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|  | | |  | Hypothesis: The relationship between the concentration of sucrose and the rate at which the yeast respire will be increasing. That is to say that as the concentration of sucrose increases, the rate at which the yeast will respire will increase.  Prediction: If the rate of respiration increases after successive tests each using a higher concentration of sucrose then the rate of respiration is not simply limited by the available food supply, but actually increases with the increase in pressure of supply.  Problem  From physics we see that pressure and volume have directly related effects to the rate of flow. For instance, a faucet has a given volume (the diameter of the faucet limits this) and has a variable pressure. As the pressure is changed the flow rate of water coming out of the faucet is changed. This applies to water, electricity, air, and most any movement of matter.  The question is whether it applies to the rate of metabolism of yeast. Naturally I would expect that it does, however its food source, sucrose, is also a natural preservative. This may cause issues as the concentration of sugar raises. In addition to this living creatures do not have to make decisions entirely based on the laws of physics. I know if I have a large sandwich put in front of me versus a small sandwich I wont eat one faster than the other; I will simply take longer to eat the large one than I would to eat the small one.  Reagents  All living organisms need energy. Growth, reproduction, movement, and the maintenance of a stable internal environment are some of the basic cellular process for which energy is required. Nearly all living organisms obtain their energy in one of two ways: the complete breakdown of sucrose in the presence of oxygen (aerobic cellular respiration), or the incomplete breakdown of sucrose in the absence of oxygen (anaerobic cellular respiration).  Yeasts were chosen for this experiment because they are so easily attainable. Yeasts are special, single-celled eukaryotic organisms that can do both aerobic and anaerobic respiration. In the presence of oxygen, yeast respire aerobically because it yields more energy, and is consequently more efficient. When oxygen is unavailable, however, yeast can still extract some energy from sucrose to perform its cellular functions, albeit much less than when it uses aerobic respiration. Organisms (or cells) that can switch from aerobic to anaerobic respiration when oxygen becomes scarce are called facultative anaerobes  1 sucrose (6 C) -> 2 ATP + 2 carbon dioxide (1 C) + 2 ethanol (2 C).  C6H12O6 -> 2 ATP + 2CO2 + 2 C2H5OH  Methodology  I had to devise a way to measure the rate of respiration. This was rather simple as I exploited the nature of yeast�s anaerobic respiration. Under anaerobic conditions yeast expels CO2 into the atmosphere. By the ideal gas law we know that this will increase the ambient air pressure as more molecules of CO2 are introduced.  The experimental procedure that I outlined provides for a very accurate and efficient method of gathering data. The overall idea behind the procedure was to set something up that was capable of running itself. Once the experiment has been configured it ran on its own for each run and the computer simply sampled once a second for however much time it would take. In order to do this I would need a way to read the pressure and then connect the pressure gauge to the computer.  I chose a simple differential pressure sensor that could read 0 � 15 PSI and outputs a 0 � 5V signal. It was important that this was a differential pressure sensor, as I wanted to insure that I could cancel the effects that a change in temperature has on the pressure. By using a differential pressure sensor I was able to measure the difference between a control tube and a experimental tube. The signal could then be read by an analog to digital converter and then inputted via serial to computer software made for the purpose of logging the voltage data as a variable of time. Using this method I was able to record samples every second!  Next I needed pressure vessels capable of withstanding at least 15 PSI and containing the sugar water with yeast. For this I constructed some special test tubes. I opted to make them out of PVC as it was a very neutral medium, often used to transport potable water in homes, and it was very nice to work with. Each tube was a simple 5 inch length of �� PVC pipe with a cap on one end and then a large retainer at the top. For the sealing cap I used simple black rubber stoppers and inserted an identical length of 1/8� rubber tubing into each stopper. These tubes were then sealed with silicon rubber to the stopper. Using these caps I was able to quickly seal each test tube immediately following the addition of the yeast so as not to lose any data. From the 1/8� tube I was able to measure the air pressure by connecting the tube to the pressure sensor.  With all of these devices in place I was capable of running the experiment almost completely untouched, which was crucial to maintaining the accuracy of the data readings and their relationship to time.    Other Experiments              BioFuel has conducted several investigations into the optimum rate of respiration of yeast, as they are concerned with finding the most efficient manner for fermenting their fuel.              The rate of respiration of yeast is also used to determine the quality of the environment as the faster the rate of respiration the better the quality of environment and the more nutrients available. This is also called the aeration factor.              This project is also useful in establishing a simple to use protocol for optimizing the efficiency of biological reactions. Now that commercial ventures are rising with use of bacteria to carry out reactions it is crucial that these companies make the most efficient use of their reagents and the bacteria. Through this cost saving procedure organizations can increase their throughput. | |
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