Cell Respiration

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:

$$C_6H_{12}O_6 + 6O_2(g) \rightarrow 6\ H_2O + 6\ CO_2(g) + \text{energy}$$

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.

Using the CO_2 Gas Sensor and O_2 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.

OBJECTIVES

In this experiment, you will

- Use an O_2 Gas Sensor to measure concentrations of oxygen gas.
- Use a CO_2 Gas Sensor to measure concentrations of carbon dioxide gas.
- 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.

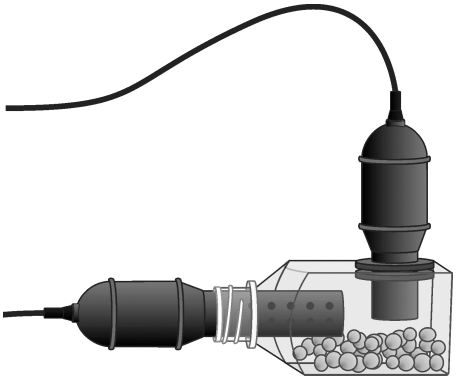

Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Vernier CO_2 Gas Sensor
Vernier O_2 Gas Sensor
BioChamber 250
25 germinating peas
25 non-germinating peas
250 mL respiration chamber
ice cubes
thermometer
two 100 mL beakers

PROCEDURE

1. If your CO_2 Gas Sensor has a switch, set it to the Low (0–10,000 ppm) setting. Connect the CO_2 Gas Sensor to Channel 1 and the O_2 Gas Sensor to Channel 2 of the Vernier computer interface.

2. Prepare the computer for data collection by opening the file "11D Cell Respiration (CO2 and O2)" from the *Biology with Vernier* folder of Logger*Pro*.

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_2 Gas Sensor into the BioChamber 250 as shown in Figure 1. Insert the sensor snugly into the grommet. The O_2 Gas Sensor should remain vertical throughout the experiment. Place the CO_2 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. Collect data for ten minutes and click ■ Stop. **Copy this data table into your notebook and write down the data points as you collect:**

Time	C02 (ppt)	O2 (ppt)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

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_2 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_2 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 cold germinating peas.
15. To print a graph of concentration *vs.* volume showing all three data runs:
   a. Click anywhere on the CO_2 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_2 graph and repeat the process to print a copy of the O_2 graph.

Pre –Lab Questions

1. In what organelle does the majority of cellular respiration occur?
2. What are the reactants of cellular respiration? What are the products?
3. What is the difference between aerobic respiration and anaerobic respiration?
4. What does oxidized mean? What substance is to be oxidized?
5. What are the differences between germinating and non-germinating seeds?
6. What do seeds need to germinate?
7. For what questions will you be gathering data in your experiment?
8. Why do we need so many seeds to test?

9. Why is it important that they all be the same?

10. How do you determine the rate of the reaction?

11. In preparation for your own inquiry investigation, what is one factor that you might change to discover something new? What would you expect to see?

12. **COMPLETE PROCEDURAL FLOWCHART**

DATA

Table 1	
Condition	Temperature (°C)
Room	

Table 2		
Peas	CO_2 Rate of respiration (ppt/min)	O_2 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?

EXTENSIONS

1. Compare the respiration rate among various types of seeds.
2. Compare the respiration rate among seeds that have germinated for different time periods, such as 1, 3, and 5 days.
3. Compare the respiration rate among various types of small animals, such as insects or earthworms.