

Aerobic Respiration

1. Introduction

If somebody challenged you to a run a race, do you think you could win? Did you know that what you drink before the race can affect how well you do? The amount of sugar in anything you eat or drink determines the amount of energy produced by your body. Foods and drinks contain different kinds of sugars which affect the rate and amount of energy your body produces for your muscles to use when performing functions.

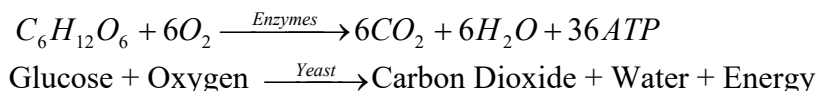
The process of breaking down sugar to produce energy, ATP, is called respiration. Cellular respiration is the opposite of photosynthesis. Instead of building energy rich glucose molecules, in cellular respiration glucose molecules are taken apart to release the energy stored in them. Then the muscles in the body use the ATP to perform life processes. In this lab we will be studying aerobic respiration, which is the process of breaking down sugar to produce energy in the presence of oxygen. We will use yeast as the living organism (enzyme) that breaks down the sugars to produce ATP.

2. Background

Cellular Respiration:

“The Life processes of all organisms require energy.” There is potential energy in the chemical bonds of all organic molecules such as glucose, sucrose, fructose, lactose, etc. However, this energy can not be used directly by the cells, therefore these bonds need to be broken to release the energy. Cellular respiration is the process where energy that is stored in organic compounds is eventually converted to a usable form called ATP (adenosine triphosphate). Sugars are a type of organic compound, and some of the common sugars are: glucose, sucrose, fructose, and lactose. The body takes glucose, or other sugars, and oxygen to produce adenosine triphosphate (ATP) that is used by the muscles to perform functions. This process occurs all the time in the cells of all living things.

The two phases of cellular respiration is anaerobic and aerobic respiration. Anaerobic respiration is the first phase and it takes place in the cytoplasm, which the cell interior. At the end of anaerobic respiration 2 molecules of ATP are produced. If there is oxygen, O_2 , present then aerobic respiration or the second phase can take place. This phase takes place in the mitochondria, which is a structure that harvests energy from organic compounds to produce ATP. Once the ATP molecules are produced, the muscles or organs use the ATP to perform their specific functions. At the end of aerobic respiration 36 molecules of ATP are produced. Aerobic cellular respiration can be summarized with the following chemical equation:



Where, yeast is used as the cell that is performing the cellular respiration, because yeast is a single celled organism that contains the enzymes that are needed to break apart the chemical bonds of organic compounds.

3. Objective

- Determine the rate of respiration while using yeast to breakdown different sugars.
- Learn how the type of sugar affects the rate of respiration.

4. Equipment

Computer	Milk
Vernier computer interface	600 ml beaker (for water bath)
Logger Pro Software	Hot and cold water
Vernier CO_2 Gas Sensor	Thermometer
250 mL respiration chamber	Five 18 x 150 mm test tube
Gatorade	10 mL graduated cylinder
Coke with CO_2 completely released	Yeast suspension
100% fruit juice	

5. Experimental Procedure

1. Label the five test tubes G, C, F, M, and W
2. Using the graduated cylinder:
 - Pour 2.5 mL of Gatorade into the test tube labeled G
 - Pour 2.5 mL of Coke into the test tube labeled C
 - Pour 2.5 mL of fruit juice into the test tube labeled F
 - Pour 2.5 mL of milk into the test tube labeled M
 - Pour 2.5 mL of water into the test tube labeled W
3. Obtain the yeast suspension from your instructor. Put 2.5 mL of the yeast suspension into all five of the test tubes. Swirl each of the test tubes to mix the yeast into the solution.
4. Then incubate the test tubes for 10 minutes in the water bath maintained at about 37-40 C.
5. When the incubation is finished, carefully pour the solution in test tube G into the 250 mL respiration chamber.
6. Quickly place the shaft of the CO_2 Gas Sensor and then gently twist the stopper on the shaft into the opening of the respiration chamber, as shown in Figure 3. Do not twist the shaft of the CO_2 Gas Sensor otherwise it will be damaged.

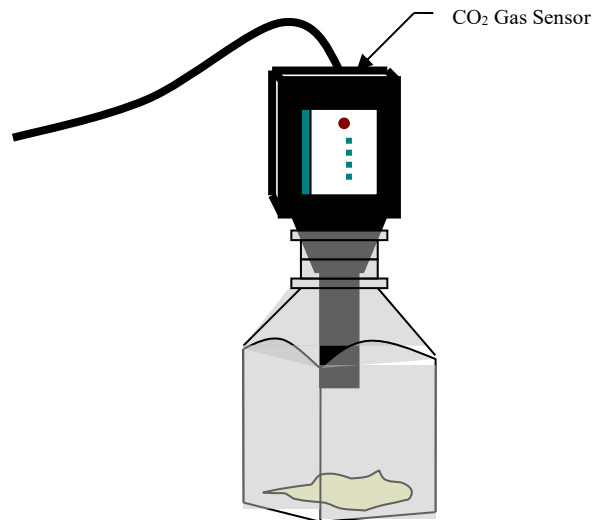




Figure 3

7. You can begin measuring carbon dioxide (CO_2) concentration by clicking on the Collect Data button,  Collect. The file is set up to collect data for 4 minutes.
8. After data collection has finished, remove the CO_2 Gas Sensor from the respiration chamber. Then rinse the respiration chamber with water. Make sure that all yeast has been removed and then thoroughly dry the inside of the chamber with a paper towel.
9. Determine the rate of respiration by clicking on the Linear Fit button . Record the slope of the line, m , as the rate of respiration and the y-intercept, b , as the initial concentration of CO_2 in Table 1. Close the linear regression floating box and move your data to a stored run. To do this, choose Store Latest Run from the Experiment menu.
10. Use a notebook or notepad to fan air across the openings in the probe shaft of the CO_2 Gas Sensor for about a minute.
11. Repeat Steps 5-10 for the four remaining test tubes.

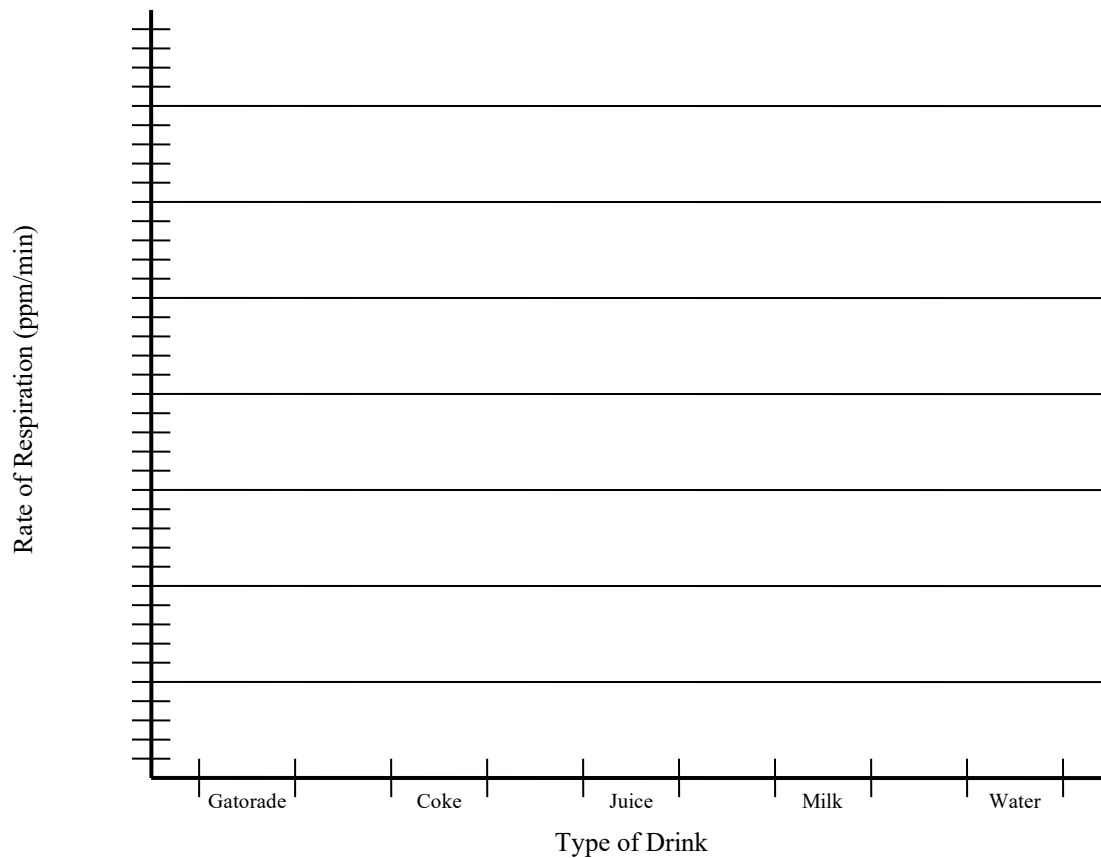
6. Results

Drink Tested	Initial CO_2 Concentration (ppm)	Respiration Rate (ppm/min)
Gatorade		
Coke		
Fruit Juice		
Milk		
Water		

7. Analysis

1. Make a bar graph, using the graph space provided below, of the rate of respiration vs. type of drink. Use the respiration rates calculated in Table 3. The rate values should be plotted on the y-axis, and the type of drink on the x-axis.

Bar Graph of Rate of Respiration



2. Looking at the bar graph, predict which drink should give you the most energy for the race. Explain why you chose this drink.
3. Explain why some of the sugars in the drinks were metabolized and the other sugars were not metabolized as much.
4. Why do you need to incubate the yeast at 37-40°C before you start collecting the data?
5. Why does all the CO_2 from the coke need to be released before the yeast is added?
6. Explain some possible sources of error.

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Teacher Information

1. To Prepare Yeast Suspension: Dissolve 7 g of dried yeast for every 100 mL of water. Incubate the suspension in 37 - 40 °C water for at least 10 minutes; then transfer the yeast to dispensing tubes. Each group will need at least 15 mL of yeast.
2. Make sure that all the CO_2 from the coke has been released.