

MiSP ENZYME ACTION

Teacher Guide, L1 - L3

Introduction

The subject of this unit, enzymes, is typically a high school topic and is studied in depth in Advanced Placement Biology. Even so, it can be successfully incorporated into Living Environment units in an intermediate-level course.

The topic of enzymes is often part of a biochemistry / organic compounds unit. It also can be used in units on nutrition and digestion.

At the middle school level, the following concepts should be addressed: enzymes are vital to life; enzymes are organic molecules; enzymes are synthesized by living things; and enzymes speed up chemical reactions. High school courses can include the ideas of active site, enzyme specificity, and the lock and key explanation of enzyme action.

This MiSP unit will address factors that affect rate of enzyme activity: temperature and concentration of enzyme and substrate. An optional topic is pH, another factor that affects enzyme activity.

The following teacher resource may be used:

<http://academic.pgcc.edu/~kroberts/Lecture/Chapter%205/enzymes.html>

Standards

ILST Core Curriculum — Major Understandings:

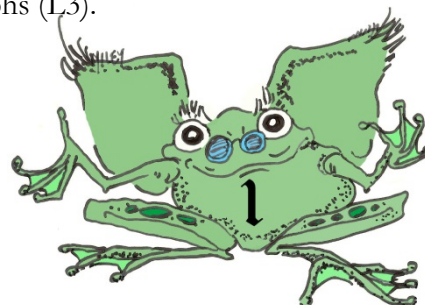
Standard 4 Living Environment 1.2c

Living Environment Core Curriculum — Major Understandings:

Standard 4 1.2h, 2.1g, 2.1i, 5.1f, 5.1g

Lesson Objectives: After completing this unit, students will be able to:

- Define *enzyme*, *substrate*, and *product*
- State that enzymes speed up chemical reactions, are organic catalysts, are proteins, and are synthesized by living things
- Explain enzyme specificity using the lock and key analogy, and explain how active sites create specificity (high school)
- Collect, graph, and interpret rate of enzyme activity data
- Determine and use the unit rate of change (slope) for changes in enzyme activity at different temperatures and concentrations (L2)
- Determine and apply the formula for a line on rate of enzyme activity graphs (L3).
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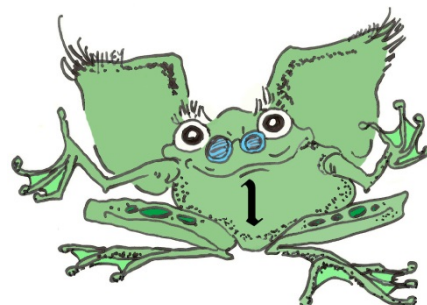
Day 1 — Introduction to Enzymes

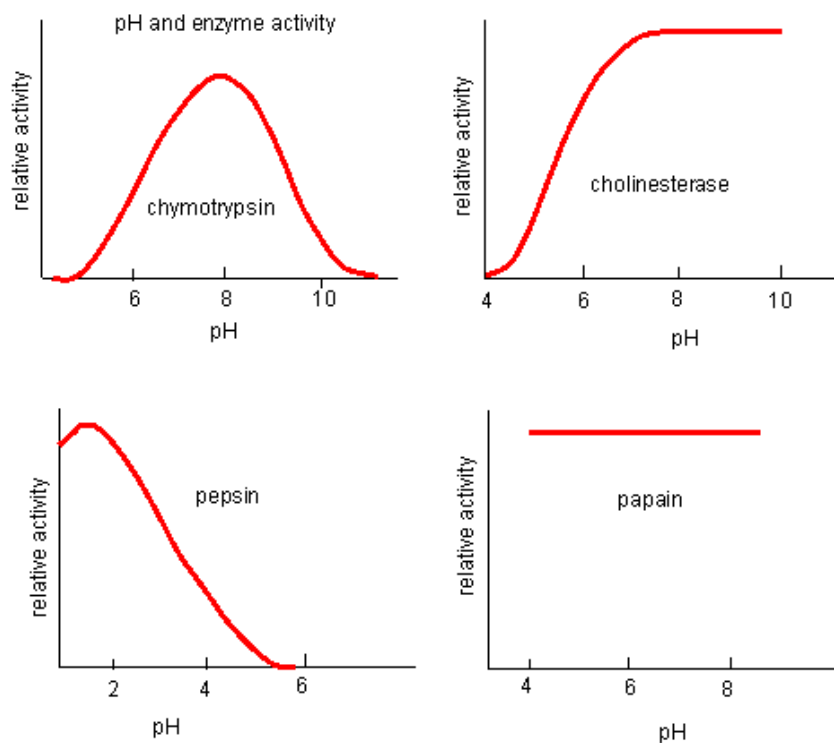
Resources:

- <http://www.ngfl-cymru.org.uk/vtc/20050330/Biology/keystage4/enzymes/enzymesac/introduct/default.htm>
- http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation_how_enzymes_work.html

Day 1 introductory discussions will depend on prior teaching and learning and the type of course. Topics/activities may include:

- Demonstrations of general catalysis and/or enzyme activity. You can use the digestion of starch by amylase to produce sugar or the catalase–hydrogen peroxide reaction. Catalase can be purchased from chemical supply vendors and is found in a variety of living tissues including yeast, liver, potatoes, blood, and ear wax. (Include a demonstration to show that enzymes can be reused.)
- Catalytic action (speeding up chemical reactions, allowing reactions to occur at a greater rate at a lower temperature, and definition of the terms *substrate* and *products*)
- Enzymes as proteins, synthesized in human beings
- The specificity of enzymes (active site, lock and key mechanism)
- The catalase-facilitated breakdown of hydrogen peroxide into water and oxygen
- Enzyme activity as affected by substrate concentration, enzyme concentration, temperature, coenzymes, and pH. It is recommended that students do these labs as inquiry experiences. Students will observe how temperature and concentration affect enzyme activity. You may want to explain pH's effect on enzymes as part of the introductory activity. Discussing pH is optional. Remember that different enzymes are affected by pH in different ways:





Question of the Day:

When you chew on a cracker (a cracker has a lot of starch in it) for a long time, you will gradually detect the sweet taste of sugar. That is because your saliva contains an enzyme called amylase that breaks down (chemically digests) starch into sugar. When you chew on a piece of steak, there is no chemical digestion of the protein or fat in the meat in your mouth. Why not?

Day 2 – The Effect of Temperature on the Rate of Enzyme Activity

This lesson will use the catalase-accelerated breakdown of hydrogen peroxide. To complete this activity in one day, do a demonstration. You can choose to present a regular activity instead but it may take more than one class period.

If a school is not equipped for the activity, a good simulation can be used to produce results; see <http://www.kscience.co.uk/animations/model.swf>.

For this lab protocol, see: <http://www.accessexcellence.org/AE/ATG/data/released/0074-GenNelson/index.php>

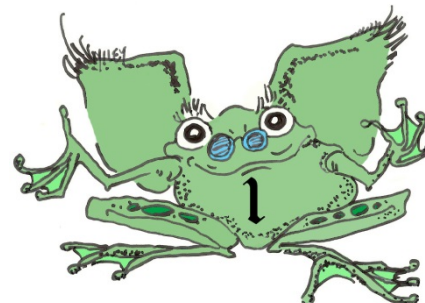
Lab notes:

Students should wear goggles.

Review the MSDS for hydrogen peroxide.

Computer probeware vendors have developed protocols for enzyme labs.

Use caution with the hot water.



Four water baths (large beakers can be used) are needed for four temperatures: ice cold, room temperature, approximately 37°C, and boiling. **YOU WILL HAVE TO TAKE TEMPERATURE READINGS AND INFORM THE STUDENTS OF THE TEMPERATURE.**

You will need to select and assign appropriate lab ware for the chemicals and reactions: test tubes, vials, and/or little beakers.

You may need to adjust volumes to fit selected glassware.

Make a catalase preparation from potatoes, as follows:

Mix 50 g of peeled potato with 50 ml cold distilled water and crushed ice, and homogenize in a blender for 30 seconds. If a blender is not available, chop the potato into very small chunks. Filter mixture through cheesecloth or allow to settle, and then decant. Add cold distilled water to make a total volume of 100 ml. Extract concentration is arbitrarily set at 100 units/ml. **ENZYME SHOULD BE KEPT ON ICE AT ALL TIMES!!**

THE ENZYME PREPARATION MUST BE TESTED! If the filter paper disk does not reach the bottom of the test tube or the reaction is too fast, dilute the preparation. If the reaction takes too long, add more potato or use shorter tubes.

It is suggested that class averages be used.

Question of the Day:

There is an enzyme in fresh pineapple called bromelain that breaks down the chemical (collagen protein) in Jell-O that makes it jell. So, if you put fresh pineapple in your Jell-O, it will not jell; it will remain a liquid. If you use canned pineapple, the problem does not occur. The Jell-O will set. Why does canned pineapple not do the same thing to Jell-O that fresh pineapple does?

Days 3 and 4 — The Effect of Substrate Concentration on the Rate of Enzyme Activity

Lab notes:

Students should wear goggles.

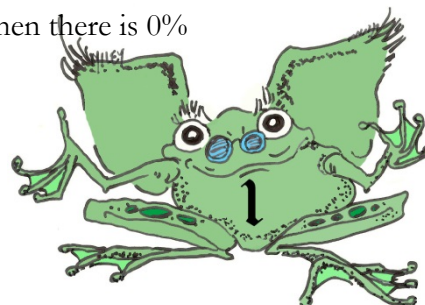
Computer temperature probes may be used; vendors have developed protocols.

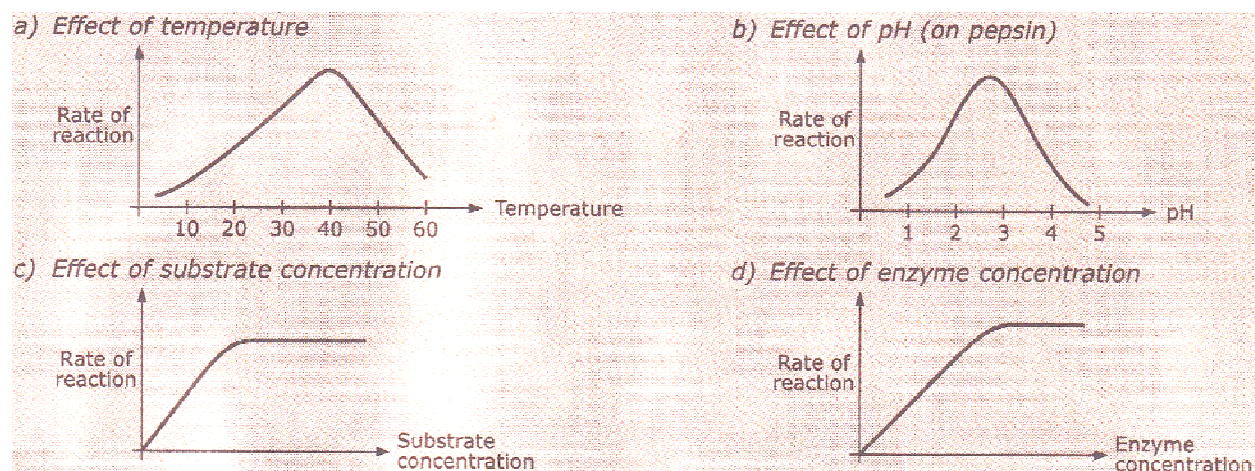
Review the MSDS for hydrogen peroxide.

Make catalase preparation, following the directions used on day 2. A new preparation should be made. The enzyme will lose its activity overnight even if kept under refrigeration.

This lab is similar to the enzyme temperature activity. Much of the introduction and many of the basic procedures are the same. With two days to work, the students should be able to complete this lab activity.

Typical enzyme rate graphs are shown below. Note that the graphs will not look like this because students are not graphing rate. Instead they are graphing the time for the reaction. Remember: Slower reactions, longer time; faster reactions, shorter time. So the graphs will be the inverse and students will not have zero reaction rates (when the enzyme is denatured or when there is 0% substrate).





Day 5 — Assessment

Administer the appropriate level assessment.

