The Dirt Eaters: The Action of Enzymes

Introduction

Lesson Introduction

From catalyzing cell functions to their use in biotechnology, proteins known as enzymes are invaluable to both life and technology.

This activity is designed to demonstrate enzyme action in detergents as an alternative to the commonly used lab activity to demonstrate the action of pineapple enzymes on Jell-o.

Grades: 6-8, 9-12
Time Needed: One 45-min class period

Learning Objectives:

After completing this lesson, students will be able to:

1. Identify the structures of enzymes.
2. Describe the actions of enzymes.
3. Describe sources of enzymes.
4. Identify the components of a controlled experiment.

Materials:

- ☐ Stained Fabric* (4 per group per detergent)
- ☐ 3 Detergent (enzyme) Samples*
- ☐ Alternatively, other enzyme containing substances such as fresh ginger, kiwi, papaya, pineapple or meat tenderizer may be used.
- ☐ 4 droppers or disposable pipettes per group
- ☐ Four 250ml beakers per group
- ☐ Access to water
- ☐ Stopwatch/clock with second hand
- ☐ Stirring rod
- ☐ Tape to label droppers

*A white t-shirt or cotton dishtowel cut into small pieces and stained with grass, dirt, catsup, etc., would be perfect for this.

**Students can bring small samples of detergents from home. They should label their sample as enzyme, non-enzyme containing and with the specific product or brand.

Next Generation Science Standards (NGSS)

As a result of activities in grades 6-8 and 9-12, all students should develop:

Topics

- **PS1:** Structure and Properties of Matter

Performance Expectations:

- **MS-PS1-2:** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction occurred.
- **HS-PS1-4:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Dimension

Practices:

- Planning and carrying out investigations
- Analyzing and interpreting data

Disciplinary Core Ideas:

- **PS1:** Matter and its interactions

Cross-Cutting Concepts:

- Stability and change

Instructional Process

This activity can be used as an introduction to or as a follow-up to lessons regarding enzymes. While this is designed for students to determine the effectiveness of various detergents on a single type of stain, one could have students determine the effectiveness of a single enzyme on varying stains.

1. Prepare cloth samples by cutting 2” x 2” squares of fabric.
2. Stain cloth in pairs with substance of your choice. Attempt to create stains of the same size and intensity.
3. Set out supplies for students to access easily.
4. See student instructions to familiarize yourself with the process that they will follow.

Sources

Chaplin, M. (2004, December 20). Sources of enzymes. Retrieved from http://www.lsbu.ac.uk/php-cgiwrap/biology/pfp.php3?page=http://www.lsbu.ac.uk/biology/enztech/sources.html

Chaplin, M. (2004, December 20). The use of enzymes in detergents. Retrieved from http://www.lsbu.ac.uk/biology/enztech/detergent.html

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Student Sheet

Introduction & Background Information

From catalyzing cell functions to their use in biotechnology, proteins known as enzymes are invaluable to both life and technology.

Enzymes are proteins that catalyze (speed up) chemical reactions in organisms, but are not used up or changed by the reaction. Enzymes are able to function as a result of their shape and tend to work on specific substrates. Within cells and organisms, enzymes are used to build some molecules and break down others. Examples include the action of the enzyme catalase (enzymes can often be identified by names ending in –ase) in breaking down cellular waste product H_2O_2 and the action of DNA polymerase in building new DNA strands during replication.

Enzymes are sensitive to pH and temperature. Each functions optimally under particular conditions and may become denatured (change shape and lose the ability to function) when pH and temperature are outside the optimum range for that enzyme.

Humans harness the power of enzymes for a wide range of purposes, from the use of Papain from the PawPaw plant to tenderize meat, to the use of restriction enzymes such as EcoRI to cut DNA in genetic analysis. Additionally, enzymes can be added to detergents to lower the water temperature required for them to be effective in stain removal. The use of enzymes also reduces the need for agitation thus reducing the physical damage to the fabric. The enzymes protease (breaks down protein; isolated from bacteria), amylase (breaks down starch; isolated from barley or fungus) and lipase (breaks down fats; isolated from fungus) may be used in detergents. Cellulase may also be used in detergents to protect the color and feel of cotton fabrics.

Sources

Chaplin, M. (2004, December 20). Sources of enzymes. Retrieved from http://www.lsbu.ac.uk/php-cgiwrap/biology/pfp.php3?page=http://www.lsbu.ac.uk/biology/enztech/sources.html

Chaplin, M. (2004, December 20). The use of enzymes in detergents. Retrieved from http://www.lsbu.ac.uk/biology/enztech/detergent.html

Purpose

- To observe the action of enzymes

Materials:

- ☐ Stained fabric (4 per group per detergent & stained with the same substance)
- ☐ 3 detergent samples (drawn into labeled pipettes)
- ☐ Four 250ml beakers each containing 60 ml of water
- ☐ Stopwatch/clock with second hand
- ☐ Stirring rod
- ☐ Tape to label droppers

Procedure

1. Obtain materials.
2. Be sure to label each dropper accurately with the name of the detergent it contains.
3. Observe the stains on each fabric piece.
4. Place one fabric sample in one of the beakers of water to wet it.
5. Fold the fabric in half and scrub the halves of fabric together for 1 minute.
6. Rinse your sample in the beaker. Wring out the excess water, spread it out & observe.

As you work you will rank the stain appearance on a scale of 0-5, with 5 being darkest and 0 being no stain. The stained fabric as it appears after this treatment represents a stain ranking of "5".

7. Record the stain rank in your data table.
8. Hang the "5" square over the edge of the beaker you used and set it aside.
9. Place another fabric square in an unused beaker of water to wet it.
10. Place 5 drops of a detergent sample on the stain.
11. Fold the fabric in half and scrub the halves of fabric together for 1 minute.
12. Rinse your sample in the beaker. Wring out the excess water, spread it out & observe.
13. Record the stain rank in your data table.
14. Hang the square over the edge of the beaker you used and set it aside.
15. Repeat steps 9-14 for the remaining fabric squares and samples.
16. Clean up your lab area and put your materials in the location designated.
17. Complete the follow-up questions for this activity and turn them in no later than _____.

Data Table

Sample	Rank
Water only	**5**
Sample 1:	
Sample 2:	
Sample 3:	

Follow-up Questions:

1. **Which sample of detergent most effectively removed or lightened the stain? Propose a reason for this.**

   _____

   _____

   _____

2. **Briefly describe the structure and make up of enzymes.**

   _____

   _____

   _____

3. **Explain the purpose of enzymes in cells.**

   _____

   _____

4. **Would the enzymes that worked well on the stains on the fabric you used work equally as well on all stains? Explain why or why not.**

   _____

   _____

   _____

   _____

5. **Considering the conditions under which enzymes function, describe what might happen if the water used in the washing process was very hot or very cold.**

   _____

   _____

   _____

   _____

6. **Identify the following in the experimental design:**

   a. **Independent variable**_____

   b. **Dependent variable**_____

   c. **Control**_____

   d. **Constants**_____

7. **Propose a follow-up experiment to this one that would test the effectiveness of the enzyme in different environments such as pH or temperature.**