Demo: Turn Milk into Plastic!

FOR THE TEACHER

Summary
In this demonstration, students will observe the process of making a polymer, casein plastic, from the casein protein found in milk.

Grade Level:
Middle or High school

Objectives:
By the end of this demonstration, students should be able to
- Describe the difference between a monomer and a polymer.
- Identify the indications of chemical and physical change throughout the process.

Chemistry Topics
This lab supports students’ understanding of
- polymers
- reactions
- chemical change
- physical change
- pH

Time
Teacher Preparation: 10 minutes
Lesson: 20 minutes (see teacher notes for possible extensions)

Materials
- 1 cup of milk (~236ml)
- 4 teaspoons of white vinegar (~20ml)
- Hotplate/microwave
- 2 -400 ml beakers
- 1 cup measuring cup or graduated cylinder
- 1 tbsp. measuring spoon or graduated cylinder
- paper towels
- spoon
- pH paper

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- Exercise caution when using a heat source. Hot plates should be turned off and unplugged as soon as they are no longer needed.
Teacher Notes

- Students should be introduced to the concepts of molecules, monomers and polymers prior to this demonstration.

- Procedure:
  1. In a 400ml beaker heat one cup or 236ml of milk until it is visibly steaming, but not boiling.
  2. Add 4 teaspoons or 20ml of white vinegar to another 400ml beaker.
  3. Carefully add the hot milk to the cup of vinegar.
  4. Mix slowly with a spoon for a few seconds.
  5. Stack several layers of paper towels on a hard surface.
  6. Once the milk and vinegar mixture has cooled, use a spoon to scoop out the curds onto the paper towel.
  7. Knead the curds together until they form a solid mass, and then shape as you wish.
  8. Optional: test the pH of the different components using pH paper throughout the steps of the procedure.

- What happens:
  - After you add the hot milk to the vinegar, small, white chunks, or curds should become visible in the mixture. The acid in the vinegar changes the pH of the milk, causing it to curdle. Use a spoon to separate the curds from the liquid. Dry the curds with a paper towel before kneading.

- Engage students in a discussion throughout the demonstration. Ask students to identify instances of physical and chemical change, citing their observations.

- This demonstration could be used as a starting point for an investigative lab for students. Students could change variables or conduct tests on the final product. Some suggestions include:
  - Compare different types of milk (fat free, 1%, 2%, whole)
  - Use more or less vinegar
  - Heat the milk for different amounts of time or temperatures
  - Compare the strength of the casein plastic to other type of plastics.
  - Compare the flexibility of the casein plastic to other type of plastics.

- Note: When you have completed the procedure steps you must knead the dough in order to shape the plastic. It can be shaped by hand or with molds/cookie-cutters. You can also add food coloring, glitter, etc. while it is wet; or paint, color with markers when it is dry.