

Magic Milk

Grade Level: 5

Strand: Matter and Materials

Topic: Properties of and Changes in matter

Specific Expectations:

Understanding Basic Concepts (5s31)

- ✚ describe changes they observe in the properties of materials when the materials interact with each other (e.g., when paints are mixed; when water is combined with gelatine)

Materials Required:

- ✚ **shallow clear container**
- ✚ **whole milk or half-and-half (at room temperature) works best** (the higher the fat content the better)
- ✚ **liquid food colouring** (red, blue, yellow, and green)
- ✚ **dish detergent** (e.g., Sunlight works well)
- ✚ **q-tips** (or toothpicks)

Procedure:

- ✚ **Pour enough milk into the container to completely cover the bottom and allow it to settle.**
- ✚ **Add 3 drops of each of the colours of food coloring to the milk.** (Widely separated and not in the centre of the dish)
- ✚ **Predict what will happen when you touch the tip of a clean q-tip to the centre of the milk. Place the tip of the clean q-tip in the centre of the milk. Observe what happens.** (It's important not to stir the mix, just touch it with the tip of the cotton swab.)
- ✚ **Place a drop of liquid dish soap on the tip of the q-tip. Predict what will happen when you touch the tip of a soapy q-tip to the centre of the milk.**
- ✚ **Place the soapy end of the q-tip swab in the middle of the milk and hold it there for 10 to 15 seconds.**
- ✚ **Notice that the food colouring streams away from the point where the soap touched the milk, and the colours in the milk continue to move even when the q-tip is removed. After a while the motion of the food coloring will stop.**
- ✚ **Add another drop of soap to the tip to the q-tip and try it again. Notice that the motion of the food colouring resumes.**
- ✚ **Experiment with placing the soapy q-tip in different places in the milk. Sometimes the food colouring will stream all the way to the side of the dish and then reappear near the center.**
- ✚ **Record what you see. What do you think happened?**



Scientific Explanation: What causes the food colouring in the milk to move?

Simplified response: The dish soap does not mix with the milk. Instead it floats on top and spreads over the surface. As it spreads, it grabs the food colouring. Soap is a "degreaser" so the molecules in it are attacking the fat in the milk, causing motion which creates the swirling of the colours. Where the colours meet, they combine and form new colours.

Liquids like water and milk have a property known as **surface tension**, due to the cohesive forces of the liquid's molecules. If you look closely at the edge of the surface of water in a clear glass, the water appears to rise up the side of the glass because the surface tension of the water is actually pulling the water away from the glass inward toward the center of the surface. Since milk is mostly water, it has surface tension like water. Homogenized milk has gone through a process where the fat is broken up into tiny pieces of fat called **globules** and spread throughout the milk. When the food coloring was added to the milk, the fat globules were steady and undisturbed. Food coloring is less dense than milk, so it floats on the surface. When dish soap touches the surface of the milk, things begin to move. Dish detergent weakens the milk's bonds by attaching to its fat molecules. As the dish soap diffuses into the solution it surrounds the fat globules in the milk.

When you drop the soap into the centre of the milk, it quickly spreads out toward the edges, because soap reduces the surface tension of water/milk. The active ingredient in dish soap is a class of chemicals called **surfactants**, which change the properties of the surface of a liquid, greatly reducing the surface tension. When the advancing surfactant 'wave' hits the colours, the surface tension relaxes and the drops of colour can mix MUCH faster. The stronger surface tension of the surrounding liquid then pulls the surface away from the weak, soapy region. The food colouring moves with the surface, streaming away from the dish soap. This movement sets up currents on the top and bottom of the milk and forces the food colouring under the surface of the milk. The soap reduces the surface tension of the milk by dissolving the fat molecules. The interaction between the dish detergent and the fat in the milk causes turbulence in the bowl as the soap breaks down the fat in the milk. This rapidly mixing fat and dish soap movement causes the food colouring to swirl. The swirling food colouring shows what is happening in the milk allowing us to observe the invisible activity of how the surface of the milk moves and changes in response to the soap breaking up the fat in the milk. As the soap becomes evenly mixed with the milk, the action slows down and eventually stops. With the soap removed from the surface, surface tension returns to its original strength. Adding another drop of dish soap will start the process again and the experiment can be repeated. Eventually all of the fat globules in the milk will be surrounded by soap and some soap will remain on the surface causing surface tension movement to stop.

References:

<http://www.stevespanglerscience.com/experiment/00000066>
<http://www.coolscience.org/CoolScience/KidScientists/tiedymilk.htm>
<http://www.ashland.edu/~marthur/swrmilk.htm>.
<http://www.easyfunschool.com/article1046.html>
<http://askville.amazon.com/Magic-Milk-video-milk-food-coloring-dish-soap-react/AnswerViewer.do?requestId=6953654>

Opportunities and other considerations:

Questions for students:

What happens to the food colouring when you first put it on the milk? Why do you think that is? What happens when you add the drop of soap? What direction does the food colouring move when you first add the drop of soap? What direction does the food colouring move after the experiment has been running for a while? Is the milk moving? Does the movement go on forever? What happens? What happens if you add another drop of soap after the colours have stopped moving?

Extensions:

Investigate using more or less soap, milk at different temperatures, different fat content milk (skim, 1%, 2%, half-and-half, or cream), and different types of detergent. Repeat the experiment using water in place of milk. Will you get the same eruption of colour? Why or why not? What kind of milk produces the best swirling of colour: skim, 1%, 2%, or whole milk? Why?

View milk under a microscope you will see that milk is made of several different parts. What does *homogenized* or *un-homogenized* mean?

Names of Presenters: Sarah Mater and Lisa Hurlbut