Lesson Plan: Making Sense of Milk

FOR THE TEACHER

Summary
In this lesson, students will compare and contrast the chemical compositions of different types of plant milk and animal milk by analyzing data and developing models.

Grade Level
Middle School and High School

NGSS Alignment
This lesson will help prepare your students to meet the performance expectations in the following standards:

- **MS-PS1-1:** Develop models to describe atomic composition of simple molecules and extended structures.
- **Scientific and Engineering Practices:**
  - Developing and Using Models
  - Constructing Explanations and Designing Solutions
  - Obtaining, Evaluating, and Communicating Information
- **Crosscutting Concepts:**
  - Scale, Proportion, and Quantity

Objectives
By the end of this lesson, students should be able to

- Define solution, colloid, and suspension.
- Compare and contrast properties of a solution and colloid.
- Explain how the macroscopic, microscopic, and particulate models are related to the physical properties of milk.

Chemistry Topics
This lesson supports students’ understanding of

- Solutions
- Colloids
- Mixtures

Time
**Teacher Preparation:** 15 minutes
**Lesson:** 1.5-2 hours
- Engage: 15-20 minutes
- Explore: 45 minutes
- Explain: 20-30 minutes
- Elaborate: 45 minutes

Materials (per group)
- Sticky notes
- Milk samples in small paper cups:
  - Soy Milk
  - Almond Milk
  - Coconut Milk
  - 2% Milk

Submitted by
Stacey Balbach
Cuba City School District
Cuba City, Wisconsin
• 4 pieces of pH paper
• Colored pencils or markers (colors needed: red, orange, yellow, green, blue, light blue, purple, black, gray, pink)
• Ruler (in cm or mm)

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Students should wash their hands thoroughly before leaving the lab.
• Make sure to provide teacher instructions for how students should clean up materials and dispose of any chemicals.
• Do not consume lab solutions, even if they’re otherwise edible products.
• Food in the lab should be considered a chemical not for consumption.
• Check with students regarding milk and soy allergies.

Teacher Notes
• The activities can be broken into three forty five minute class periods or used in one block.
• Students will read the article, “Making Sense of Milk” published in the February 2019 issue of ChemMatters during the “Explain” stage of the lesson.
• The “Elaborate” activity could be used as a standalone lab if desired.
• Students will need to be familiar with and understand the following vocabulary terms: Colloids, Solutions, Heterogeneous, Homogeneous, Viscosity, Molecule, Ion, pH.

Engage (15-20 minutes)
• Distribute the “Engage” student handout.
• Students will participate in a Think – Pair – Share. Think Pair and Share is a teaching strategy where students think of ideas individually, then pair up with a partner to share ideas. Accept all student ideas.
• Display the initial questions from the Engage handout on a screen or write them on the board, and ask students to try to answer them individually on their sticky notes. Each answer will go on one sticky note.
• Remember you do not want to tell the students the answers to these questions. You want to awaken their inner scientist. You are setting the stage for discovery, so give them the opportunity to think about each question.
• After a couple minutes or so, ask students to share their answers with an elbow partner or lab group.
• Post the answers (Answer Key document provided) to the questions on the board.
• Student groups observe all class answers after posted on the board. Remember that at this point in the lesson, the students have no idea what milk is made of, and that is okay.
• Using the answers and conversations with peers have students draw a detailed model of the composition of milk. *Remember that students do not have an understanding of the composition of milk quite yet. Example of student work is shown.
• As a class, develop a list of questions that students are wondering about that are focused on the composition of milk.
• After students have completed their initial models, collect them, and post them in the classroom so they can think about what their model.
• **Explore (~45 minutes)**
  o Distribute ~15 mL of each type of milk in small paper cups to each lab group.
  o Students will follow the instructions in the Explore lab handout gather data (physical characteristics are the macroscopic properties) on the color, pH, texture, and viscosity of each milk sample.
  o The color of the milk is a physical property of milk. Students need to look at the milk and decide what color it is. It would be helpful if a white piece of paper is made available for color comparison purposes.
  o The pH of milk will be measured with pH paper (use litmus paper if not available) by dipping the paper into the milk sample. Use the color key on the side of the pH paper container to determine the pH value.
  o Texture is based on the structure of milk. Students will determine texture of the milk by rubbing a drop of milk between the tips of their fingers.
  o Students will measure viscosity by pouring the milk sample from one cup to an empty cup. They will need to rank the flow rate on a scale from 1 to 5. Rating 5 means it flows easily (low viscosity) while rating 1 would indicate a very thick like glue (high viscosity).
  o Students are told to share data on class data sheet. This could be a shared Google document or a chart up on the board.
  o After the lab has been completed, the class should come to a consensus about each physical property of milk.
  o An Answer Key has been provided to indicate expected results.
  o Task students with completing the Explain portion of this lesson as homework (optional).

• **Explain (~20-30 minutes)**
  o I suggest assigning students to read the ChemMatters article, “Making Sense of Milk” and completing the associated “Explain” handout as homework. If this isn’t appropriate for your students, allow for 20-30 minutes of class time for students to complete this task.
  o After the Explain handout has been completed, review the list of ten ideas connecting the article to the properties of milk.
  o Students are also instructed to define some vocabulary terms and create a concept map. Students can use this video and this website to help complete the definitions.

• **Elaborate (~45 minutes)**
  o To begin the class, students share the concept map that they each created from the “Explain” section with their elbow partner.
  o Discuss the following with their elbow partner:
    - Compare what is similar between each concept map.
    - Compare what is different.
    - Make edits/update their version.
  o Address any questions that were generated from the article reading, definitions and concept map creation.
  o Give students a copy of the “Elaborate” handout.
  o Students can form partners and will choose (or teacher can assign) one specific type of milk that they will develop a model for.
  o On the “Elaborate” handout, students will use Table 1: Nutrition facts (this information was compiled from the side of actual milk bottles) in order to complete Table 2 and have all the necessary information needed to create a model.
  o Table 2 on the “Explore” handout describes the symbols that should be used in a scaled model of milk at the particulate level.
  o After students completed their models post them, so students can analyze, compare and discuss the results.
  o Finally, students will answer the Analysis Questions provided on the handout.
  o An Answer Key for the handout is available for teacher reference, as well as a separate PDF document that contains examples of models for each type of milk.