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AP Biology *Lab 5*

Cell Respiration

This investigation uses respirometry techniques to calculate the rate of oxygen consumption (cellular respiration) in germinating pea seeds. The effect of temperature and whether a seed has broken dormancy are quantified and graphed. The ideal gas law and its concepts are reviewed and applied.

Objectives

- Understand the relationships between temperature, pressure and volume.
- Study the effects of diffusion through a semipermeable membrane
- Quantify oxygen consumption rates in germinating peas under different conditions
- Predict the effect of temperature and germination state on the rate of cell respiration

Background

Each individual cell is responsible for the energy exchanges necessary to sustain its ordered structure. Cells accomplish this task by breaking down nutrient molecules to generate ATP (adenosine triphosphate), which can then be used to run cellular processes that require energy. This process is called cellular respiration which requires nutrient molecules and oxygen. Carbon dioxide and water are products of the series of reactions involved in cellular respiration.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

There are several methods of indirectly measuring the rate of cellular respiration in organisms. One method involves monitoring changes in temperature; since the process of respiration is exergonic (produces heat). Another method is to measure either the oxygen consumption or the carbon dioxide production. Respirometers are devices that measure these types of gas volume changes, and therefore provide information about the rate of cellular respiration.

In order to be able to use a respirometer, you will need to use the ideal gas law, which describes the relationship between temperature, pressure and volume. ($PV = nrT$)

During cellular respiration, two gases are changing in volume. Oxygen gas is being consumed by the respiring cells and carbon dioxide gas is diffusing out of the cells. The respirometer, therefore, has to be able to deal with two simultaneously changing gas volumes. This is accomplished by introducing potassium hydroxide into the device. KOH absorbs carbon dioxide, following this equation

$$CO_2 + 2KOH \rightarrow K_2CO_3 + H_2O$$

Potassium carbonate (K_2CO_3) is a solid precipitate. Any CO_2 produced is immediately converted from a gas to a solid and is therefore no longer governed by gas laws. This allows the respirometer to measure only one variable, the consumption of oxygen gas by living cells.