Yeast Respiration

Teacher Information

Summary

Students investigate the effects of environmental factors on the process of respiration in yeast. In Part 1, a guided inquiry, students conduct and report on an experiment to determine the effect of temperature on respiration. In Part 2, an open-ended inquiry, students design, conduct, and report on a controlled experiment to determine how changing the type of food affects yeast respiration.

Core Concepts

- Anaerobic respiration uses food (but not oxygen) to produce ATP and wastes (alcohol and carbon dioxide)
- Measuring the amount of carbon dioxide produced can be used to determine the amount of cellular respiration occurring in yeast cells.
- Many environmental factors affect cellular respiration in yeast cells.
- Designing controlled experiments to determine the answer to a research question involves hypotheses, dependent variables, independent variables, controlled variables, experimental groups, and control groups.
- The data from controlled experiments can be reported through data tables and graphs.
- Analysis of data involves drawing conclusions and recognizing the limitations and possible improvements for experiments.

Time Required

- 1 forty-minute class period for Part 1
- 1 or 2 forty-minute class periods for Part 2, depending on your students experience with experimental design.
- Consider assigning the design of the experiment for Part 2 as homework to save class time.

Kit contains

- 2 plastic 15 ml test tubes with holes punched in the caps
- 2 large and 2 small plastic cups
- measuring cup
- 2 stirrers
- 3 packet of table sugar and 1 packet of honey
- 3 small tubes of yeast

Teacher Provides

- Safety goggles for each student
- Access to cold and warm (not hot) tap water
- Paper towels for clean up

Warning: Choking Hazard

This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit components.

Reusing *Yeast Respiration* kits

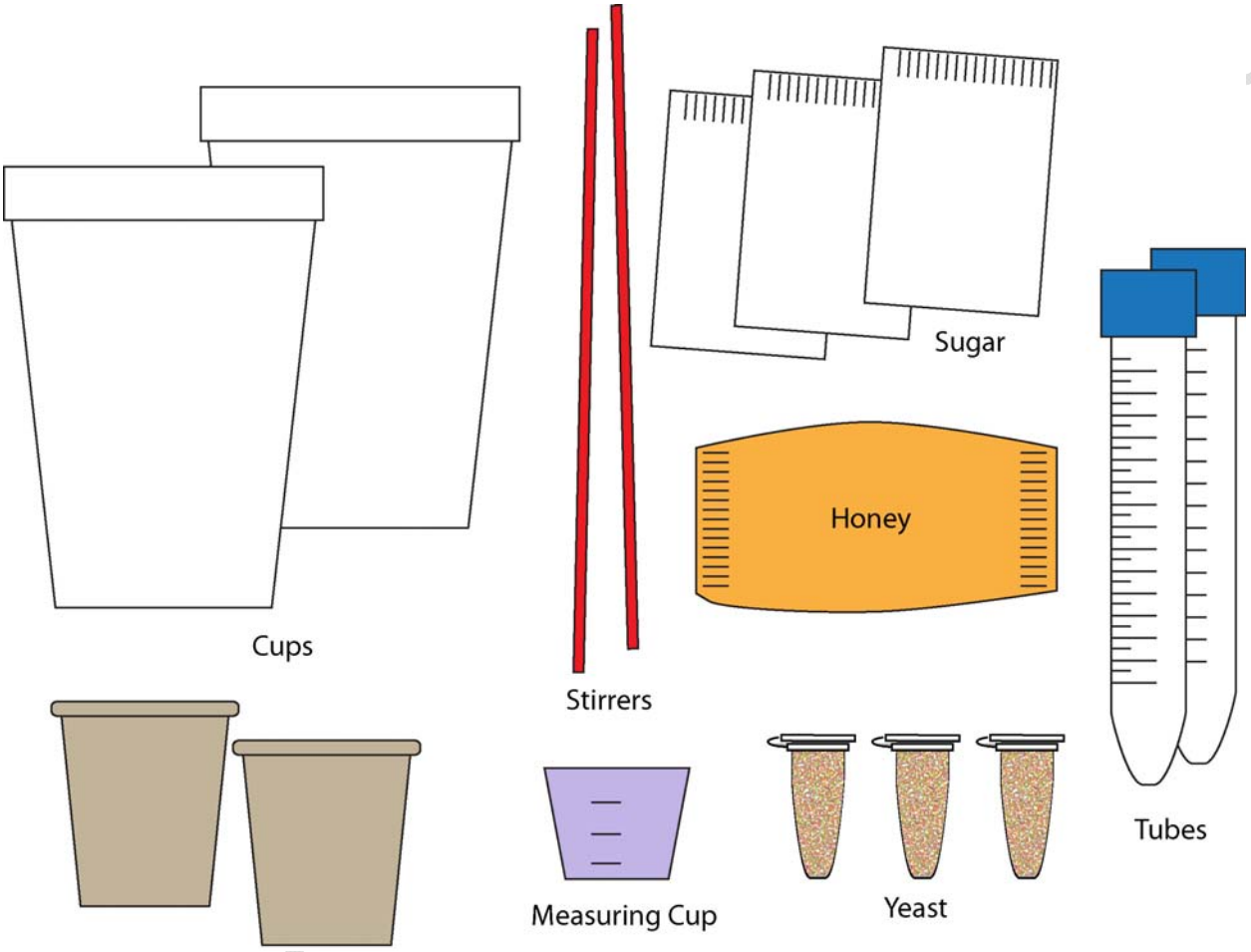
Teachers will need to instruct students on how to handle clean-up and return of the re-usable kit materials. For example, teachers might provide the following information for students:

Discard	Rinse with water and dry with paper towel	Return to kit
• Empty packets of sugar and honey	• Large cups, small cups, measuring cup • Test tubes • Stirrers	• Labeled tubes for yeast • Large cups, small cups, measuring cup (rinsed) • Test tubes (rinsed) • Stirrers (rinsed)

Refills for *Yeast Respiration* kits are available at www.sciencetakeout.com. The **10 Kit Refill Pack** includes the following materials:

- 1 Quick Guide for refilling kit
- 30 packets of sugar
- 10 packets of honey
- yeast
- funnel

Kit Contents Quick Guide



Read these instructions before using Science Take-Out kits

Parental or Adult Supervision Required

This kit should be used only under the supervision of an adult who is committed to ensuring that the safety precautions below, and in the specific laboratory activity, are followed.

Safety Goggles and Gloves Strongly Recommended

We encourage students to adopt safe lab practices, and wear safety goggles and gloves when performing laboratory activities involving chemicals. Safety goggles and gloves are not provided in Science Take-Out kits. They may be purchased from a local hardware store or pharmacy.

Warning: Choking and Chemical Hazard

Science Take-Out kits contain small parts that could pose a choking hazard and chemicals that could be hazardous if ingested. Do not allow children under the age of seven to have access to any kit components. Material Safety Data Sheets (MSDS) provide specific safety information regarding the chemical contents of the kits. MSDS information for each kit is provided in the accompanying teacher instructions.

Chemicals Used in Science Take-Out Kits

Every effort has been made to reduce the use of hazardous chemicals in Science Take-Out kits. Most kits contain common household chemicals or chemicals that pose little or no risk.

General Safety Precautions

1. Work in a clean, uncluttered area. Cover the work area to protect the work surface.
2. Read and follow all instructions carefully.
3. Pay particular attention to following the specific safety precautions included in the kit activity instructions.
4. Goggles and gloves should be worn while performing experiments using chemicals.
5. Do not use the contents of this kit for any other purpose beyond those described in the kit instructions.
6. Do not leave experiment parts or kits where they could be used inappropriately by others.
7. Never taste or ingest any chemicals provided in the kit - they may be toxic.
8. Do not eat, drink, apply make-up or contact lenses while performing experiments.
9. Wash your hands before and after performing experiments.
10. Chemicals used in Science Take-Out experiments may stain or damage skin, clothing or work surfaces. If spills occur, wash the area immediately and thoroughly.
11. At the end of the experiment, return ALL kit components to the kit plastic bag. Dispose of the plastic bag and contents in your regular household trash.

No blood or body fluids from humans or animals are used in Science Take-Out kits. Chemical mixtures are substituted as simulations of these substances.

Yeast Respiration:

IMPORTANT!

Before you begin this lab activity, you need to follow this recipe to "activate" the dry yeast.

Mix the following ingredients in the medium-sized cup:

- 1 small tube of dry yeast
- 1 packet of table sugar (food for the yeast)
- 60 mL of warm tap water – use the small measuring cup provided (Make sure that the water is NOT hot. It should be warm like bath water).

Use a stir stick to thoroughly mix the yeast, water and sugar. Allow approximately 10 minutes for the yeast to be activated. You should see a small amount of foam appear on the surface.

While you wait for the yeast to become active, read the Introduction and Part 1 procedure.

Introduction:

Yeast are microscopic one-celled organisms. To obtain the energy they need for their life activities, yeast carry out a process called cellular respiration. During respiration, yeast cells use sugar as an energy source. They release the energy stored in food (sugar) molecules and use this energy to produce ATP molecules that power the yeast cells' chemical reactions. The waste products of respiration in yeast are carbon dioxide and alcohol. The chemical reactions in cellular respiration are controlled by enzymes.

$$\underset{\text{(food)}}{\text{Sugar}} \xrightarrow{\text{enzymes}} \underset{\text{(waste)}}{\text{Carbon Dioxide}} + \underset{\text{(waste)}}{\text{Alcohol}} + \text{Energy to make ATP}$$

1. Why do living organisms carry out the process of respiration?

2. Why is measuring the amount of carbon dioxide an appropriate way to determine the amount of respiration in yeast?

3. What substance does yeast use in respiration?

4. What waste product of yeast respiration is useful in making wine?

5. What waste product of yeast respiration is useful in making bread?

Part 1: How Does Temperature Affect the Rate of Yeast Respiration?

Research Question: Yeast usually grows in warm temperatures. How does changing the environment to a cold environment affect the rate of yeast respiration?

Your hypothesis:

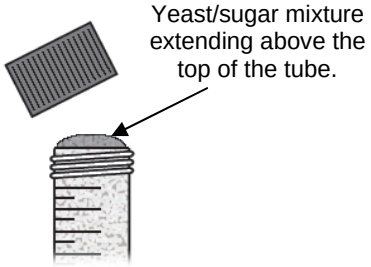
Test your hypothesis:

1. Label the two large graduated tubes and the two large cups –1 and 2.

2. Fill cup 1 approximately three-quarters full with cold tap water. Fill cup 2 approximately three-quarters full with warm tap water.

3. Use a stir stick to stir the activated yeast/sugar mixture thoroughly.

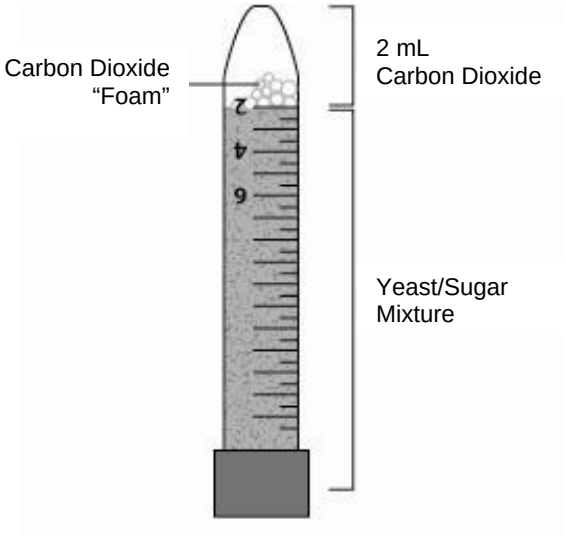
4. Fill tube 1 and tube 2 with the yeast/sugar mixture. Fill the tubes all the way to the top, extending the fluid slightly above the top of the tubes (see picture on the right).



5. Screw the caps on the tubes. It is OK to have a few drops spurt out the holes in the caps.

6. Turn the tubes upside down and check to be sure that there is only a small bubble, or no bubbles, visible in the tubes. If there is a large bubble, it means that the tubes are not filled enough, and that you will need to add more yeast/sugar mixture to the tubes.

7. Keep the tubes turned upside down and place Tube 1 in cup 1 (the cup filled with cold water) and place Tube 2 in cup 2 (the cup filled with warm water). Be sure the pointed end of the tube is up and the cap is down.



8. After 2, 5, 10, and 15 minutes, record the volume of the carbon dioxide (CO_2) gas collected at the top of the tubes on the data table on the next page. The volume of carbon dioxide includes any foam bubbles (see the diagram to the right). *Note: Some of the cloudy yeast sugar may leak out of the hole in the cap. This is OK!*

As you wait to take readings, you should answer questions 9 through 14.

Data Table:

Time (minutes)	Total Volume of Carbon Dioxide Produced (mL)	
	In Cold Water Environment	In Warm Water Environment
2		
5		
10		
15		

9. What is the research question for this experiment?

10. The **independent variable** (manipulated variable) for an experiment is the factor that you change on purpose in an experiment. What is the independent variable for your experiment?

11. The **dependent variable** (responding variable) is the variable that may change as a result of a change in the independent variable. The dependent variable is the data that is observed and measured in an experiment. What is the dependent variable for this experiment?

12. In a **controlled experiment** (fair test), the experimental group (which receives a treatment) is compared to a control group (which does not receive a treatment). Hint: Yeast usually need warm temperatures to grow.
    - Which setup is the control group?
    - Which setup is the experimental group?

13. In a **controlled experiment** (fair test) all other factors should be kept the same so that you can fairly compare the results from the control group and the experimental group. List three **controlled variables** – factors that were kept constant in both of the setups for this experiment.

14. What data are you collecting in this experiment?

15. What results would you expect if your experiment supported your hypothesis?

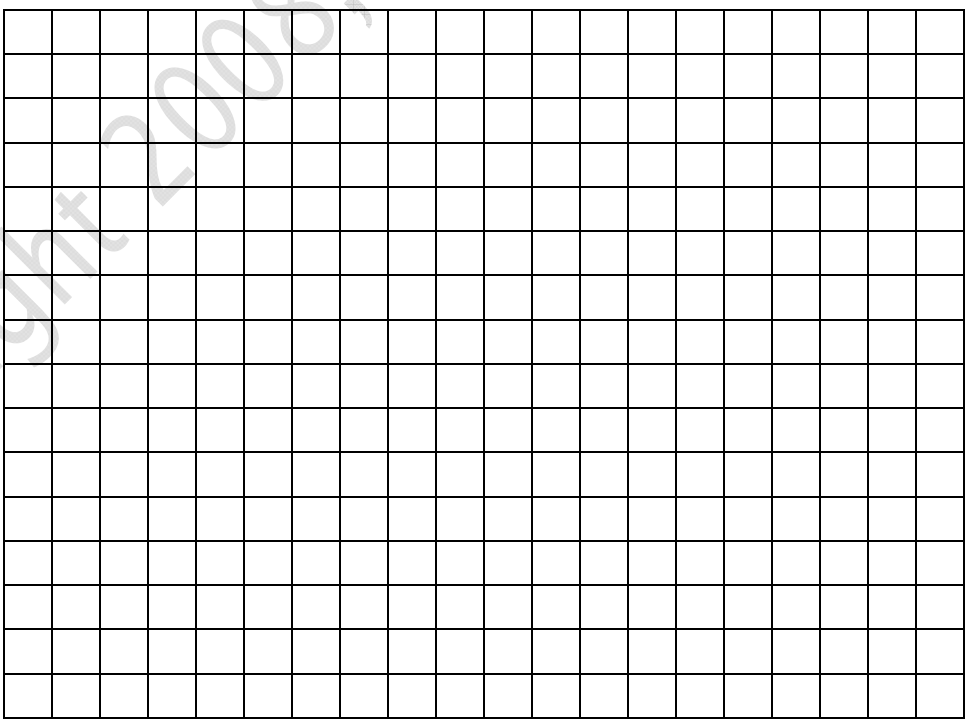
16. Once you have collected and recorded the data from your experiment, discard the yeast solution, water, and empty sugar packets. **Rinse and dry all other materials (tubes, cups, and stirrers) and return them to your laboratory kit for use in Part 2 of this lab.**

17. Prepare a graph to summarize the data you recorded in your data table.

- Label the vertical axis. Include appropriate measurement units.
- Mark an appropriate scale on each axis.
- Plot the data for the amount of carbon dioxide produced in cold water. Surround each point with a small circle (○) and connect the points.
- Plot the data for the amount of carbon dioxide produced in hot water. Surround each point with a small triangle (△) and connect the points.

The Effect of Temperature on Respiration in Yeast

Key
○ Yeast Respiration in **Cold** Water
△ Yeast Respiration in **Warm** Water



Time (minutes)

18. State ONE conclusion you can draw from this experiment.

19. Does the experiment support your hypothesis? Why or why not?

20. Predict will happen to the amount of carbon dioxide produced if you let the experiment run for an additional hour? Explain your answer.

21. Describe two specific things that you could have done to improve the reliability of this experiment.

Part 2: Design Your Own Experiment

In this laboratory activity, you will design, conduct, and report on an experiment to determine the answer to this research question:

How does using honey as a food, instead of table sugar, affect the rate of yeast respiration?

1. What is your hypothesis for this experiment?

2. What is the independent variable?

3. What is the dependent variable?

4. What is the control group for your experiment?

5. What is the experimental group for your experiment?

6. List three controlled factors that you kept the same in both the experimental and the control groups.

7. Write a procedure to describe how you will set up your experiment. *Hint: Refer to the procedure from Part 1 of this lab, and modify the procedure so that is appropriate for your research question.*

8. Make the activated yeast/food mixtures that you will need for the experiment that you design. You will need to modify the basic recipe you used before to make yeast/food mixtures that are appropriate for your experiment.

9. Explain how you modified the recipe.

10. Explain how you will collect data during your experiment.

11. Construct a data table and record the results for your experiment.

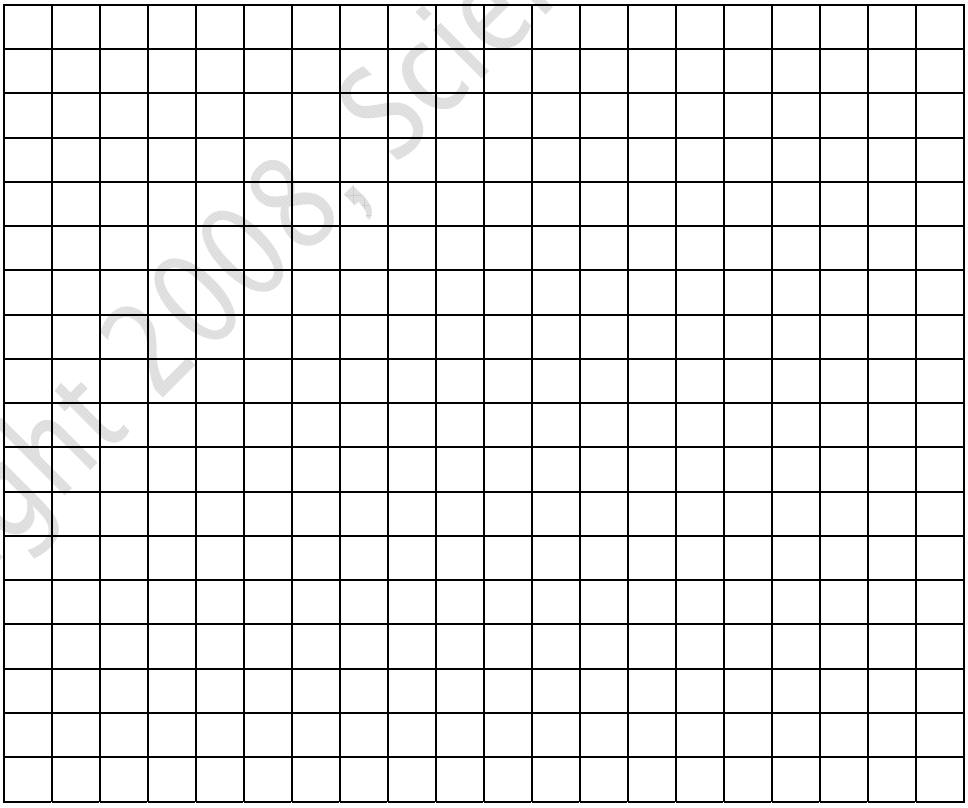
12. Set up and conduct your experiment. Record the data from your experiment in your data table.

13. Once you have collected and recorded the data from your experiment, discard all lab materials in the kit bag.

14. Prepare a line graph to summarize the results of your experiment.

Title: _____

Key
○
△



15. What conclusions can you draw based on the results of your experiment?

16. Did your experiment support your hypothesis? Explain why or why not.

17. Describe two specific things that you could have done to improve the reliability of your experiment.