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**Lab 14:** **Measuring Respiration and Photosynthesis**

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**Purpose**

Determine the effect of light on photosynthesis and respiration

**Introduction**

All living organisms require energy for growth, movement, reproduction, and metabolism. **Photosynthesis** is the process by which photo**autotrophs** convert inorganic compounds (like water and carbon dioxide) to high-energy organic compounds (like glucose) using light energy.

**Cellular aerobic respiration** is carried out within the cells of most organisms. Using oxygen, high-energy organic compounds (like glucose) are broken down and the energy is captured in a form that can be used by the cell. While autotrophs produce their own glucose, **heterotrophs** are organisms that must get their energy by consuming high-energy compounds.

Examine the two equations below. The 1st equation represents photosynthesis and the 2nd equation represents aerobic respiration. Notice that the end products of one reaction are the reactants for the other. Only cells containing chlorophyll can perform photosynthesis, while aerobic respiration can take place in most cells. Many plants perform photosynthesis and aerobic respiration simultaneously. (C6H12O6 = glucose)

**Photosynthesis**:
Light Energy
6CO2 + 6H2O ⇒C6H12O6  + 6O2

**Respiration:**

C6H12O6 + 6O2 ⇒6CO2 + 6H2O + **36ATP**

In this lab experiment, you will examine the dual nature of **photosynthesis** and **respiration**. In the presence of light, high-energy organic molecules and oxygen will be produced by photosynthesis, and CO2 will be used up. Aerobic respiration occurs in the presence or absence of light, and CO2 will be produced as a by-product

To determine whether photosynthesis or aerobic respiration have taken place, we’ll note **pH changes**. Examine the following equation:

CO2 + H2O ⇒ H2CO3 ⇒ H+ + CO3-

As you can see, when CO2 mixes with H2O, a weak acid (H2CO3) is produced, this equation is also reversible. As CO2 is added to a solution (via aerobic respiration) the pH decreases. As CO2 is removed from a solution (via photosynthesis), the pH increases.

**Materials**

* 4 test tubes
* *Elodea*
* Bean seeds
* Stoppers
* Test tube rack
* Bromothymol Blue
* Labels

**NOTE:** In this laboratory experiment, we will look for changes in acidity as CO2 is added to a solution (via aerobic respiration) or removed from a solution (via photosynthesis). We’ll use **Bromothymol Blue** as a pH indicator. It is Blue at a basic pH (above pH 8.0) and yellow at an acidic pH (below pH 6.6)

**Pre-Lab Questions**

1. *Elodea* is a green aquatic plant. Its cells contain chloroplasts. Would you expect this plant carry out photosynthesis? \_\_\_\_\_\_\_\_\_ Would you expect this plant carry out aerobic respiration? \_\_\_\_\_\_\_\_\_
2. Seeds are a dormant phase of a plant life cycle. They contain cells that feed a plant embryo before the plant germinates and is capable of photosynthesis. Would you expect a seed carry out photosynthesis? \_\_\_\_\_\_\_\_\_ Would you expect a seed carry out aerobic respiration? \_\_\_\_\_\_\_\_\_
3. **Clarify** What does a yellow/green color liquid indicate? (In terms of CO2)

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1. **Clarify** What does a Blue color liquid indicate? (In terms of CO2)

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**Procedure A-** Respiration and Photosynthesis testing

1. Set up 4 test tubes. Each tube should contain: 20 ml of tap water and 10 drops of Bromothymol Blue, a pH indicator.
2. To prepare tubes #1 and #3, add CO2 by blowing gently into the tube with a straw. Be careful not to suck any of the liquid into your mouth. Blow until the solution turns yellow. What caused the color change?

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**Tube #1** – Elodea sprig (yellow)

* Add CO2 by blowing gently into the tube with a straw. Be careful not to suck any of the liquid into your mouth. Stop blowing as soon as the liquid turns yellow.
* Place a 10 cm leafy sprig of Elodea in the tube, pressing it down so that it is completely submerged. Seal the test tube with a rubber stopper.
* Place the test tube in a dark place.

 **Tube #2** – 3 bean seeds (Blue)

* Place 3 seeds in the tube make sure they are completely submerged. Seal the test tube with a rubber stopper.
* Place the test tube in a dark place.

**Tube #3** – Elodea sprig (yellow)

* Add CO2 by blowing gently into the tube with a straw. Be careful not to suck any of the liquid into your mouth. Stop blowing as soon as the liquid turns yellow.
* Place a 10 cm leafy sprig of Elodea in the tube, pressing it down so that it is completely submerged. Seal the test tube with a rubber stopper.
* Place the test tube in a light place.

 **Tube #4** – 3 bean seeds (Blue)

* Place 3 seeds in the tube make sure they are completely submerged. Seal the test tube with a rubber stopper.
* Place the test tube in a light place.
1. Incubate your test overnight. (1 hour)
2. Look for a color change in each test tube and record your results in Table 1

**Procedure B-** Design your own experiment

1. Using the materials available, design an experiment to determine the number of seeds required to produce enough CO2 to balance amount of CO2 used by Elodea during photosynthesis. Your experiment should answer the question: How many seeds produced the same amount of CO2 used by the Elodea?

**\*Complete this part in the conclusion section**

**Observations:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Test Tube #** | **Contents** | **Starting color** | **Ending color** |
| **In Dark** | Number 1 |  |  |  |
| Number 2 |  |  |  |
|  **In Light** | Number 3 |  |  |  |
| Number 4 |  |  |  |

**Data Table 1**

**Initial**

 **In Dark In Light**

**Test tube 1 Test tube 2 Test tube 3 Test tube 4**

**Final**

**Test tube 1 Test tube 2 Test tube 3 Test tube 4**

**Analyze and Conclude**

1. **Compare and Contrast** Which test tubes changed color?

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1. **Apply Concepts** Do your results indicate that light is necessary for photosynthesis? Explain your  answer using *your* *results*.

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1. **Apply Concepts** Do your results indicate that light is necessary for aerobic respiration? Explain your  answer using *your* *results*.

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1. Fill in the diagram below using the following words: cellular respiration, photosynthesis, glucose, O2, CO2, and ATP.

1. CO2 levels have been increasing since the industrial revolution. Increasing CO2 levels correlate with increasing global temperatures. Many environmental groups advocate planting trees and other vegetation solve the problem. Based on your results from today’s experiments, how will this help solve the problem of global climate change?

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**II. Design your own experiment**

1. Briefly describe the procedure you would use to determine the amount of seeds needed to produce the same amount of CO2 as the *Elodea* consumed. Be sure to include:
* Hypothesis
* Control and experimental groups
* IV and DV
* A labeled diagram
* Create a table to present the results of your experiment.

*You may use the space below or attach a separate sheet.*

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