



Anaerobic Respiration (Fermentation)

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1999

Grade Level:
High School

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Purpose:

The purpose of this laboratory is to explore factors that might affect the rate of anaerobic respiration. In Part I students carry out an experiment to investigate and quantify one specific aspect, the effect of temperature. Part II has students design their own experiment based on another variable that might affect anaerobic respiration. The third part allows students to carry out the experiment that they designed in Part II. Students analyze and draw conclusions from their data and present their findings to the class. This activity is appropriate for students in General or Advanced Biology classes.

Objectives:

Students will be able to:

- describe factors that affect the process of fermentation.
- design a controlled experiment based on one specific variable.
- accurately collect and record data.
- analyze data gathered and come to valid conclusions.

Background Information:

This activity assumes that students are already familiar with the concept of both lactic acid and alcoholic fermentation. To introduce this laboratory, set up a number of foods that are produced by fermentation such as yogurt, buttermilk, yeast breads, kimchee (oriental section of large supermarkets or oriental food store), sour cream, etc. Use your own judgment as to the appropriateness of fermented beverages. You may also want to do taste tests so that students get a sense of the tart flavor that results from lactic acid fermentation. A brief discussion of the reasons for the different flavor (and texture) of bread and fermented beverages might prove helpful. Explain to students that they will concentrate on alcoholic fermentation since yeast organisms are easier to work with and quantifiable results are more readily obtained.

Materials:

Based on groups of two or three students

Part I:

- three plastic conical centrifuge tubes (at least 15 ml.) with perforated caps
- three beakers
- hot plate or 45°C water bath
- ice
- yeast solution (4 pkg. of yeast to 400 ml of tap water)
- 5 % glucose solution (20 grams of glucose in 400 ml of tap water)
- one thermometer
- marker
- small beakers or pipettes for transferring solutions into centrifuge tubes
- graph paper or access to computer for graphing results

Part II: None

Part III: Student-designed labs will dictate materials needed. In addition to the materials given in Part I you might want to have these available:

- brewer's yeast
- regular and fast rise baker's yeast
- weigh boats
- balances
- different types of sugars (sucrose, dextrose, etc.)
- 50 - 100 ml graduated cylinders
- beakers for mixing solutions
- wider range of water baths

Preparation

Part 1: You will need to:

- mix approximately 30 ml - 5 % glucose solution (20 grams of glucose in 400 ml tap water) for each team.
- mix 30 ml - yeast solution (four packages of yeast in 400 ml of tap water) for each team. Poke three to four small holes in the centrifuge tube caps using push pins or thumb tacks.

Part II: Conference with each group of students before allowing them to proceed to Part III. This gives you a chance to determine if there are safety issues and what equipment, etc. you might need to make available for students.

Part III: Preparation will depend on student-designed lab materials needed.

Safety:

There are no safety issues with this lab except goggles should be worn to protect from accidental splashes and students should not taste any of the experimental solutions.

Questions to Ask:

1. Does your experimental design include a control?
2. Why is fermentation going on in these conditions?
3. Does anaerobic respiration apply to humans?

Where to Go from Here:

Once students understand anaerobic respiration as it applies to microorganisms, the next step is to apply the concept to humans. If there is a place where you can take students to run/walk, try having them run/walk approximately 1/4 of a mile keeping a record of the time it takes each individual. For some this will not be a problem, for others it will be exhausting. Relate the level of exhaustion with conditioning of the cardiovascular and respiratory systems that are responsible for delivering oxygen to the cells and removing CO₂ from them. For students unable to engage in this level of activity, assign them the role of time-keeper or recorder for the times.

References and Resources:

Suggested Assessments:

These are possible criteria to use to assess student work:

Part I

_____ Data collection is complete and specific.

_____ Graph accurately reflects data on record sheet.

_____ Conclusions drawn are supported by the data.

Part II

_____ Experimental design is appropriate to question asked.

_____ Data collection plan is workable and includes specifics necessary to:

_____ a. collect data.

_____ b. organize data.

_____ c. quantify data.

Part III

Data Display

_____ Data is organized and presented in an appropriate format.

Presentation

_____ Explanation of experiment is accurate and complete.

Yeast Fermentation Lab

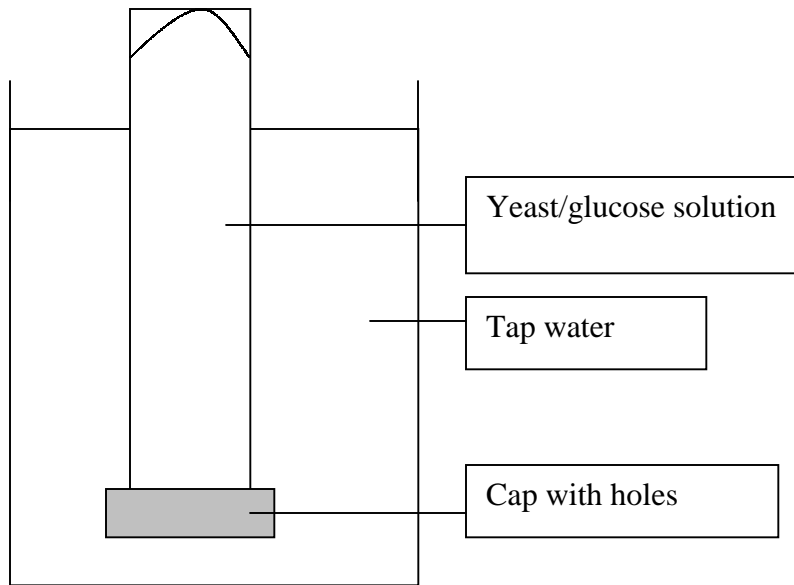
Part I

Materials each team needs to gather:

- three centrifuge tubes with perforated caps
- one beaker with warm water (approximately 45° C)
- one beaker with room temperature water (approximately 20° C)
- one beaker with cold water (approximately 5° C)
- one thermometer
- one marker
- one beaker with 30 ml sugar solution
- one beaker with 30 ml yeast solution

Procedure (see diagram below):

- Fill each tube halfway with sugar solution.
- Fill the rest of each tube with yeast solution, extending the fluid level above the top of the tube.
- Screw the cap on the tubes (a few drops will spurt out the holes).
- Check to make sure there are no bubbles visible in the tube.
- Invert the tubes.
- Place one tube in each beaker.
- Record the temperature of all three beakers (be sure to maintain the temperature within a degree or two from the beginning to the end).
- At 5-minute intervals (5, 10, 15, and 20 min)
 - lift each tube far enough out of the water to:
 - dry the tip with a paper towel.
 - mark the level of the gas bubbles (include any foam as part of the bubble).
 - lower the tubes back into the beaker and begin timing again.
- After 20 minutes empty the contents of all tubes into the waste beaker.
- Record the ml of CO₂ at each mark.
- Wash and rinse out your tubes.



Data Record Sheet:

CO₂ Collected by Displacement of Yeast/Sugar Solution (in ml)			
Time	5° C	25° C	45° C
5 minutes			
10 minutes			
15 minutes			
20 minutes			
Total			

Results:

- Complete data sheet.
- Graph the change in CO₂ over time for all three tubes.

Conclusion:

- Write a lab summary explaining the effect of temperature on anaerobic respiration (based on your data).

Part II

There are other variables that might affect the rate of respiration.

- Choose one variable (other than the three temperatures used in Part I) and design an experiment that will answer a question that you have posed.
- Be sure your experiment includes standard procedures such as statement of the question you are attempting to answer, hypothesis, materials list, procedures, record of data, analysis and conclusion.

- Before proceeding to Part III, you must conference with your teacher and get approval for your experimental design.

Part III

- Carry out the experiment that you designed.
- Create a data display (graphs, charts, etc.) to include with your experimental design.
- Based on the data collected, write an answer to your experimental question.

Present your findings to your class.