Dissolved Oxygen and Photosynthesis: 1

Time: 2 class period

National Benchmarks: Benchmarks 5A: Diversity of Life; 5D Interdependence of Life; 5E: Flow of Matter and Energy; 9B:Symbolic Relationships; 9D:Uncertainty; 12B:Computation and Estimation; 12D:Communication Skills; 12E:Critical-Response Skills.

National Science Content Standards: *Science as Inquiry: A*; *Life Science: C*: Biological Evolution; The Interdependence of Organisms; Matter, Energy, and Organization in Living Systems; *Science and Technology: E:* Abilities of Technological Design; Understandings about Science and Technology; *Science in Personal and Social Perspectives: F:* Population Growth; Natural Resources: Environmental Quality; Natural and Human-induced Hazards; Science and Technology in Local, National, and Global Challenges

New York State Standards: 1, 2, 4, 5, 6, 7

Objective: Students will know that plants produce oxygen underwater and be able to design an experiment that will test this question.

Lesson Outline:

1. Students discuss whether plants give off oxygen, and how to measure this
2. Students measure the increase in dissolved oxygen over time (one class day)
3. Students experiment with different light sources and/or intensities
4. Report and discuss results

Materials: classroom aquarium with aquatic plant, glass jar
For each group: 2 canning jars, strands of elodea (or other aquatic plant), dissolved oxygen test kit, 2 canning jars of boiled water which was sealed and left to cool at room temperature, pencils/tape or waterproof markers

Preparation: This lab is designed for an entry-level earth science or biology class, where students are just learning about the relationship between photosynthesis and respiration. This lab must be done in conjunction with the respiration lab, and it allows the students to spend the time to understand the connection between intensity of light and photosynthesis. It is also a good lab to introduce the idea of turbidity. If your students already have a relatively good grasp of this subject, or you are looking for a simpler lab that just tests the presence or absence of oxygen, please use "Dissolved Oxygen and Photosynthesis: 2". If your students understand the subject and need a challenging inquiry-based lab that they can do in groups over a period of several days, use: "Inquiry Oxygen".

This lab requires a bit of preparation on the part of the teacher, but can be modified depending on the amount of time you have and when you see your students. If you see your students every day, the best option is to prepare the jars with the Elodea beforehand. ***Note:*** If your school gets its water from an underground storage tank, allow the water to sit for a few days at room temperature before using in the experiment. Dissolved oxygen from stored water systems often have very low dissolved oxygen levels.

Put the same amount of Elodea into the jars filled (to overflowing) with aged tap water. Place these jars in the dark overnight-this causes the DO in the jars to drop due to respiration. If you do not prepare the jars in this fashion and just have the students start the activity with tap water in the light, the water will already be saturated with DO, and you will not be able to measure the oxygen bubbles the plants make. Once you have prepared the jars, the students should test them and the controls for DO and decide which jars to place in which light source. If you have minimal amounts of time, you can perform these initial tests yourself. Then, place the jars in two different light intensities. It will take about four hours in indirect sunlight to produce good results. (If you see several classes over the course of the day, you could set up the experiment with the morning class, and then record the result with the afternoon class, and then share the results with other classes on the next day.) Remember to replace water you have removed for testing with boiled, canned water (preferably through siphoning). Regardless of who conducted the original DO tests, the students should remove the jars from the testing locations and retest for DO. If you need to leave the jars overnight, the artificial light source must be very weak (do not use light bulbs that get warm, as this will introduce temperature as an additional variable). Cheesecloth makes a good cover for the 'dark' jars. Alternatively, you can do this as a demonstration with the entire class watching just one experiment led by the teacher. If you do leave your jars overnight, test the experiment yourself beforehand. Depending on the amount of light you use, the plants in the high light may stop doing photosynthesis if the water becomes saturated. This will give the plants in the low light a chance to catch up, which will affect your results.

Engage: Ask: Do you remember what happened when we placed the plants in the jars of water overnight? Students should be able to explain respiration. Using the class aquarium, ask: what will happen if I put a jar over an aquatic plant during the day? If students are having difficulty, ask: what do plants give off during the day? They should understand that aquatic plants are not different from terrestrial plants. Take the empty jar and slowly submerge it in the aquarium. You should invert it and place it over the plant. After a few minutes, you should see bubbles forming on the side of the glass.
Explore: Ask: what do plants need in order to make oxygen? Students should remember that photosynthesis requires light. Encourage students to come up with some ideas for how to test if plants produce oxygen in different types of light. Allow them to develop an appropriate hypothesis. Depending on how you prepared the samples, you may now give the students the materials and allow them to set up the experiment. They should remember to set up a control without plants. Alternatively, if you are completing the experiment as a class, perform the DO test and record the before and after results.
Explain: Oxygen is produced as a waste product of photosynthesis. Remind students of the interaction between photosynthesis and respiration. Ask: How do these two processes work together? Are we able to measure the amount of photosynthesis without respiration? No, because the oxygen that is being produced is constantly being used by respiration. The students are, in effect, measuring net photosynthesis. Ask: Where would a plant be happier, in a shallow, sunny place or in a deep, dark place? Why? Have students discuss what happens if light cannot penetrate through the water column.

Extend: If you have access to a classroom aquarium which has plants and animals (as well as a good algal population), you could try turning off the aeration system. First, try it with the light on, and then with the light off (cover with a sheet or cheesecloth for additional effect). Monitor the animals carefully to make sure they are not undergoing stress.
Evaluate: Use students' lab reports to determine the amount of information they learned about DO and photosynthesis.

Comments:

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