TEACHER PREPARATION GUIDE.

ZornScience
zornscience.org

The Cold-Water Detergent Challenge

Biology | TEACHER GUIDE

Planning notes for teachers: materials, setup, expected results, and what to watch for.

Not yet classroom-tested. This is a new lab design that has not been tested in a classroom yet. Expected results, times and costs are estimates, not measured values. Run the full lab yourself before you use it with students or grade it, and adjust amounts to match your materials.

Item	Details
Unit and lessons	Unit 5: Molecules of Life. Lessons: Enzymes, Proteins
Class time	One 50-minute period (30-minute soak), with gelatin set the day before
Groups	3 to 4 students
Cost	About $2 to $3 per group
Standards	HS-LS1-1. SEP: Planning and Carrying Out Investigations; Analyzing and Interpreting Data. CCC: Structure and Function; Cause and Effect.

Big Idea

A consumer product gives a reason to care about enzyme structure. Students see that cold slows an enzyme while heat destroys it, and that a protease works on a protein substrate.

Materials for 8 Groups

Item	Amount	Notes
Liquid laundry detergent with "protease" or "enzymes" on the label	About 50 mL	Never use pods. Check the ingredient list.
Unflavored gelatin	4 packets (about 28 g)	Grocery store.
Food coloring	A few drops	Makes the column easy to measure.
Clear drinking straws (not bendy)	About 30	Cut into 40 mm segments after the gelatin sets.
Cups (9 oz)	48	
Ice, hot tap water, thermometers		For the baths.

Advance Preparation

1. Day before: dissolve 4 packets of gelatin in 240 mL of hot water (double strength) and add food coloring.
2. Stand about 30 straws upright in a tall cup and pour in the warm gelatin so it fills the straws from the bottom. Refrigerate overnight.
3. Next day: pull the straws out, wipe them, and cut them into 40 mm segments with scissors. Keep them cold until class.
4. Make the detergent solution: 10 mL detergent plus 90 mL water (1:10). You need about 150 mL per group for cups 2 to 5.
5. Heat-treated detergent: heat part of the 1:10 solution in a beaker in a 90 °C water bath for 10 minutes, then cool to room temperature.

CC BY-NC-SA 4.0 | zornscience.org

Expected Results

Sample values are in the answer key. The amount digested in 30 minutes depends a lot on your detergent and dilution, so run one cup at room temperature during your pilot. If the room-temperature cup digests less than 3 mm, use a 1:5 dilution or a 45-minute soak.

What Can Go Wrong

- Gelatin melts above about 30 to 35 °C. That is why the warm bath is only 30 °C and cup 6 is a warm water control. Do not use hotter baths.
- Unclear end of the column. Food coloring and rinsing make the edge sharp.
- Detergents with no protease. Read the label; test one cup in your pilot.

Misconceptions to Listen For

- "Enzymes are alive" or "the heat killed the enzyme." Enzymes are proteins, not organisms; heat changes their shape.
- "Hotter is always faster." Faster only until the protein denatures.
- "Enzymes get used up." The same enzyme molecule digests many gelatin molecules.

Differentiation and Extensions

- Support: a labeled diagram of the straw before and after. Sentence frame: "The enzyme digested the most at ___ because ___."
- Extension: test meat tenderizer (contains the protease papain or bromelain) as a second enzyme source.
- Extension: pair with the ZornScience virtual Enzyme Activity Lab to explore pH.

Safety and Disposal

- Goggles and gloves throughout. Detergent is an eye irritant.
- Detergent solutions go down the drain with water. Gelatin and straws go in the trash.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS1-1:** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Disciplinary core ideas: LS1.A Structure and Function

Science and engineering practices: Planning and Carrying Out Investigations; Analyzing and Interpreting Data

Crosscutting concepts: Structure and Function; Cause and Effect

CC BY-NC-SA 4.0 | zornscience.org