Photosynthesis: Intake of Carbon Dioxide - Production of Oxygen

Purpose
To learn why the processes of photosynthesis (in which green plants use carbon dioxide to turn nutrients into food for their growth and maintenance) benefit all living organisms.

Overview
This activity consists of a long-term observation of photosynthesis using aquatic plants. Students will observe these plants as they live in a closed system within a jar. Students will learn about the two different cycles within photosynthesis and how each cycle benefits other organisms.

Time
2 two-hour block class periods or one week of daily class periods

Key Concepts
Green plants use carbon dioxide, water, and sunlight to turn minerals and nutrients into food for growth, maintenance, and reproduction.
Photosynthesis is made up of two cycles - the light cycle and the dark cycle.
Most oxygen is given off during the dark cycle of photosynthesis when the plant produces sugar.

Skills
Making observations
Collecting data
Forming hypotheses
Testing hypotheses
Making Predictions
Understanding and describing interrelationships in nature
Communicating observations and interpretations orally, in writing and graphically

Materials
Two wide mouth gallon glass jars
One small glass jar
Fresh water (no salt water nor distilled water)
Aquatic plants (purchased from an aquarium supply or pet store)

Facilitator Preparation
Make sure that the small jar will fit inside the larger gallon jar. Fill the large jar with water to a level that will not overflow when you add the smaller jar. You will need to place your hand in the jar as well, so expect some spills.

Background
Ask students to think about a world without plants. How do they envision it to be? Do they think that plants affect the temperature and humidity in the various regions on the earth? What about the composition of the air - do they think plants might play a part in that? What about the plants themselves - since they don't hunt or graze as all animals must do to survive, how do plants get their food? What about breathing - plants don't

have noses; so, do they need oxygen like animals do? Do students think that plants go through daily cycles like we do - active during the day and resting at night? Do plants sleep?
Discuss the equation for photosynthesis:

$6H_2O + 6CO_2$ ----------> $C_6H_{12}O_6 + 6O_2$

six molecules of water plus six molecules of carbon dioxide produce one molecule of sugar plus six molecules of oxygen

Procedure

1. Place some aquatic plants inside the smaller jar and submerge it in the larger jar so that it fills completely with water. Once the small jar with the plants is filled, invert it so that the mouth of the jar is resting on the bottom of the gallon container.
2. Place this closed system set-up in the sun. Ask students to observe that there is no air in the smaller inverted jar, only water and the aquatic plants.
3. Observe this closed system every 30 minutes. As a bubble of gas begins to form, lead a discussion of what caused the gas bubble.

Suggested Guided Discussion Questions:
Where did the bubbles come from? (the plants)
What do you think the gas is? (oxygen)
How do fish breathe in water? Where does the oxygen come from? (the oxygen is dissolved in the water (H_2O - with the 'O' being oxygen)). The oxygen in water can come from aquatic plants living in the water or from the mixing of air and water by wave action)
Where did the plants get the carbon dioxide it needs? (the carbon dioxide is also dissolved in the water, and is probably supplied by fish)
Why do pet stores suggest that you place aquatic plants in the fish bowl with your fish? (because of the symbiotic relationship that plants have with animals)
What might happen if you didn't put plants in the water with your fish? (eminent funeral)

4. As the bubble size increases, approximate its diameter at regular intervals and graph these.
5. Next, prepare two 1-gallon jar set-ups (same as the original set-up). But, this time, place one jar in a well-lighted area and the other jar in a darker area. Compare bubble data over the next week.
6. Finally, in comparing the light and dark cycles of photosynthesis, prepare two more 1- gallon jar set-ups. Place one jar in constant light for 24 hours a day. Place the other jug in a room where it will receive light that approximates a day (leave it by a window).
7. Predict which jug you expect will have the larger bubbles - the jar with constant light or the jug with regular light? (Most students will think that the plant with continuous light will make the largest bubbles since they are under the misconception that providing more light for the plant means more food for the plant - not realizing that the plant has the ability to store the ingredients needed to produce food during the dark cycle. The plants will not continue to grow well if they are subjected to constant light, and therefore, not getting their required dark cycle.)
8. Compare the size of the bubbles in each jar. What makes the difference? (The plant actually makes the sugar during the dark cycle of photosynthesis. This is when the most oxygen is given off. Revisit the formula for photosynthesis. Most of the carbon dioxide, water, and light were stored until the dark cycle when the sugar production takes place.)

9. Students are to draw the closed system within the gallon jar set-up. They are to label the gases and draw arrows to show the exchange of gases in the closed system. Students should turn in their Observation Logs for the course of the week. They are to write a brief description of what they think is going on in each jar set-up. Students are encouraged to include their opinions and educated guesses.

Further Investigation

This model can be used to discuss manmade pollution in rivers and lakes. Prepare two 1-gallon jar set-ups. Place a weak solution of liquid fertilizer in one jar only. Place both jars in a well-lit area. Compare the amount and size of bubbles produced by the plants in each jar. Discuss the possible appearance of algae and how this can affect the health of a river or lake.

Ethics Component:

Environmental Health Effects. Have students describe why they think plants are so important for the survival of most forms of life. What might be some consequences if forests continue to be destroyed all over the world? Do we have a right to tell other countries what they should be doing with the trees and forests in their own lands? Even within the United States, do students think that some parts of the country have better air quality than others? Do they think the air quality could be related to the amount of trees and forests that surround a countryside as compared to the lack of trees in urban areas? Ask students to describe what they think a 'concrete jungle' is. Do they think that this is a relatively new term in our society or has it been around for a while?

Student Assessment

- Did the Students draw the closed system within the gallon jar set-up. Did they label the gases and draw arrows to show the exchange of gases in the closed system.
- Did the Students complete in their Observation Logs for the course of the week.
- Did the students write a brief description of what they think is going on in each jar set-up which included their opinions and educated guesses.

Assign points for the following components of the graph of the bubble diameters:

Rubric for the Graph:

- Is the graph labeled?
- Are the x and y axes labeled?
- Are the data graphed and spaced properly?
- Were written conclusions made that match the data?