Name _____ Date _____

Respiration in Yeast

Lab 10

Background

Yeasts are tiny, unicellular fungi that live on the surfaces of fruits and grains, or wherever sugars are plentiful. Yeasts can carry on either aerobic or anaerobic respiration to produce energy, depending upon conditions.

In the presence of oxygen, yeast carries on *aerobic respiration.* With favorable temperatures (40–45°C), the cells reproduce rapidly as long as oxygen and sugar are present. As sugar molecules are broken down, much ATP energy is released. Carbon dioxide and water are produced as waste products.

In the absence of oxygen, yeast carries on *anaerobic respiration,* also known as *fermentation.* Less energy is released because sugar is only partially broken down. The products of yeast fermentation are carbon dioxide and ethyl alcohol. In bread-making, the bubbles of carbon dioxide produced by fermentation make the dough rise. The ethyl alcohol evaporates rapidly in the heat of the oven. Ethyl alcohol produced by fermentation is used in making alcoholic beverages and in many industrial processes.

Objectives

In this activity you will:

1. Allow common yeast, *Saccharomyces cerevisiae,* to grow under aerobic and anaerobic conditions.
2. Identify the waste products of yeast fermentation.

Materials

250-mL flasks
one-holed stopper fitted with a short length of glass tubing
two-holed stopper fitted with one long and one short length of glass tubing
rubber tubing
glass-marking pencil
10-mL and 50-mL graduated cylinders
test tubes
test tube rack
soda straws
limewater
10% glucose solution kept at 45–50° C
yeast suspension
Lugol's iodine solution in dropper bottle
10% sodium hydroxide solution in dropper bottle

Procedures and Observations

PART I. SETTING UP THE EXPERIMENT

Work in a group to assemble the setup and then do the rest of the activity alone.

1. Label one flask *A* and also mark it with the initials of one person in your group.
2. Pour 50 mL of the warm 10% glucose solution into flask A. Add 3 mL of the yeast suspension. Swirl the contents of the flask to mix the yeast thoroughly into the solution. Rinse the graduated cylinder well.

Formation of bubbles indicates that the yeast cells are carrying on aerobic respiration. The bubbles are carbon dioxide gas.

3. Cap the flask with the one-holed stopper fitted with a short glass tube. See Figure 1, flask A. Swirl the contents of the flask again. Set it aside.

   a. *Do you see any bubbles forming?*

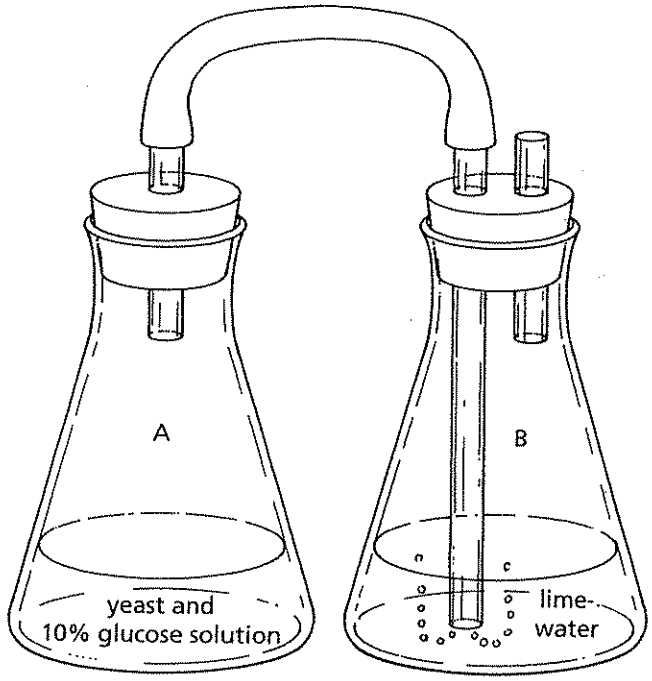

Figure 1

4. Label another flask *B* and mark it with the same initials used before.

Limewater is a clear solution. When it is mixed with carbon dioxide, it turns cloudy.

5. Pour 50 mL of limewater into flask B, using a clean graduated cylinder. Stopper the flask with the two-holed stopper fitted with a long and short glass tube. Make sure that the long glass tube extends well beneath the surface of the limewater as shown in Figure 1, flask B. **CAUTION:** *It is very easy to cut yourself when pushing glass tubing into a rubber stopper. If the glass tubing is not correctly positioned, ask your teacher to help you adjust it.*
6. Watch as your teacher assembles two control setups: (1) a flask containing yeast and warm water connected to a flask containing

limewater; and (2) a flask containing warm 10% glucose solution connected to a flask containing limewater.

7. Using rubber tubing, connect the short glass tube in flask A and the long glass tube in flask B as shown in Figure 1. Make sure the connections are tight. You wish gas to flow from flask A into the limewater in flask B.
8. Carefully swirl the contents of flask A again. Then leave the setup overnight at room temperature.
9. Pour 10 mL of limewater into a test tube. Place a soda straw in the test tube so that its end is in the limewater.
10. Blow gently through the straw so that your breath bubbles into the limewater. **CAUTION:** *Be sure to wear your safety goggles and apron. Be careful not to spatter the limewater.* Continue to blow into the limewater until a change occurs.

b. *Describe what happened to the limewater after you had blown into it.*

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PART II. OBSERVATIONS AFTER 24 HOURS

1. After 24 hours, observe your group's setup.

a. *Describe any changes you see in flask A.*

_____

b. *Describe any changes you see in flask B.*

_____

2. Observe the yeast and water control.

c. *Is there any change in the limewater flask? If so, describe it.*

_____

3. Observe the glucose control.

d. *Is there any change in the limewater flask? If so, describe it.*

_____

4. Leave the setup overnight at room temperature again.

PART III. OBSERVATIONS AFTER 48 HOURS

1. After another 24 hours, observe flask A in your group's setup.

a. *Do you see any activity in flask A? If so, describe it.*

_____

2. Observe flask B in your group's setup.

b. *Describe the appearance of the limewater.*

_____

_____

3. Disconnect the rubber tubing and unstopper the flasks. Pour 5 mL of the fluid from flask A into a clean test tube. You will test this sample for the presence of ethyl alcohol in the following way.

4. Add 4 drops of 10% sodium hydroxide. **CAUTION:** *Be careful not to spill the sodium hydroxide. If you do get any on yourself, wash the area immediately under cold running water and notify your teacher.*

5. Add 1 drop of Lugol's iodine solution. **CAUTION:** *Lugol's iodine solution can stain hands and clothing.* Gently swirl the contents of the tube. If the color disappears, add another drop of Lugol's solution and swirl again. Stop adding Lugol's solution when the faint yellow color does not disappear when you swirl the contents of the tube.

6. After you have obtained a faint yellow color that does not disappear, let the test tube stand in the rack for 2 minutes.

A layer of light yellow material that settles to the bottom of the test tube indicates the presence of ethyl alcohol.

7. Swirl the contents of the test tube again and set the tube in the rack.

c. *What do you observe?*

8. Clean up and put away your equipment and materials as directed by your teacher.

Analysis and Interpretations

1. Why was glucose mixed with the yeast cells?

2. When the yeast and glucose were first mixed together in flask A, which kind of respiration took place—aerobic or anaerobic? Why?

3. After the setups were connected, did yeast perform aerobic or anaerobic respiration? Explain.

4. What solution is used to detect the presence of carbon dioxide?

5. What was the purpose of breathing into the limewater?

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6. Did the yeast cells produce carbon dioxide? How do you know?

7. Did the yeast cells produce alcohol? How do you know?

8. Could you see any activity in flask A when you made the observations for Part II? Explain.

9. Why does a flask of yeast and warm water connected to a flask of limewater serve as a control? Why does a flask of glucose solution connected to a flask of limewater serve as a control?

10. Explain the activity you saw in flask A during Part III.

11. How can you reasonably be sure that no oxygen entered flask A once the original oxygen was used up? Why is this important?

12. What was the purpose of the small glass tube in the stopper in flask B?

For Further Investigation

1. Save the controls and test them for the presence of alcohol. Record your results. Using these results and those obtained in your laboratory activity, write a short paragraph telling how the controls help you to verify that yeast cells perform anaerobic respiration.
2. Make bread at home. While it is rising, and while it is first baking, try to detect the odor of alcohol in the vapors coming from the dough.