**Investigation: AP Biology Cellular Respiration**

Aerobic 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.

C6H12O6 + 6O2 🡪 6CO2 + H2O + energy

There are 3 ways to measure cellular respiration.

1. Consumption of O2

2. Production of CO2

3. Release of energy during cellular respiration.

We will measure the relative volume of O2 consumed by germinating and non-germinating peas at two different temperatures.

In this experiment, the CO2 produced during cellular respiration will be removed by potassium hydroxide (KOH) and will form solid potassium carbonate (K2CO3) according to the following reaction:

CO2 + 2 KOH 🡪 K2CO3 + H2O

Since CO2 is being removed, the change in the volume of gas in the respirometer will be directly related the amount of oxygen consumed.

If water temperature and volume remain constant, the water will move toward the region of lower pressure. During respiration, oxygen will be consumed. Its volume will be reduced, because the CO2 produced is being converting into a solid. The net result is a decrease in gave volume within the tube and a related decrease in the pressure in the tube. The vial with the glass beads alone will permit detection of any changes in volume due to atmosphere pressure changes or temperature changes.





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| Respirometer | Temperature | Contents |
| 1 | A | Germinating seeds |
| 2 | A | Dry seeds + beads |
| 3 | A | Beads |
| 4 | B | Germinating seeds |
| 5 | B | Dry seeds + beads |
| 6 | B | beads |

\*Suggestion temperatures are 10oC and 25oC

**Procedure**

1. Set up 2 baths at 2 different temperatures (use ice or hot water if you’d like)

2. You need to make the **volume** in each respirometer **the same** in order to meet the conditions of the gas law: **PV=nRT.**

*Where: P is the pressure of gas, V is the volume of gas, n is the number of molecules of gas, R is the gas constant, T is the temperature of the gas (in Kelvin)*

**Respirometer 1**: germinating peas

**Respirometer 2:** non-germinating peas + glass beads (in order for it to match the volume of the germinating peas)

**Respirometer 3**: glass beads

3. To assemble the six respirometers:

* obtains six vials, each with a stopper and pipette
* you need \_\_\_\_\_\_germinating seeds, \_\_\_\_\_\_\_\_\_non germinating seeds, and \_\_\_\_\_\_\_\_\_\_ glass beads.
* place a small piece of cotton in the bottom of each vial and using a dropper, moisten the cotton with 15% KOH
	+ make sure the respirometer vials are dry on the inside
* place a small wad of non-absorbent cotton on top of the KOH soaked absorbent cotton
	+ make sure the amounts of cotton and KOH are the same for each respirometer.

4. Use masking tape to hold the pipettes out of the water during an equilibration period of seven minutes.

5. Using the tape, immerse all respirometers entirely into the water baths. Water will enter the pipettes for a short distance and then stop. If the water continues to move up the pipette, check for leaks.

6. Allow the respirometers to equilibrate for three more minutes and then start recording data in data table

**Analysis Questions**

1. Write a hypothesis about the rate of cellular respiration of germinating and dry seeds
2. Write a hypothesis about the rate of cellular respiration at cooler temperature and warmer temperature
3. Identify some of the variables that were controlled in the experiment
4. Explain why water moved into the respirometers
5. Draw a graph of the oxygen consumption and time
6. From the slope of the four lines on the graph, determine the rate of oxygen consumption (in mL O2/min) for all four treatment groups.
7. Why is it necessary to correct the readings from the peas with the readings from the beads?
8. Explain the difference in oxygen consumption between germinating and dry peas.
9. Predict the results of a similar experiment using a 25g mammal and a 25 g reptile at 10oC. Justify your answer.
10. Predict the results of a similar experiment using a small mammal at 10oC and at 25oC. Justify your answer.

Assessment

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|  | Beginning | Developing | Accomplished  | Exemplary |
| Data Collection/Observations | Data tables are incomplete or incorrectObservations are missing or incomplete | Completed by hand in the lab bookMissing or incorrect data collectionObservations are incomplete | Completed by hand in the lab bookMissing or incorrectheadings/unitsobservations described but lacking detail | Completed by hand in the lab bookAppropriately labelled with headings/unitsDetailed observations described |
| Graph | There are no titlesData points plotted incorrectlyNo line of best fit represents the dataGraph does not articulates the data | Titles or components of are missingNot all data points plotted correctlyLine of best fit does not accurately represents the dataGraph somewhat articulates the data | Not all titles are accurate and appropriate with unitsData points plotted correctlyLine of best fit somewhat represents the dataGraph articulates the data | Titles are accurate and appropriate with unitsData points plotted correctlyLine of best fit accurately represents the dataGraph clearly articulates the data |
| Analysis Questions | Point formAnswers are incorrect or incomplete | Poor sentence structure(fragments)All answers demonstrate a minimal understanding of concepts | Full sentencesAll answers demonstrate a complete understanding of concepts | Clear communication through structured sentences that connect one idea to the nextAll answers demonstrate a thorough, in depth understanding of concepts |