Name:_____

Mysterious Milk Lab

Background:

Milk is mostly water but it also contains vitamins, minerals, proteins, and tiny droplets of fat suspended in solution. Fats and proteins are sensitive to changes in the surrounding solution (the milk). When you add soap, the weak chemical bonds that hold the proteins in the solution are altered. It's a free for all! The molecules of protein and fat bend, roll, twist, and contort in all directions. The food color molecules are bumped and shoved everywhere, providing an easy way to observe all the invisible activity. At the same time, soap molecules combine to form a micelle, or cluster of soap molecules. These micelles distribute the fat in the milk. This rapidly mixing fat and soap causes swirling and churning where a micelle meets a fat droplet. When there are micelles and fat droplets everywhere the motion stops, but not until after you've enjoyed the show!

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 of the surface tend to stay put. Liquid soap wrecks the surface tension by breaking the cohesive bonds between water molecules and allowing the colors to zing throughout the milk.

The drops of food coloring stay on the top surface of the milk when dropped onto the milk. This is due to the fact that the food coloring is less dense than the milk, so it floats on the surface. The colors do not mix because they were not stirred. When the soap is added, the soap reduces the surface tension of the milk by dissolving the fat molecules. Students should notice that this experiment works better for the whole milk versus the skim milk because the whole milk has a higher percentage of milk fat. The surface of the milk outside the soap drop has a higher surface tension, so it pulls the surface away from that spot. The food coloring moves with the surface, streaming away from the soap drop. Due to the convection that results from the moving surface, the food coloring may be drawn down into the liquid, only to appear rising again somewhere else. As the soap becomes evenly mixed with the milk, the action slows down and eventually stops. Addition of another drop of soap will start the process again.

Materials:

- Milk (whole or 2%)
- Dinner plate
- Food coloring (red, yellow, green, blue)
- Dishwashing soap (Dawn brand works well)
- Cotton swabs

Procedure:

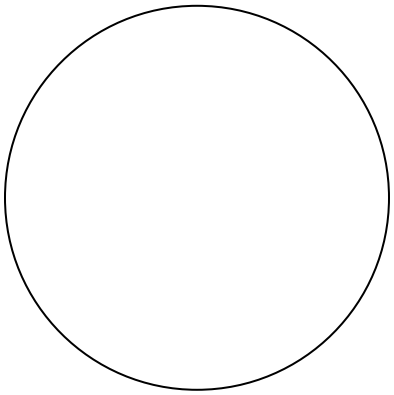
1. Pour enough milk into the dinner plate to completely cover the bottom and allow it to settle.
2. Add one drop of each of the four colors of food coloring to the milk. Keep the drops close together in the center of the plate but not touching each other.
3. Find a clean cotton swab for the next part. Touch the cotton swab to the center of the milk. It's important not to stir the mix just touch it with the tip of the cotton swab. Observe.
4. Place a drop of liquid dish soap on the tip of the cotton swab. Place the soapy end of the cotton swab back in the middle of the milk and hold it there for 10-15 seconds. Observe.

5. Add another drop of soap to the tip of the cotton swab and try it again. Experiment with placing the cotton swab at different places in the milk. Observe.
6. Optional: Try different types of milk like skim, 1%, 2%, or whole milk.

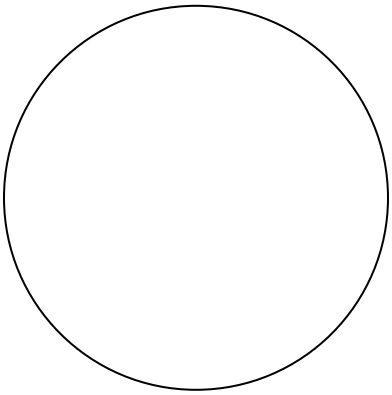
Data:

Draw a picture of your plate before you use the soap and after. Make sure you color!

Before Soap



After Soap



Follow-Up Questions: (answer all in complete sentences)

1. What happens to the food coloring when you first put it on the milk? Why do you think that is?

2. What happens when you add the drop of soap?

3. What direction does the food coloring move when you first add the drop of soap?

4. What direction does the food coloring move after the experiment has been running for a while?

5. Does the movement go on forever? What happens?

6. What happens if you add another drop of soap after the colors have stopped moving?

7. Chemically, what is main difference between whole milk and skim milk? Why is that important for this experiment?