

“A SWELL LAB” Yeast Fermentation

Science in the Real World Microbes In Action

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At a Glance

Description:

This is a two-day laboratory exercise in which the students will determine the effect of different concentrations of sugar on the respiration and fermentation rates of yeast. Students will collect data and analyze it.

Time Requirements:

This lab will require two, non-consecutive days to complete.

Curriculum Placement:

This exercise could be used as an introduction to the scientific method. It could also be done in conjunction with a unit on cellular respiration.

Equipment:

Balance

Materials: (For groups of 4)

6 balloons

14 grams of yeast (not quick start)

14 grams of table sugar

0.5 m of string

4 weigh boats

2- 50 mL graduated cylinders

600 mL beaker

Overflow pan

Permanent markers

A 'Swell' Activity

Background:

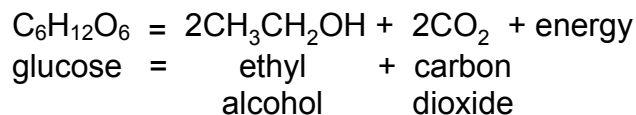
Yeast are tiny single-celled (**unicellular**) fungi. The organisms in the **Kingdom Fungi** are not capable of making their own food. Fungi, like any other organism, need food for energy. They rely on sugar found in their environment to provide them with this energy so that they can grow and reproduce.

Yeast, like bacteria grow in or on their food source. They produce and release digestive proteins (**enzymes**) into their environment where the sugar molecules are found. Sugar molecules then break down into smaller molecules that can be absorbed by the yeast and used for food (**energy**).

There are many **species** of yeast, and each has a particular food source.

- Certain yeast feed on a variety of natural sources of sugar such as fruits, nectar from plants, and molasses from the plant crop called sorghum.
- Others break down wood and corn stalks. In doing this, a compound called ethanol is produced. This compound can be used in our cars like gasoline.
- Another species break down sugar from grain into alcohol. Others break down fruits into wine, which is another type of alcohol.
- Bread recipes rely on yeast to break down sugar in our dough.

All of these processes are called **fermentation**. The formula for the yeast fermentation reaction is:



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 break down of glucose.

???? Do you think that the volume of carbon dioxide produced during fermentation would be affected by using different masses of sugar ????

In this exercise you will add the same amounts of yeast and water to different amounts of sugar in balloons and tie them off to see how much carbon dioxide gas is produced.

A 'Swell' Lab (for the Block Schedule)

Team of Four Students (Students on the team will work in pairs on the preparation of the balloons...then one pair will be responsible for all the mass measurements and the remaining pair of the team will be responsible for all the volume measurements.

1. Split up into pairs. Each pair should will mark and fill three balloons. Using a permanent marker or a ballpoint pen write your initials on the balloons. Label the balloons A, B, C and so on. Your team should have balloons labeled A through F.
2. Using a plastic spoon or spatula place some of the yeast in a weigh boat on the balance. Measure out a total of 2 grams of yeast. Then, using a separate weigh boat, measure 2 grams of sugar. Move over with your weighed yeast and sugar and proceed to fill the balloon while the other pair of students on your team weighs their yeast and sugar in separate weigh boats. (**While one pair weighs, the other pair fills the balloons using the funnel)
3. Next, measure with a graduated cylinder exactly 50 milliliters of water and add to the same balloon and remove the funnel.
4. Use a piece of string to tie off the balloon just above the water line so that no air is inside of the balloon. One person must hold the balloon while the other person ties off the balloon opening. The person holding the balloon must also gently press on the balloon from the sides to force the air out while the other person ties a tight double knot in the string. Leave the excess string on the balloon.
5. Knot the rubber band as close as you can to the knot in the string.
6. Place the prepared balloons on ice to prevent fermentation.
7. Prepare all six balloons as above using the 3, 4, 5, 6, and 7 grams of sugar to each balloon respectively. (Remember, you are a team, therefore if one pair is having difficulty, and you have finished...help each other out!) Remember, all the balloons must remain on ice to prevent the start of fermentation.
8. Once all six balloons are tied, it is time to measure the mass and volume of your balloons.
9. The pair weighing the balloons will mass the balloons in grams. Round off to the second decimal number. Return to the ice bucket.
10. The pair of students measuring volume will determine the volume using the water displacement method:

Place a 600 ml beaker or large jar in an overflow pan. Fill the container to the

very top with tap water. Completely submerge (push the balloon under the water and allow the water to spill over the sides and into the pan. Stop when your fingers touch the water. The water in the pan is the volume of your balloon. Measure it carefully in a graduated cylinder and record your measurements on a data table for your team. Return balloon to ice as soon as possible.

11. Now that all six balloons have been massed and measured for volume, place all the balloons in a water bath or foam cooler with water at 37 degrees Celsius. (If using a foam cooler you may use 40-degree water, as you tend to lose a little heat in the process.) Make observations as to which balloons sink or float. Keep time and record all the changes in the balloons over a 15-30 minute incubation time...your teacher will decide how long you have for this process.

_____ time used for incubation at approximately 37 degrees Celsius.

12. After the incubation time, dry the outside of the balloons with a paper towel. The same pair of students should mass the balloons again and then hand that balloon to the other pair, who once again will measure the volume of each balloon with the water displacement procedure. Both sets of data are recorded onto the data table.
13. Calculate the changes in the mass and volume numbers that occurred.
14. One member of the team should add the changes that occurred to the class data table on the board/overhead. Then the team should figure the mean (class average) for the changes that occurred in the balloons with this exercise. While this is being done, the other members should hang their balloons on the clothesline provided by the teacher. Or you can clip or tie your balloons to a hanger to be hung overnight.
15. Finally, clean up your work area. Wash and dry the equipment and return it to its proper place.

Day three: What happened to the balloons?

1. Record observations about your balloons. Using scissors, snip the tied balloons off of the clothesline or hanger used to hang them the previous day. (Remember to use all of your senses when making the observations.)
2. Using the methods from the previous day, once again mass the balloons and measure the volume using water displacement method.
3. Prepare a new chart showing the mass and volume measurements for both days.

Name _____

Date _____

Data Sheet

Hypothesis: Explain your hypothesis in the space below, using an “If...then...” statement.

Control: What tube do you consider to be your control? Why?

**Table A-Group Data
Day 1**

Sugar Concentration

| | 2 g | 3 g | 4 g | 5 g | 6 g | 7 g |
|-------------------|-----|-----|-----|-----|-----|-----|
| Mass of balloon | | | | | | |
| Volume of balloon | | | | | | |

**Table A-Class Data
Day 1**

Sugar Concentration

| | 2 g | 3 g | 4 g | 5 g | 6 g | 7 g |
|-----------------|-----|-----|-----|-----|-----|-----|
| Mass of balloon | | | | | | |
| Average | | | | | | |

| | | | | | | |
|-------------------|--|--|--|--|--|--|
| Volume of balloon | | | | | | |
| Average | | | | | | |

Analysis:

1. How did your results compare with that of the class? If your results were different, what may have happened?

2. What happened to the balloons? Why?

**Table B- Group Data
Day 2**

Sugar Concentration

| | 2 g | 3 g | 4 g | 5 g | 6 g | 7 g |
|-------------------|-----|-----|-----|-----|-----|-----|
| Mass of balloon | | | | | | |
| Volume of balloon | | | | | | |

Questions:

1. After 48 hours, what has happened to the balloons?

2. What are some possible explanations for these happenings?

3. In most cases the balloons decreased in size. What do you think was lost from the balloons?

4. Would the loss of _____ (use your previous answer to fill in the blank) be called diffusion or osmosis?

5. Draw a diagram showing what is happening to the molecules inside the balloon.

6. Imagine a cell with a cell membrane much like the rubber membrane created by the balloon. The cell is full of water and other chemicals that help the cell to live. How does the balloon observations relate to what goes on in a cell on a daily basis?

How does the cell or an organism regulate these losses? This regulation on keeping a balance of water and other important substances is called **homeostasis**. Homeostasis helps a cell to maintain a proper balance in order to stay alive. If the cell cannot maintain a certain balance, the cell activities shut down and the cell will die.

Teacher notes:

This is a true lesson in cooperative learning. The team of four must work together to get this lab done! Stress teamwork to your class

My first inclination was to have my student pairs mass the initial volumes and the other pair measure volumes and then switch jobs so that each can have the experience. (If you have them switch jobs for the second mass/volume measurements, this adds one extra variable as each pair may do the procedure a little differently.) Therefore, I wrote that the pairs should remain doing their original job to completion of this part of the lab.

Useful hints:

1. It takes two packets of yeast per team. (14 grams per team and each packet has 7 grams in it.
Buy the jar of yeast. The jar runs about \$6.00 and is much more economical. The four-ounce jar (113 grams) is the equivalent to 16 packets of yeast. The package of 3 packets costs nearly \$2.00 with only 7 grams per packet....21 grams total.
2. If you do not have overflow pans or deep trays, foil 9" x 13" cake pans do nicely and they are reusable!
3. Some students find a problem with filling the beaker with water due to the lip on the beaker. If you find this is so, large plastic containers such as tall/large 24-ounce cottage cheese containers could be used for the water displacement procedure.