The Effect of External Temperature Change on Homeotherms and Poikilotherms

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The oxidation of carbohydrates, fats, and proteins require the process of cellular respiration whose chemical formula is represented by the equation:

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + \text{energy}$$

and which obtains the oxygen from the surrounding environment, usually the atmosphere, necessary for oxidation and which also eliminates CO_2. Oxygen consumption is therefore a good way to measure metabolic change in organisms. Whenever physical work is involved the body and the excited muscles need more oxygen than when in a state of rest. Also, in a cold environment, since the body is losing energy to maintain body temperature, the body needs more oxygen.

The purpose of this experiment is to measure the intake of oxygen of **poikilotherms** (organisms whose temperature varies with the environmental temperature) and **homeotherms** (organisms who maintain a stable body temperature independent of the environment) in different environmental temperatures and compare the results.

The hypothesis for this experiment is that the change in temperature from warm to cold will cause a rise in the metabolic rate in the homeotherm since its oxygen needs will increase as it regulates its body temperature. Conversely, the metabolic rate will fall in the poikilotherm as the environmental temperature declines since its body temperature equalizes with external temperature and its oxygen needs are less.

Methods and Materials

In order to do this experiment, two water baths were needed, one with a temperature of 10 degrees Celsius, and the other at 25 degrees Celsius. The poikilotherm (a frog) was placed in a 125 ml flask and the homeotherm (a mouse) was placed in a 500 ml flask. To allow for more accurate results several groups did the experiment with one frog each and the other groups did the same experiments with one mouse each.

After putting the frog in the flask our group closed the flask with a rubber stopper through which ran a flexible rubber tube . Inside of the flask at the end of the tube which extends to about the middle of the flask is attached an open vial within which is placed a few drops of KOH which is sandwiched in between absorbent cotton on the bottom and non-absorbent on the top. The KOH absorbs the CO_2 exhaled from the organism and thus helps to determine the amount of O_2 consumed and thus the metabolic rate of the organism. The other end of the tube which is external to the flask is connected to a manometer which is a U-shaped glass tube which is filled with dyed water that moves as the gas expands between the flask and the water-filled tube. The distance the water moved in the tube is measured against a grid marked in centimeters. The metabolic rate is determined by dividing the volume of O_2 consumed which is divided by the elapsed time; this result is in turn divided by the weight of the organism. Since the temperature of the water changed during the course of the experiment a control was used by placing marbles of about equal volume of the frog in another flask of equal volume with the same attached apparatus. After the flask was immersed in the water for 20 minutes at 25 degrees Celsius , the distance the manometer moved was recorded during two ten minute intervals. The experiment was again repeated twice; this time in water of 10 degrees Celsius. The distance the control manometer moved was also indicated during the same intervals.

The other groups recorded results from the same experiment using 500 ml flasks to determine the metabolic rate of the mouse.

Results

The combined and averaged class results were as follows:

Metabolic Rates (O_2/time/weight)

	Frog (poikilotherm)	Mouse (Homeotherm)
Warm (25°C)	11.55	10.38
Cold (10°C)	6.38	32.40

Conclusions and Discussion

The metabolic rates changed according to the environmental temperature as predicted in the hypothesis. The metabolic rate of the poikilotherms (frog) was slower in cold temperatures than in warmer temperatures. The metabolic rate of the homeotherm (mouse) was faster in colder temperatures than in warmer temperatures since he had to create his own warmth to maintain constant body temperature. The mouse needed more O_2 in colder surroundings to maintain body warmth. The frog consumed less O_2 since his metabolism did not need to maintain a constant temperature. The biological advantage of homeothermy is a stabilization of metabolic processes though they require more fuel and food to maintain body temperature and thus consume more food and oxygen. They also need body covering to insulate heat whereas poikilotherms (also called ectotherms or "cold-blooded" such as reptiles and amphibians) adapt to external temperature. The hair and feathers of the homeotherms (also called endotherms or "warm-blooded" animals such as birds and mammals) is nature's way of insuring and insulating extra warmth as well as human being's artificial inventions such as clothing and heaters which require labor to produce. Despite the variations in data because of experimental variation, the hypothesis was supported by the experimental results, specifically, that homeotherms require more energy and oxygen to maintain warmth in cold temperatures than poikilotherms.