

Cellular Respiration Lab

AP Biology - *Energy*

Background:

Respiration refers to two different but related processes: one is the active acquisition of gaseous oxygen by an organism and the other is the release of energy from organic compounds within a cell. The latter process, a chemical oxidation, is more commonly referred to as cellular respiration.

During this laboratory investigation you will measure the rate of cellular respiration under different conditions. You will experimentally answer the following three questions:

- **“Does cellular respiration occur in living pea seeds?”**
- **“Does cellular respiration occur at the same rate for germinating and dormant pea seeds?”**
- **“Does cellular respiration occur at the same rate for pea seeds at 10°C and 25°C?”**

The chemical equation for the complete oxidation of glucose is shown below. Note that oxygen is required for this energy-releasing process to occur.



The chemical formula gives some clues as to how you might study the rate of cellular respiration. You could measure the consumption of oxygen (i.e., how many molecules of oxygen are consumed when 1 molecule of glucose is oxidized?), the production of carbon dioxide (i.e., how many molecules of carbon dioxide are produced when 1 molecule of glucose is oxidized?), or the consumption of oxygen and the release of carbon dioxide (i.e., how many molecules of carbon dioxide are produced for every molecule of oxygen consumed?).

In this laboratory exercise, you will measure the relative volume of oxygen consumed by germinating and non-germinating pea seeds at two different temperatures over time.

In order to measure the volume of oxygen consumed over time you must eliminate all the carbon dioxide produced by the reaction. In this experiment, the carbon dioxide will be removed by reacting with potassium hydroxide (KOH) to form solid potassium carbonate (K₂CO₃).



Therefore, if the temperature and volume in the experimental apparatus remain constant, any gas volume change will be due to the amount of oxygen consumed. A control apparatus will be used to detect any experimental results due to atmospheric pressure change or temperature change.

Materials:

- Plastic pan
- Ice
- Thermometer
- 100 mL graduated cylinder
- Germinating peas
- Dormant peas
- Plastic beads
- Glass vials
- Stopper-pipette apparatus
- Absorbent cotton
- Micropipette
- KOH solution (15%)
- Non-absorbent cotton
- Masking tape
- Weights

Procedure:**Part A. Preparations**

1. Propose and record both null and experimental hypotheses for each of the problems being studied in this laboratory investigation. Be sure to include your rationale for each hypothesis.
2. Both a room temperature bath and a 10°C bath should be set up immediately in plastic pans to allow time to adjust each temperature. Add ice to attain the 10°C bath. (Each group of four will have 2 people in a room temperature group and 2 in a cold group).

Part B. Determining Pea Volume

1. While the baths are equilibrating, obtain a 100 ml graduated cylinder and fill it with 50 ml of tap water. Drop in 20 germinating peas and determine their volume by measuring the amount of water that was displaced. Record the volume of the 20 germinating peas, then remove them and place them on a paper towel. They will be used in Respirometer 1.
2. Refill the graduated cylinder with 50 ml of water. Drop 20 dormant peas into the graduated cylinder and then add enough plastic beads to attain a volume equal to that of the germinating peas. Remove the peas and beads and place them on a paper towel. They will be used in Respirometer 2.
3. Refill the graduated cylinder with 50 ml of water. Determine how many plastic beads alone are required to attain a volume equal to the germinating peas. Remove the beads and place them on a paper towel. They will be used in Respirometer 3.

Part C. Setting up the apparatus

1. To assemble the respirometers, obtain 3 glass vials and 3 stoppers with attached pipette. Place a small wad of absorbent cotton in the bottom of each test tube and, using a micropipette, saturate the cotton with 750 μL (microliters) of 15% KOH solution. Make sure that the respirometer tubes are dry on the inside; do not get KOH on the sides of the respirometer. Place nonabsorbent cotton on top of the KOH-soaked absorbent cotton.
2. Label the respirometer tubes with appropriate numbers and then place one set of germinating peas, dormant peas and beads, and beads in Tubes 1, 2, and 3 respectively. Insert the stoppers fitted with calibrated pipettes.
3. Make a sling of masking tape attached to each side of the water baths to hold the pipettes out of water during an equilibration period of 5 minutes. Place the respirometers in the water bath. (See Figure 1 below.) Attach weights to the respirometers as demonstrated by Mr. Erlenbeck.

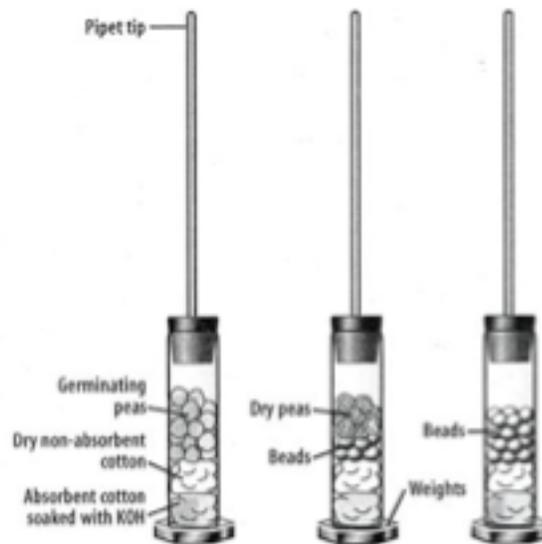


Figure 1.

Part D. Collecting Data

1. After an equilibration period of 5 minutes, immerse all respirometers entirely in their water baths. Water will enter the pipettes for a short distance and then stop. (If the water continues to move into a pipette, check for leaks in the respirometer.) Working swiftly, arrange the pipettes so that they can be read through the water at the beginning of the experiment. They should not be shifted during the experiment. Keep your hands out of

the water bath after the experiment has started. Make sure that a constant temperature is maintained.

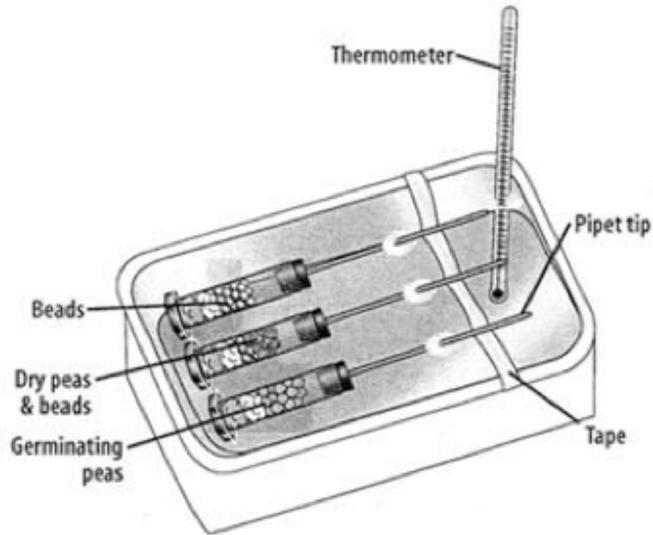


Figure 2.

- Allow the respirometers to equilibrate for 30 seconds and then record, to the nearest 0.01 ml, the initial position of water in each pipette (time = 0). Check the temperature in both baths. Record the changes in the water's position in each pipette every 5 minutes for 20 minutes. Data can be recorded in a table similar to Table 1 below.

Table 1.

Temp P. (°C)	Time (min.)	Beads Alone		Germinating Peas			Dormant Peas		
		Reading (ml) at time X	Diff.*	Reading (ml) at time X	Diff.*	Corrected	Reading (ml) at time X	Diff.*	Corrected
25	0		0		0			0	0
	5								
	10								
	15								
	20								
10	0		0		0			0	0
	5								
	10								
	15								
	20								