Cellular Respiration and Fermentation Yeast Lab (SB3 a,b)

Yeasts are eukaryotic microorganisms classified in the kingdom Fungi, with 1,500 species currently described. Yeasts are unicellular and reproduce asexually by mitosis, and many do so by an asymmetric division process called budding. Yeast is a facultative anaerobe, meaning that it can participate in aerobic respiration when possible, but when this is impossible, it respires anaerobically. For example, when using yeast in making dough, the yeast will use the initial oxygen up very quickly and then start to respire anaerobically. ATP will then be made via glycolysis, which requires no oxygen. Without oxygen present, the yeast cells will quickly run out of NAD+ molecules which are vital to the process of glycolysis. To regenerate the NAD+, the yeast will undergo alcoholic fermentation, which converts pyruvic acid into CO_2 as well as ethyl alcohol, with the NADH being oxidized in the process. Overall, the final equation for glycolysis plus fermentation would be: $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH + 2\ ATP$. For the yeast cell, this chemical reaction is necessary to produce the energy for life. The alcohol and the carbon dioxide are waste products produced by the yeast. It is these waste products that we take advantage of. The chemical reaction, known as fermentation can be watched and measured by the amount of carbon dioxide gas that is produced from the breakdown of glucose. The purpose of this lab is to observe evidence indicating that the processes of cellular respiration and fermentation occur in a unicellular fungus (i.e., yeast).

Procedure: 1). Fill a 250 ml Erlenmeyer flask with 200-225 ml of apple cider, or any other substance containing glucose. Just make sure to record the amounts of each substance you use. Add ½ teaspoon of yeast. Shake the flask vigorously to mix oxygen into the solution. 2). Obtain the temperature and pH of the solution using the appropriate LabQuest2 digital probe. 3). Repeatedly stretch, blow up, and deflate a balloon. Next, attach the deflated balloon to the flask to close off the system. 4). Make a hypothesis for what should initially occur in the closed system. In other words, make a prediction for what you think will happen in the flask between today and tomorrow. Explain what this will look like and why. Write your hypothesis above your data table. 5). Create a data table to record and organize your data. You will need pH, temperature, qualitative data, circumference of balloon, diameter of balloon and the volume of gas produced. You will record data for three days total. Please note you will only collect temperature and pH data on days 1 and 3 of the lab. 6). *Day 2 and 3*; Use a piece of string to measure the circumference of the balloon. Use the circumference of the balloon and the following equations to calculate the diameter of the balloon. Fill out the data table $C = 2\pi r$; $d = 2r$ Calculate the volume of gas produced using the following equation. Fill out the data table. Volume of Gas Produced = $4.187 \times (\text{diameter of balloon in cm} / 2)^3$

Conclusion:

1.) Yeasts are facultative anaerobes. What does this mean and how might this convey an advantage to the species?

2.) What was the specific source of energy in the apple juice the fungi used for cellular respiration and fermentation?

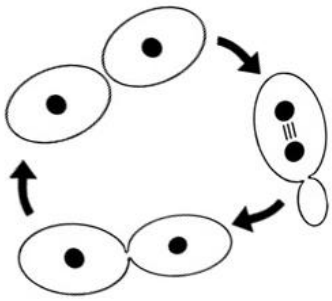
3.) The fungi began respiration aerobically, but then after time completed it anaerobically. How do these two processes differ in terms of the products and energy yielded in this process? List several ways in which the two respiration processes are similar?

4.) How did the physical evidence collected in this investigation support the hypothesis that yeast carry on cellular respiration and fermentation?

5.) How would changes in room temperature influence this investigation? Explain why in terms of your knowledge of reaction rates and enzyme efficacy.

6.) Write down the chemical equations for both cellular respiration and photosynthesis. Circle the reactants and underline the products for each equation. Describe how these two processes are connected.

7.) Yeast reproduce asexually, which is represented in the below figure. Identify three specific types of asexual reproduction and explain the advantages and disadvantages for this type of reproduction.



8.) Calculate the percentage change for the circumference of the balloon between days 2 and 3. Show your work.

9.) *Big Picture Connection*: Write a short essay explaining how the following terms are connected: Yeast, fungi, cellular respiration, ATP, ADP, mitochondria, glucose, anaerobic, fermentation, chitin, eukaryotic, heterotrophic, cytoplasm, asexual, carbon cycle. Underline each term in your essay.