LESSON IT'S JUST RIGHT

About this Activity

Some organisms on Earth can withstand extremes of temperature by shutting down their energy needs. In this activity, students set up an experiment to determine yeast's temperature tolerance extremes.

Objectives

Students will:

- Experiment with gas production of yeast at different temperatures,
- Take, record, and plot data from an experiment,
- Discuss extreme temperature environments on Earth and Mars.

Background

Metabolism refers to the physical and chemical processes that make energy available to an organism. Metabolism is affected by temperature, the colder the temperature the slower the reaction rate. When the rate of these life-sustaining reactions drops beneath a critical level, the organism will die.

In this activity, you will observe the relationship between temperature and metabolism. The subjects for this experiment are *Saccharomyces cerevisiae* – one-celled organisms more commonly known as baker's yeast. These cells have been specially packed, treated, and stabilized so they can remain in a suspended but viable state for several months. When placed in warm water, the cells activate. As the metabolism awakens, the cells generate carbon dioxide gas. By observing the presence of this gas, you will be able to make inferences about metabolism. Both the yeast and some multicellular organisms can survive states of suspended animation or low metabolic activity.

Organisms on Earth live in a wide range of environment. They live in hot boiling springs as well as in the ice of Antarctica. The microbes that live in these extreme environments are called extremophiles. Some scientists are studying microbes that can live in Earth's extreme environments in order to have a better understanding of places where life might have existed on other bodies in our solar system. Mars once had volcanic heat and water – maybe it too had hot springs where microbes could live. Ice exists on Mars and Europa, an icy moon of Jupiter. Could there be microbes there now?

Vocabulary List

Metabolism, microbe, extremophiles, multi-cellular

Materials per group

- 4 0.5 L or smaller clear beverage containers per group (~16-oz)
  All bottles in a group need to be the same size and shape.
- 4 20 – 25 cm balloons per group (8-10 inch)
- 2 packages of dry baker's yeast or equivalent

Groups with small containers will need a total of 10 ml (2 teaspoons). Groups with large containers will need a total of 20 ml (4 teaspoons).

- Warm Tap water – not hot water
- Basin filled with ice water -- large enough to hold one container from each team (5 or 6) or one basin per group
- Basin filled with warm water (about 40^{o}C) – can place on heating source for more extreme temperature. The basin needs to be large enough to hold one container from each team (5-6) or one basin per group.
- 3 thermometers (fewer thermometers are needed if using large classroom basin)
- 40 ml sugar (~1/4 cup)
- 2 measuring spoons
- Measuring cups
- 2-4 magnifying lens
- Metric rulers

Procedure

Advanced Preparation

1. Read Background, Student Procedure Sheet, and Student Data Sheet
2. Determine number of groups and assemble appropriate equipment and materials.
3. Make copies of Student Procedure Sheet and Student Data Sheet.

Classroom Procedure

1. Guide students through the Student Procedure
2. Lead class discussion after the experiments and the students have completed the questions.

Ingredient	Container less than 237 ml (8 oz.)	Container greater than 237 ml (8 oz.)
Yeast	2.5 ml (1/2 teaspoon) in A, B, C, D	5 ml (1 teaspoon) in A, B, C, D
Sugar	5 ml (1 teaspoon) in A, B, C, D	10 ml (2 teaspoons) in A, B, C, D
Water (Warm, not Hot)	None in container A 59 ml (1/4 cup) warm water in B, C, D	None in container A 118 ml (1/2 cup) warm water in B, C, D
Balloons 20 – 25 cm (8" to 10")	Immediately stretch over mouth of A, B, C, D	Immediately stretch over mouth of A, B, C, D
	Place A and B on desktop C in basin of warm water D in basin of ice water	Place A and B on desktop C in basin of warm water D in basin of ice water
	Place thermometers on desktop and in basins	Place thermometers on desktop and in basins
	Record temperatures and balloon width every 5 minutes.	Record temperatures and balloon width every 5 minutes.

STUDENT PROCEDURE SHEET

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1. Obtain materials for your group.

2. Read all instructions and develop a plan with your team on how to carry out the experiments.

3. Put a few granules of yeast on a light colored piece of paper. Examine the grains of dried yeast with the magnifying lens. Does the yeast appear alive? Explain.

4. Label the beverage containers A, B, C, D.

5. Slightly blow up each balloon to check for holes. Collapse balloons completely.

6. Spoon yeast into the containers. Make sure you use containers of equal volumes. Be careful to measure equal amounts of yeast into each container. Use about 5 ml (½ teaspoon) of yeast in containers less than 237 ml (8 oz.) and 10 ml (1 teaspoon) of yeast in containers greater than 237 ml (8 oz.)

7. Add sugar to each container. Add 10 ml. (1 teaspoon) of sugar to each container 237 ml (8 oz.) or less. If the containers are greater than 237 ml (8 oz.), add 20 ml. (2 teaspoons). Again, make sure equal amounts are in each container.

8. Set container A aside. It is the control.

9. Have balloons ready to attach, check for obvious holes, replace if necessary

10. Add warm water **(not hot)** to B, C, D containers.
    [If the containers are less than 237 ml (8 oz.), add 59 ml (¼ cup) of warm tap water **(not hot)** to containers B, C, D. If the containers are greater than 237 ml (8 oz.), use 118 ml (½ cup) of warm water.]

11. **Immediately**, stretch and secure a balloon over the mouth of each of the four, labeled containers. Attach all balloons in the same manner so the balloon volumes will be the same.

12. Set containers A and B on a desktop. Place container C in a basin filled with warm water (on a heating source to maintain temperature). Place container D in a basin filled with ice water.

13. Carefully place thermometers in the basins and on the desktop and secure. Using the data table, record the temperatures and width of balloon every 5 minutes for 30 minutes.

14. Record observations, using your senses, after 20 minutes.

STUDENT DATA SHEET

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	Container A		Container B		Container C		Container D	
Time	(°C) Temperature	(cm) Balloon Width	(°C) Temperature	(cm) Balloon Width	(°C) Temperature	(cm) Balloon Width	(°C) Temperature	(cm) Balloon Width
0 Initial								
5 mins.								
10 mins.								
15 mins.								
20 mins.								
25 mins.								
30 mins.								

Questions

1. Did any of the balloons change in appearance? If so, how?

2. What caused this change?

3. What happened to the yeast in container A? Explain.

4. After 20 minutes, how did the appearance of the yeast change in each container?

5. Using the data collected, predict the range of tolerance for the yeast. That is, what is the highest temperature recorded that yeast survived and continued to produce gas? What is the lowest temperature that yeast can tolerate and still live?

6. Make two line graphs of your data. Use different colors for each container. The horizontal axis should be time.

7. What could you do or redesign to make the data more accurate?