EXPLORATIONS

Activity 3

Metabolic Magicians

Objectives

- To understand the relationship between various environmental factors and enzyme reaction rates
- To recognize the metabolic differences between endotherms and ectotherms as they relate to enzyme activity
- To generate graphs by inputting reasonable data modeling enzyme activity rates

In this activity you will

- examine graphs about enzyme activity.
- analyze the data about the graphs.
- produce your own graphs.

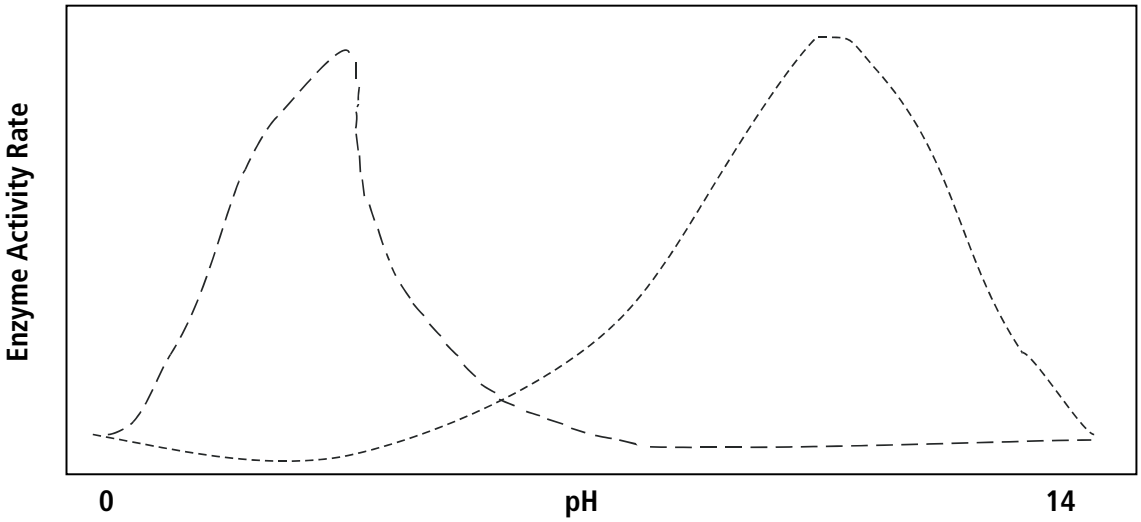
Introduction

Some of the most amazing molecules in your body are enzymes. Enzymes are usually protein molecules that serve as catalysts for chemical reactions. Most of the time, they speed up reactions so that those reactions can happen at lower energy levels. Sometimes, enzymes speed up reactions so much that those reactions would not even occur if the enzymes were not there. They are really biological magicians! Even though they are amazing and necessary for your survival, they are usually very picky about the conditions in which they will work. They are strongly affected by changes in temperature and pH, so your body must work hard to control your temperature and pH so that your enzymes work at their best.

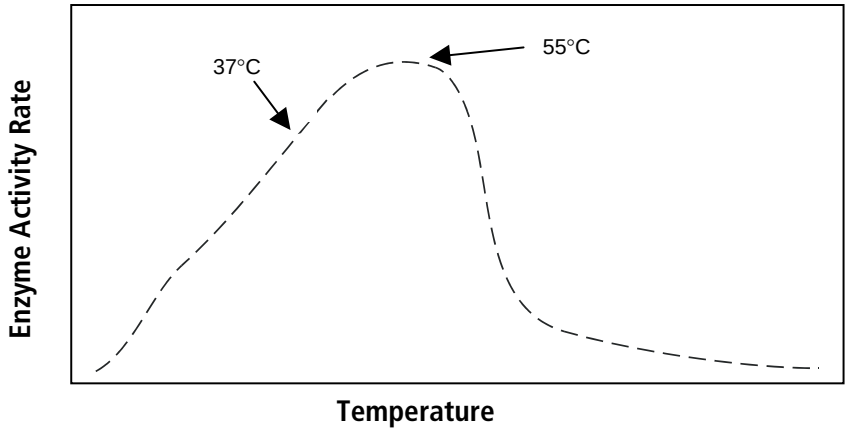
Problem

How do enzymes react to pH and temperature changes? Observe the two graphs on the next page. On the *Data Collection and Analysis* page, you will use your understanding of graphs to analyze the enzyme actions and answer questions about them. You will then use that knowledge to model your own enzyme reaction using your TI-83 Plus.

Graph 1: Enzyme Activity Rate versus pH from 0-14



Graph 2: Enzyme Activity Rate versus Temperature



Data Collection and Analysis

Activity 3: Metabolic Magicians

Name _____

Date _____

Questions for Discussion and Writing

1. If the two plots in Graph 1 represent the activity of different digestive enzymes, where in your body do you think each of the two enzymes would work most effectively? Explain your answer.

2. What does Graph 1 tell you about the relationship between pH and enzyme activity?

3. Why does each enzyme show such a sudden drop in activity after its peak?

4. Using your TI-83 Plus, try to reproduce the graph of Enzyme Activity Rate versus Temperature. Describe your method.

5. Why does your body work so hard to maintain pH levels? Explain the role of buffers.

6. In very general terms, explain what Graph 2 means.

7. The average human body temperature is 37°C, yet according to Graph 2, enzymes work best at around 55°C. Enzymatically, what would be the danger of having a body temperature of 55°C?

8. Why do reactions usually occur rather slowly at lower temperatures and faster at higher temperatures?

9. One way to preserve food is to heat it up and put it in sealed jars. Why does this method work?

10. Why is refrigeration another effective method of preventing food spoilage?

11. Try to duplicate Graph 1 using your TI-83 Plus. Explain your strategy and method.

12. Why is a snake or a lizard sluggish on a cool morning?

13. You may feel sluggish on a cool morning, but why don't you have the same metabolic challenges as a snake or a lizard?

14. Using your TI-83 Plus, try to produce a graph with two plots on it; one for the daily metabolic rate of a lizard and one for your daily metabolic activity rate. On the X-axis, plot time in hours of the day, and on the Y-axis, plot the metabolic activity.

Teacher Notes

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Concepts

- Enzyme reaction rates and conditions
- Factors affecting enzymes

Questions for Discussion and Writing – Answer Key

1. The first peak occurs in the stomach because the enzyme works in acidic pH's. The second peak occurs in the small intestine because the enzyme works in basic (alkaline) pH's.
2. Different enzymes work most effectively at different pH's. Also, outside the effective pH range for an enzyme, its effectiveness decreases dramatically.
3. Enzymes show sudden drops in activity after their peak because they are so specific in their pH requirements. They may become denatured at pH's outside of these effective ranges.
4. Allow the students to enter data in **L1** and **L2**, graph the data, then go back to the lists and modify the data until they have a reasonable representation of the graphs. Suggestion: enter **25,30,35,…80** in **L1**. Allow students to explore options for **L2**.
5. Your body works hard to maintain pH levels because enzymes will not work unless pH levels are closely controlled. Buffers help to maintain the pH of solutions—including solutions in the bloodstream.
6. Enzymes work best at certain temperatures, and do not work at all in extreme temperatures.
7. If someone had a fever, that person would be a real risk of denaturing many of his/her enzymes.
8. Enzymes work better, to a point, at higher temperatures. Molecules move around faster at higher temperatures, increasing the chance of collision.
9. Heating kills bacteria and denatures enzymes that may contribute to food spoilage.

10. At cooler temperatures, reactions occur more slowly. Because food spoilage involves living organisms, cooler temperatures slow the rate of metabolism in these organisms.

11. Suggestion: enter **0,1,2,3,…14** in **L1**. In **L2** and **L3**, have the students decide which numbers to enter.

12. Snakes and lizards are cold-blooded and their metabolisms are slow until they warm up.

13. Humans maintain their body temperatures at a fairly constant level. Humans are warm-blooded.