LABORATORY EXERCISE #3--HOW DOES LIGHT AFFECT PHOTOSYNTHESIS?

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Selection from *Modern Biology,* Biology Investigations, Teacher's Edition, by James H. Otto, Albert Towle, W. David Otto, and Myra E. Madnick. Copyright 1977 by Holt, Rinehart and Winston, Inc. Reprinted by permission of the publisher.

**Materials needed**

*Anacharis (Elodea)* Medicine dropper   
6 Pyrex test tubes Forceps   
4 pieces of glass rod (5 cm) Test-tube rack  
150-watt reflector lamp 250-ml beaker  
Sodium bicarbonate 6 sheets of cellophane; 7 cm by 15 cm;  
Dilute brom thymol blue solution red, yellow, green, blue and 2 clear  
0.1% hydrochloric acid solution Soda straw   
6 test tube stoppers Rubber bands

**Part I: The Rate of Photosynthesis**

The rate at which photosynthesis takes place can be determined by recording the number of oxygen bubbles that escape from the cut end of a sprig of *Anacharis*. In this part, you will observe the effect of light on the rate of photosynthesis.

Fill 4 test tubes with water within 3 cm of the top. Select 4 sprigs of *Anacharis* that have been growing in bright light. Each sprig should be about 7 cm. Wind each sprig around a glass rod and immerse in one of the test tubes. Sodium bicarbonate forms carbon dioxide in water. Add a small amount of sodium bicarbonate to each test tube.

a. Why should this be done?

Place one test tube under bright sunlight or a reflector lamp; the second should be in daylight; the third in diffuse light; and the fourth in total darkness. Allow the plants to remain in these light conditions for 15 minutes. Observe the cut ends of each plant. Use a timer or a watch with a second hand and count the number of oxygen bubbles given off by each plant in 1 minute.

b. What do the bubbles tell you about the rate of photosynthesis?

1. Under which condition is the bubble count the greatest?

d. Under which light condition is the bubble count the least?

e. What conclusions can you draw from this investigation?

Continue to record the results of the investigation by counting the bubbles for 5 minutes. Record your observations in the table provided.

|  |  |  |  |
| --- | --- | --- | --- |
| **Environmental  Condition** | **Rate per Minute** | **Rate per 5  Minutes** | **Average Rate  per Minute** |
| Sunlight or  reflector lamp |  |  |  |
| Day light |  |  |  |
| Diffuse Light |  |  |  |
| Darkness |  |  |  |

f. How do you account for the variation in the rate of bubbles in the 4 plants?

**Part II: The Effect of Wavelengths of Light on Photosynthesis**

In Part I, the effect of light on photosynthesis was clearly indicated. In this part, you will examine the effect of the different wavelengths (colors) of light on photosynthesis. Different wavelengths of light contain varying amounts of energy.

Fill a beaker with 100 ml of water. Add brom thymol blue to color the water a pale blue. Using a soda straw, blow into the solution. This will cause a change in color.

a. What color does the solution become?

b. What causes this color change?

Place 5 test tubes in a test tube holder and insert a sprig of *Anacharis* in each. Add the solution from the beaker to cover the sprigs of *Anacharis* in the test tubes. Place a stopper in each test tube. Fill a sixth test tube with the same solution, but do not place an *Anacharis* sprig in it. Stopper this tube.

c. What function does this tube perform?

Wrap a cellophane sheet of a different color around each test tube. Wrap one tube containing *Anacharis* and one without the plant with clear cellophane. Use rubber bands to secure the cellophane sheets. Expose the test tubes in the rack to the light of the lamp for about 20 minutes. Examine each test tube and record your results in the table below.

|  |  |  |
| --- | --- | --- |
| **Test Tube** | **Color of Indicator  after 20 minutes** | **Number of drops of  Hydrochloric Acid to  Restore Color** |
| Red |  |  |
| Yellow |  |  |
| Green |  |  |
| Blue |  |  |
| Clear |  |  |

d. How do you account for the changes in the test tubes?

e. What substance were the *Anacharis* sprigs absorbing?

f. Which wavelength (color) was most effective in increasing the rate of photosynthesis?

g. Which color was least effective in increasing the rate of photosynthesis?

Remove the *Anacharis* from the 5 test tubes. Add 0.1% hydrochloric acid drop by drop to each test tube until the original color returns. Count the number of drops necessary for each to change color. Record your findings in the second column of the table.

h. Why does the hydrochloric acid return the color to the original?

i. What was the color of the liquid in the tube without the *Anacharis*?

j. What was the purpose of this test tube?

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**Part III: Summary**

a. How can the rate at which photosynthesis takes place be determined?

b. Why was sodium bicarbonate added to the test tubes in Part I of this investigation?

c. Under which condition of light was the bubble count the greatest?

d. Under which condition of light was the bubble count the least?

e. What conclusions did you draw from Part I of this investigation?

f. What substance was absorbed by the *Anacharis* sprigs in Part II of the investigation?

g. Which wavelength was most effective in speeding up the rate of photosynthesis?

h. How do you know this is so?

**Part IV: Investigations On Your Own**

1. The effect of temperature on the rate of photosynthesis can also be determined. Prepare 4 sprigs of *Anacharis* as you did for Part I. Place one test tube in a water bath and, using ice chips, reduce the temperature to 10oC. Record the oxygen bubbles given off after 1 minute and after 5 minutes. Add hot water to the water bath and separately raise the temperature to 20oC, 30oC, and 40oC. Use a separate test tube of *Anacharis* at each temperature and record the number of oxygen bubbles released. Draw conclusions from your investigation concerning the effect of temperature on the rate of photosynthesis.

2. Design an original investigation that will show how different concentrations of carbon dioxide affect the rate of photosynthesis.