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Overview

This *Delta Science Module* introduces students to the world of fungi. Students begin, in Activity 1, by identifying the structures of seed plants—seeds, stems, leaves, and roots—and discussing their functions. Later they will use this information to compare and contrast the structures of seed plants with those of fungi.

In Activity 2, the students begin their study of fungi by examining a mushroom and some bread mold. First they dissect and name the parts of a mushroom. Then they examine the mold and identify its parts, including the hyphae and mycelia. Lastly they compare and contrast the parts of these two fungi with the parts of a seed plant.

In Activity 3, students make spore prints of mushrooms which allow them to further explore the reproductive process of these familiar fungi.

The students become familiar with the characteristics of a single-celled fungus, yeast, in Activity 4. They observe dry yeast granules and then add warm water to see how they grow. They compare yeast to other types of fungi and to seed plants, and study the reproduction of yeast by budding.

In Activity 5, students prepare two populations of yeast—one with food and one without—and observe the effect that the availability of food has on their ability to reproduce.

In Activity 6, students grow mold "gardens", or cultures, using four kinds of mold growing on two different media. Over a period of 10-15 days, they observe and compare the changes that take place in the different mold cultures. They note and record the differing growth rates between the molds in each culture.

Students return to working with yeast in Activity 7. They prepare three cultures at different temperatures and then give them time to grow and reproduce. From this they draw conclusions about the effects of temperature on the budding process.

In Activity 8, students attempt to extract pigments from seed plants and fungi. Using chromatograms made from isopropyl alcohol and blotter paper, students confirm that green seed plants contain chlorophyll but that fungi do not. They discuss photosynthesis and the significance of the absence of chlorophyll in fungi.

In Activity 9, students learn about fermentation, the process by which yeast releases energy from food and gives off carbon dioxide gas and alcohol. Using limewater as an indicator, they confirm the presence of carbon dioxide first in their exhaled breath, and then in the gas produced from an actively growing yeast culture.

Students learn about the use of yeast in the production of breads and alcoholic beverages in Activity 10. They prepare pretzel dough, with and without yeast, and note the differences between the two batches of dough. In Activity 11, students work again with the mold gardens they grew in Activity 6. They apply different substances to the gardens and then compare the ability of these substances to kill the mold cultures. The activity ends with a discussion of the usefulness—and the potential hazards—of fungicides.

Finally, in Activity 12, students are asked to form an opinion about whether fungi are "good" or "bad." They conduct library research to find out that some fungi are harmful, and some are useful. From their research and classroom debate, they conclude that fungi can be both "good" and "bad."

Materials List

Qty		Description
2	c	adhesive dots, p/96
1	c	alcohol, 1 pt
64	c	bags, reclosable, 6" x 6"
1	c	bleach, 2 oz
8		bowls, mixing
1	c	cream, anti-fungal, ½ oz
1		cup, measuring
32		cups, plastic, 1-oz
16	c	cups, paper, 16-oz
16		flasks, 125-mL
3	c	flour, 2 lb
1		funnel
8		knives, plastic
1	c	limewater, 1 liter
16		magnifiers, tri-lens
1	c	paper, blotter
8		pencils, wax
16		petri dishes
100	c	salt, packets
1		seeds, kidney bean, p/700
1		seeds, pea, p/100
1		seeds, sunflower, p/80
1		spoon, measuring, ½-tsp
8		stoppers, rubber, with hole
32	c	straws, drinking
75	c	sugar, packets
1	c	sugar, 1 lb
1	c	tape, masking
11		thermometers, Fahrenheit
8	c	tongue depressors
1	c	toothpicks, flat, p/750
8		trays, plastic
8		tubing, 15"
18	c	yeast, packets
1	c	yeast, 1 lb
1		teacher's guide

Teacher provided items

1	c	bag, plastic, large
1		clock
–	c	foods, for growing molds/cultures
44	c	mushrooms
3		pans, large
1 roll	c	paper towels
8	c	paper, white, sheets
8		pencils or pens
–		photographs, mold/mushrooms/plants
1		plant, potted
8		rulers, metric
1		scissors
–		spinach leaves
–	c	water, tap
1		marker
32		books, hardcover, heavy

c = consumable item

Activity 9
It's a Gas!

Objectives

Fermentation has been important in the making of bread, wine, and beer for thousands of years. This activity will introduce students to the fermentation process and the role of carbon dioxide in it.

The students

- identify and observe limewater as an indicator for carbon dioxide
- infer that carbon dioxide gas is produced by yeast during fermentation
- describe the role of carbon dioxide in the production of bread

Schedule

About 50 minutes

Vocabulary

carbon dioxide
fermentation
respiration

Materials

For each student

1	Activity Sheet 9

For each team of four

2	flasks
1	stopper, 1-hole
4	straws
4 mL	sugar
1	tray, plastic
1 pc	tubing, 15"
50 mL	*water, tap (between 78°F and 82°F)
3 mL	yeast

For the class

2	cups, medicine
800 mL	limewater
1	*pan, large
1	thermometer
	*towels, paper

*provided by the teacher

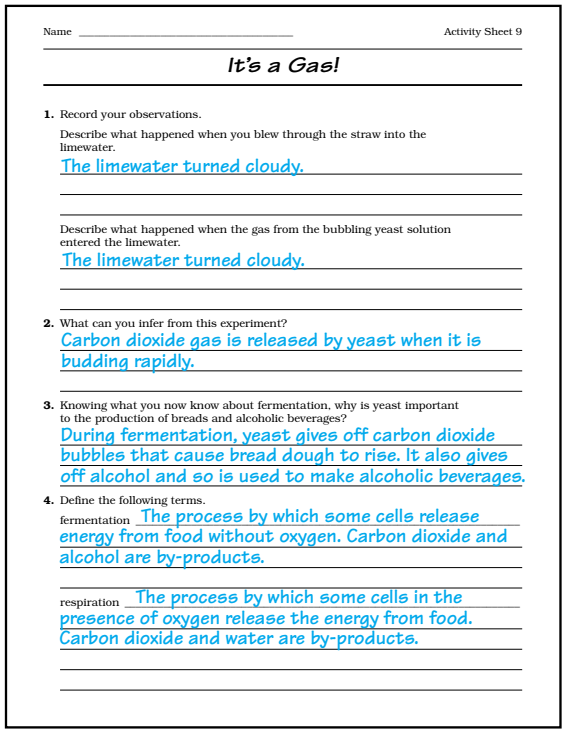
Preparation

1. Make a copy of Activity Sheet 9 for each student.
2. Insert one end of each piece of the tubing into a rubber stopper until the end of the tube is flush with the bottom of the stopper.
3. Use the two medicine cups to measure wet and dry ingredients: For each team pour 50 mL of limewater into one flask. (Keep the container handy in order to replace the limewater that the students use up early in the activity.) Measure 3 mL of yeast and 4 mL of sugar into another flask.
4. Prepare a tray for each team containing a length of tubing in a stopper, a flask of limewater, a flask of yeast and sugar, and four straws.
5. Prepare a large pan of water, warmed to between 78°F and 82°F. Set the pan someplace where students will be able to come up and get water from it when the activity begins.

Background Information

Seed plants release the energy in their stored food by a process call *respiration.* The "foods" of seed plants are the sugars and starches they produce during photosynthesis. Oxygen is required for respiration, and carbon dioxide and water are given off.

Yeast, on the other hand, releases energy from food by a process called *fermentation.* Fermentation takes place without oxygen. Sugars are broken down and their energy released. Alcohol and carbon dioxide are produced. When baking bread, the carbon dioxide gas is trapped in the dough. As the gas bubbles expand, the bread dough rises. When the bread is baked, the high temperature in the oven causes the alcohol to evaporate. In the production of alcoholic beverages, such as beer and wine, the carbon dioxide gas is bubbled off and the alcohol remains.



Name _____ Activity Sheet 9

It's a Gas!

1. Record your observations.

Describe what happened when you blew through the straw into the limewater.

The limewater turned cloudy.

Describe what happened when the gas from the bubbling yeast solution entered the limewater.

The limewater turned cloudy.

2. What can you infer from this experiment?

Carbon dioxide gas is released by yeast when it is budding rapidly.

3. Knowing what you now know about fermentation, why is yeast important to the production of breads and alcoholic beverages?

During fermentation, yeast gives off carbon dioxide bubbles that cause bread dough to rise. It also gives off alcohol and so is used to make alcoholic beverages.

4. Define the following terms.

fermentation The process by which some cells release energy from food without oxygen. Carbon dioxide and alcohol are by-products.

respiration The process by which some cells in the presence of oxygen release the energy from food. Carbon dioxide and water are by-products.

Teaching Suggestions

Divide the class into groups of four. Distribute the trays containing the flasks, tubing, stoppers, and straws. Ask students to observe the flask with the liquid in it. Ask, **How would you describe this liquid?**

Explain to the students that this is limewater, an indicator that changes from clear to cloudy when *carbon dioxide* is present. Ask, **What is carbon dioxide? What do you think will happen if you blow into the limewater with a straw?**

Instruct the students to take turns blowing into the flask of limewater, each using his or her own straw. Caution them to blow slowly. Have them record their observations on Activity Sheet 9. Ask, **What happened to the limewater? What does this indicate about the gas that humans exhale?**

Additional Information

1

Students will note that it is clear.

Explain that carbon dioxide, like oxygen, is one of the gases used, or given off, by organisms. Students may or may not respond that the limewater should turn cloudy, since our bodies exhale carbon dioxide.

2

Students will observe that the limewater turns cloudy, proof that we exhale carbon dioxide.

Write the word *respiration* on the board. Explain that respiration is the process by which some cells release energy from food and convert it into a useable form. Tell the students that oxygen is necessary for respiration, and carbon dioxide is a by-product. Seed plants and animals all respire and give off carbon dioxide gas.

Have each team empty their flask of cloudy limewater, rinse it thoroughly with warm water, and refill it with 50 mL of new limewater.

3

While plants use carbon dioxide in photosynthesis, and produce oxygen as a by-product, their cells must also respire, and thus produce carbon dioxide, to carry out biological functions.

Ask the students to turn their attention to the flask on their tray containing the powdery substance. Tell them to smell it. Ask, **What do you think is in this flask?**

4

By this time, students should be familiar with the sight and smell of yeast and be able to identify it as such.

Ask, **Based on your experience with yeast, what do you think would happen if you added warm water and sugar to the yeast?**

The students should suggest that the yeast will begin to grow and bud and that they will observe bubbles in the mixture and foam on top.

Ask, **How can you find out if the gas bubbles produced by yeast are carbon dioxide?**

The students may suggest bubbling the gas through the limewater.

Tell the students that they will now test this idea. Have one student from each team bring the flask containing yeast and sugar up to the pan of warm water and pour 50 mL of water into the flask. (Use a medicine cup to measure.) Direct the students to swirl the solution in the flask until the yeast and sugar have dissolved.

5

Step 6 should be completed as soon as the students have received the warm water.

Ask, **How does your yeast solution appear? Why?**

The students will notice that it is bubbling and foaming because the yeast is growing and reproducing.

Tell the students they will now test the gas produced by the yeast solution to find out if it is carbon dioxide. Direct them to push the stopper with the tubing attached securely into the top of the flask containing the yeast/sugar solution. Tell them to place the other end of the tubing all the way down into the flask containing fresh limewater.

6

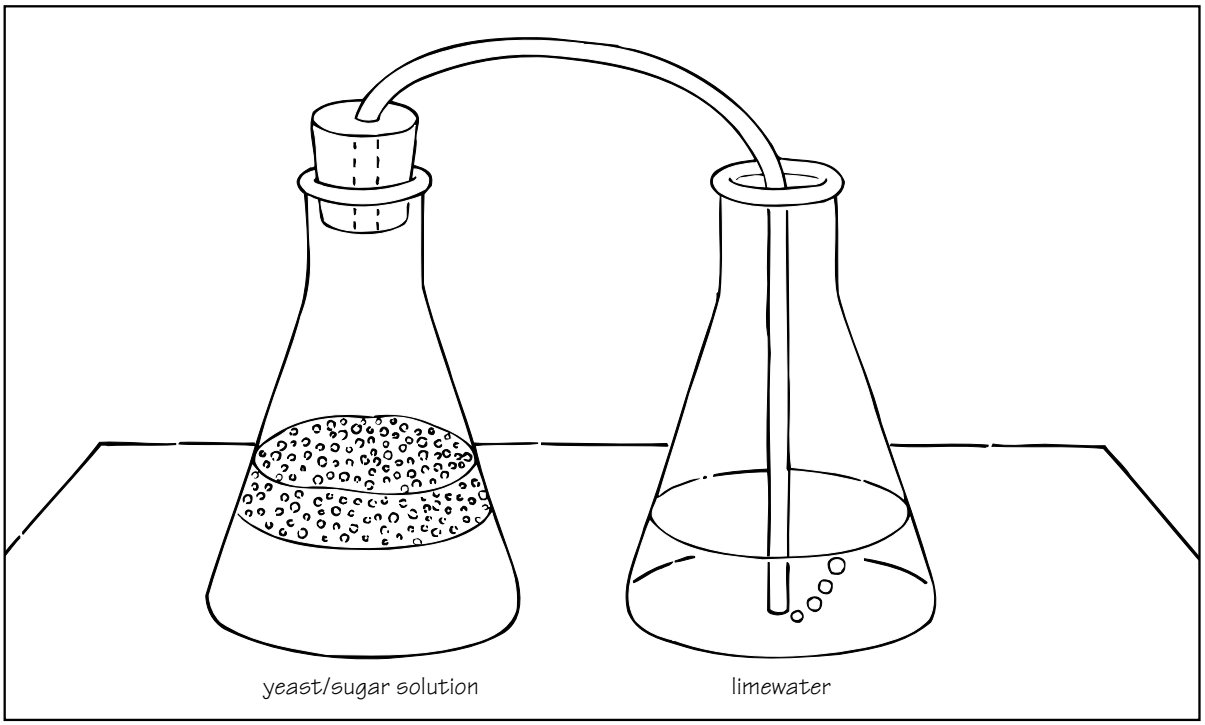


Figure 9-1. Using limewater to test for carbon dioxide gas.

Have them record their observations on the Activity Sheet.

Ask, **What is happening to the limewater? Is this the same reaction you got when you blew through the straw into the limewater?**

Students will note that the limewater becomes cloudy, the same reaction they obtained when exhaling through the straw into the limewater.

Ask, **What kind of gas do you think is being produced by the yeast solution?**

Students should be able to infer that it is carbon dioxide gas.

Write the word *fermentation* on the board. Tell the students that some organisms, including yeast, release the energy from food by fermentation, not respiration. No oxygen is necessary. During fermentation, the yeast breaks down the sugar and releases carbon dioxide and alcohol, as well as energy. Recall for students that yeast fermentation is used in the production of alcoholic beverages, as well as in baking bread.

7 You may want to emphasize that, earlier, they exhaled through the limewater to observe that carbon dioxide turned the limewater cloudy. You should explain that although humans and yeast produce carbon dioxide, the process that leads to the production of carbon dioxide gas is different in each case.

Have the students complete Activity Sheet 9.

Reinforcement

Have students dissolve a yeast/sugar mixture in 15 mL of warm water in a clear container. After about five minutes, when the yeast is beginning to reproduce, have the students add 15 mL of flour to the solution, stir carefully, and let it sit for about ten minutes. As the dough rises, have the students observe the bubbles of carbon dioxide trapped on the sides of the container.

Cleanup

Have students remove the tubing from the stoppers and rinse the flasks, tubing, stoppers, and trays. Discard the straws and return all materials to the kit.

Connections

Science Challenge

Encourage students to design and conduct experiments to test the effect of various amounts of yeast or sugar on the amount of carbon dioxide gas that is produced by a solution. Students might try attaching a balloon to the neck of a flask after water is added to a yeast-and-sugar mixture, or they could subjectively evaluate the amount of carbon dioxide gas by observing the cloudiness of limewater. Let students share their experimental designs and results in a follow-up discussion.

Science and the Arts

Have students cut pictures from magazines to make a collage showing various kinds of foods and beverages that make use of the fermentation process in their production. Attach a label with the word *fermentation* in the center of the bulletin board, and let students arrange the pictures they have collected around the label.

Science and Health

Tell students that yeasts are a source of important vitamins, including folic acid, niacin, riboflavin, pantothenic acid, and vitamins B-1, B-6, and B-12. Encourage students to research the functions of these vitamins in the human body and to identify dietary sources.

Science and Language Arts

Review the meaning of the term *symbiosis,* discussed in the second Science Extension for Activity 5, and discuss some examples of symbiotic relationships in nature. Make sure students clearly understand the difference between parasitism, in which the host organism is harmed or killed, and symbiosis, in which neither organism is harmed and both organisms benefit. Have each student research one example of a symbiotic relationship involving a fungus and write a report describing the relationship, focusing on the benefits to the fungus and to the other organism. Encourage students to include in their reports pictures they have drawn illustrating the relationship between the two organisms. Examples of symbiotic relationships involving fungi include lichen, the fungus "gardens" of termites and leaf-cutter ants, and the beneficial growth of fungi on plant roots (an association called *mycorrhizae*).

Science, Technology, and Society

If there is a yogurt production facility in your area, arrange a tour for your class. Ask the tour guide to describe the use of yeast in yogurt production and to explain how the fermentation process occurs. If a visit to a yogurt production facility is not possible, ask someone who makes homemade yogurt to visit the class and describe the procedure.