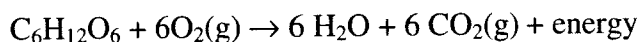


# Cell Respiration (Method 1–CO<sub>2</sub> and O<sub>2</sub>)

Cell 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 according to the following equation:



All organisms, including plants and animals, oxidize glucose for energy. Often, this energy is used to convert ADP and phosphate into ATP. Peas undergo cell respiration during germination. Do peas undergo cell respiration before germination? Using your collected data, you will be able to answer the question regarding respiration and non-germinating peas.

## OBJECTIVES

In this experiment, you will

- Measure gas production.
- Study the effect of temperature on cell respiration.
- Determine whether germinating peas and non-germinating peas respire.
- Compare the rates of cell respiration in germinating and non-germinating peas.

## MATERIALS

computer  
Vernier computer interface  
LoggerPro  
Vernier CO<sub>2</sub> Gas Sensor  
Vernier O<sub>2</sub> Gas Sensor  
BioChamber 250

25 germinating peas  
25 non-germinating peas  
250 mL respiration chamber  
ice cubes  
thermometer  
two 100 mL beakers

## PROCEDURE

Using the CO<sub>2</sub> Gas Sensor and O<sub>2</sub> Gas Sensor, you will monitor the carbon dioxide produced and the oxygen consumed by peas during cell respiration. Both germinating and non-germinating peas will be tested. Additionally, cell respiration of germinating peas at two different temperatures will be investigated.

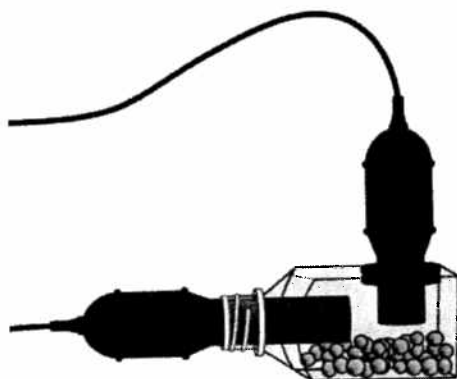



Figure 1

1. If your CO<sub>2</sub> Gas Sensor has a switch, set it to the Low (0–10,000 ppm) setting. Connect the CO<sub>2</sub> Gas Sensor to Channel 1 and the O<sub>2</sub> Gas Sensor to Channel 2 of the Vernier computer interface.
2. Prepare the computer for data collection by opening the file “05 Cell Resp M1 CO<sub>2</sub> O<sub>2</sub>” from the *Advanced Biology with Vernier* folder of *LoggerPro*.
3. Obtain 25 germinating peas and blot them dry between two pieces of paper towel. Use the thermometer to measure the room temperature. Record the temperature in Table 1.
4. Place the germinating peas into the respiration chamber.
5. Place the O<sub>2</sub> Gas Sensor into the BioChamber 250 as shown in Figure 1. Insert the sensor snugly into the grommet. The O<sub>2</sub> Gas Sensor should remain vertical throughout the experiment. Place the CO<sub>2</sub> Gas Sensor into the neck of the respiration chamber as shown in Figure 1.
6. Wait four minutes for readings to stabilize, then begin collecting data by clicking . Collect data for ten minutes and click .
7. When data collection has finished, remove the sensors from the respiration chamber. Place the peas in a 100 mL beaker filled with cold water and ice.
8. Fill the respiration chamber with water and then empty it. Thoroughly dry the inside of the respiration chamber with a paper towel.
9. Determine the rate of respiration:
  - a. Click anywhere on the CO<sub>2</sub> graph to select it. Click the Linear Fit button, , to perform a linear regression. A floating box will appear with the formula for a best fit line.
  - b. Record the slope of the line,  $m$ , as the rate of respiration for germinating peas at room temperature in Table 2.
  - c. Close the linear regression floating box.
  - d. Repeat Steps 9a–c for the O<sub>2</sub> graph.
10. Move your data to a stored run. To do this, choose Store Latest Run from the Experiment menu.
11. Obtain 25 non-germinating peas and place them in the respiration chamber
12. Repeat Steps 5–10 for the non-germinating peas.

**Part II Germinating peas, cool temperatures**

13. Remove the peas from the cold water and blot them dry between two paper towels.
14. Repeat Steps 5–9 to collect data with the germinating peas at a cold temperature.
15. To print a graph of concentration vs. volume showing all three data runs:
  - a. Click anywhere on the CO<sub>2</sub> graph. Label all three curves by choosing Text Annotation from the Insert menu, and typing “Room Temp Germinated” (or “Room Temp Non-germinated”, or “Cold Germinated”) in the edit box. Then drag each box to a position near its respective curve. Adjust the position of the arrow head.
  - b. Print a copy of the graph, with all three data sets and the regression lines displayed. Enter your name(s) and the number of copies of the graph you want.
  - c. Click on the O<sub>2</sub> graph and repeat the process to print a copy of the O<sub>2</sub> graph.

**DATA**

Table 1	
Condition	Temperature (°C)
Room	

Table 2		
Peas	CO <sub>2</sub> Rate of respiration (ppt/min)	O <sub>2</sub> Rate of consumption (ppt/min)
Germinating, room temperature		
Non-germinating, room temperature		
Germinating, cool temperature		

**QUESTIONS**

1. Do you have evidence that cell respiration occurred in peas? Explain.
2. What is the effect of germination on the rate of cell respiration in peas?
3. What is the effect of temperature on the rate of cell respiration in peas?
4. Why do germinating peas undergo cell respiration?

## TEACHER INFORMATION

## Cell Respiration (Method 1—CO<sub>2</sub> and O<sub>2</sub>)

1. This experiment correlates with Lab 5 in the 2001 College Board's AP Biology Lab Manual.
2. The student pages with complete instructions for data-collection using LabQuest App, Logger *Pro* (computers), and EasyData (calculators) can be found on the CD that accompanies this book. See *Appendix A* for more information.
3. If you are using calculators for data collection, this activity can be performed with calculators from the TI-83 Plus or TI-84 Plus families and a LabPro or CBL 2. It can not be performed with Easy products because the CO<sub>2</sub> Gas Sensor is not supported by EasyLink.
4. Allow the seeds to germinate for three days prior to the experiment. Prior to the first day, soak them in water overnight. On subsequent days, roll them in a moist paper towel and place the towel in a paper bag. Place the bag in a warm, dark place. Check each day to be sure the towels remain very moist. If time is short, the peas can be used after they have soaked overnight. For best results, allow them to germinate for the full three days.
5. The O<sub>2</sub> Gas Sensor should always be stored upright in the box in which it was shipped.
6. The morning of the experiment, fill a 1 L beaker with ice and water so that students will have cold water. Students will also need access to ice.
7. The calibrations stored in this experiment file for both sensors work well for this experiment. Initial readings that seem slightly high or low will still reflect an accurate change in gas levels.
8. The stopper included with the older-style CO<sub>2</sub> Gas Sensor is slit to allow easy application and removal from the probe. When students are placing the probe in the respiration chamber, they should gently twist the stopper into the chamber opening. Warn the students not to twist the probe shaft or they may damage the sensing unit.
9. To conserve battery power, we suggest that AC Adapters be used to power the interfaces rather than batteries when working with the older-style CO<sub>2</sub> Gas Sensor.