Photosynthesis and Respiration

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:

6 H2O + 6 CO2 + light energy  C6H12O6 + 6 O2

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:

C6H12O6 + 6 O2(g)  6 H2O + 6 CO2(g) + energy

All organisms, including plants and animals, oxidize glucose for energy. Often, this energy is used to convert ADP and phosphate into ATP.

objectives

In this experiment, you will

* Use an O2 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.

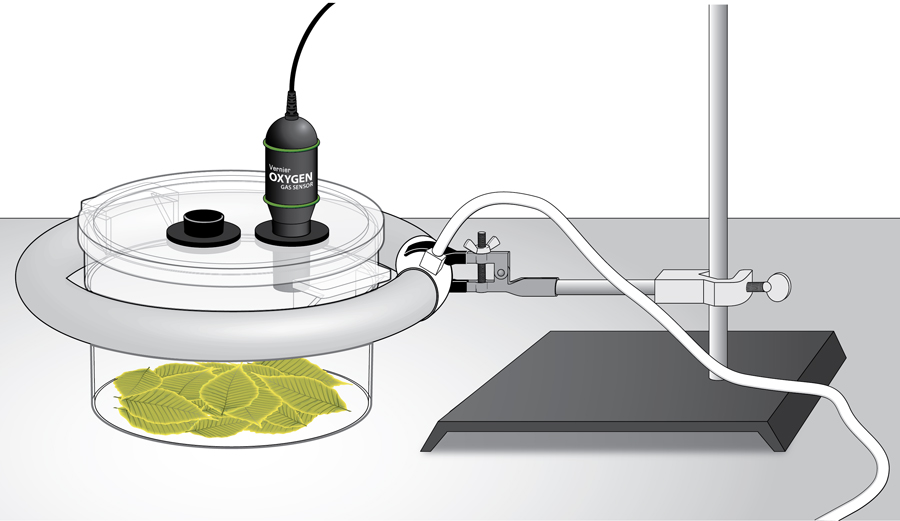


Figure 1

MATERIALS

|  |  |
| --- | --- |
| TI-83 Plus or TI-84 Plus graphing calculator | aluminum foil |
| EasyData application | ringstand |
| data-collection interface | utility clamp |
| Vernier O2 Gas Sensor | 12 inch ring fluorescent bulb setup |
| BioChamber 2000 | #6 rubber stopper |

PROCEDURE

1. Wrap the BioChamber with aluminum foil so that no light will reach the leaves.

1. Wrap the outside of the chamber with foil.
2. Cover the lid with foil, poking the holes open to insert the sensor and the rubber stopper.

2. Cover the bottom of the chamber with one layer of fresh turgid spinach leaves. Remove any stems that could interfere with an even lining of the bottom.

3. Turn on the calculator. Connect the O2 Gas Sensor, data-collection interface, and calculator.

4. Set up EasyData for data collection.

1. Start the EasyData application if it is not already running.
2. Select from the Main screen, and then select **New** to reset the application.



1. Select from the Main screen, then select **Time Graph…**



1. Select on the Time Graph Settings screen.



1. Enter 1**5** as the time between samples in seconds and select .



1. Enter **60** as the number of samples and select (data will be collected for 15 minutes).



1. Select to return to the Main screen.



5. Secure the lid on the chamber. Insert the O2 Gas Sensor into one the holes and the rubber stopper into the other.

6. Wait five minutes for the sensor to equilibrate, then select to begin data collection. Data will be collected for 15 minutes. Note: The graph may not show the slight change in O2 level that occurs during the experiment.



7. When data collection has finished, a graph of O2 vs. time will be displayed.

8. Perform a linear regression to calculate the rate of respiration.

1. Select , and then select **Linear Fit**.



1. The linear-regression statistics for these two lists are displayed for the equation in the form:

*y* = a*x* + b

1. Enter the value of the slope, *a*, as the rate in Table 1.
2. Select to view a graph of the data and the regression line.



9. Select to return to the Main screen.



10. Store the data from the first run so that it can be used later.

1. Select , and then select **Store Run**.



1. Select to store your latest data and overwrite the data in Lists 3 and 4 (L3 and L4).



11. Assemble the lamp as shown in Figure 1. **Important:** Do not turn the lamp on until instructed to do so.

12. Remove the aluminum foil from the respiration chamber and invert the chamber to remove the leaves and accumulated CO2 gas.

13. Line the bottom of the chamber with fresh turgid spinach leaves.

14. Secure the lid on the chamber and insert the sensor and rubber stopper into the holes.

15. Place the chamber inside the bulb and turn on the lamp.

16. Repeat Steps 6–9 to collect and analyze data. **Note**: After selecting , select to start collecting data. Your stored data will not be overwritten.

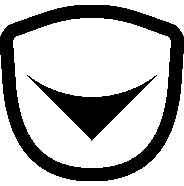


17. Graph both runs of data on a single graph. To do this:

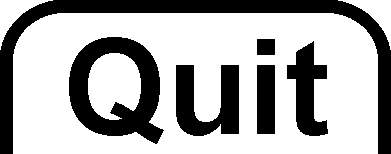
1. Select , then select **L2 and L3 vs L1**.



1. Both runs should now be displayed on the same graph. The flashing cursor will be on the graph for the second run (in the light). The data from the first run (in the dark) is identified by square point protectors.
2. Examine the data points along the displayed curve of L2 (light) *vs.* L1. As you move the cursor right or left, the time (X) and oxygen concentration (Y) values of each data point are displayed above the graph.
3. Press to switch the cursor to the curve of L3 (dark) *vs.* L1. Examine the data points along the curve.



1. Use the displayed graph and Table 1 to answer the questions below.
2. (Optional) Print a copy of your graph per your teacher’s instructions.
3. Select to return to the Main screen. Select , then to leave EasyData.



18. Clean and dry the respiration chamber.

DATA

|  |  |
| --- | --- |
| Table 1 | |
| Leaves | Rate of O2 gas production/consumption (ppt/min) |
| Dark |  |
| Light |  |

Questions

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

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.