

## DO IT AT HOME!



The goal of this experiment is to create a moldable plastic while exploring bonding. It is easily done in the classroom and even at home! All you and your student will need is:

- 1 cup milk (2% works best, but any kind works!)
- 4 teaspoons acid (lemon juice, vinegar, soda, or any other type of safe household acid you can find at home or the grocery store)
- Measuring cups
- Measuring spoons
- Disposable cups that hold at least 1 cup of milk
- Paper towels, cheesecloth, or gauze
- Plastic spoons
- Microwaveable container

A detailed protocol is included in the accompanying student worksheet. Briefly, you will:

- Heat the milk in the microwave for about 2 minutes, or until it is about as warm as you want for hot chocolate. 5 minutes on 50% power also works well.
- Once the milk is warm, add the acid of your choice and begin to stir the mixture. You will see clumps forming immediately but continue stirring for about 30 seconds to 1 minute.
- Once you are done, take the curds out of the liquid and squeeze the excess liquid out using the paper towels.
- Begin kneading the plastic until it becomes smooth – it can now be molded into any shape you want!

## TRY SOMETHING NEW!

One of the most fun parts of an experiment is coming up with new ideas with your student and seeing what happens when you change something! Try brainstorming some questions with your student, make predictions about what you think will happen, and then repeat the experiment to see what is the same and what is different!

Here are some questions to get started:

- ❓ What do you think will happen if we use more milk or more acid?
- ❓ What do you think will happen if we use a different type of milk?
- ❓ How do you think the polymer might be different if we use cold milk? What about boiled milk?
- ❓ What are some different types of acid? How might they change the type of polymer we get?

This experiment is meant to strengthen your student's STEM identity – to show that science is all around them and can be done anywhere. Cool experiments like these are easily done at home and can have a lasting impact on their future and careers.

## HOW DOES IT WORK?

The milk plastic in this experiment forms due to a chemical reaction between small proteins in milk. This is called a *polymer*.

A polymer is a chemical or molecule composed of repeating units. Polymers can take on different shapes. They can be three-dimensional (like a cube), two-dimensional (like a sheet of paper), or one-dimensional (like a chain). Think of a Lincoln log structure for 3D, a mesh net for 2D, and a paper or paper clip chain for 1D.

Polymers are covalently linked together by bonds between the repeating units. Polymers are found in nature but can also be created for specific purposes. The most abundant example of a natural polymer is DNA, which is composed of nucleotide monomers. Plastics like those we find in squeeze bottles and types are polymers of different simple chemicals.

Milk contains a specific molecule called casein. In milk, casein forms a *micelle*, or a small sphere. Although casein micelles are extremely stable, when you add heat and acid, it causes casein and another milk protein, whey, to bind to each other in a long chain.

The combination of the heat and acid create a chemical change where you can watch the bonds being broken and reformed in a new way. While the experiment is occurring, students will immediately see a change in the milk once they start stirring after the acid is added. The milk will separate and curd will form as the denaturing and reforming process that is taking place.

## WANT MORE INFORMATION?

Check out some of these resources:

[American Chemistry – Polymer Basics](#)



[Properties of Polymers](#)



[Intro to Bonding](#)



[Structures and Bonding](#)



[What can we do with milk  
polymers?](#)

