470134-784

AP® Biology Investigation #13:

Interactions: Enzyme Activity

Meets Revised College Board AP Biology Standards

WACP470134-086

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abstract

Chemical reactions underlie metabolism. Organisms have evolved catalytic proteins, called enzymes, that can make the reactions more efficient by lowering the activation energy of a chemical reaction. Catalytic efficiency of enzymes is dependent upon the precise shape of the active site in the protein that interacts with substrates and products. The abiotic conditions of the reaction affect the rate of enzyme-mediated conversion of substrate to product by altering the conformation of this active site. In this set of investigations, students will use an extract of turnips containing the enzyme peroxidase to react with its substrate (hydrogen peroxide) and a color indicator (guaiacol) for formation of product (O_2), to estimate the rate of peroxidase activity under a variety of experimental conditions.

required prior knowledge

Students should:

- be able to make and record good observations.
- have a strong understanding of basic protein structure.
- be able to demonstrate the concept of induced fit.
- understand the roles of enzymes and how structure, function and environment are intertwined to allow reactions to occur.

activity learning objectives

In this investigation, students will perform activities to help them answer the following question:

Why are some individuals unable to digest lactose?

materials checklist

For a list of replacement items, visit: www.wardsci.com, and click on the AP Biology tab for this kit/item #.

materials included in kit:

- 1 vial/100 pH paper, range 1-14
- 250 test tubes, 16 x 150 mm
- 250 mL guaiacol
- 24 syringes, 2.5 mL
- 16 syringes, 10 mL
- 1 hydrogen peroxide, 3%, lab grade
- 5 pieces cheesecloth, 9 x 12 each
- 80 disposable pipets, 9"
- 1 buffer set: Includes envelopes of pH 2-11 (one each, for a total of 10 envelopes), 500 mL buffer
- 1 instructions (this booklet and student guide)

materials needed but not provided:

- 1 fresh turnip
- Test tube racks
- Ice
- Beakers and/or flasks, 1000 mL, 500 mL, 150 mL, 50 mL
- Graduated cylinders, 20-500 mL and 1 L
- Parafilm
- Distilled water
- Timer
- Brown bottle, 500 mL, or bottle wrapped in foil
- Lab notebook
- Refrigerator
- Blender
- Scale/balance
- Personal protective equipment (gloves, apron, safety glasses)
- Other materials as determined by students' experimental design

optional materials (not provided)

- Light probe or spectrophotometer

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standards alignment

This lab activity is aligned with the 2012 AP Biology Curriculum (registered trademark of the College Board). Listed below are the aligned Content Areas (Big Ideas and Enduring Understandings), the Science Practices, and the Learning Objectives of the lab as described in AP Biology Investigative Labs: An Inquiry-Based Approach (2012). *This is a publication of the College Board that can be found at: http://media.collegeboard.com/digitalServices/pdf/ap/APBioTeacherLabManual2012_2ndPrt_lkd.pdf*

Big Ideas	**2**	Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis.
	also connects to 4	Biological systems interact, and these interactions possess complex properties.
Enduring Understandings	**2.D.1**	All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
	4.A.1	The subcomponents of biological molecules and their sequence determine the properties of that molecule.
	4.B.1	Interactions between molecules affect their structure and function.
Science Practices	**4.2**	The student can design a plan for collecting data to answer a particular scientific question.
	5.1	The student can analyze data to identify patterns or relationships.
	6.1	The student can justify claims with evidence.
	6.4	The student can make claims and predictions about natural phenomena based on scientific theories and models.
	7.2	The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.
Learning Objectives	**2.23**	The student is able to design a plan for collecting data to show that all biological systems are affected by complex biotic and abiotic interactions.
	4.3	The student is able to use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.
	4.17	The student is able to analyze data to identify how molecular interactions affect structure and function.

time requirements

	TIME FRAME	TEACHER TASKS	STUDENT TASKS
pre-lab prep	45 minutes 1 day before lab	Prepare solutions and color palette. See pre-lab prep.	Read background and answer pre-lab questions.
activity 1	10 minutes	Organize work stations and provide prepared solutions.	Mix solutions to establish baseline and compare to palette standard.
activity 2	45 minutes	Provide prepared pH buffer solutions.	Calculate the rate of reaction relative to pH.
activity 3	Will vary, depending on student's experimental designs.	Review and approve student experiment designs.	Design and conduct open inquiry experiment.

lab specific safety

- Guaiacol is a poison and flammable. Review the Safety Data Sheet (SDS) for this chemical.
- Remind students to use proper pipeting techniques. Never mouth pipet.

general safety:

- The teacher should 1) be familiar with safety practices and regulations in his/her school (district and state) and 2) know what needs to be treated as hazardous waste and how to properly dispose of non-hazardous chemicals or biological material.
- Consider establishing a **safety contract** that students and their parents must read and sign. This is a good way to identify students with allergies (e.g., latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals.
- Students should know where all **emergency equipment** (safety shower, eyewash station, fire extinguisher, fire blanket, first aid kit etc.) is located.
- Require students to remove all dangling jewelry and tie back long hair before they begin.
- Remind students to **read all instructions, SDSs and live care sheets** before starting the lab activities, and to ask questions about safety and safe laboratory procedures. The SDSs and the most updated versions of live care sheets can be found at www.**wardsci.com**. Updated SDSs can also usually be found on each chemical manufacturer's website.
- In student directed investigations, make sure that collecting safety information (like SDSs) is part of the experiment procedure.
- As general laboratory practice, it is recommended that students **wear proper protective equipment**, such as gloves, safety goggles, and a lab apron.

at the end of the lab:

- Before disposing of any chemicals in the trash or down the drain, review local regulations or consult with local authorities.
- All laboratory bench tops should be wiped down with a 10% bleach solution or disinfectant to ensure cleanliness.
- Remind students to wash their hands thoroughly with soap and water before leaving the laboratory.

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