce outputs of glucose and oxygen. In this investigation, you will think more about the oxygen a plant produces through the reactions of photosynthesis.

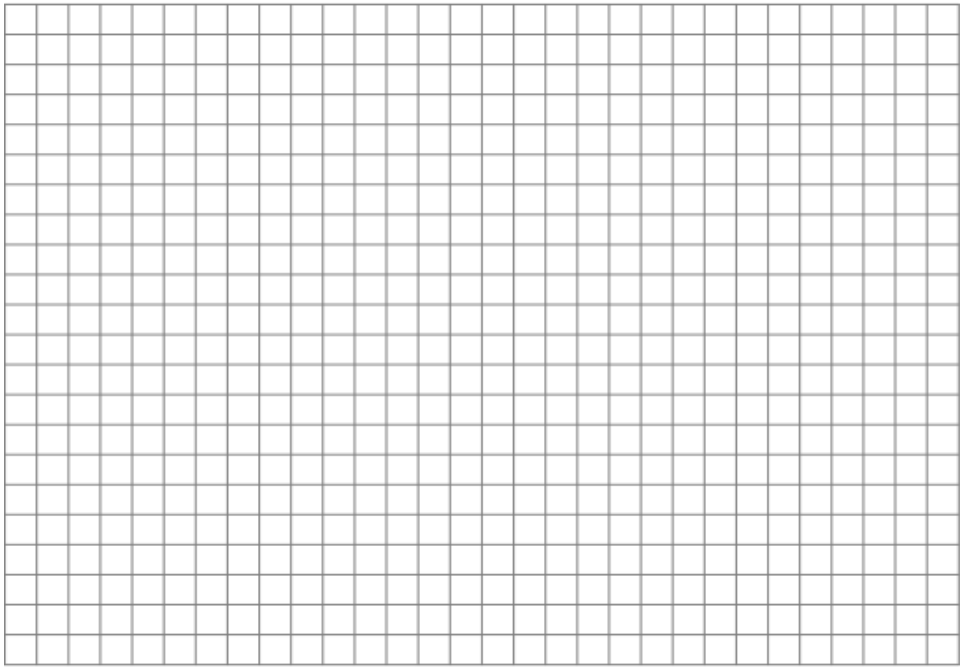
7. Read the procedure for conducting the leaf disk investigation with your group, making sure that everyone in your group understands the purpose for each step.

   Follow your teacher's directions to set up the leaf disk investigation.

8. Record the number of leaf disks floating in each solution in the table below.

Time / Solution	2 min	4 min	6 min	8 min	10 min	12 min	14 min	16 min	18 min	20 min
H_2O										
CO_2										

9. Graph your data. Be sure to label the axes and include a key identifying each solution.



10. Use Identify and Interpret (I^2) on the graph by writing “What I see” and “What it means” statements. Be sure to include arrows from the “What I see” statements to the trend, pattern, high-point, or low-point on the graph.

11. Read the article, *Where Does the Oxygen Come From?* As you read, underline important ideas.

Where Does the Oxygen Come From?

In the chemical reactions of photosynthesis, the atoms of carbon dioxide (CO_2) and water (H_2O) are separated and recombined into glucose ($C_6H_{12}O_6$) and oxygen. (O_2). The overall reaction for photosynthesis can be written as:

carbon dioxide + water → glucose + oxygen

A molecule of glucose is composed of carbon, hydrogen, and oxygen atoms. From the overall reaction, we can see that the carbon atoms of a glucose molecule come from carbon dioxide, and the hydrogen atoms come from water. However, both carbon dioxide and water contain oxygen atoms. Do the oxygen atoms in glucose come from the oxygen atoms in carbon dioxide or the oxygen atoms in water?

To answer this question, scientists used radioactive isotopes to follow the atoms as they move through chemical reactions. An isotope is a different form of an element that behaves identically in chemical reactions. Because it is radioactive, the isotope can be detected using a Geiger counter or other detection device. Scientists used radioactive isotopes of oxygen atoms to follow their movement through the reactions of photosynthesis as shown in the table below:

The Path of Radioactive Oxygen Isotopes in Photosynthesis

Key
O = non-radioactive oxygen
O = radioactive oxygen isotopes

	Experiment 1	Experiment 2
Inputs	$C\mathbf{O}_2$ H_2O	CO_2 $H_2\mathbf{O}$
⬇	⬇	⬇
Outputs	$C_6H_{12}\mathbf{O}_6$ O_2	$C_6H_{12}O_6$ $\mathbf{O}_2$

Use the space below to record important ideas from your class discussion.

12. Place a check mark in the appropriate column to show which input molecule is the source of the atoms in glucose and oxygen - the output molecules of photosynthesis.

Inputs		**Outputs**	
Carbon dioxide (CO_2)	**Water (H_2O)**	**Atom of output molecule**	**Output molecule**
		Carbon (C)	**Glucose ($C_6H_{12}O_6$)**
		Hydrogen (H)	
		Oxygen (O)	
		Oxygen (O)	**Oxygen (O_2)**

Synthesize and Summarize Ideas

13. Following your teacher's directions, create a drawing, or model, that shows how the plant in the terrarium is a system. Add labels showing characteristics, or key features of a system to your model.

14. Reread your initial response to the lesson focus question. Consider the ideas from the activities you completed. If you would like to add to or revise your ideas, do so in a different color.