  Graphical Analysis 31

Photosynthesis and Respiration

(CO2 and O2 Gas Sensors)

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 is often 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 by the following equation:

C6H12O6 + 6 O2 → 6 H2O + 6 CO2 + energy

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

Objectives

* Use an O2 Gas Sensor to measure the amount of oxygen gas consumed or produced by a plant during respiration and photosynthesis.
* Use a CO2 Gas Sensor to measure the amount of carbon dioxide consumed or produced by a plant during respiration and photosynthesis.
* Determine the rate of respiration and photosynthesis of a plant.

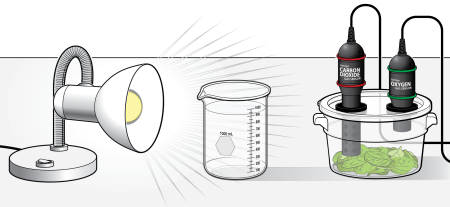


Figure 1

MATERIALS

Chromebook, computer, or mobile device

Graphical Analysis 4 app

Vernier data-collection interface

O2 Gas Sensor

CO2 Gas Sensor

BioChamber 2000

600 mL beaker

aluminum foil

spinach leaves

goggles

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 sensors.
2. Cover the bottom of the chamber with a one centimeter layer of fresh, turgid spinach leaves.
3. If your CO2 Gas Sensor has a switch, set it to the Low (0–10,000 ppm) setting. Connect the CO2 Gas Sensor and the O2 Gas Sensor to the data-collection interface, and then connect the interface to your Chromebook, computer, or mobile device. Launch Graphical Analysis.
4. Set up the data-collection mode.
   1. Click or tap Mode to open Data Collection Settings.
   2. Change Rate to 15 samples/min and End Collection to 15 min. Click or tap Done.
5. Change the unit to ppt by clicking or tapping the CO2 meter and choosing ppt from the Units menu. Repeat the process with the Oxygen Gas meter to select ppt as the units for the O2 Gas Sensor.
6. Secure the lid on the chamber and insert the sensors into the holes.
7. Wait 5 minutes for the sensors to equilibrate, then click or tap Collect to start data collection.
8. When data collection is complete, determine the rate of respiration/photosynthesis.
   1. Click or tap Graph Tools, , for the CO2 graph and choose Apply Curve Fit.



* 1. Select Linear as the curve fit. Click or tap Apply.
  2. Record the slope of the line, m, as the rate of respiration/photosynthesis for CO2 in Table 1.
  3. Repeat this process for the O2 data.

1. Make a heat sink by filling a 600 mL beaker with water.
2. Set up the lamp and heat sink as shown in Figure 1. Important: Do not turn the lamp on until instructed to do so.
3. Remove the aluminum foil from the respiration chamber.
4. Turn on the lamp.
5. Repeat Steps 7–8 to collect and analyze data for photosynthesis. Note: Data from the previous run will automatically be stored.
6. Graph both runs of data on a single graph.
   1. To display multiple data sets on a single graph, click or tap the y-axis label and select the data sets you want to display. Dismiss the box to view the graph.
   2. Use the displayed graph and Table 1 to answer the questions below.
7. Clean and dry the respiration chamber.

DATA

|  |  |  |
| --- | --- | --- |
| Table 1 | | |
| Leaves | CO2 Rate of respiration/photosynthesis (ppt/min) | O2 Rate of respiration/photosynthesis (ppt/min) |
| In the dark |  |  |
| In the light |  |  |

Questions

1. Was either of the rate values for CO2 a positive number? If so, what is the biological significance of this?
2. Was either of the rate values for O2 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.