

## Milk- not just liquid from a cow!!

FRAMEWORK
I. Scientific and Engineering Practices
II. Cross-Cutting Concepts
III. Physical Sciences

SKILLS/OBJECTIVES
To learn about the protein that is in milk (casein), and why it is important for humans to have protein in their diet. Also learn about the different protein and fat contents in different milk.
Learning how to extract protein from milk, using an acid, and then neutralizing that acid with a base.
Seeing that there are proteins and fats in milk from the way milk reacts with food coloring. Also to realize that different types of milk have different fat and protein content.
Realizing that science is all around you- even in your food!
Help to notice that what food we eat does affect our body and how we feel, and that eating foods that have nutrients that we need is good for our bodies.

MATERIALS
<ul style="list-style-type: none"><li>• Skim milk</li><li>• Beaker, 250 mL/ Tupperware</li><li>• Vinegar</li><li>• Baking soda</li><li>• Funnel/filter paper</li><li>• Stirring rod</li><li>• Water</li><li>• Milk (whole and 2%)</li><li>• Almond Milk, Soy Milk</li><li>• Water</li><li>• Orange Juice (if we need to fill extra time)</li><li>• Dinner plate</li><li>• Food coloring (red, yellow, green, blue)</li><li>• Dish-washing soap (Dawn brand works well)</li><li>• Q-Tips</li><li>• Paper for using the “glue”</li></ul>

## NOTES

Help may be needed to filter the curds out of the milk using either filter paper. Also, the younger kids might need help stirring the milk and vinegar mixture to separate the curds from the whey.

Activity could run short or too long; if too short, complete the second experiment using water or orange juice as another example, or repeat experiments again. Also talk about what other foods have protein in them (meat, nuts etc.). If experiment runs too long, only complete the second experiment with one variety of milk.

Make sure during/before every activity the kids make predictions about what they think is going to happen.

Measurements for Activity 1 can be approximated. All of the activities are meant to be

## BACKGROUND

- How do our muscles, and our bodies, get big and strong?
- Why is it important to eat healthy food?
- What is protein?
  - Milk has protein in it, which is important for a healthy body! It helps your cells stay healthy and strong, and is needed for all of the parts of your body. Protein also helps your muscles grow big and strong- so drink your milk!
- Why is it important to eat protein?
  - Hair and nails are mostly made of protein. Your body uses protein to build and repair tissues. You also use protein to make enzymes, hormones, and other body chemicals (enzymes and hormones are fuel for your body's everyday functions). Protein is an important building block of bones, muscles, cartilage, skin, and blood. So basically, protein is important in all parts of your body, and if you don't eat any, it's very unhealthy!
- There are different types of protein; the most important one in milk is called casein. It is sticky and produces glue because it likes to stick to the insides of our stomach and slowly release protein to the rest of our body- so drinking a glass of milk sends protein to your body for quite a while! Today we are going to see what casein looks like by making milk-glue!

Activity #1	Making Protein Glue
Materials	<ul style="list-style-type: none"> <li>○ Skim milk</li> <li>○ Beaker, 250 mL</li> <li>○ Vinegar</li> <li>○ Baking soda</li> <li>○ Funnel/filter paper/cheesecloth</li> <li>○ Stirring rod</li> <li>○ Water</li> </ul>

- Do you wonder what the protein in milk actually looks and feels like? Today we're going to find out!
- Place 125 mL of skim milk in a 250 mL beaker.
- Add 25 mL of vinegar, which is an acidic solution.
- Stir mixture constantly until small lumps begin to form (~1 minute). Allow lumps to settle.
- Filter the solid (curds) from the liquid (whey) using funnel and filter paper (or use cheesecloth).
- Gently press the filter paper/ cheesecloth around the curds to squeeze out the excess liquid through the filter paper/ cheesecloth.
- Return the solid to the beaker. Add 30 mL of water to the solid and stir.
- Add 1/2 tsp. of baking soda to neutralize vinegar, bubbles should appear. Add a little more baking soda until no more bubbles appear.
- The substance in the beaker is glue! Test the adhesive properties, including waterproof property. (If you want, the kids can use this "glue" as part of an art project if there is time left over at the end of the activity)
- Why do you think it's important that this protein is sticky- like glue?
  - Answer: so it can stick in our stomachs after we drink it and slowly release protein into our blood, keeping us strong and healthy all day!
  - If casein was *not* sticky and globular like glue, it would quickly go through your digestive system and you would not get as much protein pumped into your blood to the rest of your body.

Activity #2	Rainbow Milk
Materials	<ul style="list-style-type: none"> <li>○ Milk (whole and 2%, skim, almond, soy, etc)</li> <li>○ Orange Juice and water (for fun/ if have extra time)</li> <li>○ Dinner plate</li> <li>○ Food coloring</li> </ul>

	(red, yellow, green, blue) ○ Dish-washing soap (Dawn brand works well) ○ Q-Tips
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- Pour enough milk in the dinner plate to completely cover the bottom. Allow the milk to settle.
- Add one drop of each of the four colors of food coloring - red, yellow, blue, and green - to the milk. Keep the drops close together in the center of the plate of milk.
- Find a clean Q-Tip for the next part of the experiment. Predict what will happen when you touch the tip of the Q-Tip to the center of the milk.
- It's important not to stir the mix. Just touch it with the tip of the Q-Tip. Go ahead and try it!
- Now place a drop of liquid dish soap on the other end of the Q-Tip. Place the soapy end of the Q-Tip back in the middle of the milk and hold it there for 10 to 15 seconds. Look at that burst of color! It's like the 4th of July in a bowl of milk!
- Add another drop of soap to the tip of the Q-Tip and try it again.
- Experiment with placing the Q-Tip at different places in the milk.
- Notice that the colors in the milk continue to move even when the Q-Tip is removed. What makes the food coloring in the milk move?
- Repeat the experiment using water in place of milk. Will you get the same eruption of color? Why or why not? What kind of milk produces the best swirling of color: skim, 1%, 2%, or whole milk? Why?
- Why does this happen?
- Milk is mostly water but it also contains vitamins, minerals, proteins, and tiny droplets of fat. Fats and proteins are sensitive to changes in the milk. When you add soap, the proteins aren't held in the milk as well, they repel each other like magnets. (Remember the protein in milk that we just learned about? What's its name again?) It becomes a free-for-all! The molecules of protein and fat bend, roll, twist, and move in all directions. The food coloring molecules are bumped and shoved everywhere, providing an easy way to observe all the invisible activity.
- At the same time, soap molecules disturb the fat in the milk. This rapidly mixing fat and soap causes swirling and churning. There's another reason the colors explode the way they do. Since milk is mostly water, it has surface tension like water. The drops of food coloring floating on the surface tend to stay put. Liquid soap wrecks the surface tension by breaking the bonds between water molecules and allowing the colors to zing throughout the milk. (This more complicated explanation is best for older)

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## CONCLUSIONS

- What is the purpose of protein? Where can it be found?
  - It helps give our muscles and bodies energy and helps us grow strong. It can be found in milk, but also in meat and nuts.
- Drinking milk and eating protein is smart!
- Fat isn't always bad- we need some to burn for energy!
- What is your favorite food that has protein in it?