

Measuring the Effect of Environmental factors on an Enzyme

INTRODUCTION:

Enzymes are proteins that function as biological catalysts. **Catalysts** are substances that speed up chemical reactions. Enzymes either:

1. Catalyze the *breakdown* of a substrate molecule into products.
2. Catalyze the *assembly* of substrate molecules (monomers) into a larger product (polymer)

As catalysts, enzymes lower the amount of energy required to make a reaction occur, which is called **activation energy**. By lowering the activation energy, enzymes serve to speed up the rate at which the reaction occurs.

Enzymes are substrate specific. A **substrate** is a molecule that temporarily binds with the enzyme at an area on the enzyme called the **active site**. Each enzyme catalyzes one specific reaction because there is only one type of substrate molecule with the exact shape that will fit into the enzyme's active site. See figure 1 for an example of the substrate sucrose and the enzyme sucrose.

Heat and strong acids can destroy the shape of the active site and make the enzyme nonfunctional. This is called **denaturization**. The enzyme is **denatured** and no longer functions.

Enzymes are essential to life because they sustain chemical reactions that take place in cells. One such enzyme is catalase. **Catalase** is found inside cells and is used to breakdown **hydrogen peroxide (H₂O₂)**, a poisonous by-product of cell reactions. If cells did not decompose H₂O₂, they would be poisoned and die. This is true for all cells in all living things. The catalase breaks down hydrogen peroxide into water and oxygen as shown in the chemical equation below.



A reaction that releases heat is called an exothermic reaction.

This lab will use the enzyme **catalase** and the substrate **hydrogen peroxide**.

METHODS:

PART A - Observe Normal Catalase Reaction in Carrots – this is what happens in our body, too.

Throughout this investigation you will estimate the rate of the reaction (how rapidly the solution bubbles) on a scale of 0-5 This is qualitative data. (0=no reaction, 1=slow.... 5= very fast). Assume that the reaction in step 3 below happens at a rate of "4"

1. Wash your hands well before doing this lab.
2. Using a plastic knife CAREFULLY cut a small cross section of carrot about ¼ inch thick and place it on a paper plate. Then cut it into several smaller pieces. With clean hands drop the pieces into a test tube.



3. Using the pipette, drop just enough H₂O₂ (hydrogen peroxide) into the test tube to cover the carrot pieces. Observe what happens. (Things to talk about with your group: Do carrots contain cells? Are they living? If catalase is doing its job, what should it do to the H₂O₂? What is the enzyme? What is the substrate? What are the products?) This is considered the control setup, why?

BEFORE you begin Part B make predictions on your data sheet.

PART B – Is Catalase (an enzyme) Reusable?

1. After the reaction has slowed or stopped and bubbles are no longer being produced carefully pour out the liquid in the waste beaker on your table. (Things to discuss with your group: What gas made the bubbles? What is the liquid you are blotting off?)
2. Again, using the pipette, drop just enough H₂O₂ (hydrogen peroxide) into the test tube to cover the carrot pieces. Observe what happens. (Things to talk about with your group: Is catalase still working, is it reusable? What is catalase? What do you expect to see if it is reusable? If catalase is not reusable what do you expect to see as a reaction?)

BEFORE you begin Part C make predictions on your data sheet.

PART C - What is the Effect of Temperature on Catalase Activity?

1. Wash your hands well before doing this part of the lab.
2. Get a boiled carrot slice from your teacher using a plastic fork and place it on your paper plate. RINSE AND WIPE DOWN YOUR KNIFE BEFORE YOU CUT! Then cut the boiled piece of carrot into several smaller pieces. With clean hands drop the pieces into a second test tube.
3. Using the pipette, drop just enough H₂O₂ (hydrogen peroxide) into the test tube to cover the carrot pieces. Observe what happens. (Things to talk about with your group: Is boiled carrot still living? Are the cells alive? Does the enzyme still work? What do you expect to see? Does heat affect how the enzyme reacted? If so, how? Do you think freezing the corn would have an effect? What might that effect be? What does "denature" mean?)
4. Repeat steps 1 – 3 with the frozen carrot.
5. SWISH YOUR TEST TUBES IN THE TUB OF SOAPY WATER AND RINSE THEM WELL IN THE SINK. PLACE THEM UPSIDE DOWN IN YOUR TEST TUBE HOLDER. THROW YOUR PLATE AND CARROT PIECES AWAY.

Student Lab Sheet

Pre-Lab: After reading the lab procedure, but BEFORE performing the lab, answer the following questions:

1. Define activation energy –
2. What is the molecule(s) that an enzyme is acting on called?
3. What has happened to a denatured enzyme?
4. What is the function of the enzyme catalase?
5. What is the substrate in this lab?

Data Table for Part A:

H ₂ O ₂ added to -	Rate of Reaction (0 – 5)
Fresh Carrot (this is the control)	

After completing part A, answer the following questions BEFORE doing Part B.

Predictions for Part B:

1. If the enzyme is reusable, it can break down more H₂O₂. What will happen when new H₂O₂ is added to the fresh carrot in part A a second time? Third time?

2. If the enzyme is not reusable, what will happen when new H₂O₂ is added to the carrot a second or third time?

Data Table for Part B:

H ₂ O ₂ added to -	Rate of Reaction (0 – 5)
Used fresh Carrot	

3. Explain what this data tells you:

After completing part B, answer the following questions BEFORE doing Part C.

Predictions for Part C:

1. How do you think catalase will react to temperature changes, will it speed up the reaction, slow it down or have no effect?

2. Will warm temperature affect it differently than cold temperature? Write a complete answer below:

Data Table for Part C:

H₂O₂ added to -	Rate of Reaction (0 – 5)
Boiled Carrot	
Frozen Carrot	

3. Explain what this data tells you when comparing it to the control reaction rate:

CLEAN UP LAB STATION FOLLOWING TEACHER INSTRUCTIONS

CONCLUSION

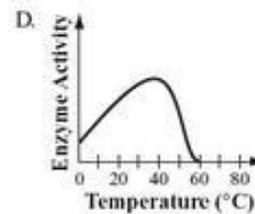
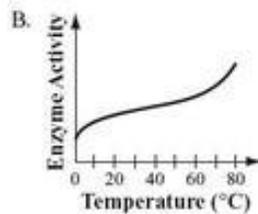
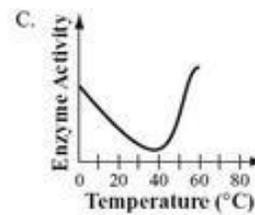
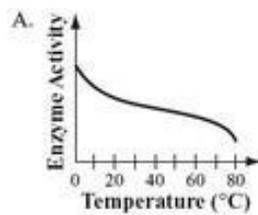
Part 1: QUESTIONS (To be answered after clean-up)

1. What gas was released in all reactions with the catalase and hydrogen peroxide?
_____What liquid was formed in all reactions with the catalase and hydrogen peroxide? _____
2. Are enzymes reusable? _____ Use your data to support your answer:

3. What does boiling the carrot do to the enzyme and how did this affect the results?

4. What does freezing the carrot do to the enzyme and how did this affect the results?

5. Which graph below correctly shows how temperature affects enzymes?



Part 2: CER

Question: Where is catalase found and what is its function?

Claim <i>an answer to the question based on the data</i> COMPLETE SENTENCE!
Evidence <i>summary of the data or observations (I²)</i> SITE YOUR DATA!
Reasoning <i>background knowledge and science based on the evidence</i> EXPLAIN WHY!