

# SUGAR FERMENTATION IN YEAST with LQ

## LAB 12 B

From *Biology with Vernier*

**Westminster College**

**STANDARDS ADDRESSED**

# 3.1.6-8.G Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

# 3.1.9-12.F Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon based molecules.

# 3.1.9-12.G Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

# 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 the aerobic fermentation of sugars is much more efficient, in this experiment we will have yeast ferment the 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 ferment 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 fermentation rate and metabolic activity of the organism.

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

C6H12O6→2 CH3CH2OH + 2 CO2 + energy

glucose ethanol carbon dioxide

Note that alcohol is a byproduct of this fermentation.

# OBJECTIVES

* Use a gas pressure sensor to measure the pressure change caused by carbon dioxide released during fermentation.
* Determine the rate of fermentation.
* Determine which sugars yeast can metabolize

# MATERIALS

LabQuest Gas Pressure Sensor

1-hole rubber stopper assembly Plastic tubing with Luer-lock fitting 5% glucose, sucrose, lactose, and fructose solution

2-18 x 150 mm test tubes test tube racks

1 L beaker (for water bath) beral pipet

Hot and cold water thermometer

Yeast suspension vegetable oil in dropper bottle

Utility clamp ring stand

Goggles

# PROCEDURE

1. Connect the plastic tubing to the valve on the Gas Pressure Sensor.
2. Connect the Gas Pressure Sensor to LabQuest and choose New from the File menu.
3. Prepare a water bath for the experiment. A water bath is simply a large beaker of water at a certain temperature. This ensures that the yeast will remain at a constant and controlled temperature.
   1. To prepare the water bath, obtain some warm and cool water from your teacher.
   2. Combine the warm and cool water in the 1 L beaker until it reaches 38- 40°C. The beaker should be filled with about 600-700 mL of water.
   3. Place the thermometer in the water bath to monitor the temperature during the experiment.



1. Obtain two test tubes and label them 1 and 2.

*Figure 2*

1. Your team will test two of the four sugar solutions. Obtain two of the four sugar solutions: glucose, sucrose, lactose, and fructose solution, as directed by your instructor.
2. Place 3.0 mL of the first sugar solution into test tube 1 and 3.0 mL of the second sugar solution into test tube 2. Record which solutions you tested in Table 1.
3. Pipet 3.0 mL of yeast suspension into test tube 1. Gently swirl the test tube to thoroughly mix the yeast into the solution. **Important:** The yeast suspension must be removed from the middle of a yeast source that is being stirred by a magnetic stirrer at a constant stirring speed.
4. In test tube 1, place 1 mL of vegetable oil to completely cover the surface of yeast/glucose mixture as shown in figure 2. **Note:** Be careful to not get oil on the inside wall of the test tube.
5. Insert the single-holed rubber-stopper into the test tube. **Note:** Firmly twist the stopper for an airtight fit.
6. Connect the free-end of the plastic tubing to the connector in the rubber stopper as shown in Figure 3.
7. Set test tube 1 in the water bath and secure it with a utility clamp and ring-stand as shown in figure 1. **Note:** be sure that most of the test tube is completely covered by the water in the water bath. The temperature of the air in the test tube must be constant for this experiment to work well. Be sure to keep the temperature of the water bath constant.



*Figure 3*

1. Start data collection. **Note:** Maintain the temperature of the water bath during the course of the experiment. If you need to add more hot or cold water, first remove about as much water as you will be adding, or the beaker may overflow.
2. Data collection will end after 15 minutes. Monitor the pressure readings displayed on the screen. Monitor the pressure readings displayed on the screen. If the pressure exceeds 130 kilopascals, the pressure inside the tube will be too great and the rubber stopper is likely to pop off. Disconnect the plastic tubing from the Gas Pressure Sensor if the pressure exceeds 130 kilopascals.
3. When data collection has finished, a graph of pressure *vs*. time will be displayed.
4. Disconnect the plastic tubing connector from the rubber stopper. Remove the rubber stopper from the test tube and discard the contents in a waste beaker.
5. Determine the rate of fermentation:
   1. Tap and drag your stylus across the sloping portion of the graph to select these data points.
   2. Choose Curve Fit from the Analyze menu.
   3. Select Linear for the Fit Equation.
   4. Record the slope of the line, *m*, as the rate of fermentation in Table 1.
   5. Select OK.
6. Store the data from the first run by tapping the File Cabinet icon.
7. Repeat Step 7-16 using test tube 2.

# DATA

|  |  |  |
| --- | --- | --- |
| Table 1 | | |
|  | Type of sugar | Rate of fermentation (kPa/s) |
| Test tube 1 |  |  |
| Test tube 2 |  |  |

|  |  |
| --- | --- |
| Table 2 Class Averages | |
| Type of sugar | Average rate of fermentation (kPa/s) |
|  |  |
|  |  |
|  |  |
|  |  |
| Control |  |

**PROCESSING THE DATA**

1. Share your data with the rest of the class by recording the sugar type you tested and the rate of fermentation on the board.
2. Using the class data, calculate the average rates of fermentation for each of the sugar types tested. Record the average rates in Table 2, along with the names of the four sugars tested.
3. Use the class data in Table 2, make a bar graph of rate of fermentation *vs.* sugar type. The rate values should be plotted on the y-axis, and the sugar type on the x- axis.

# QUESTIONS

1. Consider the results of this experiment, can yeast utilize all of the sugars equally well? Explain
2. Hypothesize why some sugars were not metabolized while other sugars were.
3. 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.