Photosynthesis

Lesson Overview

Photosynthesis occurs when plants use sunlight to convert water and carbon dioxide into sugars and oxygen. This is essential for plants because they need to produce their own food in order to survive. In this lesson, students will analyze the structures in a leaf that are involved with photosynthesis. Students can conduct several optional experiments about photosynthesis to gain a deeper understanding of this important process.

Grade Level: 6th – 8th

Lesson Time: 90 minutes

Key Terms:

Chloroplasts
Chlorophyll
Guard Cells
Indicator
Photosynthesis
Respiration
Stomata

Resources:

Cyber Science 3D Session
- Ginkgo Leaf Cross Section
Photosynthesis Experiments worksheet (optional)

Materials needed:

Research center about photosynthesis
Center with supplies for photosynthesis experiments (optional)
hydrogen carbonate indicator,
1% hydrogen carbonate solution, pondweed (Cabomba or Elodia)
clear containers,
straws, scissors, timers,
a light source

Objectives

- Conduct in-depth research about photosynthesis using multimedia sources
- Carry out several multi-step experiments about photosynthesis and analyze the results
- Find evidence that photosynthesis plays a role in the flow of matter and energy into and out of the plant
- Present conclusions about photosynthesis using experimental evidence and relevant details

Standards (NGSS and Common Core)

For state specific standards visit edu.zspace.com/activities

Next Generation Science Standards

- Life Science – Structures and Processes
    - MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Common Core Connections

- Language Arts
    - RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
    - RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
    - SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Differentiation

- Provide a handout with a list of vocabulary terms and definitions that will appear in their activity

Introduction

Students need a basic knowledge of photosynthesis before beginning this lesson. The teacher will ask the students to describe the process of photosynthesis. Using zView and the Ginkgo (tree) model in the Botany section of Cyber Science 3D, the teacher will review the tree structures that are involved with photosynthesis: roots for the absorption of water, xylem/phloem in the trunk for the transport of water, and leaves for the absorption of sunlight and the movement of carbon dioxide and oxygen. Then, using zView and the Ginkgo Leaf model, the teacher will "Hide" the blade lobes to reveal the small leaf cross section that the students will analyze next. The teacher will explain to the students that they will observe the structures inside a leaf that are specifically involved with photosynthesis. They will also conduct some experiments to find evidence that photosynthesis plays a role in the movement of matter and energy into and out of the plant *(optional).*

Activity - Photosynthesis

1. Open the "Ginkgo Leaf Cross Section" session in Cyber Science 3D.
2. Click on the "Presenter" mode at the top left corner of the screen. This will display a list of slides along the left side.
3. Follow the presentation: Click on the "Play Slides" button to pause the session at the first slide. When you are ready for the next slide, click the next slide on the list. Follow the directions on each slide and explore at your own pace.
4. Pay special attention to the structures in the leaf that play a role in photosynthesis, particularly with the absorption of sunlight or the intake and movement of air and water.
5. At a research center with textbooks and the Internet, conduct research on photosynthesis and the movement of matter and energy between plants and their surroundings.
6. *Optional:* Conduct several experiments about photosynthesis. See the directions on the "Photosynthesis Experiments" worksheet.
7. Record the results of your experiments results on the provided worksheet *(optional).*
8. Present your evidence that photosynthesis plays an important role in the movement of matter and energy into and out of the plant.

Teacher Note: Students may wonder why the container with the plant in the dark changed color to yellow, indicating that there is more carbon dioxide in the solution. This is due to a process called respiration, which is the opposite of photosynthesis. Respiration occurs all the time in plants, and the rate is not affected by the presence or absence of light. During the daytime, the amount of photosynthesis outweighs the amount of respiration, so plants take in carbon dioxide during the day, but release carbon dioxide at night.

Closing

After the students make their presentations, they will discuss any discrepancies in the data. They will share their conclusions about how photosynthesis plays an important role in the movement of matter and energy into and out of the plant.

Questions for Discussion

1. Based on your research and experiments, how does photosynthesis play an important role in the flow of matter and energy into and out of the plant? And which plant structures are specifically involved with this process?

   Answers will vary. Sample Answer: Plants need to produce their own food in order to grow and survive. During photosynthesis, both energy and matter need to flow into and out of the plant. Plants absorb water through their roots. Plants soak in sunlight with the chloroplasts in their leaves that contain chlorophyll. Plants take in carbon dioxide and release oxygen through the stomata and guard cells in their leaves.

2. Were you able to find evidence that plants take in carbon dioxide during photosynthesis? How?

   Answers will vary. Sample Answer: Yes, I was able to find evidence that plants take in carbon dioxide during photosynthesis. The container with a plant in bright light changed color to purple, indicating that there is less carbon dioxide in the solution. This shows that the plant took in carbon dioxide from its surrounding environment during photosynthesis.

3. Were you able to find evidence that plants release oxygen during photosynthesis? How?

   Answers will vary. Sample Answer: Yes, I was able to find evidence that plants release oxygen during photosynthesis. When the plant was placed near a light source, it produced the most bubbles. As the plant moved farther away from the light source, the amount of bubbles decreased. The amount of bubbles indicates the rate of photosynthesis. So the rate of photosynthesis decreased as the plant moved farther away from the light source.

∆Investigate Further

Extension Activity: Students could conduct additional photosynthesis experiments about the intake of carbon dioxide, for example, using different colors/wavelengths of light.

Extension Activity: Students could conduct additional photosynthesis experiments about the release of oxygen, for example, using light bulbs of different intensity.

Photosynthesis Experiments

Experiment 1: How can we prove that plants take in carbon dioxide during photosynthesis?

Materials:
- Hydrogen carbonate indicator
- 4 clear containers with lids
- Sprigs of pondweed (for example Cabomba or Elodia)
- Light Source
- Straw
- Clear cap

Directions:
1. Pour an inch of hydrogen carbonate indicator into a clear cup.
2. Using a straw, blow into the liquid and observe the change in color.
   Hydrogen carbonate indicator is used to measure carbon dioxide levels in aquatic systems. It is red when CO_2 levels are equal to surrounding air. It turns from red to orange to yellow as CO_2 levels increase. It turns from red to magenta as CO_2 levels decrease.
3. Fill four clear containers with an equal amount of indicator and label them #1, #2, #3, and #4.
4. Close the lids of container #1 and #2. These will be the controls.
5. Place equal length sprigs of pondweed in containers #3 and #4 and close the lids.
6. Record starting data on the first three rows of the following chart.
7. Place containers #1 and #4 near a bright light source about 250cm away (to prevent overheating). Place containers #2 and #4 in a dark cupboard.
8. Make predictions about what color changes will occur.
9. After 24 hours, gather all four containers and place them in front of a white wall.
10. Observe the color changes and record your results.

Container	1	2	3	4
Light or dark				
With plant or no plant				
Color of indicator at start				
Color of indicator after 24 hours				

Questions:

1. What were the results of your experiment?
   _____
   _____
   _____
   _____
   _____

2. Which containers changed color? Why?
   _____
   _____
   _____

3. Were you able to prove that plants take in carbon dioxide during photosynthesis? How?
   _____
   _____
   _____

Photosynthesis Experiments

Experiment 2: How can we prove that plants release oxygen during photosynthesis?

Materials:
1% Hydrogen carbonate solution
Sprigs of pondweed (for example Cabomba or Elodia)
Tall, clear containers (for example measuring cylinders or test tubes)
Scissors
Light sources
Timer

Directions:

1. Take a piece of pondweed and flatten the fronds against the stem with your fingers
2. Lower the pondweed into a tall, clean container and hold the stem against the glass with your finger.
3. Fill the container with 1% sodium hydrogen carbonate solution.
4. Submerge the stem and cut off the end at an angle under the surface of the liquid. This cut end must remain in the liquid in order to submerge gas bubbles rising from the cut.
5. Place the container in front of a bright light source and wait five minutes.
6. Make predictions about the production of bubbles when the container is placed near or far from light.
7. Count the number of bubbles produced in 30 seconds. Repeat two more times and record your results on the chart provided.
8. Repeat step #7 at increasing distances from the light source.
9. Calculate the average number of bubbles produced at each distance.
10. Analyze your results.

Distance from light source (cm)	Number of bubbles produced in 30 seconds			Average # of Bubbles
	Test 1	Test 2	Test 3	

Questions:

1. What were the results of your experiment?

_____
_____

2. Did you notice a pattern in the results? Why?

_____
_____

3. Were you able to prove that plants release oxygen during photosynthesis? How?

_____
_____