

Sugar Fermentation of Yeast Lab

Names:

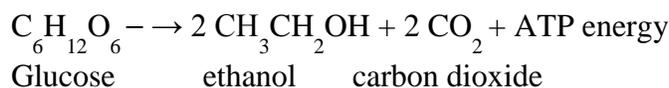
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INTRODUCTION

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 CO₂ is produced—there would be no change in the gas pressure in the test tube. When yeast ferments the sugars anaerobically, however, CO₂ 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:



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 O₂ 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 O₂ is available.

When O₂ 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 O₂ 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 CO₂, 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 CO₂ being produced.
3. **Controlled Variable:** Mr. Hanson's test tube with just yeast and water.

EQUIPMENT/MATERIALS

Laptop Computer
LabQuest 2 computer
Beaker with Warm Water
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
Wood stirrer

COMPUTER SET-UP

1. **Log onto a laptop.**
2. **Get a LabQuest 2, Gas Pressure Sensor, and a USB cable.**
3. **Plug the USB cable into the LabQuest2 and the laptop.**
4. **Open the Logger Pro Icon on the desktop.**
5. **Plug in the Gas Pressure Sensor to the Labquest 2.**
6. **Follow Mr. Hanson's directions on the SmartBoard to set up "Data Collection"**
7. **Mr. Hanson will instruct you on how to use the interface.**

PROCEDURE (FERMENTATION)

1. Mr. Hanson will set up a Controlled Variable just using water and yeast.
2. Choose which type of sugar you 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.
4. Using the dropper, load 4 mls of the Yeast suspension into your test tube.
5. 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 anaerobically (without oxygen).
6. On your data table write down your beginning pressure in Kilo Pascals per minute or kPa/min before you put the rubber stopper in the tube.
7. Hold the test tube straight up, and cap your test tube with the rubber stopper insure the rubber stopper is firmly in the test tube so no air can escape (like a cork).
8. Place the test tube in the Flask and incubate the tube in the warm water for 7 minutes.
9. Insert the tube in the connector on the top of the rubber stopper by twisting it until it is tight in place. This creates a seal so no air escapes.
10. Start your data collection by clicking on the green button on your computer screen. Data collection will last for 15 minutes.
11. In your journal write down your observations about what is happening in the test tube, and what is happening with the pressure on the graph on your screen. Carbon Dioxide gas pressure is measured in Kilo Pascals per minute or kPa/min.
12. At the end of 15 minutes record the end pressure in your data table.
13. Mr. Hanson will show you how to save your data graph on the Student Common Drive under the folder "Fermentation Lab Graphs and Data". When you save your data file, save it as Fermentation Lab Data and the names of your team.
14. Find the difference in pressure in kPa/min using your start pressure and your final pressure.

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.

