

Project 3.2.4: Investigating Enzyme Action

Introduction

In the previous activity, you investigated the basic structure of the digestive system as well as the importance of enzymes in the chemical breakdown of food. Our diet supplies us with the raw materials needed to synthesize the energy compound adenosine triphosphate (ATP), an amazing molecule that provides power to the human machine. However, just as raw petroleum out of the ground must be processed before it can be used in automobiles, food must be broken down into much smaller molecules before it can be used efficiently by the body.

As part of the digestive process, chemical reactions break complex polymers in our food into the simple monomers that can be used by the body for energy production and for growth and repair. These chemical reactions are catalyzed by enzymes, proteins that increase the rate of reaction without being changed or used up. In Activity 3.2.1, you built a model to explore the structure, function, and action of enzymes. In this activity you will look closer at factors that have an impact on how these important proteins operate. Even though all enzymes are specific to a given substrate, many behave in similar ways under extreme environmental conditions.

Hydrogen peroxide, H2O2, is toxic to most living organisms. Many organisms are capable of enzymatically destroying the H2O2 before it can do much damage. Although this reaction occurs spontaneously, enzymes increase the rate considerably. At least two different enzymes are known to catalyze this reaction: *catalase,* found in animals and protists, and *peroxidase*, found in plants. A great deal can be learned about enzymes by studying the rates of enzyme-catalyzed reactions. In this project you and a partner will design and carry out experiments to investigate the way in which factors such as temperature and pH can affect the action of the enzyme catalase. Enzymes are specific to the reaction they catalyze, and each one functions under unique environmental conditions.

Equipment

* Computer with Internet access and Vernier Logger*Pro®* software
* LabQuest Mini
* Vernier Gas Pressure Sensor
* Laboratory journal
* *PLTW Biomedical Science Experimental Design* handout
* *How to Write a Scientific Laboratory Research Report* handout
* Science Laboratory Report rubric

Procedure

**Part I: Standard Reaction**

In this part of the project, you will run a standard reaction to investigate the action of catalase as it breaks down hydrogen peroxide. As H2O2 isdecomposed, it produces oxygen gas. You will use a Gas Pressure Sensor to determine the rate of catalase activity by measuring the pressure caused by the oxygen gas that is produced.

Before data collection begins and product begins to be produced, pressure is the same as the atmospheric pressure in the room. Shortly after data collection begins, oxygen accumulates at a rather constant rate. The slope, or rise of the curve, at this initial time is constant and is called the initial rate. In this investigation we will refer to this slope as the rate of catalase activity. As the peroxide is decomposed, less of it is available to react and the O2 is produced at lower rates. When no more peroxide is left, O2 is no longer produced.

1. Remember that as an enzyme works, it interacts with its substrate(s) and converts the substrate(s) to product(s).

**Enzyme**

Substrate(s) ------------🡪 Product(s)

1. Research the action of the enzyme catalase.
2. In your laboratory journal, write the simple equation that describes the action of the enzyme catalase. What is/are the substrate(s)? What is/are the product(s)?
3. Watch the video demonstrating catalase activity using a gas pressure sensor at <https://www.vernier.com/experiments/bwv/6b/enzyme_action_testing_catalase_activity/>
4. Answer Conclusion questions 1 and 2.

Part II: Experimental Design

In this project you and a partner will investigate how a specific environmental factor influences enzyme function. You will design and carry out your own investigation.

1. Work with a partner to generate a researchable question dealing with catalase activity and pH. Record your ideas in your laboratory journal.
2. Visit and complete the laboratory investigation on enzyme activity and pH. <http://glencoe.mheducation.com/sites/dl/free/0078802849/383930/BL_11.html>
3. Answer the remaining Conclusion questions.

Conclusion

1. List and describe three factors that could possibly affect catalase activity.
2. Why is it important that cells contain catalase?
3. Based upon your experimental results, write a paragraph discussing the relationship between environmental conditions and enzyme function.
4. High fever can be a very dangerous condition for anyone, as it is an indicator of a serious infection. Based on this project, suggest a possible explanation for this medical concern.
5. Amylase is an enzyme that has the ability to break down starch, a polysaccharide, into smaller disaccharides. In the last project, you saw that two types of amylase function in the human digestive system, salivary amylase and pancreatic amylase. Salivary amylase and pancreatic amylase are released by two accessory organs of the digestive system. In what structures do the enzymes actually chemically digest food?
6. Each enzyme functions in a different area of the body, but both work to harness the power in carbohydrates and break these complex molecules into simple sugars. Based on the information you have learned about the digestive system, what do you expect to be the optimal pH for the enzymatic action of pancreatic amylase?