Ap bio lab report

Science, Chemistry

Effect of temperature on the rate of respiration in the case of big cricket versus the small cricket Aammar Alam Paracha 10/26/2012 Introduction: Abstract: Cellular respiration is the basic process by which organism make energy and increases the chances of the survival in the world. In this experiment, the amount of oxygen taken up by the organism(in this case crickets) is investigated, and how this uptake is affected by the temperature and the time of the lifecycle that an organism is in. The subjects are placed in different vials completely submerged in water that have different temperatures. This investigation used three trials at different temperatures. The amount of oxygen consumed was calculated by the amount of water that enters the pipette of the respirometer and the level it moves in a time of 20 minutes. It was found that at lower temperatures the crickets would respire more quickly than they would do at higher temperatures. We placed three different respirometers in different water chambers. They all had different temperatures. One respirometer had a big cricket another had a small cricket and the last one had glass beads which acted as our control. We noted the amount of water that moved in the respirometer after every 5 minutes for 20 minutes. Then the results were corrected for difference and then plotted on the graph for the three temperatures. The results show that consumption of oxygen is highest at 13 degree Celsius and lowest for temperature at 26 degree Celsius. Background: Cellular respiration is a process in which the food molecules are broken down to release the energy; and it has three main parts: glycolysis, the Krebs cycle, and the electron transport system. Glycolysis takes place in the cytosol of the cell. When it gets oxygen, then it splits one sugar compound into two pyruvates in ten steps that are catalyzed by an enzyme. These steps can be divided into two phases: an energy investment phase, in which the cell spends ATP for the fuel, and an energy payoff phase where ATP is produced by substrate-level phosphorylation and NAD+. Glycolysis, the initiative process occurs in the cytosol. Glucose is split into two compounds of pyruvic acid. Upon entering the mitochondrion, the pyruvate converts to Acetyl CoA for use later in the Krebs cycle that occurs in the mitochondrial matrix. In the Krebs cycle, each pyruvate yields 4 NADH, 1 FADH2, and 1 ATP molecule. NADH and FADH2 go to the electron transport chain to produce more ATP molecules. The electron transport chain is the chain of molecules, located in the inner mitochondrial membrane, that passes electrons along during the process of chemiosmosis to regenerate NAD+ or FAD+2 to form the ATP molecule. Chemiosmosis is the coupling of the movement of electrons down the electron transport chain with the formation of ATP driven by a proton gradient. The result of the electron transport chain is a contribution of about 34 ATP molecules. Overall, cellular respiration produces the maximum of 38 ATP molecules per glucose. (World of chemistry 2006) However, if there is no presence of oxygen in glycolysis, the process still goes on by replacing the oxygen to NAD+. That process is called fermentation. The balanced chemical equation for cellular respiration is shown below. Notice that oxygen is proportional to carbon dioxide by 1: 1, therefore, during the experiment, measuring the amount of oxygen consumed can determine the amount of carbon dioxide produced. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy It is important to understand how the general gas law applies to the apparatus. The gas law states: $PV= nRT$ where P is the pressure of the gas, V is the volume of the gas, n is the number of molecules of gas, R is the gas constant, and T is the temperature of the gas. For this experiment, if the temperature and volume of the water remain constant, the water will move toward the region of lower pressure due to the consumption of O_2 because according to the concepts about gases, gases flow from regions of high pressure to regions of low pressure. While the temperature and volume of content are constant, the pressure is directly proportionally to the molecules of gases present. Cellular respiration requires the living organism to activate the process. Either plants or animals would work for this experiment, but the plants could be more easily handled than the animals; therefore, the germinating peas are easier and safer to use and fit in the respirometer. They will consume oxygen and contribute carbon dioxide. The non-germinating peas are set up as the control group that consists of peas that are not currently germinating, and give this experiment a baseline with which to compare the respiration rate of the germinating peas. Two gases contribute to the volume around the peas: O_2 and CO_2. While measuring the amount of consumption of O_2 during respiration, it is necessary that CO_2 is not present in the air inside of the vial. Adding potassium hydroxide would handle this problem by making CO_2 separate from the volume of air around the peas. The role of KOH is to bind with CO_2 to form a solid and to prevent CO_2 production from affecting gas volume. Glass beads are another control group that is non-metabolizing; therefore, the vial with glass beads can correct any changes in volume due to the atmospheric pressure. In addition, it is important that the three vials contain an equal volume of contents. Adding glass beads to the vial with the dormant peas appears an equal volume since the dormant peas take up less space than an equal quantity of germinating peas. The respirometer is an instrument that measures the changes in gas volume related to the consumption of oxygen. You can construct a respirometer by putting any small organism in a vial with a pipette attached. When the tip of the respirometer is submerged, no additional air will enter. As O2 is used up, the pressure of gases inside the respirometer decreases. This causes water to enter the pipette. Hypotheses: Null hypotheses: The rate of respiration of small versus the big crickets would not change by the changes in the temperature. Alternative hypothesis: The rate of respiration of small and big crickets would increase by increasing the temperature of the system. Methods and Materials: The lab conducted used glass cylinders with weights attached to it, a 100ml pipette, and absorbent cotton, non- absorbent cotton, KOH, small crickets, big crickets, glass beads, food dye and water baths, with ice cubes, rubber stoppers, white paper and timers. I, Annie and Sammy conducted this experiment with three respirometers. One with big cricket, another with a small cricket, finally the third had glass beads with equal volume to the other vials which acted as our control. We placed all the vials in a water bath with the system temperatures at 13, 19 and 23 degrees Celsius. An absorbent cotton ball was placed initially in the vial to absorb 2 to 3 drops of KOH; this compound absorbs CO2 and made only oxygen available in the vial. Be sure that no KOH is on the walls of the cylinder. Another piece of cotton was placed on the top of KOH; this provided a barrier between the subject and the compound. After the crickets are placed in the vial it is capped with a stopper and a pipette. The same steps are done with the other 2 respirometers. They are placed in the water bath with the tips out of the water; finally food dye is added to give a reference point in the pipette. After five minutes the tips of the respirometer were submerged in the water and as the dye moved, it was made the starting point of the data. After the vials are standing in the water for 5 minutes, the data is noted for every 5 minutes. The dependent variable was oxygen used for the experiment for the three temperatures used. The independent variable for this was the time that we took to measure the water movement. The time for the experiments was 20 minutes except the vials with the temperature of 13 of degree Celsius in which the dye moved along the respirometer very quickly. The group assumed that nothing changes the temperature of the water bath and that CO_2 did not affected the experiment as well as the temperature.

Results: The graphs for the big and small crickets for the temperatures of 19 and 26 degree Celsius were approximately the same as the change in the amount of water moved was about the same thus implying that oxygen consumption for both the subjects and rate of respiration is same. All three temperatures with the corrected differences are plotted in the graph. All the graphs are plotted are very close to each other with the exception of the graph when the systems temperature was 13 degree Celsius. The results shown are the corrected differences between the vials and the control.

Discussion: The lab conducted didn't proceed as our group had anticipated; the alternative hypothesis stated that the rate of respiration would increase by the increase in the temperature, which is not supported by the results shown above. The rate of respiration increases by lowering the temperature as the vials in the systems temperature at 13 degree Celsius the fastest. However, the null hypothesis is rejected as proven by the data, in fact temperature do affect the rate of respiration. The group had many experiment difficulties, the group planned on doing the experiment based on the germinating and non- germinating seeds, but they were rotted. one of our partners injured her hands while placing the stopper in the tube tightly, which a main concern in this experiment as if the stopper was not placed properly I would allow water to enter the chamber and render the experiment useless. One more problem that we faced frequently was the reading of the food coloring; the dye would come out of the respirometer every time the vials were placed in the solution. The figure shows that some graphs are below the x axis this was because the control had produced more change for the same time range. There were many factors affecting the movement of water in the respirometer which included pressure in the chamber and the atmospheric chamber. Pressure is also able to affect the volume around the peas; therefore, it is necessary to correct the crickets reading with the beads reading by the beads measuring the atmospheric pressure. Even though the beads are not alive and do not respire the air, there were still changes in the readings of the beads' vial because since the system is discorded and not perfect, it is hard to keep the pressure constant. Correcting the crickets' reading with the beads' reading would lead to more accurate data. Before the respirometer lay down into the water, the fresh air equilibrates with the air that is inside the vial. After the tip of respirometer is submerged, there is no additional water entering. As the experiment proceeds, the consumption of oxygen begins during respiration. That causes the pressure of gases inside the respirometer to decrease because, according to the gas law, when the moles of gases decrease, the pressure decreases too. Inside the respirometer, the consumption of oxygen means less moles of oxygen during respiration. Decreasing pressure causes the water to be drawn into the pipette. For a new investigation, it be interesting to look onto the comparison between the rate of respiration of warm and cold blooded mammals which act differently toward their environment and respond differently to the same stimuli. As based on the background, reptiles are the cold-blooded organisms which mean that they have no thermal homeostasis (Hermans-Kilam). They maintain their body temperature in a different way than mammals do. The rate of poikilothermic organism changes due to changes in the environment. Whatever the environmental temperature is, that is what reptile's body temperature is too. Mammals are the warm-blooded organisms which mean they can maintain thermal homeostasis (Hermans-Kilam). That is they keep their body temperature at a constant level. For example, if the environment is too cold for a mammal, the mammal maintains that temperature by shivering or wearing thick covers. In the experiment, the rate of respiration in reptiles would be slower than that of mammals because reptile's metabolic process slows the rate of respiration due to the lower temperature. There were many sources of error in this experiment as water could have leaked in the respirometers and interfered with our experiment. The graph that was produced turned out produced some vague results as the respirometers with the lowest temperatures had higher rate of respiration rate. Some of the readings were both positive and negative. The stopper was placed improperly and caused many problems during the experiment this could have resulted in the entrance of water in the chamber. This is a possible explanation of the incorrect fluctuations of the readings in our data. The group had problems with noting the reading downs and this would have caused inaccuracy in our work. An improvement on this experiment would be using white paper and place it in the water bath with the respirometers on top of it, thus making it easier for the reading to be noted. Taking more trials on the same temperature would also reduce the error as an average would reduce human reaction time. References: AP Biology Lab Handout: Cellular Respiration Holtzclaw, Theresa Knapp. LabBench Activities: Cellular Respiration. from http://www. phschool. com/science/biology_place/labbench/lab5/intro. html Hermans-Kilam, Linda. Warm and Cold Blooded., from http://coolcosmos. ipac. caltech. edu/image_galleries/ir_zoo/coldwarm. html