Science Unit: ***Living with Oxygen***

Lesson 4: ***Oxygen Producers –Plants and The Cycle of Life***

School Year:	2012/2013
Developed for:	J.W. Sexsmith Elementary School, Vancouver School District
Developed by:	Sheila Thornton (scientist); Duncan Kay and Danielle Conrad (teachers)
Grade level:	Presented to grade 7; appropriate for grades 6 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	Many aquarium plants, including *Elodea* spp., are invasive species. This is an excellent opportunity to discuss the concept with the students and ensure that all of the plants are bleached/destroyed to prevent release into the environment.

Objectives

1. Learn the basic concepts related to photosynthesis
2. Understand the importance of plants in the carbon cycle
3. Explore the necessary components for photosynthesis
4. Learn about the risks of invasive species

Background Information

Photosynthesis is the process by which a plant transfers the light energy from the sun into chemical energy in the bonds of sugar molecules. Plants need only light energy, CO_2, and H_2O to make sugar. Carbon dioxide from the atmosphere provides the carbon source for photosynthesis, and water provides the hydrogen needed. By following the equation below, students are able to see the source of the oxygen that is released into the environment.

The overall chemical reaction for photosynthesis is:

$6CO_2 + 12H_2O + \text{energy} \Rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$

(Carbon dioxide + water + light energy ⇒ glucose + water + oxygen)

Vocabulary

Photosynthesis:	The process used by plants to convert light energy into chemical energy. Carbon dioxide and water are used to synthesize carbohydrates, such as sugar.
Carbon cycle:	The carbon cycle describes the movement of carbon as it is recycled and reused throughout the biosphere.
Invasive species:	Also referred to as invasive exotics; they are introduced or non-native plants or animals that adversely affect the habitats and regions that they invade.

Materials

- Test tubes 16x100mm
- Tap water
- Ruler (mm scale)
- Distilled water
- Parafilm
- Marker (sharpie)

- Scissors or blade
- *Elodea* sp. (pond weed) – local pet store or aquarium shop (Aquariums West, Fraser Aquarium, Noah's Pet Ark, etc)
- Bleach (for plant disposal)
- Timer
- Soda water (degassed – or a 5% baking soda solution)
- Test tube rack

In the Classroom

Introductory Discussion

1. The Earth supports more than 300,000 different types of plants, and plants in turn support life on Earth. In our last experiment, we discussed why animals require oxygen, and its role as the final electron acceptor in the metabolic process.
    - The basic building blocks for photosynthesis are light, carbon dioxide, and water, resulting in the release of oxygen into the environment.
    - What do you think might happen if we cut down too many forests?
    - What might happen if there is too much carbon dioxide in the atmosphere?
2. The planet Venus is almost exactly the same size as Earth and is made up of similar materials. However, once scientists gained more information about the atmosphere on Venus, they soon realized that the levels of carbon dioxide in the atmosphere were much higher than our own. These high levels trap the heat of the sun on the planet, driving the surface temperature up above 200˚C.
    - Do you think the earth's atmospheric carbon dioxide levels are falling or rising?
    - What might contribute to the atmosphere's carbon dioxide levels?
    - Why would an increase in carbon dioxide in our atmosphere be a negative event?
3. Just as we need a balance between food, oxygen and water to survive, plants also need to have a balance of components in order to function at an optimal level.
    - What happens if you deprive a plant of water?
    - What happens to photosynthesis if carbon dioxide is not available?
    - What if you were to increase the amount of carbon dioxide available to a plant?
4. The balance in our ecosystem is vital for our survival. As humans exert a greater impact upon the earth, this balance could be jeopardized. What kind of experiment could you design in order to alter the balance in the photosynthesis equation?
    - How would you vary the components of the equation?
    - What would be your control?

Science Experiment

Experiment Title: Oxygen producers and the rate of photosynthesis

Purpose of Experiment: To illustrate the role of carbon dioxide in the photosynthetic process.

Experimental Treatments: Control (tap water), distilled water (no carbon dioxide), soda water (excess carbon dioxide)

Prediction or Hypothesis: Lead the students to develop hypotheses as to the rate of oxygen production when the aquatic plant *Elodea* species is placed in each of the three solutions (distilled water; tap water; soda water).

Methods and Instructions:

Working in groups of 4, each group is provided with 6 test tubes, a marker, three solutions and sufficient *Elodea* to ensure each tube has an approximately equal length of plant stem.

1. Instruct the students to perform a replicate when undertaking the experiment.
2. Label two tubes each for distilled, tap and soda water.
3. Cut the Elodea stems into six equal pieces and place a piece in each test tube. The stem should almost fill the tube, but a small margin needs to be left at the tube opening.
4. Fill each tube with the appropriate solution; tap the tubes to release all bubbles.
5. Using a pipette, fill each tube right to the top with the appropriate solution.
6. Prepare the squares of Parafilm and set the timer.
7. Seal all tubes simultaneously (or as close as possible) with the Parafilm and begin timing. Ensure you have a tight seal.
8. After 5 minutes, invert the tubes and measure the air bubble (distance from the bottom of the tube). This bubble represents the oxygen produced through photosynthesis.
9. Continue timing to the second point (these time limits are dependent on the amount of plant matter, the species, environmental factors, etc). Five minutes is often sufficient to observe a noticeable difference in oxygen production, but a second time point may reveal a change in rate.
10. At the conclusion of the experiment, ensure all pieces of *Elodea* species are collected and placed in a strong bleach solution prior to disposal. Provide commentary on invasive species and the dangers of introducing exotics into our native ecosystem.

Closure Discussion

1. Which solution resulted in the greatest oxygen production (rate of photosynthesis)?
2. Was your hypothesis correct?
3. What would be the negative impacts of altering the substrate quantity in the photosynthesis equation?

Further Reading and Resources

Excellent website with downloadable lesson plans for plant experiments:
http://www.plantscafe.net/en/experiments/

Invasive species information from the Global Invasive Species database:
http://www.issg.org/database/species/ecology.asp?si=290