

Lab: What Affects the Rate of Photosynthesis?

Duration: 45 min

Class Size: Up to 32 students

General Overview: In this lab, students will make hypotheses about how different variables (such as light intensity, water pH, and CO₂ availability) might affect the rate of photosynthesis in Elodea plants, and then students will carry out a series of 2-minute experiments under different conditions to test their hypotheses. The rate of photosynthesis will be measured by counting the number of oxygen bubbles produced by the Elodea plants in each 2-minute trial. After completing a number of experiments, students and teachers will discuss their findings in relation to macro-level factors that affect ecosystem health and climate change.

Objectives: Students will gain a better understanding of the biochemical process of photosynthesis as well as the ecological factors that affect and are affected by photosynthesis processes.

SWBAT: Students will be able to:

- Identify the equation for photosynthesis and each of its component parts
- Identify ecological factors that will affect the input components of photosynthesis
- Identify ecological factors that will be affected by macro-level changes in photosynthesis rates
- Write clear and testable causal hypotheses
- Modify hypotheses based on experimental findings
- Manipulate physical variables in a controlled and precise manner
- Synthesize findings from lab based research and apply them to ecological analyses

Materials:

- Elodea plants (1 plant per class, or 1 fresh/new elodea sprig per group)
- 2 solutions of baking soda and water (one strong and one weak)
- Vinegar
- Graduated cylinders (1 per group)
- 100 – 150 watt hand-held lights or desk lamps (1 per group)
- Rulers
- Data worksheets

Procedure:

1. *Introduction:* If teachers have not already discussed the process and equation for photosynthesis, this should be done first. Teachers will have the equation for photosynthesis on the board or in front of students and will begin by brainstorming what might affect photosynthesis. This discussion

will be guided toward ecological factors that might affect the 3 input components of photosynthesis: sunlight, water & carbon dioxide. Teachers will then transition into the lab by discussing how we can test some of these variables in the lab. Teachers will give an overview of the experiment as well as an introduction to the materials (highlighting the fact that the baking soda solutions increase levels of CO₂ in the water and that vinegar decreases the pH of the water).

2. *Lab Instructions:* Instructions for the lab will be written on the board and discussed verbally with the class
 - a. Students will break into groups of 4-6. Each group will have one set of materials as listed above.
 - b. Students will first conduct a baseline test of the rate of photosynthesis under standardized conditions (neutral water & 10 cm. light source).
 - c. Students will first peel the leaves off of the stem of the elodea and crush the stem with their fingers (this allows oxygen bubbles to escape from the stem more easily).
 - d. Students will place the elodea sprig upside down into the graduated cylinder. The cylinder will be filled with normal tap water or spring water, and the stem of the elodea should be submerged 1-2 inches in the water.
 - e. Students will place their light source 10 cm. from the body of the elodea sprig and will count the number of oxygen bubbles released from the stem over a 2 minute period. This is the baseline test. Conditions and results will be recorded on the data worksheets.
 - f. After the baseline test, students will write a hypothesis about what might increase or decrease the rate of photosynthesis. They will then manipulate the variables to test this hypothesis (i.e. adding baking soda solution to the water, or moving the light source closer). They will again record the conditions of the test and the oxygen bubble count for a 2-minute trial.
 - g. Students will replicate this procedure for 4-5 trials, altering one variable each time and recording changes in rate.

3. *Discussion:* As a class, students will report their results and will discuss how each of the variables affected the rate of photosynthesis. Further discussion questions are: What ecological factors affect the various variables we observed as they exist in the natural environment? What role do humans play in causing changes in these factors? What implications do these results have for the health of ecosystems and for climate change?

Notes to Instructors:

- Students can expect to count 25-60 oxygen bubbles in 2 minutes when the elodea is in neutral water and a 150 watt bulb is 10cm from the plant (baseline conditions)

- Students can expect to count up to 80 oxygen bubble per 2 minutes in the strong baking soda solution and with intense direct light
- Students and Teachers will get more consistent and effective results if new elodea sprigs are given to each group. These new sprigs should be stored in a dark container until they are used. Otherwise if the same sprigs are used all day by all groups, they tend to become “saturated” and the rate of photosynthesis slows significantly (if it can be observed to occur at all).

What Conditions Affect the Rate of Photosynthesis?



Variables:

1. Distance of light source
2. Intensity of light source
3. Clarity of light source
4. Acidity of water (pH)
5. Available CO_2 in water
6. Oil pollutants in water

Baseline Trial (2 min):

Distance of Light Source: _____

Intensity of Light source _____

pH: _____

Available CO_2 in water (amount of baking soda): _____

O_2 bubbles per 2 minutes: _____

Trial 1 (2 min):

Hypothesis: _____

Variable A: Name: _____ Amount: _____

O_2 bubbles per 2 minutes: _____

Trial 2 (2 min):

Hypothesis: _____

Variable A: Name: _____ Amount: _____

Variable B: Name: _____ Amount: _____

O_2 bubbles per 2 minutes: _____

Trial 3 (2 min):

Hypothesis: _____

Variable A: Name: _____ Amount: _____

Variable B: Name: _____ Amount: _____

Variable C: Name: _____ Amount: _____

O₂ bubbles per 2 minutes: _____

Trial 4 (2 min):

Hypothesis: _____

Variable A: Name: _____ Amount: _____

Variable B: Name: _____ Amount: _____

Variable C: Name: _____ Amount: _____

Variable D: Name: _____ Amount: _____

O₂ bubbles per 2 minutes: _____

Trial 5 (2 min):

Hypothesis: _____

Variable A: Name: _____ Amount: _____

Variable B: Name: _____ Amount: _____

Variable C: Name: _____ Amount: _____

Variable D: Name: _____ Amount: _____

Variable E: Name: _____ Amount: _____

O₂ bubbles per 2 minutes: _____