The Need for Speed – A Look at Enzyme Activity

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Grade Level:

High School

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Introduction:
As science teachers, we realize how important enzymes are to living organisms. I have found it difficult to convey this importance to students because it is a subcellular process they cannot see and expensive to duplicate in a lab. This activity provides a hands-on and inexpensive method for students to learn the function of enzymes.

Purpose:
The purpose of this lab is to give students an opportunity to demonstrate enzyme reactions and the environmental variables that affect these reactions.

Objectives:
Students will be able to:

- understand the reaction rates of an enzyme-mediated reaction.
- understand the effects of environmental variables on enzyme function.
- collect, graph, and analyze data relating to the enzyme reaction.

Materials:
Students will work in teams of three. Each **team** of three will need:

- 50 pennies
- 10 nickels
- roll of masking tape
- tennis ball
- two-feet of rope
- glove
- five buttons (various sizes)
- scissors
- two index cards
- 10 popsicle sticks
- shoe box or lab tub
- 10 marbles

Preparation:
In order for students to answer the questions in "Questions to Ask," they should have read about proteins and enzymes or have previously learned it in the classroom. This lab may be used to reinforce a lesson on proteins and enzymes, a lesson on protein synthesis, enzymes in the digestion system, or perhaps when talking about addiction and enzymes that destroy neurotransmitters. Students need to be familiar with key words such as: *non-competitive inhibition*, *denaturation*, and *competitive inhibitors*. Allow approximately 45 minutes for the students to complete the lab and approximately 30 minutes for students to present their procedures and graphs.

Procedure:

1. The teacher will distribute 500 pennies on the floor.

2. One team member will attempt to pick up as many pennies as possible in 10 seconds. The team member picking up the pennies must observe the following rules:
    a. Pick up one penny at a time
    b. Take it back to the group table
    c. Lay it down FACE UP.
3. The other team members will be responsible for counting and correctly recording the number picked up. Write the data in the Team Data Table under Trial 1.
4. This process will be repeated for six 10-second intervals.
5. Do not return the pennies until the end of Trial 1.
6. Each group will take 50 pennies back to their lab tables.
7. Using the materials given, each group will demonstrate both denaturation and competitive inhibition. If time allows, student groups should design their own models for denaturation and competitive inhibition and obtain the teacher's approval before proceeding to data collection.
8. Denaturation will be Trial 2. Denaturation is a form of non-competitive inhibition in which the enzyme changes shape. As a result, the substrate is not able to bind correctly and the enzyme becomes ineffective. Students may tape their fingers together or use the glove as an example of denaturation. Like Trial 1, the students are to have six to 10 second intervals, and record the numbers on the Team Data Table.
9. Competitive inhibition will be Trial 3. Competitive inhibition occurs when a substance other than the substrate blocks the active site, preventing the enzyme from binding. Students may tape the nickels, marbles, or the tennis ball to their hand to represent competitive inhibition. Students will have six 10-second intervals and record their data in the Team Data Table.
10. Using butcher paper, students will write up their labs--materials used, procedure, etc.--and make a line graph for each set of data on their Team Data Table.

Safety:

In this lab, there are no hazardous materials other than the scissors. If the marbles fall on the floor, they pose a risk of an accident. It is necessary for students to stay with their groups at all times.

Questions to Ask

1. What is a protein?
2. How are proteins made?
3. Why does DNA have to send a "messenger" to make proteins?
4. What is a catalyst?
5. Why do we need enzymes?
6. What is an active site?
7. What is a substrate?
8. What is an inhibitor?

Where to Go from Here:

This is a great lesson to use in genetics when explaining “one gene--one enzyme,” DNA replication, and transcription. This activity can be used before discussing photosynthesis, glycolysis, or lessons that discuss various enzymes, such as the digestive system.

References and Resources:

1. Campbell, Mary. (1991) *Biochemistry*. Chicago, IL: Saunders College Publishing.
2. Essenfield, Bernice, Gontang, Carol, and Moore, Randy. (1996). *Biology*. Menlo Park, CA: Addison-Wesley Publishing Company.
3. Wessells, Norman and Hopson, Janet. (1988). *Biology*. New York: Random House Publishing.

Suggestions For Assessment:

Students should complete their lab and present it to the class. The presentation should include their hypothesis, experimental procedures, data tables, graphs, and follow-up questions. You may want to assign them the task of researching ten different enzymes, their function, and drugs or other substances that act as inhibitors to these enzymes.

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Student Activity Sheet

Team Data Table

Time (in seconds)	***Trial 1*** ***Normal Enzyme Activity***	***Trial 2*** ***Denaturation***	***Trial 3*** ***Competitive Inhibition***
0-10 seconds			
11-20 seconds			
21-30 seconds			
31-40 seconds			
41-50 seconds			
51-60 seconds			
Total			

Answer these questions on an attached sheet of paper. Number each answer with the question number.

1. In this activity, what object represented the enzyme? the substrate? the inhibitor?
2. In Trial 1, why did the rate eventually decrease? What could have been added to maintain the initial rate?
3. If more substrate were present in Trial 1 at the beginning, would the initial rate have been higher? Why or why not?
4. If we assume that the enzyme is represented by the hand, what happened to the active site during Trial 2?
5. Why does an enzyme not work as well if its active site is changed?
6. What environmental factors affect the enzyme shape?

7. What effect did inhibition have upon the reaction rate?
8. How might chemicals affect you if they acted like inhibitors during your bodily reactions?