AP BIOLOGY NAME_____
CELLULAR ENERGETICS
ACTIVITY #3 DATE_____HOUR____

CELLULAR RESPIRATION LAB

OBJECTIVES: After doing this lab you should be able to:

1. calculate the rate of cellular respiration from experimental data,
2. relate gas production to respiration rate, and
3. test the effect of temperature on the rate of cell respiration in ungerminated versus germinated seeds in a controlled experiment.

INTRODUCTION:

Cellular respiration is the release of energy from organic compounds by metabolic chemical oxidation in the mitochondria within each cell. Cellular respiration involves a series of enzyme-mediated reactions.

The equation below shows the complete oxidation of glucose. Oxygen is required for this energy-releasing process to occur.

$C_6H_{12}O_6$ + 6 O_2 → 6 CO_2 + 6 H_2O + 686 kilocalories of energy / mole of glucose

By studying the equation above you will notice there are three ways cellular respiration could be measured. One could measure the:

1. consumption of O_2. (How many moles of O_2 are consumed in cellular respiration?)
2. production of CO_2. (How many moles of CO_2 are produced in cellular respiration?)
3. release of energy during cellular respiration.

In this experiment the relative volume of O_2 consumed by germinating and nongerminating (dry) peas at two different temperatures will be measured.

Several physical laws relating to gases are important to the understanding of how the respirometers used in this lab work. The laws are summarized in the general gas law below:

$$PV = nRT$$

where
P is the pressure of the gas,
V is the volume of the gas,
n is the number of gas molecules,
R is the gas constant, and
T is the temperature expressed in Kelvins (K).

The general gas law implies the following:

1. if temperature and pressure are constant the volume of the gas is directly proportional to the number of gas molecules.

2. if the temperature and volume are constant then the pressure of the gas changes in direct proportion to the number of gas molecules present.

3. if the number of gas molecules and the temperature are constant then the pressure is inversely proportional to the volume.

4. if the temperature changes and the number of gas molecules is constant then either pressure or volume (or both) will change in direct proportion to the temperature.

It is also important to remember that gases and fluids flow from regions of high pressure to regions of low pressure.

In this experiment the CO_2 produced during cellular respiration will be removed by potassium hydroxide (KOH) and will form solid potassium carbonate (K_2CO_3) according to the following reaction:

$$CO_2 + 2\,KOH \text{ ----> } K_2CO_3 + H_2O$$

Since CO_2 is being removed the change in the volume of gas in the respirometer will be directly related to the amount of O_2 consumed.

The respirometers with the seeds will be submerged in a water bath that is kept at a constant temperature. The volume inside the respirometers is kept constant. As the seeds consume O_2 the pressure inside the respirometers will decrease. Because of the lower pressure inside the respirometers water will move into the pipet attached to the respirometer. The more O_2 consumed by the seeds the more water will move into the pipet.

PROCEDURE:

1. Access the www.biology87.org web site. Navigate through the following links: AP Biology…..Units…..Cellular Energetics. Click on the Flash Activity link under Activity #3.

2. When the Flash Activity begins review the information provided under Objectives, Introduction, and Lab Set Up.

3. Proceed to the 25°C Data Collection section and record data for the three respirometers in the Data Table on page 4. Be sure to record the pipet readings in the Reading at time X column for each respirometer (Beads Alone, Germinating Peas, and Dry Peas and Beads.)

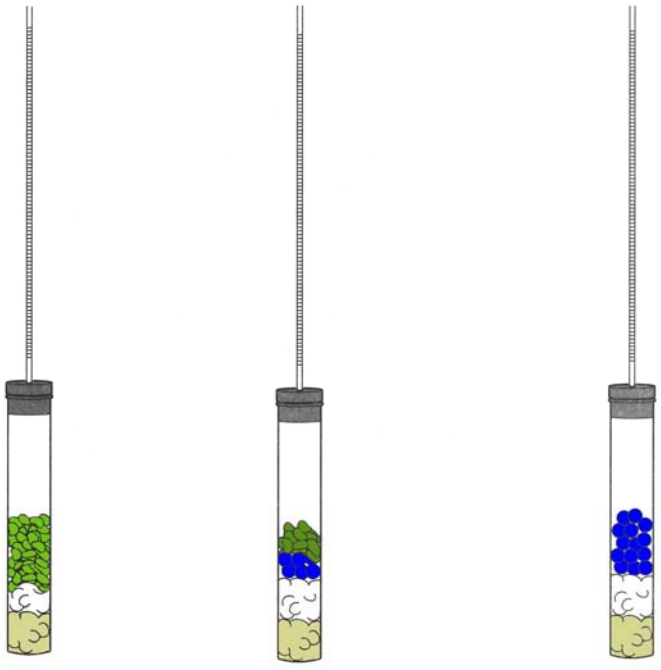
4. Proceed to the 10°C Data Collection section and record data for the three respirometers in the Data Table on page 4. Be sure to record the pipet readings in the Reading at time X column for each respirometer (Beads Alone, Germinating Peas, and Dry Peas and Beads.)

5. Complete the Diff. column by calculating the difference using the formula below:

   Difference = (initial reading at time 0) – (reading at time *X*)

6. Complete the Corrected Diff. column by calculating the corrected difference using the formula below:

   Corrected Different = Pea (germinating or dry) Diff. – Bead Diff.



DATA TABLE:
MEASUREMENT OF O_2 CONSUMPTION BY SOAKED AND DRY PEA SEEDS AT ROOM TEMPERATURE AND ICE WATER TEMPERATURE

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

ANALYSIS OF RESULTS:

1. In this activity you are investigating both the effect of germination versus nongermination and warm temperature versus cold temperatures on respiration rate. Identify the hypothesis being tested in this activity.

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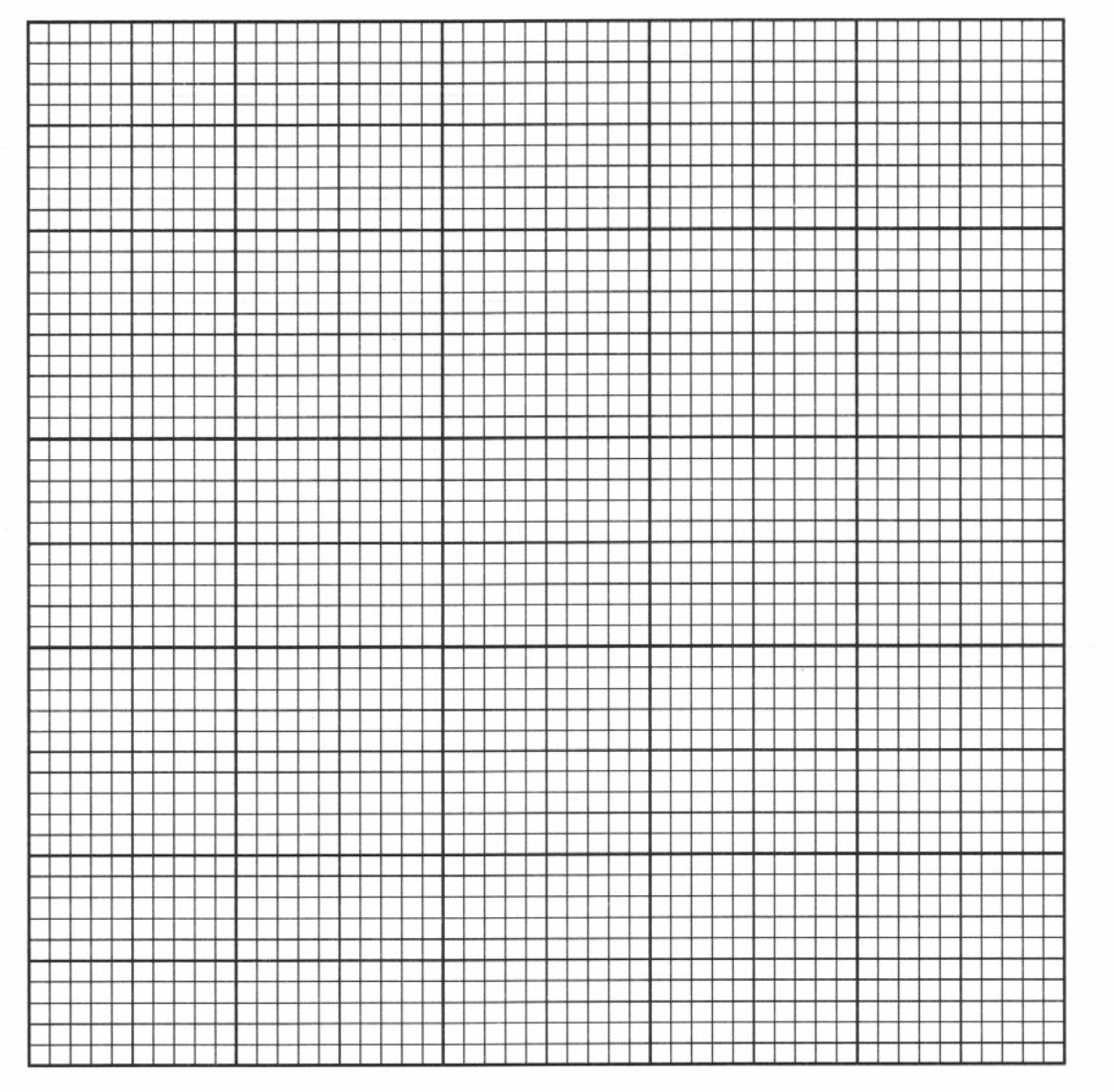
2. This activity uses a number of controls. Identify at least three of the controls and describe the purpose of each control.

Control	Purpose

3. Graph the corrected difference results for the germinating peas and the dry peas at both 25°C and 10°C.



4. Describe and explain the relationship between the amount of O_2 consumed and time.

Description	Explanation

5. From the slope of the four lines of the graph, determine the rate of O_2 consumption of germinating and dry peas during the experiments at 25°C and 10°C. Use the formula below to calculate slope (rate):

$$\text{rate} = \frac{\Delta y}{\Delta x}$$

Condition	Show Calculations Here	Rate in mL O_2 / min.
Germinating peas at 10°C		
Germinating peas at 25°C		
Dry peas at 10°C		
Dry peas at 25°C		

6. Why is it necessary to correct the readings from the peas with the readings from the beads?

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7. Explain the effect of germination (versus nongermination) on pea seed respiration.

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8. What is the purpose of KOH in this experiment?

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9. Why did the vial have to be completely sealed around the stopper?

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10. If you used the same experiment design to compare the rates of respiration of a 25 g. reptile and a 25 g. mammal, at 10^{o}C, what results would you expect? Explain your reasoning.

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11. If respiration in a small mammal were studied at both room temperature (21^{o}C) and 10^{o}C what results would you predict? Explain your reasoning.

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12. Explain why water moved into the respirometers' pipettes.

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