Milk as a mixture

Focus question	What are the components of milk? How might we discover the different types of substances and make a model to explain them?
Vocabulary	Colloid, casein, lactose, mixture, solution, homogenization

Milk is a biological product that contains water, fat globules, casein (milk protein that gives milk its white color), lactose (milk sugar), and vitamins/minerals. It is produced from a lactating mammal (an animal that has recently given birth). Most milk consumed by humans is from dairy cows, usually part of a herd cared for by dairy farmers. These cows have given birth to a calf, and are milked for a limited period of time afterwards to collect the milk. The milk is trucked to a milk processing plant to be separated into various dairy products such as cream, cheese, and milk of varying fat content (skim, 2%, and whole milk), and bottled to be sold in a grocery store for consumption. (Watch **floridamilk.com/on-the-farm/from-the-farm-to-the-fridge.stml** for more details about milk processing).

Materials

- Glass beakers (200–250 mL)
- Paper or white boards
- Microscopes
- Slides and coverslips
- Disposable pipettes
- Sudan III
- Milk
- Heavy cream
- Water
- Food coloring
- Test tubes or jars with lids
- Sugar
- Salt
- Soy lecithin
- pH strips

Procedure

Day 1

1. Obtain a milk sample. Observe the milk sample and create a diagram to show the structure and components of milk.
2. Include labels for each of the components.
3. Guess the relative amounts of each substance within milk. (This could be shown as a pie chart.)
4. Watch the teacher demonstration of the Tyndall effect. Add information to your drawing to help explain what happened.
5. Collect information from the presentation about the components of milk. Add information to your drawing.
6. Examine a drop of milk under the microscope. Prepare your slide.
   a. Use a disposable pipette to put one drop of milk on a slide.
   b. Add one drop of Sudan III stain to the drop.

c. Take a coverslip, touch its edge to the outside edge of the drop at a 45-degree angle, then slowly lower over the drop of milk.
d. Look at the drop under the microscope to observe fat droplets and other ingredients of milk.
e. Add a drawing of what you see to your milk particle diagram. Write down any other observations.

Day 1 reflection

1. What particles did you include in your drawing?

2. Explain the Tyndall effect.

3. Draw what you saw under the microscope.

Day 2

1. Obtain 5 mL of heavy cream in a small capped tube or jar. Add 1mL of colored water. Observe the mixture.
2. Shake the tube or jar vigorously for 30 seconds. (Be sure the lids are capped tightly!)
3. Observe the mixture again. How is it different?
4. Record the time, set that mixture aside. Check the mixture every 5–10 minutes. Record your observations.
5. Repeat steps 1–4 again and this time add a pinch of “stabilizer” to the tube or jar before shaking. Choose from salt, sugar, or soy lecithin.
6. Hypothesize whether the “stabilizer” will help the emulsion stay mixed for a longer period.
7. Time how long it takes for separation to begin for both mixtures.
8. Make a data table to record your observations.
9. Add a section to your drawing to show the mixture after shaking.

Data table

Day 2 reflection

1. How did shaking affect the mixture?

2. Did salt, sugar, or soy lecithin make a difference in stability?

Day 3

1. Observe your mixtures from the previous day. Make note of any new observations.
2. Look at two samples of milk: one that's been heated and cooled and one left at room temperature.
3. Measure the pH using pH strips or Universal Indicator. Record your observations.

Day 3 reflection

1. What might account for the difference in pH?

2. Why are emulsions important in foods like milk?

3. How do additives help stabilize emulsions in processed foods? (Think about chocolate or salad dressings.)

4. How does this experiment relate to milk homogenization?

5. What is the purpose of pasteurization?

Rubric for self-assessment

Skill	Yes	No	Unsure
I can identify and classify the components of milk, such as water, fats, proteins, and sugars.			
I can analyze and interpret data from experiments that separate milk components.			
I can develop a clear model to show milk's molecular composition as a mixture, solution, or colloid.			
I can explain the difference between physical changes (e.g., homogenization) and biological changes (microbial growth) in milk.			
I can draw connections between the molecular scale of milk's components and their observable properties.			
I can use evidence from my experiments to explain how milk behaves during processing, like homogenization or separation.			
I can connect the scientific concepts I've learned about milk to real-world applications in dairy science and industry.			