## SBI4U: Metabolic Processes

# Teacher Demonstration: Carbon Use by an Aquatic Plant

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| Topics carbon  photosynthesis  Phenol Red  aquatic plant (such as *Elodea*) | Timing preparation: 5min  demonstration: 60min |

## Specific Expectations [SBI4U](#_sbi4u_1)

## Introduction

This activity demonstrates the use of carbon by an aquatic plant. The process of photosynthesis can be represented by the reaction: CO2 + H20 + light → C6H12O6 + O2. There are two distinct steps: the *light dependent* reactions (involving H20) and the *light independent* reactions (involving CO2). The light reactions supply the energetic molecules (ATP and NADPH) required to carry out the fixation of carbon from CO2 into larger organic molecules that can be formed into glucose. Though the carbon fixation reactions do not require light, they are dependent upon the energy (in the form of ATP and NADPH) supplied by the light reactions.

## Materials

50mL phenol red 0.02% aqueous solution

sprig of *Elodea*

one 150mL Erlenmeyer flask

two test tubes

one plastic straw

one pair safety goggles

one pair gloves

## Safety Considerations

The 0.02% phenol red solution can irritate eyes and skin and may be toxic by ingestion and inhalation, check the current MSDS information.

Wear eye protection and gloves.

Avoid spills and promptly wipe spills with paper towels if any occur.

**Procedure**

**Preparation:**

Wear gloves and goggles for this demonstration.

Prepare 0.02% phenol red solution from stock if no prepared solution is available.

Add 75mL of 0.02% phenol red to an Erlenmeyer flask.

**Predict/Explain:**

Hold up 150mL Erlenmeyer flask with 50mL 0.02% phenol red solution.

Explain that phenol red is a universal indicator for pH that is bright pink for basic solutions and bright yellow for acidic solutions.

Ask students to work in pairs and record their thoughts to these guiding questions:

a) What would be an easy source of CO2 for the solution?

b) What will happen to dissolved CO2 when a plant is added to a solution?

c) What other factors could affect the colour of the given solution?

**Observation**

Add the straw to the Erlenmeyer flask. Gently and carefully blow into solution until it just turns yellow. Be sure no splashing occurs by covering the opening of the flask with a gloved hand.

Divide solution equally between two test tubes.

Add sprig of *Elodea* to one tube so that it is just covered by solution.

Place both tubes under grow lights or in direct sunlight on a windowsill.

Monitor changes in color over the next 60min.

**Explain**

Instruct students to review their initial thoughts and revise their notes.

Ask pairs to share their thoughts to explain the change observed.

## Disposal

Dispose phenol red solution according to chemical disposal guidelines following the protocol of the employer.

The used straw can be thrown in the garbage stream.

Dispose of *Elodea* sprigs in waste. DO NOT rinse them with water that goes down the drain. Do not add to the compost stream.

DO NOT release *Elodea* into the environment.

## What happens?

Blowing into the red solution of phenol red will change its colour to yellow. The yellow will gradually change back to red in the test tube with *Elodea* in it.

## How does it work?

Carbon is introduced into phenol red solution by blowing into it, where the carbon dioxide (CO2) in exhaled breath dissolves in water to form carbonic acid (H2CO3). This acid lowers the pH of the solution and the colour of the solution changes from red to yellow (phenol red turns yellow in pH lower than 7). When a sprig of *Elodea* is added, the color will gradually change back to red as the plant performs photosynthesis and uses the available carbon.

## Teaching Suggestions/Hints

1. Aquatic plants in the genus *Elodea* are commonly known as waterweeds and can be purchased through a biological supplier or at (aquatic) pet stores. Order as far in advance as possible as sometimes plants must be special-ordered.
2. If phenol red is not available, bromothymol blue indicator can be used instead.
3. The more carbonic acid in the indicator solution, the longer the demonstration will take, so stop blowing into phenol red solution as soon as its color is clearly yellow.
4. This activity works best if it is set up at the beginning of class and monitored over the course of the period.
5. Ask students why it is difficult to observe the use of water in the reaction. Ask them to suggest ways to study the movement of water molecules (students reviewed the concept of isotopes in the Biochemistry Strand and could suggest the introduction of isotopes of water at different steps.)
6. Ask students to propose ways to reverse the colour change. If no one suggests using a plant, ask the class to predict what would happen if a sprig of *Elodea* was added and why.

## Next Steps

1. Prepare a flask or test tube of 0.1mol/L solution. Add just enough CO2 through a straw to change the solution colourless. Methylene blue will turn blue in the presence of oxygen. Swirl the flask to add oxygen into the solution and show the colour change.
2. Students can take these experiences to plan an investigation to test for the products of photosynthesis.
3. This demo may be performed with different plants or different light sources to compare if and how these variables impact the rate of photosynthesis.

## Additional Resources

This activity was adapted from ‘The Red and the Yellow: Carbon Fixation’: http://huntington.org/uploadedFiles/Files/PDFs/GIB-RedAndYellow.pdf

## Specific Expectations

## SBI4U

A1.1 formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge

C2.3 conduct a laboratory investigation of the process of photosynthesis to identify the products of the process, interpret the qualitative observations, and display them in an appropriate format

C3.2 explain the chemical changes and energy conversions associated with the process of

photosynthesis (e.g., carbon dioxide and water react with sunlight to produce oxygen and

glucose)

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