Casein Plastics

Supplies: (bare minimum in blue)

- ❑ Whole milk
- ❑ White vinegar (acetic acid 5%)
- ❑ Microwave safe container (alternative is to heat the milk on the stove)
- ❑ Thermometer
- ❑ Teaspoon (or disposable pipette)
- ❑ Slotted spoon
- ❑ Potholder
- ❑ Paper towel
- ❑ Fine mesh strainer
- ❑ A second container big enough to strain the milk into.

Extended lab:

- ❑ Pens or paint
- ❑ Formalin (Formaldyhe)
- ❑ Container with lid

Protocol:

Notes: You will not need to act quickly for this lab, but it will work better if you don't spend too much time after the milk is heated before adding the vinegar. If you add the vinegar after the milk cools down, the reaction takes much longer and is not as exciting for the students.

1) Pour 1 cup of milk into the microwave safe container or into a pot on the stove. Heat the milk slowly to avoid burning to a temperature of 55°C (131 °F). the milk needs to be heated throughout without boiling. Temperature should not be above 55°C as this will denature the proteins to the point of destruction. The more precise you are with the temp, the better the curds will come out.

2) Once the milk is heated through, add 4 teaspons of white vinegar, stirring gently between each teaspoon addition.

3) While you wait for the acid to work, set up your straining station and paper towels. The straining station should be the fine mesh strainer over the container, and for the paper towels set out a thick layer of 5 - 6 towels. This will get messy!

4) Move back to the millk, and gently remove clumps and place these on the stack of paper towel. These are your first pieces of casein you'll mold and turn into plastic!

5) Using the potholder, tilt the milk into the straining station, and strain out the remainder of the milk, collecting as many clumps as you can. Don't push the clumps into the strainer while doing this. They tend to get stuck in the wholes of the strainer.

6) Tip the clumps out of the strainer onto the stack of paper towels.

7) Take a few more towels and gently pat the excess liquid from the casein clumps. You don't want it to be too dry here. Think cookie dough levels of moisture for easy moulding. If it's too wet, it will crack as it dries. If it's too dry, it becomes crumbly and brittle.

8) Mould the casein into any shapes you want! Or, flatten out with a rolling pin and use a cookie cutter to cut into shapes.

9) Set off to the side to dry for a few days.

Extended lab will be available to Hands on Science Pupils in their membership portal!




Making Art:

Casein plastics were made into buttons, combs, pencil bodies, necklaces, beads, etc. Industrially, it was hard to keep the casein plastic from shrinking and keeping the same shape as it dried, so blanks were often made.

You can mould your casein in a variety of different ways to suit your desires and needs. The best results will come from things that are not ornate and are 1/8inch thick or so. Too thin and the item you make will be brittle or warp. The thicker you make the shape, the longer it will take to dry.

The protocol above is to make a casein blank. If you wish to colour it, it takes pigment quite well.

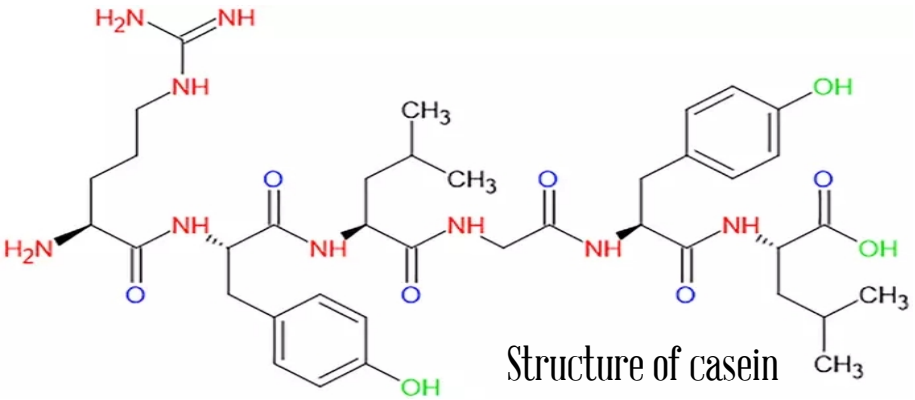
To do this, knead the dough you have made for about 3 minutes then add things you wish to colour it with. We have had success with the following:

- Finger paints
- Acryllic paints
- Paint pigments
- Glitter

After you add the pigment, knead a little more to distrubute the colour or glitter as much as you want. Then, shape.

Notes:

Like the differences between scones and bread, it's all about the moisture level. You could follow this protocol to the letter, but if it's a humid day, it might throw it all off while drying.



Structure of casein

Science:

If you have done any cheese making, you know that we just made a **temporary** plastic out of the curd. The same stuff you would make cheese out of. To make it a permanent plastic, you would have to soak it in formalin (formaldyde), which is what we go through in the extended lab. This unpreserved, unharded plastic? Just like cheese left on the counter, it will mold and biodegrade.

Science of cheese:

Milk has casein, whey, and lipids floating around in suspension. The calcium phophate and kappa casein work together wihin the casein molecules keeps the casein hydrophillic - it loves water and will stay in suspension. (Image next page)

But, over time or with the introduction to heat or enzymes, the micelles alter and become hydrophobic - they hate the water and begin to bond together. The liquid is called whey, while the casein is called curds. Squeezing all the liquid out is the beginning of making cheese or plastic!

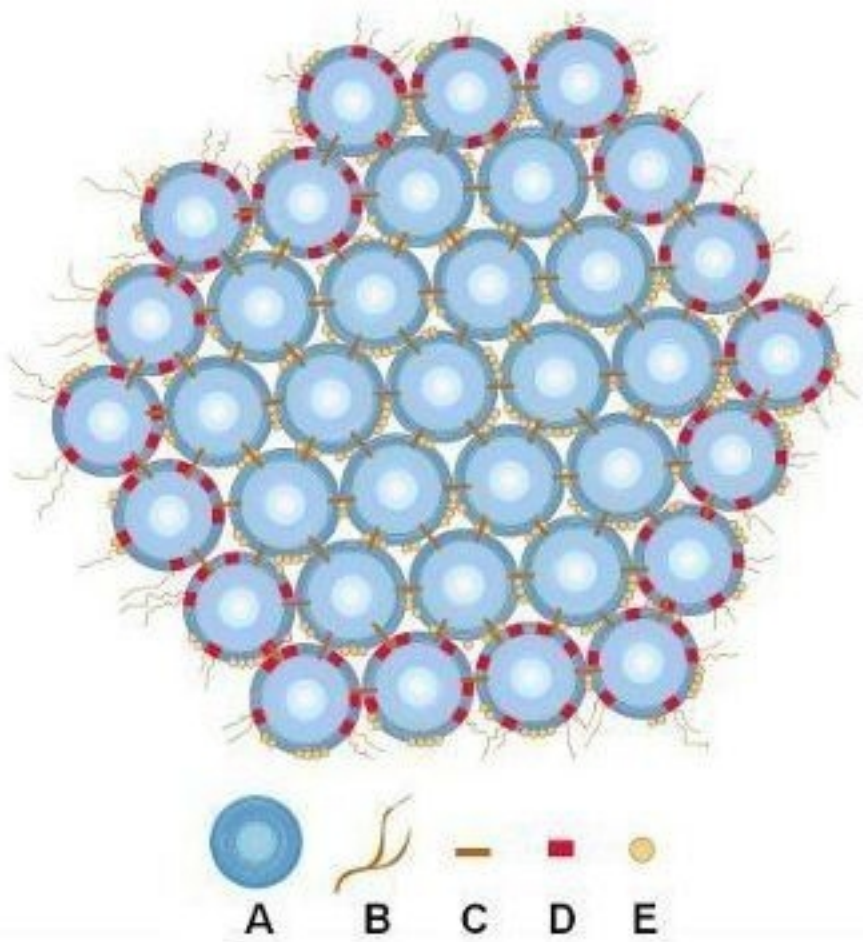
Here is a great resource to see the entire science of cheese:
https://www.sciencelearn.org.nz/resources/827-the-science-of-cheese

Science of casein plastic:

The science of plastic starts up where cheese leaves off. We've removed the whey and we moulded the curd. But to make it into a long lasting plastic, we need to treat it with formaline, also known as formaldahyde. This process takes a long time, but it fills freezes the

The details of this are in the extended lab available in the membership.

Casein Micelles



Food-Info.net/Food-Info Foundation, Wageningen University

A: submicelle

B: protruding chain

C: calcium phosphate

D: kappa casein

E: phosphate group