

# Chemistry: Make Plastic Out of Milk!



## MAIN IDEA

Experiment with chemistry concepts as you engineer your very own plastic polymer from casein, a protein found in milk, using common kitchen ingredients.

## SCIENCE BACKGROUND

Polymers are materials made of long, repeating chains of molecules that can be found all around us including in everyday materials that we use like rubber, glass, plastic, and even our DNA. Materials like plastic water bottles, tires, and clothing are made up of artificial polymers, whereas DNA is considered a natural polymer. Casein, a protein found in milk, forms polymer chains and when extracted can be dried into a type of plastic. Casein plastics have been used previously for small items such as buttons and beads.

Polymers are mostly composed of hydrocarbons, combinations of carbon and hydrogen atoms, but may also include other elements, such as oxygen, nitrogen, and sulfur. The difference in polymer characteristics such as their form and texture depends on the order of the molecules that compose that polymer.

Molecules are made up of atoms, the smallest unit of matter, and held together by chemical bonds. Think of water. Water is also known as  $H_2O$ . That means the water molecule has two hydrogen atoms and one oxygen atom.

## MATERIALS

Bowl or cup

Fine mesh strainer, cheese cloth or paper towels

Measuring cup

Microwave or stovetop

Mug

Paper towels

Spoon

Vinegar – 4 teaspoons

Wax paper (if available)

Whole Milk – 1 cup

*Optional:* cookie cutters, food coloring, rolling pin, or shaped molds



## ACTIVITY PROCEDURE

**STEP 1:** Pour one (1) cup of milk into a mug or microwave safe cup.

*Optional: Add a few drops of food coloring if desired.*

**STEP 2:** Warm milk in a microwave until heated through but not boiling. This typically takes between 1-1:30 minutes in a microwave. If using a stove, make sure to take the milk off the heat right when it starts to bubble.

**STEP 3:** In a small bowl or cup, pour in your warmed milk and mix in four (4) teaspoons of vinegar, stirring gently. *Warning: this can get smelly!*

- Can you see any solids forming?

**STEP 4:** With a spoon, scoop out the solids onto a paper towel stack (approx. 5-6 towels thick).

**STEP 5:** Strain the remaining liquid in a fine mesh strainer into the sink to acquire the rest of the solids. Combine your strainer solids with the larger group of solids that were collected on the stack of paper towels. Use extra paper towels as needed to pat your solids and remove as much moisture as possible.

**STEP 6:** Combine the solids together and knead them into a smooth dough-like ball either in your hands or on the table. *Optional: You can use a rolling pin to help shape your solids if desired.*

**STEP 7:** After your ball has been smoothed out, mold your dough into any shape(s) of your choice. *Optional: You can use cookie cutters and shaped molds if desired.*

**STEP 8:** Place your shape(s) on wax paper and allow to dry for a few days until your creation hardens. *Please note that this drying process can cause your plastic shapes to warp, crack, and shrink.*

- What does your creation look like?



## EDUCATIONAL STANDARDS

### Grade 2

#### Big Idea 9: Changes in Matter

SC.2.P.9.1 - Investigate that materials can be altered to change some of their properties, but not all materials respond the same way to any one alteration.

### Grade 5

#### Big Idea 8: Properties of Matter

SC.5.P.8.4 - Explore the scientific theory of atoms (also called atomic theory) by recognizing that all matter is composed of parts that are too small to be seen without magnification.

#### Big Idea 9: Changes in Matter

SC.5.P.9.1 - Investigate and describe that many physical and chemical changes are affected by temperature.

### Grade 8

#### Big Idea 8: Properties of Matter

SC.8.P.8.5 - Recognize that there are a finite number of elements and that their atoms combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.

### Grade 9-12

#### Big Idea 8: Properties of Matter

SC.912.P.8.13 - Identify selected functional groups and relate how they contribute to properties of carbon compounds.

## ADDITIONAL RESOURCES

### What is a Polymer?

<https://www.pslc.ws/macrog/kidsmac/basics.htm>

### The Basics: Polymer Definition and Properties

<https://plastics.americanchemistry.com/plastics/The-Basics/>

### Periodic Table

<https://kids.britannica.com/kids/article/periodic-table/600334>

### Science of Plastics

<https://www.sciencehistory.org/science-of-plastics>

