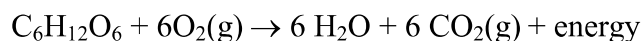


Cell Respiration

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:



All organisms, including plants and animals, oxidize glucose for energy. Often, this energy is used to convert ADP and phosphate into ATP. Using your collected data, you will be able to answer the question regarding respiration and the effects of temperature on garbanzo beans.

Using the CO₂ Gas Sensor and O₂ Gas Sensor, you will monitor the carbon dioxide produced and the oxygen consumed by garbanzo beans during cell respiration at three different temperatures (4°C 25°C and 37°C)

OBJECTIVES

In this experiment, you will

- Use an O₂ Gas Sensor to measure concentrations of oxygen gas.
- Use a CO₂ Gas Sensor to measure concentrations of carbon dioxide gas.
- Study the effect of temperature on cell respiration and compare the rates of cell respiration on garbanzo beans.

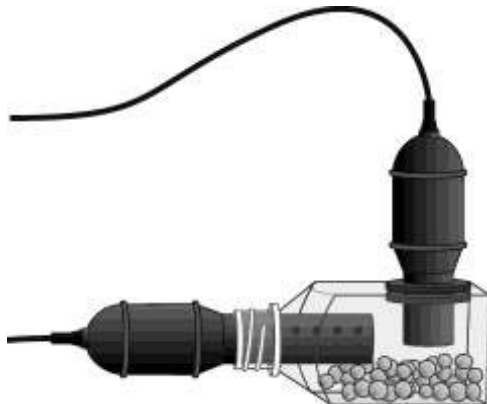


Figure 1

MATERIALS

LabQuest
Vernier O₂ Gas Sensor
Vernier CO₂ Gas Sensor
Vernier Temperature Sensor
60 garbanzo beans
incubator

BioChamber 250
ice cubes
two plastic tubs
Water bath
Logger *Pro* (optional)

PROCEDURE

1. If your CO₂ Gas Sensor has a switch, set it to the Low (0–10,000 ppm) setting. Connect the O₂ Gas Sensor and the CO₂ Gas Sensor to LabQuest. Choose New from the File menu. If you have older sensors that do not auto-ID, manually set up the sensors.
2. On the Meter screen, tap Rate. Change the data-collection rate to 0.1 samples/second and the data-collection length to 600 seconds.
3. Measure the room temperature using a thermometer and record the temperature in Table 1.
4. Obtain 20 garbanzo beans and place them into the respiration chamber.
6. Place the O₂ Gas Sensor into the BioChamber 250 as shown in Figure 1. Insert the sensor snugly. The O₂ Gas Sensor should remain vertical throughout the experiment. Place the CO₂ Gas Sensor into the neck of the BioChamber 250.
7. Wait two minutes, then start data collection.
8. When data collection has finished, remove the sensors from the respiration chamber. Place the 20 garbanzo beans in a 100 mL beaker prechilled to 4°C and sitting on ice to maintain the temperature.
9. Fill the respiration chamber with water and then empty it. Thoroughly dry the inside of the respiration chamber with a paper towel.
10. Place the chamber on ice and wait 5 minutes. Place the garbanzo beans in the empty chamber and wait 5 minutes.
11. Perform a linear regression to calculate the rate of respiration.
 - a. Choose Curve Fit from the Analyze menu and select CO₂ Gas.
 - b. Select Linear as the Fit Equation. The linear-regression statistics for these two data columns are displayed for the equation in the form
$$y = mx + b$$
 - c. Enter the absolute value of the slope, m , as the rate of respiration for the CO₂ Gas Sensor in Table 2.
 - d. Select OK.
12. Calculate the rate of respiration for the O₂ Gas Sensor.
 - a. Choose Curve Fit from the Analyze menu and select O₂ Gas.
 - b. Select Linear as the Fit Equation. The linear-regression statistics are displayed for the equation in the form
$$y = mx + b$$
 - c. Enter the absolute value of the slope, m , as the rate of respiration for the O₂ Gas Sensor in Table 2.
 - d. Select OK.
13. Repeat Steps 6-7. Once run is finished repeat steps 11-12.

14. When data collection has finished, remove the sensors from the respiration chamber. Place 20 new garbanzo beans in a 100 mL beaker preheated to 37°C and place them in the incubator for 5 minutes.
15. Fill the respiration chamber with water and then empty it. Thoroughly dry the inside of the respiration chamber with a paper towel.
16. Place the chamber in the 37°C incubator and wait 5 minutes. Place the garbanzo beans in the empty chamber.
17. Repeat Steps 6-7 and keep the chamber and probes in the incubator. Once run is finished, repeat steps 11-12.

DATA

Table 1	
Condition	Temperature (°C)
Room	

Table 2		
TEMPERATURE	O ₂ Rate of respiration (ppt/s)	CO ₂ Rate of respiration (ppt/s)
room temperature: 25°C		
ICE BATH: 4°C		
INCUBATOR: 37°C		

PRESENT YOUR DATA IN BAR GRAPH FORM

QUESTIONS

1. Do you have evidence that cell respiration occurred in garbanzo beans? Explain.
2. What is the effect of temperature on the rate of cell respiration in garbanzo beans?
3. Propose a cellular model as to the effects that temperature would have at the cellular level (substances, molecules etc.) that would have been directly or indirectly responsible for what you observed for all three