

Chapter 6 Project

Bioenergetics through Enzymatic Activity

Project Goal + Timeline

In this project, we will be reviewing your knowledge on enzymatic activity. We'll do this with a simple experiment with hydrogen peroxide (H_2O_2) and the enzyme catalase. This project should be completed within a group of 2–3 students in a two-hour time frame.

Hydrogen peroxide (H_2O_2) is a chemical compound produced as a byproduct of metabolic reactions in cells. If not removed from the cell, hydrogen peroxide can attack and damage cellular components, such as proteins and nucleic acid. The cellular enzyme catalase neutralizes hydrogen peroxide by decomposing it into water (H_2O) and oxygen gas (O_2).

In this experiment, you'll use catalase from potatoes to examine how temperature affects enzymatic activity. In your experiment, you'll be able to visualize the oxygen gas produced by the reaction as bubbles in water.

Directions

Part 1: Catalase Activity Experiment

Follow these steps to complete your experiment.

1. Use masking tape and a marker to label one large and one small test tube with “cold temperature,” one large and one small test tube with “room temperature,” and one large and one small test tube with “boiling temperature.”
2. Prepare a hot water bath by filling a 400 mL beaker approximately two-thirds full water and placing it on a hot plate.
3. Add 5 mL (1 teaspoon) of water to each large tube.
4. Cut three cubes of potato, each with an edge length of approximately 2 centimeters. Remember: the cubes should be the same size to obtain the same amount of catalase in each reaction tube.
5. Place one potato cube in the water in each of the three large tubes.
6. Place the tube labeled “cold water” in a freezer or refrigerator for 5 minutes. Carefully place the tube labeled “boiling water” in the hot water bath for 5 minutes. Let the tube labeled “room temperature” sit out for 5 minutes.
7. Add 5 mL of hydrogen peroxide to each of the labeled small test tubes.
8. Remove the “cold water” tube from the freezer. Use tongs to carefully remove the “boiling water” tube from the hot water bath and place it in a test tube rack.
9. Add the 5 mL of hydrogen peroxide from the small test tubes to each of the large test tubes. Start timing the reaction when the hydrogen peroxide is added.
10. Measure the time, in seconds, between when you added the hydrogen peroxide and when you saw the first bubbles in the test tube. Record the time for each tube in Table 1. If no bubbles are detected, write “no reaction.”
11. Observe the strength of the reaction: are the bubbles forming rapidly or slowly? Rate the strength of the reaction on a scale from 1 to 5 (1 being weak and 5 being strong). Record your strength rating in Table 1. If no bubbles are detected, write “no reaction.”

TABLE 1

	Cold Temperature	Room Temperature	Boiling Temperature
Reaction Speed (sec)			
Reaction Strength (1–5)			

Part 2: Data Analysis

Use the data in the table to create two graphs. Make sure to include a title for each graph.

1. Create Graph 1 of the reaction speed versus the reaction temperature. In the graph, the y -axis will be the speed of bubble formation (in seconds), and the x -axis will be the relative temperature (cold, room, boiling).
2. Create Graph 2 of the reaction strength versus the reaction temperature. In the graph, the y -axis will be the strength of bubble formation, and the x -axis will be the relative temperature (cold, room, boiling).

Part 3: Post-experiment Questions

1. What is the equation for the reaction catalyzed by catalase? In the equation, label the reactants and the products.
2. Define the independent variable (i.e., what was changed) and the dependent variable (i.e., what was measured) in the experiment.
3. How did you measure enzymatic activity in your experiment?
4. Describe the results of your experiment. What do your results reveal about catalase activity?
5. Was the catalase denatured at any of the temperatures tested? Provide evidence to support your answer.
6. The activity of catalase is greatest at a temperature of approximately 35°C. How might this optimum temperature contribute to catalase's physiological function?
7. Explain any sources of error in this experiment. How could you correct those errors?

Project Materials

- 6 test tubes (3 small and 3 large). If test tubes are not available, other heat-proof containers may be used.
- Test tube rack
- Potato
- Knife
- Graduated cylinder or measuring spoons
- Hot water bath (beaker and hot plate)
- Tongs (to remove the test tube from the hot water bath)
- Access to a refrigerator or freezer
- Hydrogen peroxide (3%)
- Masking tape
- Fine-tipped marker
- Stopwatch or other timing device
- Graphing software or graph paper
- Table for recording data

** Student Checklist**

- ☐ Perform the experiment as stated in the instructions
- ☐ Complete the table of experimental results
- ☐ Draw the two graphs
- ☐ Complete the questions