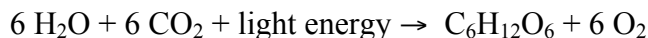


# Photosynthesis and Respiration

50 Points

Plants make sugar, storing the energy of the sun into chemical energy, by the process of photosynthesis. When they require energy, they can tap the stored energy in sugar by a process called cellular respiration.

The process of photosynthesis involves the use of light energy to convert carbon dioxide and water into sugar, oxygen, and other organic compounds. This process can be summarized by the following reaction:



Cellular respiration refers to the process of converting the chemical energy of organic molecules into a form immediately usable by organisms. Glucose may be oxidized completely if sufficient oxygen is available in the following reaction:



All organisms, including plants and animals, oxidize glucose for energy. Often, this energy is used to convert ADP and phosphate into ATP. Using the O<sub>2</sub> Gas Sensor, you will attempt to monitor the oxygen consumed or produced by plants.

## OBJECTIVES

In this experiment you will

- Use an O<sub>2</sub> Gas Sensor to measure the amount of oxygen gas consumed or produced by plants during photosynthesis or respiration.
- Determine the rate of respiration and photosynthesis of a plant.

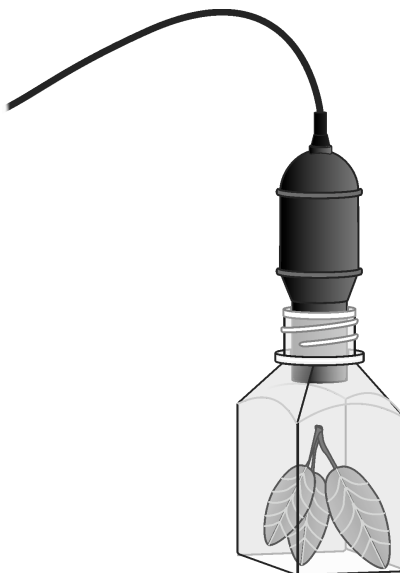


Figure 1

## MATERIALS

LabQuest	aluminum foil
LabQuest App	plant leaves
Vernier O <sub>2</sub> Gas Sensor	lamp
250 mL respiration chamber	forceps
500 mL tissue culture flask	

## PROCEDURE

1. Connect the O<sub>2</sub> Gas Sensor to LabQuest and choose New from the File menu. If you have an older sensor that does not auto-ID, manually set up the sensor.
2. On the Meter screen, tap Length. Change the data-collection length to 600 seconds.
3. Change the scale options for the graph.
  - a. Tap Graph.
  - b. Select Graph Options from the Graph menu and select Manual to change the scaling to manual.
  - c. Enter **215** as the Top value (the maximum y-axis value).
  - d. Enter **200** as the Bottom value (the minimum y-axis value).
  - e. Select OK.
4. Obtain several leaves from the resource table and blot them dry, if damp, between two pieces of paper towel.
5. Place the leaves into the respiration chamber, using forceps if necessary. Wrap the respiration chamber in aluminum foil so that no light reaches the leaves.
6. Place the O<sub>2</sub> Gas Sensor into the bottle as shown in Figure 1. Gently push the sensor down into the bottle until it fits snugly. The sensor is designed to seal the bottle without the need for unnecessary force. Wait 3 minutes before proceeding to Step 7.
7. Start data collection. Data will be collected for 10 minutes.
8. When data collection has finished, a graph of oxygen gas *vs.* time will be displayed.
9. Perform a linear regression to calculate the rate of respiration.
  - a. Choose Curve Fit from the Analyze menu.
  - b. Select Linear as the Fit Equation. The linear-regression statistics are displayed to the right of the graph for the equation in the form
$$y = mx + b$$
where  $x$  is time,  $y$  is oxygen concentration,  $m$  is the slope, and  $b$  is the y-intercept.
  - c. Record the absolute value of the slope,  $m$ , as the rate of respiration in Table 2.
  - d. Select OK.
10. Remove the aluminum foil from around the respiration chamber.

11. Fill the tissue culture flask with water and place it between the lamp and the respiration chamber. The flask will act as a heat shield to protect the plant leaves.
12. 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 leaves should be exposed to the light from the lamp for 3 minutes prior to beginning data collection.
13. Store the data from the first run by selecting the File Cabinet icon.
14. Wait three minutes and then repeat Steps 7–9.
15. Graph both runs of data on a single graph.
  - a. Tap Run 2, and select All Runs. Both runs will now be displayed on the same graph axes.
  - b. Examine the data on the displayed graph. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the two oxygen values and the corresponding time value will be displayed to the right of the graph.
  - c. Use the displayed graph and Table 1 to answer the questions below.
  - d. (Optional) Print a copy of your graph per your teacher's instructions.
16. Remove the plant leaves from the respiration chamber, using forceps if necessary. Clean and dry the respiration chamber.

## DATA

Table 1	
Leaves	Rate of photosynthesis/respiration (ppt/s)
Dark	
Light	

## CONCLUSION (SUMMARY OF EXPERIMENT, ANALYSIS OF DATA, DISCUSSION OF ERROR)

## QUESTIONS

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

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2. Were either of the rate values a negative number? If so, what is the biological significance of this?
3. Do you have evidence that cellular respiration occurred in leaves? Explain.
4. Do you have evidence that photosynthesis occurred in leaves? Explain.
5. List five factors that might influence the rate of oxygen production or consumption in leaves. Explain how you think each will affect the rate.

### **EXTENSIONS**

1. Design and perform an experiment to test one of the factors that might influence the rate of oxygen production or consumption in Question 5.
2. Compare the rates of photosynthesis and respiration among various types of plants.