Mr. Hanson's Fermentation of Yeast Lab

Names: Period:
Date:

INTRODUCTION

Yeast are able to metabolize some foods, but not others. In order for an organism to make use of a potential source of food, it must be capable of transporting the food into its cells. It must also have the proper enzymes capable of breaking the food's chemical bonds in a useful way. Sugars are vital to all living organisms. Yeast are capable of using some, but not all sugars as a food source. Yeast can metabolize sugar in two ways, *aerobically*, with the aid of oxygen, or *anaerobically*, without oxygen.

In this lab, you will try to determine whether yeast are capable of metabolizing a variety of sugars. Although aerobic fermentation of sugar is much more efficient, in this experiment we will have yeast ferment sugars anaerobically. When the yeast respire aerobically, oxygen gas is consumed at the same rate that CO_2 is produced—there would be no change in the gas pressure in the test tube. When yeast ferments the sugars anaerobically, however, CO_2 production will cause a change in the pressure of a closed test tube, since no oxygen is being consumed. We can use this pressure change to monitor the respiration rate and metabolic activity of the organism. A Gas Pressure Sensor will be used to monitor the fermentation of sugar.

The fermentation of glucose by Yeast can be described by the following equation:

$$\text{Yeast} + \underset{\text{Glucose}}{C_6H_{12}O_6} \longrightarrow 2\ \underset{\text{ethanol}}{CH_3CH_2OH} + 2\ \underset{\text{carbon dioxide}}{CO_2} + 2\ \underset{\text{Adenosine Tri-Phosphate}}{\text{ATP energy}}$$

Yeast use the glucose as energy. Note that alcohol is a byproduct of this fermentation.

All living cells, including the cells in your body and the cells in yeast, need energy for cellular processes such as pumping molecules into or out of the cell or synthesizing needed molecules. **ATP** is a special molecule which provides energy in a form that cells can use for cellular processes. Each cell in our body and each yeast cell can use the energy stored in organic molecules in food to make ATP. When O_2 is available, cells use **aerobic cellular respiration** to transfer energy from the organic molecules in food to ATP. As shown in the figure, aerobic cellular respiration is a complex process that begins with **glycolysis**, followed by the **Krebs cycle** and the **electron transport chain**. Aerobic cellular respiration can make up to 29 molecules of ATP per molecule of glucose. Most of this ATP is produced by the electron transport chain which can only function if O_2 is available.

When O_2 is not available, cells can make ATP using glycolysis followed by **fermentation**. Glycolysis produces 2 ATP and fermentation restores molecules needed for glycolysis to continue. Glycolysis followed by fermentation produces much less ATP than aerobic cellular respiration, but fermentation is very useful when O_2 is not available. In the figure, fermentation is referred to as **anaerobic** processes. The "an" in front of aerobic means "not aerobic". There are two types of anaerobic fermentation:

- **lactate fermentation** (e.g. in muscles when an animal exercises hard)
- **alcoholic fermentation** (e.g. in yeast, which can be used to make wine or beer)

PURPOSE

The purpose of this lab is to study the ability of yeast to respire anaerobically using various sugars. A Gas Pressure Sensor will be used to measure the production of CO_2, which will be used to determine the respiration rate.

OBJECTIVES

In this experiment, you will:

- Use a Gas Pressure sensor to measure the pressure change caused by carbon dioxide released during yeast fermentation.
- Determine the rate of fermentation.
- Determine which sugars yeast can metabolize and use for energy in the process of fermentation.

HYPOTHESIS: **Discuss with your partner what your hypothesis and write it here: If we add our _______________ sugar to yeast in a test tube without oxygen, then the yeast will process our ____________sugar through anaerobic respiration. Our __________________ sugar will have the fastest rate of anaerobic respiration.**

VARIABLES: **List the:**

1. **Independent Variable: The three different sugars: Agave, Glucose, and Corn Sugar.**
2. **Dependent Variable: The difference in the rate of anaerobic respiration as measured in pressure of CO_2 being produced.**
3. **Controlled Variable: Mr. Hanson's test tube with just yeast and water.**

EQUIPMENT/MATERIALS

Laptop Computer
LabQuest 2 computer
Warm Water (Bring your Flask to the sink and Mr. Hanson will give you some – has to be 98 degrees F)
Vernier Gas Pressure Sensor
5% glucose, agave, corn sugar solutions
Droppers
Test tube
250 ml Flask
Small Beaker
Measuring spoon
Yeast
Vegetable oil
Rubber stopper and tubing for the Gas Pressure Sensor

COMPUTER SET-UP

1. **Log onto a laptop. The Fermentation Lab Document will be shared with you by Mr. Hanson. In your google drive, open the document, click on file, then "make a copy". Name the document, Fermentation Lab, your names, Team #, and period number. Share this document with your partners, and christopher.hanson@student.dodea.edu**
2. **All of your data, observations, analysis, and conclusions will be written on your Lab Document in your Google Drive.**

3. **Look at LabQuest 2 and Gas Pressure Sensor connections. Mr. Hanson has already connected them together and they are ready to go.**
4. **You will turn on the LabQuest 2 during the procedures below. Do not turn on at this time.**

PROCEDURE (FERMENTATION)

1. **Mr. Hanson will set up a Controlled Variable just using water and yeast.**
2. **Mr. Hanson will choose which type of sugar your team will use (5% glucose, agave, corn sugar solutions). Using the dropper, load 4 mls of sugar solution into your test tube.**
3. **Mr. Hanson will turn on the water to a certain temperature. Fill 175 mls of warm water in your Flask. The warm water will allow the yeast to incubate.**
4. **IMPORTANT: Turn on your LabQuest computer by holding down the power button for 4 seconds. When it powers up, insure that the Gas Pressure Sensor is reading the Ambient Air Pressure in KPa or Kilo Pascals, which is the unit of measurement for Gas Pressure.**
5. **IMPORTANT: On your data table write down your beginning pressure in Kilo Pascals per minute or kPa/min that is indicated on your Labquest screen, before you put the rubber stopper on the tube.**
6. **Using the dropper, load 4 mls of the Yeast suspension into your test tube.**
7. **Using the dropper, load 2 mls of vegetable oil in your test tube (TILT YOUR TEST TUBE AND LET IT SLIDE DOWN THE INSIDE OF THE TUBE). This is done so no air or oxygen can get through to the yeast and they have to process sugar anerobically (without oxygen).**
8. **Hold the test tube straight up, and cap your test tube with the rubber stopper tight insure the rubber stopper is firmly in the test tube so no air can escape (like a cork). PLACE THE TEST TUBE IN THE FLASK SO THE YEAST CAN INCUBATE.**
9. **Start your data collection by clicking on the green arrow button on your computer screen. Data collection will last for 15 minutes.**
10. **Write down your observations below using your computer about what is happening in the test tube, and what is happening with the pressure on the graph on your screen. Carbon Dioxide gas which the Yeast are giving off in the process of making ATP energy, is pressure that is measured in Kilo Pascals per minute or kPa/min.**
11. **Monitor your gas pressure. Insure you write down the highest pressure reading during that 15 minutes in your data table. REMEMBER, THE HIGHEST GAS PRESSURE READING IN YOUR DATA TABLE.**
12. **At the end of 15 minutes record the end pressure in your data table.**
13. **Find the difference in pressure in kPa/min using your Start pressure and your Highest pressure and write this data in your data table.**
14. **Turn off your LabQuest 2 by holding the power button for 4 seconds until you see the countdown screen. Disconnect the rubber stopper from the test tube. Rinse out your test tube with soap and insure there is no soap left over in the test tube. Place the test tube back in your bin. Pour out the water in your flask in the sink and return the flask to your bin. You may take off your goggles. Place all the materials back the way you found them. Do not put the LabQuest 2 or the Gas Pressure Sensor in the bin, they must be outside of it on the table.**

OBSERVATIONS: Write your observations here:

ANALYZE DATA: **Write an analysis of your data – what does it mean:**

MAKE YOUR CONCLUSIONS:

1. **Was your hypothesis correct or not and why?**
2. **What did you learn about how Yeast use energy in the form of sugar in cellular respiration and fermentation?**
3. **What are yeast?**
4. **Considering the results of this experiment, can yeast utilize all of the sugars equally well? Explain.**
5. **Hypothesize why some sugars were not metabolized while other sugars were.**
6. **Why do you need to incubate the yeast before you start monitoring air pressure?**
7. **Yeast live in many different environments. Make a list of some locations where yeast might naturally grow. Estimate the food sources of each of these locations.**
8. **What is aerobic and anaerobic metabolism of sugar?**
9. **Research this online if you need to. Also, write about what you learned in this experiment – use of technology, etc.**

CLEAN UP LAB PROCEDURES

1. **Log off your laptop.**
2. **Insure the LabQuest 2 is turned off**
3. **Charge the laptop.**
4. **Disconnect the test tube plug and tube from the test tube.**
5. **Rinse out the test tube in the sink very well with soap and hot water so that no yeast or oil is left.**
6. **Dump out the water in the flask in the sink.**
7. **Place the test tube in the flask.**
8. **Put all the materials in the bin, but do not get the Gas Pressure Sensor wet or the Labquest. They will stay outside the bin.**
9. **Bring the Gas Pressure Sensor, tube, and rubber stopper to Mr. Hanson.**

Table 1					
Tube #	**Type of Sugar**	**Start Pressure kPa/min**	**Highest Pressure recorded kPa/min**	**End Pressure kPa/min after 15 minutes**	**Difference in Pressure (Start and Highest kPa/min**
Test Tube 1 (Yours)					
Test Tube 2 (Mr. Hanson's Controlled Variable)	**Just Yeast in Water**				

Table 2: Class Averages	
Sugar Tested	**Fermentation Rate (kPa/min)**
Team #1: Glucose	
Team #2: Glucose	
Team #3: Glucose	
Team #4: Agave	
Team #5: Agave	
Team #6: Agave	
Team #7: Corn Sugar	
Team #8: Corn Sugar	
Team #9: Corn Sugar	
Control	
Glucose Class Average	
Agave Class Average	
Corn Sugar Class Average	