MiSP PHOTOSYNTHESIS
Teacher Guide

Introduction

This weeklong unit can be implemented in a variety of places in an eighth-grade science curriculum: plant structures and functions, cell biology, or ecology.

Students should become familiar with the basics of the photosynthetic process through discussion and demonstrations. Following that, students will examine factors that affect photosynthesis.

Standards

ILST Core Curriculum — Major Understandings:
Standard 4 Living Environment 5.1d, 6.2a, 6.2b
Standard 4 Physical Setting 4.3a
Living Environment Curriculum — Major Understandings:
Standard 4 Living Environment 5.1a, 5.1b

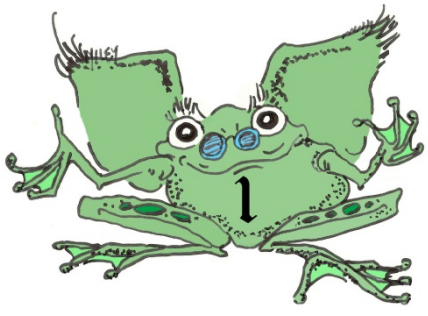
Lesson Objectives: After completing this unit, students will be able to:

- Describe the "big picture" of photosynthesis: what is utilized and what is produced
- Create and interpret a graph showing the effect of temperature on the rate of photosynthesis
- Conduct an experiment that measures oxygen production during photosynthesis
- Graph and interpret experimental results showing the relationship between distance from a light source and oxygen production during photosynthesis
- Quantify the changes in oxygen production by calculating unit rate of change
- Calculate the formula for segments of the oxygen graph and use those formulas to calculate expected oxygen production at different distances from the light source.

Day 1 — The Process of Photosynthesis

Show the students a living plant. Ask if it is alive, and reveal that it is by showing that it meets the criteria for life. Ask where a green plant gets its food. Be prepared for the common misconception that a plant gets food from the soil or from fertilizer (remember that many fertilizers are called "plant food") or the misconception that water is a plant's food. However, many students may actually know that plants make their own food. Review or introduce the words *autotroph* and *heterotroph*.

Use Photosynthesis Worksheet#1: Guided Notes to lead the students to a basic understanding of photosynthesis.



1. Define *photosynthesis*.
2. Review or introduce the photosynthesis equation $CO_2 + H_2O + \text{energy} \rightarrow O_2 + C_6H_{12}O_2$.
3. Perform demonstrations (set them up in advance) to illustrate components of the photosynthetic process:
    a. Place elodea under a glass funnel and test tube with collected oxygen. Test for the oxygen with a glowing splint. A glowing splint bursts into flame when exposed to oxygen.
    b. Use geraniums, coleus, or similar plants. Keep some in normal light/dark conditions and keep others in the dark. Boil leaves in ethanol to remove the chlorophyll (show the students the chlorophyll), and stain the leaves with iodine to show the production of starch in the leaves that are exposed to light. Iodine forms a black precipitate in the presence of starch.
    c. Place elodea in bromothymol blue solutions. Bromothymol blue is an acid-base indicator. It will turn yellow in the presence of a weak acid. Bubbling one's breath into the solution turns it yellow because of the carbon dioxide added. In the dark, an elodea plant will turn a bromothymol blue solution yellow as it produces carbon dioxide as a product of respiration. An elodea plant exposed to light will turn yellow bromothymol blue back to the blue color as it uses carbon dioxide. Place two pieces of elodea in blue solution and two in yellow solution. Place one of each in the dark and one of each in the light. Yellow and blue solution without elodea should be placed in each location as controls. The blue solution should turn yellow in the dark and the yellow solution should turn blue in the light. Introduce the word equation for photosynthesis: carbon dioxide plus water (using chlorophyll in chloroplasts in the presence of light) produces oxygen and food (sugar/starch/carbohydrate). Optionally, you may want to discuss that this process is an example of energy conversion—light energy is converted to chemical energy.
4. Stress that plants also use cellular respiration (24 hours per day) to break down food to release energy; that's part of being alive. In the process, plants use oxygen. The respiration use of oxygen during the daylight is overshadowed by the production of oxygen during photosynthesis, but it is still occurring.

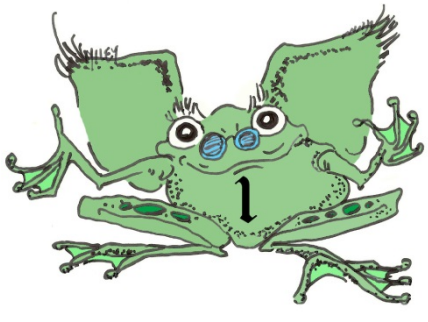
Question of the Day:

Years ago hospital staff removed plants from patients' rooms at night and returned them in the morning. Why did they do this?

Day 2 — The Rate of Photosynthesis

Students will work on Photosynthesis Worksheet #2: Photosynthesis and Temperature.

A preliminary activity may be used to demonstrate the effect of temperature on rate of reaction (students will need to understand that photosynthesis is a series of chemical reactions). A simple demonstration is to place Alka-Seltzer tablets in three containers holding water at different temperatures.



The rate of photosynthesis is actually measured in micromoles of carbon dioxide per mm^2 per second. The "label" has been simplified to carbon dioxide used per second. (It is not expected that the students will have a problem with that change.)

The level 2 lesson requires the students to calculate the unit rate of change of two different sections of the graph and relate that calculation to their earlier interpretation of the graph.

In the level 3 lesson, the students determine the linear equation for two different sections of the graph. They conclude the exercise with two calculations for the same *x*-value that produces two different values for *y*. Students are asked to consider which value is correct. They will need guidance to understand that the experimental information does not provide enough information to show when the rate of photosynthesis peaked.

Question of the Day:

It is known that autotrophic plants use blue and red light in photosynthesis. When you look at plants, it is obvious that they do not use green light for photosynthesis. Why is it obvious?

Days 3 and 4 — Photosynthesis and Light Intensity

In this experiment the students will measure the amount of O_2 produced at different light intensities. The intensity of the light is changed by moving a light source with a 100 W bulb different distances from a branch of elodea.

Procedure Notes:

Add 5 ml of 0.25% sodium bicarbonate solution per 100 ml of aquarium water used. Healthy elodea is needed. Order it well in advance and keep it in a well-lit, oxygenated aquarium so that it will be healthy when needed for the experiment. You may set up the plants for the students to save time. However, it is not a good idea to set up workstations with the light at various distances from the light and have the students move from station to station. The plants will behave differently so all data should be taken from the same plant.

Day 5

Administer the appropriate level assessment.