

# Making Glue at Home

By Alexa Silva and  
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## SAFETY SUGGESTIONS

- Safety goggles required
- Protective clothing suggested
- Caution: hot liquids!
- Do not eat or drink any of the materials used in this activity
- Gloves should be used if you are allergic to casein or other milk proteins
- Thoroughly wash hands after this activity
- Have a parent or adult help you

**Disposal:** There are no hazardous materials used in this activity, and everything can be disposed of in the trash. Containers should be cleaned for reuse.

**Note:** Follow Milli's Safety Tips found in this issue of *Celebrating Chemistry*.

## Introduction

**In** this activity, you will be able to make glue out of milk! The main ingredient is a protein in milk called casein that you will turn into your own glue, and then test against a commercial glue.

## Materials

- ½ cup (118 mL) of skim (or non-fat) milk
- 1 tbsp. (15 mL) of vinegar (acetic acid solution)
- 1½ tsp. (7 mL) of baking soda (sodium bicarbonate)
- 1 tbsp. (15 mL) of water
- stirring spoon
- plastic funnel
- paper coffee filter, cheesecloth, or paper towels
- 1-cup (236 mL) microwave-safe dish
- small plastic cup
- 16-oz. (473 mL) disposable plastic cup
- potholder or insulated kitchen glove
- Popsicle sticks
- single-hole punch
- binder clip
- 12-inch (30 cm) piece of string
- 3–4 lbs. (1.4–1.8 kg) of dry sand
- store-bought glue for comparison
- thermometer

## Procedure

1. With the supervision of an adult, warm up (30 seconds in the microwave works!) ½ cup (118 mL) of skim milk in the dish. The temperature should be about 165° F (74° C). Do not overheat the milk. Using a potholder or insulated kitchen glove, remove the dish of milk from the microwave.
2. Stirring constantly, add the vinegar to the milk. Continue stirring until no more lumps form.
3. Let it settle for 5 minutes. You should observe the separation of the solids (which sink to the bottom) from the liquid (which stays on top).
4. Put a paper coffee filter (or cheesecloth or paper towel) in the funnel. Place a plastic cup under the funnel. Pour the liquid first, and then the solids into the funnel. Pour the filtered liquid down the drain, and save the solid in the filter paper.
5. Using the spoon, gently squeeze off any excess liquid left in the solid. Transfer the solid from the paper filter into a plastic cup.
6. Add one tbsp. (15 mL) of fresh water to the solid in the plastic cup. Mix it well with a spoon.
7. Slowly add the baking soda, mixing it well. Repeat the process until no more gas bubbles are formed. (Slightly more than ¼ tsp. (1.2 mL) of baking soda may be needed — but don't use too much.)
8. Your glue is ready! This glue will be usable for about one day, and will then spoil. The spoiled glue can be disposed of in the trash.

## Where's the chemistry?

This experiment uses vinegar to make the protein casein clump together and separate from the liquid part of the milk. The protein solids are also called 'curds' and the liquid part is called 'whey.' Just like Little Miss Muffet, we are working with curds and whey!

The **chemical reaction** between the milk and vinegar promotes the linkage of many molecules of casein. These links form tangled chains, and these tangled chains are what make glue sticky! It is important to use milk without fat in it; fat gets in the way of the reaction and prevents the chains of the polymer from sticking together. The baking soda (sodium bicarbonate) neutralizes the excess of vinegar (acetic acid solution); the bubbles produced in the reaction are made of carbon dioxide gas.

## How good is your glue?

Now, let's compare the strength of your glue with store-bought glue.

1. Use the glue you made to stick together two Popsicle sticks. Place them so that only one inch (2.5 cm) of the sticks overlap each other and stick together. Make a couple of these test samples.
2. Repeat the same procedure using the commercial glue. Label the Popsicle sticks clearly.
3. Wait several hours for the glue to dry.

Before testing, which glue do you think will be stronger? Why do you think that? To get a general idea of how strong the glues are, try to separate the sticks in one of the samples by hand. What do you observe? How much force does it take to break them apart? Was each one easy or hard? Next, we will test them more carefully.

## Single-Lap-Joint Shear Test for Popsicle Sticks

In the chemical industry, chemists and chemical engineers agree on standard testing methods. That way, everyone around the world can do the same test on products. The Single-Lap-Joint Shear Test measures the strength of glue to hold together two pieces of metal as they are pulled apart. We'll do a version using two Popsicle sticks instead of metal.

1. Have an adult help you use a single-hole punch to make two opposite holes near the top rim of a plastic cup.
2. Loop the string through the binder clip and both holes of the cup. Knot the string at both ends, so the knots are next to the holes in the cup.
3. Pick up the two sticks you glued together with store-bought glue. Attach a binder clip to the bottom stick.
4. Holding the other end of the stick assembly, add sand slowly to the cup until the glue can no longer hold them together. Record the amount of sand used by estimating how full the cup was (such as  $\frac{1}{4}$  or  $\frac{1}{3}$  full). Repeat with your homemade glue.

Single Lap Shear Test	Amount of Sand Added Before Glue Failed
Homemade Glue	
Commercial Glue	

What do you think would happen if you tested different ingredients? What if you tried a milk with higher fat content (2% milk, for example)?

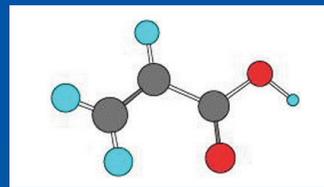
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# Patching People Up: How Wound Adhesives Work

By Verrill M. Norwood III

Have you ever cut or hurt yourself and had to use an adhesive bandage, such as a Band-Aid? If so, then you know that an adhesive bandage is a small piece of sticky adhesive tape with an absorbent pad that you use to cover small cuts or wounds on your body. The absorbent pad is often made of cotton, and there is sometimes a thin coating over the pad, to keep it from sticking to the wound. The adhesive bandage protects the wound and scab from bacteria, damage, or dirt, so that the healing process of the body is less disturbed.



Acrylic acid contains the elements carbon (shown in black), oxygen (red), and hydrogen (blue).

The adhesive used in bandages is commonly an acrylic polymer. What is a polymer? **Polymers** are very big molecules made up of many smaller molecules chemically attached together in a repeating pattern. In fact, the word *polymer* is Greek for 'many parts.'

The smaller molecules that come together to form polymers are called **monomers** — small units that link together over and over to form a large polymer. Think of monomers like paper clips that link together to form a chain, and the chain is a polymer. By changing the type of monomer used, chemists can make polymers with many different characteristics. Acrylate monomers are one type that is especially useful in making glues.

We've all had cuts and scrapes that adults help us take care of at home. But what about more serious wounds — the kinds that involve a trip to the doctor? In selecting a way to close up patients' wounds, today's doctors have many different choices, including sutures (also called "stiches"), staples, adhesive strips, and adhesive glues.

Doctors use adhesive glue — also called "skin adhesive" or "liquid stitches" — to close both major and minor wounds. Skin adhesives have many benefits, such as less pain, antibacterial activity, and less visible scars. They are very effective in closing small, straight wounds on sensitive areas like the face and head.

Most skin adhesive glues used today are made from a type of acrylate polymer known as **cyanoacrylate**. At first, cyanoacrylates were used for non-medical purposes. Have you ever heard of superglue? It was not until 1998 that the U.S. Food and Drug Administration approved a special kind of cyanoacrylate for medical use. Medical cyanoacrylates are less toxic than the regular superglue your parents might use around the house.

What is it that makes acrylates so sticky? The answer is found at the molecular level. The **atoms** in the acrylates tend to have an attraction to other molecules, a force that is similar to what you see in static cling. You can see static cling happening when your clothes stick together as they come out of the dryer, or when you rub a balloon on your head to make it stick to a wall. Stickiness can also come from the glue flowing into the gaps and crevices and holding tight within itself.

One thing for sure is that glues and adhesives can be used in many different ways, as long as we find the right kind of glue for the job!

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