Cellular respiration and fermentation

Science, Biology

The effect of different Sugar Type on the speed of Energy Production in Yeast Fermentation Respiration is the metabolic process, through which carbohydrates are converted into energy for synthesis by cells. The process is important, as it allows for the breakdown of food compounds, especially sugar – which are then absorbed by cells. The materials required during the study include four 100 ml beakers labeled as 1-4, a 200 ml beaker, deionized water; 5% glucose, fructose and sucrose solutions. Others materials included a sugar solution, yeast, a 300 Celsius water bath and four fermentation tubes, labeled as 1-4. The experiment involved using different sugar compounds: glucose, sucrose and fructose. Glucose proved more effective as compared to sucrose and fructose – as it went through glycosis without the need for breakdown. The Krebs cycle electron transport and oxidative phosphorylation took place in glucose first. The Effect of Different Sugar Type on the Speed of Energy Production in Yeast Fermentation Introduction Respiration is the cell's metabolic process, through which carbohydrates are transformed into energy for use by the cell. The respiration processes can be anaerobic or aerobic. Anaerobic respiration takes place without oxygen. This process generates less oxygen than the aerobic respiration pathway, as only glucosis takes place. The Krebs and electron transport phases are obstructed, as oxygen is not available – for the acceptance of electrons at the end of the process. In the anaerobic pathway, the glycosis process is succeeded by a corresponding process to reproduce NAD+, which helps in the acceptance of the electrons from the carbohydrate (Harris 54; Rich 1098). Ethanol fermentation starts with the conversion of glucose into two pyruvates through glycosis. The pyruvate is later broken into acetylealdehyde and carbon, which is released as CO_2. Ethanol is developed after the reduction process of acetylealdehyde, which is triggered by NADH (Freeman 72). Baker's yeast is a fungus that undergoes ethanol fermentation without oxygen. Through its anaerobic respiration, the ethanol required for alcoholic drinks is produced, and is useful in the rising of bread, due to its production of carbon dioxide (Cummings et al). Different types of yeast are used to process a number of carbon compounds, although most yeast can metabolize sucrose and glucose. For this study, it was theorized that during the process of yeast fermentation – fructose, glucose and sucrose can all generate energy, but would differ in efficiency (Stryer 45). Prior research in the area shows that the study is credible. Yeast can decompose different sugars through varied integration processes into glycosis, although glucose is the highest in efficiency, as it is a major reactant during the process (Berg et al. 34). Materials Four 100 ml beakers labeled as 1-4 200 ml beaker Deionized water 5% glucose, Fructose and Sucrose solutions Sugar solution Yeast 300 Celsius water bath Four fermentation tubes, labeled as 1-4. Method The four 100 ml beakers labeled as 1-4 were secured. 5ml of deionized water is placed in each of the beakers 1-4. Beaker 1 is set aside as the control specimen; contains no sugar solution. 15 ml of 5% glucose solution is added to beaker number 2; 15 ml of 5% fructose solution added into beaker number 3; and 15 ml of 5% Sucrose added to beaker number 4. In the 200ml beaker, 14mg yeast is placed in 100ml of deionized water, and the solution was fully mixed and placed aside. The 300 Celsius bath of water was prepared. The four fermentation tubes labeled as 1-4 are secured. 15 ml of the Yeast solution is placed in the four beakers – so that the fermentation process starts immediately. Recording rates of fermentation The solutions were moved to the respective fermentation tubes. The original level of gas bubble at the top of the each tube was recorded for the four solutions. The four fermentation tubes were placed inside the 300 Celsius bath. The actual height of the air bubble for the different tubes was recorded after every 2 minutes. The carbon dioxide generated through the fermentation process was calculated through subtracting the original height from the recorded height. The procedure was continued for 20 minutes. After the completion of the process, the fermentation tubes were removed from the 300 Celsius water bath. Results 1. The respiration and fermentation process in general The hypothesis was verified for the different sugar forms – as they all produced energy, and glucose was the highest in efficiency. The CO2 generated is directly linked to the energy generated through fermentation, as the carbon dioxide is a result of the ethanol fermentation process (Harris 54). The control specimen without sugar did not produce energy, as the glycosis process requires sugar, so that fermentation can take place. Glucose resulted in the greatest highest rate of energy generation – as depicted from its high rate of carbon dioxide ejection. Sucrose showed the second highest level of carbon dioxide generation, while fructose showed the least. The energy production level of glucose was more than thrice that of fructose. Glucose was directly consumed during the glycosis process, thus did not need any extra energy for its conversion into usable form (Freeman 154). This demonstrated why glucose was the highest in efficiency. Sucrose required energy and an enzyme injection, so that it could be broken down into fructose and glucose, for its processing during the glycosis process

(Freeman 189). Fructose could also not be consumed instantly at the glycosis chain – as it had to be converted, so it could go into the process as one of the intermediaries (Berg et al. 34). The process of converting the non-glucose sugars into absorbable forms decreased their efficiency when compared to glucose. 2. Glycosis did not take place in the control specimen, as a source of sugar is needed for the process to take place. As a result, there was no energy production. Glucose was consumed directly during the process – as it did not require conversion to usable form. The glycosis of Sucrose required the input of energy and enzyme – which helped break it into glucose and fructose – so that the glucose could be processed during glycosis. Sucrose also necessitated the input of energy and enzyme, so it could be broken down – for it to go through the glycosis (Berg et al. 34). The Krebs cycle for the different sugars took place after varied durations, while glucose sucrose delayed due to the breakdown of the sugars into usable form. The process involved the conversion of the energy used into ATP. The electron transport chain took place at comparatively similar durations, where the energy from the pyruvic acid molecules was broken down at the Krebs cycle. Electron transport and oxidative phosphorylation involved the organization of a proton gradient across the NADH membrane generated at the Krebs cycle. ATP synthesis then took place through the ATP synthesis enzyme – in creating the phosporylation of ADP. The electrons were lastly moved to oxygen, where water was produced (Berg et al. 54). Conclusion Cellular respiration is an important process, as it is the process that leads to the formation of ethanol, which is an important ingredient in the manufacturing of alcohol. The process is also necessary in baking, as it

allows for the raising of bread, through the generation of carbon dioxide. The process is necessary for the breakdown of foods, especially sugars, for dietary needs. One of the most important aspects of cellular respiration is molecular change, through oxidation at the glycosis stage. Works Cited Berg, Jeremy, John, Tymoczko, and Lubert Stryer. 16. 1: Glycolysis Is an Energy-Conversion Pathway in Many Organisms. Biochemistry, 2010. Web. 19 Oct. 2010 from . Cummings, Richard, et al. " Saccharomyces Cerevisiae, the Model Yeast." Essentials of Glycobiology, 2012. Web. 19 Oct. 2012 from http://www. ncbi. nlm. nih. gov/books Freeman, Scott. " An Introduction to Carbohydrates, Cellular Respiration and Fermentation." Biological Science 2. 4 (2011): 72-77. Print. Harris, Kelly. Symbiosis: The Pearson Custom Library for the Biological Sciences. New York: Pearson Custom, 2009. Print. Rich, Rumelt." The molecular machinery of Keilin's respiratory chain". Biochemical Society Transactions 31. 6 (2003): 1098-1099. Print. Stryer, Lubert. Biochemistry. Basingstoke: W. H. Freeman and Company, 1995. Print.
Appendix 1 Production of Carbon dioxide using yeast with different sugar compounds Time (Minutes) Tube 1 Tube 2 Tube 3 Tube 4 Recorded CO2 Recorded CO2 Recorded CO2 Recorded CO2 2 6 0 28 14 0 0 9 4 4 6 0 45 31 0 0 18 13 6 6 0 55 41 3 3 25 20 8 6 0 68 54 6 6 37 32 10 6 0 85 71 10 10 50 45 12 6 0 97 83 17 17 59 54 14 6 0 105 91 20 20 69 64 16 6 0 115 101 34 34 81 76 18 6 0 122 108 42 42 91 86 20 6 0 132 118 56 56 102 97 Appendix 2 Test Tube Sugar Average rate of CO2 generation (mm/min) 1 None-glucose 0 2 Fructose 12. 64 3 Sucrose 3. 99 4 Glucose 9. 27