Enzyme Environment Activity: Environmental Effects on Enzyme Function

AP Biology/College Level Teacher Guide

Overview

This guide supports implementation of the Enzyme Environment Activity: Environmental Effects on Enzyme Function using the 5E instructional model.

Learning Objectives

- Students will analyze how temperature and pH affect enzyme structure and function
- Students will determine optimal conditions for various digestive enzymes
- Students will explain denaturation and the role of environmental factors in protein stability

Standards Alignment

Topic 3.1: Enzymes

- **LEARNING OBJECTIVE 3.1.A:** Explain how enzymes affect the rate of biological reactions.
- **ESSENTIAL KNOWLEDGE 3.1.A.1:** The structure and function of enzymes contribute to the regulation of biological processes. Enzymes are proteins that are biological catalysts that facilitate chemical reactions in cells by lowering the activation energy.
- **ESSENTIAL KNOWLEDGE 3.1.A.2:** For an enzyme-mediated chemical reaction to occur, the shape and charge of the substrate must be compatible with the active site of the enzyme. This is illustrated by the enzyme-substrate complex model.

Topic 3.2: Environmental Impacts on Enzyme Function

- **LEARNING OBJECTIVE 3.2.A:** Explain how changes to the structure of an enzyme may affect its function.

- **ESSENTIAL KNOWLEDGE 3.2.A.1:** Change to the molecular structure of a component in an enzymatic system may result in a change to its function or efficiency.
- i. Denaturation of proteins, such as enzymes, occurs when the protein structure is disrupted by a change in temperature, pH, or chemical environment, eliminating the ability to catalyze reactions.
- ii. Environmental temperatures and pH outside the optimal range for a given enzyme will cause changes to its structure (by disrupting the hydrogen bonds), altering the efficiency with which it catalyzes reactions.
- **ESSENTIAL KNOWLEDGE 3.2.A.2:** In some cases, enzyme denaturation is reversible, allowing the enzyme to regain activity.
- **LEARNING OBJECTIVE 3.2.B:** Explain how the cellular environment affects enzyme activity.
- **ESSENTIAL KNOWLEDGE 3.2.B.2:** Higher environmental temperatures increase the average speed of movement of molecules in a solution, increasing the frequency of collisions between enzymes and substrates and therefore increasing the rate of reaction until the optimal temperature is achieved.

Prerequisites

- Protein structure (primary through quaternary)
- Understanding of pH and temperature scales
- Basic knowledge of digestive system

Time Estimate

50 minutes

Materials Needed

- Computer with internet access
- Student Activity Sheet
- Graph paper (optional)

Teaching Tips by Phase

Phase 1: ENGAGE (5-10 minutes)

- Start with the phenomenon or problem presented

- Elicit student predictions and prior knowledge
- Create cognitive dissonance if possible
- Build excitement for investigation

Phase 2: EXPLORE (15-20 minutes)

- Allow students to investigate with minimal guidance
- Circulate and ask probing questions
- Encourage systematic data collection
- Note common discoveries and difficulties

Phase 3: EXPLAIN (10-15 minutes)

- Have students share their findings first
- Build on their observations to introduce concepts
- Address misconceptions directly
- Connect to broader biological principles

Phase 4: ELABORATE (10 minutes)

- Apply knowledge to new scenarios
- Make real-world connections
- Encourage deeper investigation
- Support transfer of learning

Phase 5: EVALUATE (5-10 minutes)

- Use varied assessment strategies
- Focus on conceptual understanding
- Provide immediate feedback
- Plan follow-up based on results

Remember:

The goal is student discovery through guided inquiry. Resist the urge to explain concepts before students have explored them!
