Name:_____ **Date:_____**

Photosynthesis and Respiration

1. Introduction

When you eat a hamburger, you get energy from the sun indirectly. Plants, such as grass, capture the energy in sunlight. The beef in a hamburger comes from a cow that ate grass. The bun, lettuce, and tomato come directly from plants.

2. Background

Photosynthesis is the process that provides energy for almost all life. As following steps shows, photosynthesis has three stages:

stage 1 Energy is capture from sunlight.

stage 2 Light energy is converted to chemical energy, which is temporarily stored in ATP and NADPH.

stage 3 The chemical energy stored in ATP and NADPH powers the formation of organic compounds, using carbon dioxide, CO_2.

Photosynthesis occurs in the chloroplasts of plant cells and algae and in the cell membrane of certain bacteria. Photosynthesis can be summarized by the following equation:

$$6\ H_2O + 6\ CO_2 + \text{light energy} \rightarrow C_6H_{12}O_6 + 6\ O_2$$

However, this equation does not show how photosynthesis occurs. It merely says that three carbon dioxide molecules, three water molecules, and light are needed to form one three carbon organic compound (a sugar) and three molecules of oxygen. Plants use the organic compounds they make during photosynthesis to carry out their life processes. For example, some of these sugars are used to make components for cell walls. Some are used to form starch, which can be stored in stems or roots. The plant may later break down the starch to make ATP used to power

metabolism. All of the proteins, nucleic acids, and other molecules of the cell are assembled from fragments of these sugars.

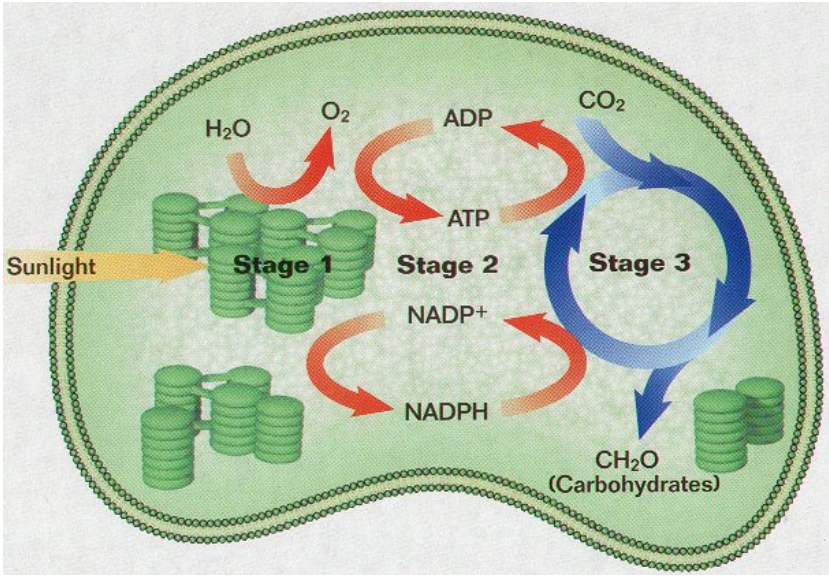


Figure 1. The process of photosynthesis occurs in three stages.

http://www.sirinet.net/~jgjohnso/photosynthesis.html

3. Objectives

In this experiment, you will

- Use an O_2 Gas Sensor to measure the amount of oxygen gas consumed or produced by a plant during photosynthesis.
- Use a CO_2 Gas Sensor to measure the amount of carbon dioxide consumed or produced by a plant during photosynthesis.
- Determine the rate of photosynthesis of a plant.

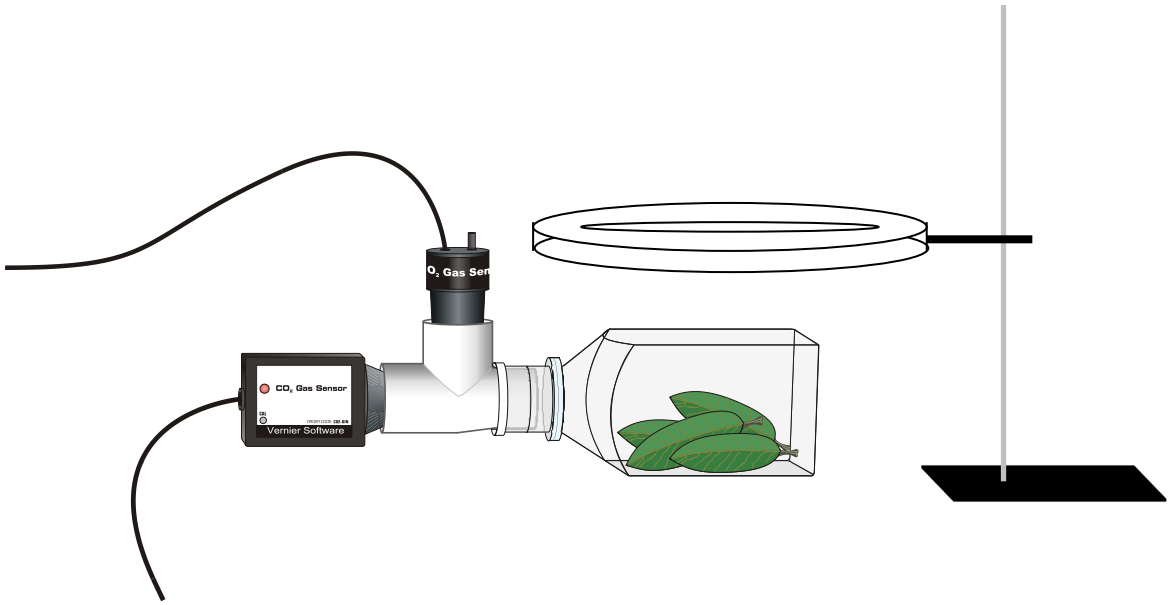


Figure 2.

4. Equipment

Logger *Pro*
Vernier O_2 Gas Sensor
Vernier CO_2 Gas Sensor
CO_2–O_2 Tee
Forceps
250-mL respiration chamber
Spinach leaves
500-mL tissue culture flask
Lamp

5. Experiment Procedure

1. Before collecting data, set up the data collection mode.

   a. To select MODE, press up arrow key twice and press ENTER key.

   b. Select TIME GRAPH from the SELECT MODE menu.

   c. Select CHANGE TIME SETTING from the TIME GRAPH SETTING menu.

   d. Enter "15" as the time between samples in seconds.

   e. Enter "60" as the number of samples (data will collect for 10minutes).

2. Connect the CO_2 Gas Sensor to Channel 1 and the O_2 Gas to Channel 2 of the Vernier computer interface.

3. Fill the tissue culture flask with water (not the respiration chamber) and place it between the lamp and the respiration chamber. The flask will act as a heat shield to protect the plant leaves.

4. Turn the lamp on. Place the lamp as close to the leaves as reasonable. Do not let the lamp touch the tissue culture flask. Note the time. The lamp should be on for 3 minutes prior to beginning data collection.

5. After the three-minute time period is up, click Collect to begin data collection. Collect data for 10 minutes and click Stop.

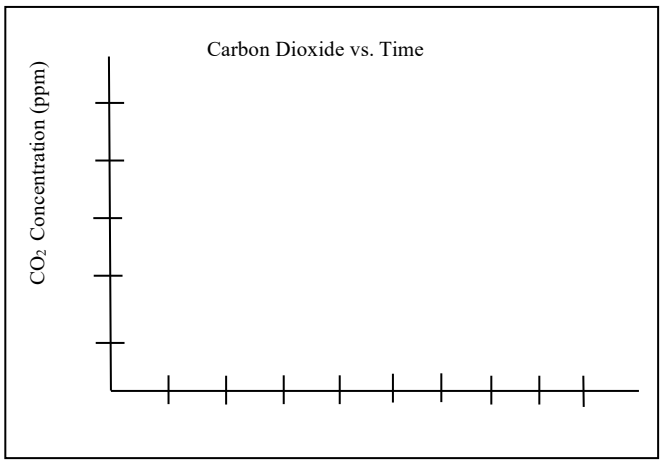
6. When data collection has finished, determine the rate of photosynthesis:
   a. Click anywhere on the CO_2 graph. Move the mouse pointer to the point where the data values begin to decrease. Hold down the left mouse button. Drag the pointer to the point where the data ceases to decrease and release the mouse button.
   b. Click on the Regression button, , to perform a linear regression. A floating box will appear with the formula for a best-fit line.
   c. Record the slope of the line, *m*, as the rate of photosynthesis in Table 1.
   d. Close the linear regression floating box.
   e. Repeat steps 13a-d for the O_2 graph. However, you will need to move the mouse pointer to the point where the data values begin to increase, hold down the mouse button and drag to the point where the data ceases to increase.

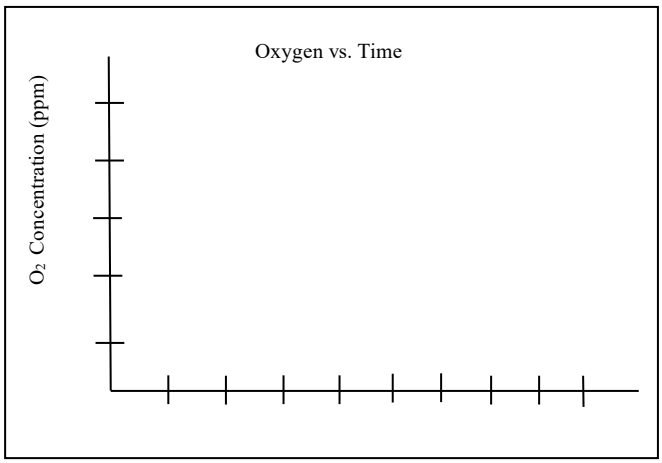
7. Print a graph showing your photosynthesis and respiration data.
   a. Label each curve by choosing Make Annotation from the Analyze menu. Enter "Photosynthesis" in the edit box. Repeat to create an annotation for the "Respiration" data. Drag each box to a position near its respective curve.
   b. Print a copy of the Graph window, with both data sets displayed. Enter your name(s) and the number of copies of the graph you want.

8. Remove the plant leaves from the respiration chamber, using forceps if necessary. Clean and dry the respiration chamber.

6. Results

Table 1	
Leaves	Rate of photosynthesis (ppt/min)
In Light	





7. Analysis

Time(min)

1. Were either of the rate values for CO_2 a positive number? If so, what is the biological significance of this?

2. Were either of the rate values for O_2 a negative number? If so, what is the biological significance of this?

3. Do you have evidence that photosynthesis occurred in leaves? Explain.

4. List five factors that might influence the rate of oxygen production or consumption in leaves. Explain how you think each will affect the rate?