Chloroplast Blast: Photosynthesis

**Key Question:** How does photosynthesis work, and why is it important?

In this investigation, students will work in teams and play the Chloroplast Blast game, moving around the light reactions and the Calvin cycle and answering questions in order to build a glucose molecule.

**Learning Goals**

- Compare and contrast the two stages of photosynthesis: the light reactions and the Calvin cycle.
- Model the energy dynamics of photosynthesis.
- Relate photosynthesis to botany, ecology, and example organisms.

**GETTING STARTED**

**Time** 50 minutes per game (play the game multiple times for increased fun and effectiveness)

**Setup and Materials**

1. Make copies of investigation sheets for students.
2. The game can be played in groups of 4–6.
3. Each group of players will need the Level B card set.
4. Make sure students set aside the LEARN™ target card and then shuffle the card set before starting the game.

**Materials for each group**

- Chloroplast Blast game board
- Player marker tokens
- High-energy molecule tokens

**NGSS Connection** This investigation builds conceptual understanding and skills for the following performance expectation.

**HS-LS1-5.** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

- Carbon atoms, 6 per team of 2
- Glucose molecule holder, 1 per team of 2
- Number cube
- Level B card set
- Completed App Map from previous investigation, 1 per student

**Online Resources**

Available at www.curiosityplace.com

**Student Vocabulary Words**

- **ADP** – adenosine diphosphate, an organic molecule composed of a molecule of adenine, a 5-carbon sugar called ribose, and two phosphate groups. It is the low-energy version of ATP and is produced during the Calvin cycle and converted into ATP during the light reactions.
- **ATP** – adenosine triphosphate, an organic molecule composed of a molecule of adenine, a 5-carbon sugar called ribose, and three phosphate groups. This high-energy molecule is produced by the light reactions and used in the Calvin cycle.
- **Calvin cycle** – the stage of photosynthesis in which carbon dioxide is used to make 3-carbon precursors of glucose.
- **Carbon dioxide** – CO₂, the starting substance for the Calvin cycle.
- **Chloroplast** – the organelle in which photosynthesis takes place.
- **Glyceraldehyde-3-phosphate** – G3P, the 3-carbon precursor to glucose, made during the Calvin cycle.
- **Grana** – stacks of thylakoids.
**TEACHER BACKGROUND**

**mesophyll cells** – type of leaf cell that contains chloroplasts (ADD)

By now, you’ve explored photosynthesis in depth using the LEARN™ app, and are ready to play Chloroplast Blast! If you would like a detailed review of photosynthesis, go to the background section for Investigation A1. Here, we will focus on relating the game to the process, giving you a behind-the-scenes look at the design of the board, answering questions, and reviewing gameplay action.

Chloroplast Blast, like photosynthesis, takes place in the chloroplast, an organelle found mainly in mesophyll cells of leaves. While most chloroplasts are found in the leaves of plants, other green plant structures such as stems and unripe fruit contain these organelles as well. Even plants with reduced leaves, such as cacti, and some protists, such as algae and phytoplankton, have chloroplasts, allowing them to perform photosynthesis.

Similar to photosynthesis, the board is separated into two regions—the light reactions and the Calvin cycle.

**light reactions** – the stage of photosynthesis during which sunlight is captured and, along with water, used to produce oxygen, ATP, and NADPH

**lumen** – the inner space of the thylakoid

**NADP⁺** – low-energy version of NADPH; electron carrier without electrons

**NADPH** – high-energy electron carrier

**ribulose-1,5-bisphosphate** – RuBP, the 5-carbon molecule that combines with carbon dioxide and is later regenerated during the Calvin cycle

**stroma** – the inner space of the chloroplast where the Calvin cycle takes place

**thylakoids** – the membrane-bound compartments within the chloroplast in which the light reactions take place

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The light reactions play area features thylakoids stacked in formations known as grana. Thylakoids are membrane-bound compartments, and the light reactions happen both within the thylakoid membrane and inside the thylakoid space called the lumen. The light reactions player moves freely around and amongst the grana, emphasizing the interconnected nature of the thylakoid grana.

The light reactions side also features high-energy molecule spaces, which give the player an extra high-energy molecule from the Energy Stash. These molecules represent both ATP and NADPH, which are produced by the light reactions.

The Calvin cycle play area, like the cycle itself, is continuous with no true end or beginning (except the very first and last turn). This side is situated in the stroma of the chloroplast, showing where the cycle actually occurs. The Calvin cycle player moves around the board, encountering spaces that allow them to gain a carbon, symbolizing the incorporation of a carbon dioxide (CO₂) molecule, or recycle a carbon, which refers to the regeneration of ribulose-1,5-bisphosphate, RuBP, the molecule that keeps the cycle turning.

During play, the light reactions player, upon answering a question correctly, passes 3 high-energy molecules to the Calvin cycle, a movement that occurs during photosynthesis as well. Although the high-energy molecules refer to both ATP and NADPH, the number 3 comes from the 3 ATP produced per 2 water molecules hydrolyzed. ATP and NADPH produced during the light reactions then enter the Calvin cycle, powering the reactions that convert CO₂ into its glucose-precursor glyceraldehyde-3-phosphate, G3P.

The game lists glucose as the result of the Calvin cycle for simplicity. The 3-carbon molecule G3P actually exits the cycle and is subsequently converted to glucose or other carbohydrates.

When the Calvin cycle player correctly answers a question, they return 5 low-energy molecules to the light reactions player in exchange for a carbon atom. This represents the ADP and NADP⁺ that are returned to the light reactions to be recharged after being used during the Calvin cycle. The number 5 represents the number of ATP and NADPH it took to incorporate each of the 6 carbons into a glucose molecule (18 ATP and 12 NADPH total for the 6-carbon glucose). Being a 6-carbon ring, 6 carbons must be earned in order to form glucose. This back-and-forth play symbolizes the interdependent relationship between the two processes within photosynthesis.

Questions to be answered are grouped into two card types: Solo Mission and Team Blast. The Solo Mission cards, answered by the turn taker, explore the photosynthetic process itself, asking about reactants, products, steps, etc. The Team Blast questions, which are answered by both members of a team, feature bigger-picture questions. These ask about the role of photosynthesis in food chains and webs, different types of ecosystems, interesting organisms, and plant structures, providing context for the process. A third group of cards, BioBits, do not feature questions, but instead give fun-facts about photosynthesis, plants, ecology, and other related topics.
**Engage**

Arrange students in groups, and give each group a location from the following list. Have them discuss the impact on that location if photosynthetic organisms were to suddenly disappear from Earth this very minute, and choose one main topic to present to the class.

- **Riverbed** (erosion, change shape of the river)
- **Rainforest** (decreased wildlife due to loss of food, shelter)
- **Mount Everest** or other high mountain (even less oxygen as the elevation increases, increased avalanches)
- **Ocean** (less wildlife, less oxygen since photosynthetic organisms in the ocean produce about 50% of oxygen on Earth)
- **Desert** (less wildlife due to loss of food, shelter)

**Explore**

Have students complete Investigation B2, Chloroplast Blast. Students will work in teams and play the Chloroplast Blast game, moving around the light reactions and the Calvin cycle and answering questions in order to build a glucose molecule.

**Faster gameplay:**

Completing an entire game will sometimes take more than one class period. Students can take a photo at the end of class and continue the game later from where they left off. If you want a round to be completed in one period, here are ways to modify the gameplay to make it faster:

- start with 2 or 3 carbon atoms in the glucose molecule holder
- remove Team Blast cards so there is a higher ratio of BioBit to question cards.

**Explain**

Revisit the key question: *How does photosynthesis work, and why is it important?* Tracing the energy transformations is a great way to explain how photosynthesis works. Have students form the same groups they had the last time they played Chloroplast Blast. List the words electrical, chemical, heat, light, motion, and sound. Explain that these are different forms of the same property. Forms of what property? The property of energy. Biological and physical systems all around us can be described by how energy in that system is converted or transformed from one form to another. The law of conservation of energy states that energy within a system is neither created nor destroyed—it is just transformed from one type to another. Describe or sketch three simple systems (or project examples from an image search): campfire, solar calculator, and a person riding a bike. Ask students to trace the energy transformations that happen in each of the scenarios. Do the first one together as an example.

- campfire: chemical energy from the burning of the wood to heat, light, and sound
- solar calculator: light energy to electrical energy (if there is a battery backup, some light energy is transformed to chemical energy and then back to electrical, or if the battery is independent of the solar panel, the transformation would be chemical to electrical when no light energy is available)
- person riding a bike: chemical energy in muscles to motion energy of pedals to motion of wheels to heat and sound

Now ask students to apply the practice of tracing energy transformations to the process of photosynthesis. Explain that there are three major energy transfers that you would like them to find and annotate on their App Maps—two in the light reactions, and one in the Calvin cycle:

**In the light reactions:**

- Light energy is transformed by the photosystems and electron transport chain to chemical energy in NADPH.
- Light energy is also transformed to chemical energy in the form of ATP, when hydrogen pumps and water hydrolysis set up a chemical gradient that provides energy for the ATP synthase to phosphorylate ADP (some of the chemical energy is converted to energy of motion when the ATP synthase spins as it phosphorylates the ADP).

**In the Calvin cycle:**

- When the energy of NADPH and ATP is used to build glucose (or G3P molecules) from the carbon contained in CO₂ molecules, their chemical energy is transferred to the glucose/G3P molecules.

**Elaborate**

Have students select one BioBit card from the Chloroplast Blast game and research the topic to learn more about it. Once students have gathered more information, have them create 3 of their own BioBit cards based on their research.

**Evaluate**

After completing the investigation, have students answer the assessment questions on the Evaluate student sheet.
Guiding the INVESTIGATION

1. Introduction to Chloroplast Blast

Now that students have explored how photosynthesis works through the LEARN™ app, they have an opportunity to apply their understanding while playing a fun and challenging game. Each board can have 4–6 players:

4 players: Students pair up and form 2 teams of 2.
5 players: The fifth player asks the questions and subs in when a stage switch card is drawn.
6 players: Students pair up and form 3 teams of 2.

Be sure each group of players has an B-level card set (there are separate sets for levels A, B, and C). Review the Background section for information on the types of cards and questions contained in the sets. A list of key words, terms, and concepts covered in the B-level cards can be found in the Topic Tracker at the end of this Teacher Guide section. A Teaching Tip has been included with suggestions on how students might use the Topic Tracker.

Allow time for the game groups to work together to become familiar with the game board layout and materials. Students can work in their groups to answer the guiding questions, or you can discuss them in a whole-class setting. Make sure all students have their photosynthesis App Map for reference throughout the game, and access to the LEARN™ app. Students might want to refer to the app for help, and they will need it if they come across a card that contains a LEARN™ logo.

As you monitor the progress of the groups, be sure that everyone can identify the high- and low-energy molecule icons that are shown moving from the light reactions to the Calvin cycle and back again.

Explore INVESTIGATION B2

B2 Chloroplast Blast: Photosynthesis

How does photosynthesis work, and why is it important?

Photosynthesis uses the sun's energy, carbon dioxide, and water to make sugars. This incredible process is the foundation for nearly every food web on Earth! You and your Chloroplast Blast game partner will navigate different areas of the chloroplast. As you move around the game board, Solo Mission questions will help you understand how photosynthesis works. Cooperative Team Blast questions will focus on how important the process is to the organisms, ecosystems, and biomes of Earth. Your team of two is in a race to collect six carbon atoms to build a glucose molecule. Collecting carbon atoms will require you to learn and share your understanding of photosynthesis. Ready, set, CHLOROPLAST BLAST!

Materials:
- Chloroplast Blast game board
- Player marker tokens
- Carbon atoms, 6 per team of 2
- Number cube
- Level B card set
- Completed App Map from previous investigation, 1 per student

TEACHING TIP

Card Management The Chloroplast Blast game card sets are color-coded for level A, B, and C, and each individual card also has a level A, B, or C icon for quick identification. There might be times when you would like groups in the same class to play the game at different levels. There may even be times when you let students choose which level they use. To keep leveled sets together without having to look at each individual card, have students hold up their boxes, slightly tilted. You can quickly scan the tops of the cards as they are lined up in the set to see that they are all the same color. Encourage students to orient the cards in the box so all the fronts and backs face the same way. Also be sure they keep the correct target card with each level.
GAMEPLAY BASICS

This game has one member of a student team moving through the light reactions while the other member of the team moves through the Calvin cycle. Help students notice that light reactions players can move in any direction after the first turn, while Calvin cycle players move clockwise.

Another unique aspect of this game is that the light reactions/Calvin cycle partners will be exchanging high- and low-energy molecule tokens as they work toward collecting all 6 carbon atoms to build a glucose molecule. This exchange of high- and low-energy molecule tokens represents how the light reactions produce high-energy NADPH and ATP for use in the Calvin cycle, which returns low-energy NADP⁺ and ADP for “recharging.” Players must answer questions correctly to earn the opportunity to do the molecule exchange and receive carbon atoms for the team. Help students notice that one side of the high-energy molecule token can be used to represent the high-energy state, and the other side can represent the low-energy state.

TEACHING TIP

Using the Topic Tracker The game cards allow students to encounter many photosynthesis vocabulary terms as well as ideas and topics that demonstrate how photosynthesis impacts daily life, organisms, and ecosystem dynamics. The Topic Tracker provides these key words in categories. Here are some ways you could use the Topic Tracker:

1. Students can check off the words they encounter on the game card they draw on each turn. This list can be used for multiple games, and then students have a record of which terms they covered. (This extra game task might be too distracting for some students—use with caution.)

2. If students keep the cards that they draw on each turn, they could go through the checklist at the end of the game and mark off the words they encountered. Then, you could have them find cards (or create their own) that would complete certain categories.

3. You could give the Topic Tracker to students and have them highlight certain terms to look for and check off as they play the game. This makes the list more manageable and allows you to focus on certain concepts.

4. You can use the Topic Tracker to guide a whole-class review of game highlights. For example: Ask “Who remembers answering a question about producers? What is a producer? What does it have to do with photosynthesis?”
Explore INVESTIGATION B2

a. When a light reactions (LR) player answers a question correctly, 3 HEM tokens are passed to Calvin cycle (CC) partner.
b. When a CC player answers a question correctly, 5 tokens (now they are considered to be low-energy molecules, or LEM) are passed back to LR partner, and a carbon atom is placed on team's glucose molecule holder card.

7. HEM tokens that are traded between team partners are the tokens that belong to them. The only way to gain HEM tokens from the general energy stash is when:
   • a LR player lands on a special HEM board space
   • a CC player gets an answer correct but doesn’t have enough HEM tokens to trade in for a carbon atom
   • a CC player passes the “begin” space in the Calvin cycle.
   • a BioBit card with a positive result is selected by a LR player

3. Chloroplast Blast rules

This game has teams of two playing against one another, instead of the individual play featured by most games (including the next game, Mighty Mitochondria). This might seem a little confusing at first, but once you study the rules and take a few turns, you will catch on quickly.

Turn-taking: All light reactions players take their turns first, and then Calvin cycle players take their turns in the same order as their light reactions partners. If there are three or five players, the odd player can ask the questions and this position can rotate into a team (and a current team member take the odd position) whenever a “stage switch” card is drawn.

Light Reactions Players
1. Start with 5 high-energy molecules.
2. Go to the begin space in light reactions. Roll the number cube, move the token, and draw a card. You may choose your own path until your team enters the glucose molecule ring inside the Calvin cycle. If on any turn, you draw a Solo Mission or Team Blast card, and you do not have any high-energy molecules, your turn is over.
3. Consult the summary tables that follow for information on special board spaces, cards, scoring, and how to get help.

Calvin Cycle Players
1. Go to the begin space in the Calvin cycle. Roll the number cube and land on a space. Draw a card and answer the question. Continue to move clockwise around and around the cycle until your team enters the glucose molecule ring.
2. Each time you pass the begin space, take 1 high-energy molecule token from the energy stash.
3. Consult the summary tables that follow for information on special board spaces, cards, scoring, and how to get help.

LEARN™ Energy Quest INVESTIGATION B2

If you land on...
- Light reactions player
- Calvin cycle player

<table>
<thead>
<tr>
<th>Unmarked space</th>
<th>Draw a card; see the next table for what to do with each card type.</th>
<th>Draw a card; see the next table for what to do with each card type.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-energy molecule space</td>
<td>Gain 1 high-energy molecule token from energy stash and take a regular turn.</td>
<td>n/a</td>
</tr>
<tr>
<td>Carbon atom recycle space</td>
<td>n/a</td>
<td>Lose 1 carbon atom from the glucose molecule holder and take a regular turn.</td>
</tr>
<tr>
<td>Free carbon atom space</td>
<td>n/a</td>
<td>Gain 1 carbon atom from the glucose molecule holder and take a regular turn.</td>
</tr>
<tr>
<td>Occupied space</td>
<td>Invader (new to the occupied space) draws until they reach a Solo Mission or Team Blast question card. Both players have a chance to write down the answer. Correct answers receive 2 high-energy molecule tokens from the energy stash. No penalty for wrong answers. Invader ROLLS AGAIN AND TAKES ANOTHER TURN.</td>
<td></td>
</tr>
</tbody>
</table>

If you draw a...
- Light reactions player
- Calvin cycle player

| Solo Mission card | Answer the question on your own. | Correct answer: Pass up to 3 high-energy molecule tokens* to Calvin cycle partner, your turn is over. Incorrect answer: Turn is over. |
| Team Blast card | Collaborate with partner to answer question. | Correct answer: Light reactions player passes 3 high-energy molecule tokens* to Calvin cycle partner and gains a carbon atom for the glucose molecule holder. If unable to gain a carbon (if fewer high-energy molecule tokens), gain 1 high-energy molecule token from the energy stash. Your turn is then over. Incorrect answer: Your turn is over. |

BioBit card | Follow instructions on card. | n/a |

How to win: When your team earns 6 carbon atoms for the glucose molecule holder, move to the “GO for the Glucose!” ring on your next turn and collaborate on the first question you draw. You must answer correctly to win, or wait in the ring until your next team turn and try again. If you do not have time in one class period to finish the game, make a note of where you are on the board, how many HEM tokens you have, and how many carbon atoms your team has so you can continue the game later. Better yet, just take a photo!

How to get help: For any given question, you can spend 1 high-energy molecule token for a look at your photosynthesis App Map, or to consult the LEARN™ App.

Review: Take a couple of minutes to look at examples of the three types of cards that can be drawn on any given turn. Review the summary tables to see what happens once questions are answered.

Guiding the INVESTIGATION

Chloroplast Blast rules

Have students read through all rules and summary tables. Make sure students pull examples out of the deck for Solo Mission, Team Blast, and BioBit cards so they can differentiate between the front and the back of the cards, and how to orient them in the box so when the question is drawn, the player cannot see the answer.

Roleplay a few turns for the class, so they can see how the turn-taking order works, and what to do when a question is answered correctly or incorrectly. Review what to do if a player lands on an occupied space. New players will always need to refer to the summary tables as they play, but once you have played one round of the game, the rules and gameplay action become familiar and easy to remember.

House Rules

There are lots of opportunities for you and/or your students to add, delete, or modify rules to speed up, or slow down, increase or decrease the challenge level, or just to add more fun. Here are some “house rules” you might want to try, or have each group come up with their own modification:

- For level A and B students, have the next-level set available so students decide on each turn what level card they want to draw. Correct answers for a level up earn additional high-energy molecule tokens.
- Students keep cards that they answer incorrectly. End the game early enough so that students have 5–10 minutes to review the cards they answered incorrectly, ask questions, or make notes.
- The teacher calls out “stage switch” a couple of times during a game round, causing all partners in the class to switch to the other stage.
**Addressing Misconceptions**

**Misconception:** *Photosynthesis produces energy.*

Photosynthesis uses light energy to produce glucose—or more specifically, to produce 3-carbon molecules, glyceraldehyde 3-phosphate, which are combined to make a 6-carbon molecule of glucose. Glucose is not energy. Glucose is used as energy storage in plants, and energy is released during cellular respiration. Alternatively, glucose can itself be used in the following ways:

- stored as large starch molecules for later use
- synthesized into the highly soluble sucrose for transportation to other parts of the plant
- turned into cellulose for structure

Note: It is true that the light reactions produce energy in the form of ATP, but that chemical potential energy is used in the Calvin cycle to produce the G3P molecules. The overall product of photosynthesis, then, is glucose (not ATP or energy).

**Misconception:** *Photosynthesis requires a green plant.*

Most organisms that perform photosynthesis are green, because the main photosynthetic pigment, chlorophyll, reflects some green light. All plants, algae, and cyanobacteria that perform photosynthesis have chlorophyll. There are, however, organisms that perform photosynthesis that are not green. Blue-green cyanobacteria, red algae, and brown algae are examples of non-green organisms that perform photosynthesis. They do contain chlorophyll, but they also contain accessory pigments such as carotenoids and phycobilins that mask the green color. Photosynthesis does not require a green plant.

**Guiding the Investigation**

**GO for the glucose!**

Students may not have enough time on the first day of gameplay to collect all 6 carbon atoms to build a glucose molecule. As you monitor group progress, you might want to announce that only 3 carbon atoms will be needed before a team can advance to the glucose molecule ring. This is a great time to point out that the Calvin cycle actually produces 3-carbon molecules, glyceraldehyde 3-phosphate (G3P), which are later combined to form 6-carbon glucose.

If you want students to continue the game on another day, have them make a note on their investigation page of their space number and the number of high-energy molecules they have, as well as how many carbon atoms their team has.
Evaluate
INVESTIGATION
B2

Congratulations! You are well on your way to becoming a photosynthesis expert. Study this experiment and answer the questions to show what you know.

**How can you tell that photosynthesis is happening when you can’t actually see the process?**

Bromothymol blue is an indicator that can show the presence of carbon dioxide. The solution is blue, but in the presence of carbon dioxide, it turns yellow.

1. You insert a straw into a container of bromothymol blue and gently blow bubbles into the solution. What color will bromothymol blue turn when you blow bubbles of exhaled air into the solution? Why?
   - The color will turn yellow, because exhaled air contains carbon dioxide, and bromothymol blue turns yellow when carbon dioxide is added to it.
   - When the carbon dioxide is removed, the solution should turn back to a blue color.

2. Suppose the carbon dioxide was removed, or used up. What color would the solution be then? Why?
   - The solution will be yellow, because it is saturated with carbon dioxide.

3. Next, you pour 25 mL of bromothymol blue into each of four containers. IMPORTANT NOTE: The bromothymol blue solution has been saturated by bubbles of exhaled air. What color should the solution be? Why?
   - Photosynthesis should occur in container 1. Photosynthesis needs a plant with photosynthetic pigments, like chlorophyll, carbon dioxide, and water. Container 1 has all of these things. Photosynthesis won’t occur in the other containers.
   - Container 2 is missing the light energy because it is blocked by the aluminum foil. Container 3 has no plant, and container 4 has no plant or light energy.

**WRAPPING UP**

Have your students reflect on what they learned from the investigation by answering the following questions:

1. What are the two stages of photosynthesis?
2. How are the two stages of photosynthesis dependent upon one another?
3. What is the ultimate goal of each stage?
5. Which containers serve as the control group? Explain why this is important to the experiment.

Containers 3 and 4 are the control group. To better observe evidence of photosynthesis, you need to compare it to setups that you know for sure will not conduct photosynthesis.

6. Would the presence of plants in the container cause the carbon dioxide level to increase, decrease, or stay the same? Explain.

Photosynthesis uses carbon dioxide, so the carbon dioxide level in the containers in which photosynthesis occurs should decrease.

7. You unwrap each container, carefully remove the plants from containers 1 and 2, and observe the final color of the solutions. What is the final color of the solution in containers 1 and 2, and why? Use the table to record your answers to this question. The control group data is completed for you.

<table>
<thead>
<tr>
<th>Container</th>
<th>Initial color</th>
<th>Final color</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>yellow</td>
<td>blue</td>
<td>Photosynthesis occurs and uses the carbon dioxide, so the bromothymol blue turns back to a blue color.</td>
</tr>
<tr>
<td>2</td>
<td>yellow</td>
<td>yellow</td>
<td>Photosynthesis cannot occur, so the carbon dioxide level does not decrease, and the solution stays yellow.</td>
</tr>
<tr>
<td>3</td>
<td>yellow</td>
<td>yellow</td>
<td>There is no photosynthesis, so the carbon dioxide level stays constant and the solution stays yellow.</td>
</tr>
<tr>
<td>4</td>
<td>yellow</td>
<td>yellow</td>
<td>There is no photosynthesis, so the carbon dioxide level stays constant and the solution stays yellow.</td>
</tr>
</tbody>
</table>

8. Do plants use carbon dioxide at night? Does this experiment answer that question?

Plants do not use carbon dioxide at night, because photosynthesis, the process that uses carbon dioxide, does not occur when there is no light energy available. Container 3 simulates a plant in darkness—and the carbon dioxide level did not decrease. This supports my statement that plants do not use carbon dioxide at night.