Types of Cellular Respiration

Topic
Aerobic and anaerobic cellular respiration are methods by which cells break down food for energy.

Introduction
Cellular respiration is a process in cells that produces energy. All organisms depend on either aerobic or anaerobic respiration. In the aerobic form, cells use oxygen to convert sugar to energy. A waste product of this reaction is carbon dioxide. Under anaerobic conditions, oxygen is not available and cells make energy through the process of alcohol fermentation. This reaction also releases carbon dioxide.

Yeast are single-celled organisms that are facilitative anaerobes. If oxygen is available, they will use it to carry out aerobic respiration. In the absence of oxygen, they carry out alcohol fermentation. The ability of yeast to convert sugar to alcohol and carbon dioxide is basis for the manufacture of products such as bread and alcoholic beverages. In this activity, you will design an experiment to find out the optimal amount of sugar for yeast growth. You can assume that the amount of carbon dioxide produced by yeast indicates the activity level of the yeast.

Time Required
2 hours

Materials
- 1/2 teaspoon active dry baker’s yeast
- 40 milliliters (ml) warm water
- sugar
- teaspoon
electronic scale or triple beam balance
latex balloon
50-ml Erlenmeyer flask
spoon
metric measuring tape
science notebook

Safety Note  Please review and follow the safety guidelines.

Procedure
1. Your job is to design and perform an experiment to find out the optimal amount of sugar in water for yeast growth.
2. You can use any of the supplies provided by your teacher, but you will not need to use all of them.
3. Before you conduct your experiment, decide exactly what you are going to do. Write the steps you plan to take (your procedure) and the materials you plan to use (materials list) on the data table. Keep in mind that your experiment should have only one variable and it needs a control. Be sure that your experiment produces measurable results. Show your procedure and materials list to the teacher. If you get teacher approval, proceed with your experiment. If not, modify your work and show it to your teacher again.
4. Once you have teacher approval, assemble the materials you need and begin your procedure.
5. Collect your results on a data table of your own design.
### Analysis

1. What happened to the appearance of the yeast and sugar water mixture over the experimental period?

2. How can you show that a gas was produced as yeast consumed sugar?

3. Bo wanted to see how much carbon dioxide he could collect by fermenting apple cider with yeast. He poured some warm apple cider in an Erlenmeyer flask and covered the top of the flask with a funnel. Initially, when the balloon was placed on the flask, oxygen was trapped inside.
   a. What type of respiration occurred while the oxygen was present?
   b. After the oxygen was used up by the yeast, what type of respiration took place?
   c. Where did the yeast get the food needed for respiration?
What’s Going On?
Sucrose, or table sugar, is made of glucose molecules. Yeast can break down sucrose into individual glucose molecules, which it then uses to carry out cellular respiration. The purpose of cellular respiration is to produce energy to support life processes. As long as oxygen is present, yeast carries out aerobic cellular respiration, yielding 36 ATP molecules per glucose molecule. In the absence of oxygen, yeast carries out fermentation, a much less efficient process. Fermentation yields only two ATP molecules per molecule of glucose. A by-product of both aerobic respiration and fermentation is carbon dioxide. Because glucose is not completely broken down in fermentation, this process also produces ethanol.

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TYPES OF CELLULAR RESPIRATION

Suggestion for class discussion: Ask students to recall their knowledge of cellular structures and relate cellular respiration to the structure of the mitochondrion.

Analysis

1. The mixture appears cloudy and has bubbles rising from the cider. Over time, the bubbles decrease and a layer of white material forms on cider.
2. Carbon dioxide gas produced during respiration causes bubbles.
3. (a) aerobic respiration; (b) anaerobic respiration; (c) sugar
Each experiment includes special safety precautions that are relevant to that particular project. These do not include all the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read and remain mindful of the General Safety Precautions that follow. Experimental science can be dangerous, and good laboratory procedure always includes following basic safety rules. Things can happen very quickly while you are performing an experiment. Materials can spill, break, or even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following the basic safety guidelines during the entire experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. For one reason, we want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical.

Read the safety precautions here and at the beginning of each experiment before performing each lab activity. It is difficult to remember a long set of general rules. By rereading these general precautions every time you set up an experiment, you will be reminding yourself that lab safety is critically important. In addition, use your good judgment and pay close attention when performing potentially dangerous procedures. Just because the book does not say “Be careful with hot liquids” or “Don’t cut yourself with a knife” does not mean that you can be careless when boiling water or using a knife to punch holes in plastic bottles. Notes in the text are special precautions to which you must pay special attention.

**GENERAL SAFETY PRECAUTIONS**

Accidents caused by carelessness, haste, insufficient knowledge, or taking an unnecessary risk can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to
check the individual experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone. When you are working off-site, keep in groups with a minimum of three students per groups, and follow school rules and state legal requirements for the number of supervisors required. Ask an adult supervisor with basic training in first aid to carry a small first-aid kit. Make sure everyone knows where this person will be during the experiment.

PREPARING
- Clear all surfaces before beginning experiments.
- Read the instructions before you start.
- Know the hazards of the experiments and anticipate dangers.

PROTECTING YOURSELF
- Follow the directions step by step.
- Do only one experiment at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure there is adequate ventilation.
- Do not horseplay.
- Keep floor and workspace neat, clean, and dry.
- Clean up spills immediately.
- If glassware breaks, do not clean it up; ask for teacher assistance.
- Tie back long hair.
- Never eat, drink, or smoke in the laboratory or workspace.
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult.

USING EQUIPMENT WITH CARE
- Set up apparatus far from the edge of the desk.
- Use knives or other sharp-pointed instruments with care.
• Pull plugs, not cords, when removing electrical plugs.
• Clean glassware before and after use.
• Check glassware for scratches, cracks, and sharp edges.
• Clean up broken glassware immediately.
• Do not use reflected sunlight to illuminate your microscope.
• Do not touch metal conductors.
• Use alcohol-filled thermometers, not mercury-filled thermometers.

USING CHEMICALS
• Never taste or inhale chemicals.
• Label all bottles and apparatus containing chemicals.
• Read labels carefully.
• Avoid chemical contact with skin and eyes (wear safety glasses, lab apron, and gloves).
• Do not touch chemical solutions.
• Wash hands before and after using solutions.
• Wipe up spills thoroughly.

HEATING SUBSTANCES
• Wear safety glasses, apron, and gloves when boiling water.
• Keep your face away from test tubes and beakers.
• Use test tubes, beakers, and other glassware made of Pyrex™ glass.
• Never leave apparatus unattended.
• Use safety tongs and heat-resistant gloves.
• If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it.
• Take care when lighting your Bunsen burner; light it with the airhole closed, and use a Bunsen burner lighter in preference to wooden matches.
• Turn off hot plates, Bunsen burners, and gas when you are done.
• Keep flammable substances away from flames and other sources of heat.
• Have a fire extinguisher on hand.

FINISHING UP

• Thoroughly clean your work area and any glassware used.
• Wash your hands.
• Be careful not to return chemicals or contaminated reagents to the wrong containers.
• Do not dispose of materials in the sink unless instructed to do so.
• Clean up all residues and put them in proper containers for disposal.
• Dispose of all chemicals according to all local, state, and federal laws.

BE SAFETY CONSCIOUS AT ALL TIMES!