Measuring the Effect of Light Intensity on Photosynthesis

Introduction

Photosynthesis captures energy from sunlight. Plants, algae, and some bacteria use the energy captured during photosynthesis for their metabolic reactions. During photosynthesis in plants, chlorophyll and enzymes in leaves convert certain wavelengths of light into chemical energy. A simple equation can be used to represent photosynthesis.

Light + Water + Carbon Dioxide produces High-energy sugars + water

In this investigation you will examine the relationship between the amount of light energy available and the rate of use of carbon dioxide by a plant in the process of photosynthesis.

Problem

What is the relationship between light intensity and the rate of photosynthesis?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. What are the variables in this experiment? Identify the manipulated and responding variables and two controlled variables.

2. How will you provide carbon dioxide to the evergreen sprigs?

3. How will you know whether the carbon dioxide has disappeared from the solutions in the test tubes?

4. If the carbon dioxide does disappear from the solutions in the test tubes, how will you know whether it was consumed by photosynthesis or simply evaporated into the air?

5. How do you expect the intensity of light to affect the color of the BTB indicator? Predict the result you expect for this experiment.

Procedure

1. Work in groups of two or four students. **CAUTION:** *Wear safety goggles, and a lab apron*. Obtain eight large test tubes and four test-tube racks. Place two test tubes in each test tube rack.

2. Using a beaker, fill each of the eight test tubes with distilled water to about 4 cm from the top.

3. If you are using a carbon dioxide probe, see your teacher for instructions. Bromthymol blue indicator solution (BTB) indicates the presence of carbon dioxide by turning yellow. Add BTB to one test tube, one drop at a time, stirring with a straw. Count the drops you add. Stop when the water changes color to a pale blue. Then add the same amount of BTB to each of the other seven test tubes. Stir each test tube with a straw.

4. Using a straw, blow gently into each test tube of BTB-water solution to add carbon dioxide to the solution. Continue blowing until the color changes to a pale yellow color. **CAUTION:** *Be careful not to inhale any of the BTB solution*.

5. Obtain four sprigs of an evergreen plant and place them on a paper towel. Using a scalpel or razor blade, carefully cut and remove about 0.5 cm from the base (blunt) end of each sprig. Cut more if necessary to ensure that all four sprigs are the same size.

CAUTION: *Be careful when using sharp tools*. In each of the four test-tube racks, place one sprig, cut end down, into one of the two test tubes of BTB-water solution.

6. Place one test-tube rack 50 cm from the floodlight or other light source provided by your teacher. Place the second rack 40 cm from the light source, the third rack 20 cm from the light source, and the fourth rack 10 cm from the light source. Record the time you place each rack in front of the light source in the Data Table.

7. Observe the test tubes for the remainder of your lab period. Record in the Data Table the time required for a color change to occur in each test tube.

8. Compare the results in your Data Table with those of other groups in your class, according to your teacher's instructions.

9. Make a graph of the observations that you recorded in the Data Table. On the horizontal axis, plot distance from the light source. On the vertical axis, plot the time required for the color of the BTB solution to change. Use two different colors or symbols to graph the results from the test tubes that contained sprigs and those that did not contain sprigs.

Analysis and Conclusions

1. Analyzing Data In the test tubes that contained plant sprigs, how did distance from the light source affect the time required to see a color change? How can you explain this result?

2. Inferring Were there any test tubes in which you did not see a color change? How can you explain this observation?

3. Drawing Conclusions Was your prediction correct? Explain what the results tell you about the effect of light intensity on photosynthesis.

4. Comparing and Contrasting Were results consistent throughout the class? If not, explain what may have affected the results.

5. Predicting Predict what would happen to the color of the BTBwater solution if you placed a tube with a plant sprig in darkness.

Going Further

Based on the results of this investigation, propose a hypothesis about whether or not a temperature change in the test tubes, caused by the light source, could be a factor affecting the results. Propose an experiment to test your hypothesis about the effect of temperature on photosynthesis. If the necessary resources are available and you have your teacher's permission, perform the experiment.