The Leibfarth Group presents….

CASEIN POLYMERS: MAKING MILK INTO PLASTIC

MATERIALS NEEDED:
Milk
Coffee Mug
Cup
White Vinegar
Paper Towels
Spoons
Funnel
Filter Paper
Cookie Cutters*
Food Dye*

*optional

DIRECTIONS	SCIENTIFIC MEANING
1. Heat the milk in a microwave-safe mug for 5 minutes. This time will vary based on amount of milk in the mug.	Heating the milk denatures the casein protein. Denaturing proteins is like popping popcorn – once you pop the kernel, if can't go back to its unpopped state.
2. Pour some hot milk into a tall dixie cup until it is about halfway full.	
3. Make a separate solution of vinegar in another cup.	The white vinegar is called acetic acid. It has a low pH around 5, meaning it is acidic.
4. Use a tool to transfer about 6 mL of vinegar to the hot milk.	If you have a graduated pipette, use it!
5. Add food dye if desired.	
6. Stir the milk/vinegar solution until it is very clumpy.	Adding an acid, like vinegar, to the milk changes the milk's pH. The casein molecules unfold and reorganize into a long chain.
7. Pour the solid/liquid mixture over a funnel with filter paper. Collect the solids and dry with a paper towel.	The polymer is very "wet" because it can hold water within its chains. You will need many paper towels to dry this polymer!
8. Mold into the desired shape, or use a cookie cutter.	You have taken milk, a typical food, and made it into a plastic.

Other questions to explore: What happens when I change how much acid is added? How much casein polymer can I collect? What is the coldest temperature the milk can be and still denature the protein? Does the type of milk matter?