



## Phase Changes of Cream into Butter

### Description:

Besides being just plain fun, making butter is a great way to demonstrate one of the many ways food is made, as well as how liquids can be converted into solids. You can get more in depth and use the lesson to demonstrate *phase change*. Couple this activity with *Ice Cream in a Bag* lesson to demonstrate and compare it with *physical changes of matter*.



*Butter making - start with heavy cream, shake vigorously for 10 minutes, pour off buttermilk and enjoy.*

**Directions:** (Note: Before starting students need to thoroughly wash their hands.)

1) Divide students into groups of 4-5. Each group will need a 2 oz. container with a tight sealing lid, 1.5 oz. of heavy cream, and a paper towel. Ask students how butter is made, and hypothesize what will happen in this experiment. Record guesses.

2) Students should pour 1.5 oz. of heavy whipping cream into the 2 oz container. Make sure there is air space in the container and then seal with lid tightly.

3) To add variability to the experiment, have half of the students add 1/4 tsp of salt to their containers with the cream.

4) Before students begin shaking the container, have them hypothesize about what they think will happen. Consider these questions: How much time will they need to shake the container before butter is formed? Does the force and speed of the shaking make a difference? Does temperature matter? Will the salt affect the butter making process? Record their responses on the board. Have different groups shake their containers at different rates. Record findings.

5) Have students begin to shake the sealed containers of cream. Wrap the container with a paper towel to catch any leaks. Have different groups shake at different speeds and forces based on their earlier hypotheses.

6) Compare the salted butter to the unsalted butter. How does it look? Taste? List similarity and differences and compare to earlier hypotheses. Record findings.

### What You Should See:

After approximately 10 minutes of vigorous shaking, a lump of butter will form. There will also be some liquid (buttermilk). Pour the buttermilk off and keep shaking until no more liquid separates.

Add a math element to the lesson by having students measure how much buttermilk comes off each container. Compare this to earlier measures of the cream to determine percentage of buttermilk and butter (fat solids). Traditionally, when people made their own butter, they would collect the buttermilk in a jar and cool it for drinking or baking.

**Grade Level:** K-3

**Essential Skills:** 5, 9

**NGSS:** 2-PS1-1

**Mathematics:** MP.2,  
MD.5.C.3

**Time:** 1 class period

**Materials:** Heavy Whipping Cream (1.5 oz./ per container); plastic 2 oz. containers with lids (1 container per 4-5 students); salt; paper towels

**Phase Change** is a change from one state (solid, liquid or gas) to another without a change in the chemical composition. In this experiment the cream is changed from a liquid into congealed fat solids and liquid through shaking.

### AITC Library Resources:

#### Books:

*Dairy on my Plate*  
*Dairy Cows Send Their Best Vroom: Dairy Farming for Kids*

*Alison Investigates: Does Chocolate Milk Come From Brown Cows*  
*Four Quarts Makes a Gallon*  
*My Cows - A Welcome Book*

#### Videos:

Moo 2 You  
Make Mine Milk  
From Moo to You

#### More Lessons:

Physical Changes of Matter and Ice Cream; Yogurt and Microorganisms

**Instructional Unit:** Science in Your Food Supply

**Butter History:** The earliest butter was made from sheep or goat's milk about 4,000 B.C. An ancient method of butter making, still used today in parts of Africa and the Near East, involves a goat skin half filled with milk, and inflated with air before being sealed. The skin is then hung with ropes on a tripod of sticks, and rocked until the movement forms butter. In the Mediterranean climate, non-clarified butter spoils quickly— unlike cheese, butter making is not a practical way to preserve milk.

In the cooler climates of northern Europe butter was able to be stored for a longer period before it spoiled. Through much of the Middle Ages butter was a common food across most of Europe, but one with a low reputation and eaten principally by peasants.

Until the 19th century butter was mostly made by hand on farms. The first butter factories appeared in the United States in the early 1860s, after the successful introduction of cheese factories a decade earlier. In the late 1870s, a centrifugal cream separator was invented. This dramatically sped up the butter-making process by eliminating the slow step of letting cream naturally rise to the top of milk. Initially, whole milk was shipped to the butter factories, and the cream separation took place there. Soon, though, the separation was done on dairy farms, and the cream alone shipped to the factory. By 1900, more than half the butter produced in the United States was factory made; Europe followed suit shortly after.

**What is Butter?** Butter is made by churning cream until it reaches a semi-solid state. The churning separates the fat solids and the buttermilk. By U.S. law, butter must be at least 80% butter-fat. The USDA grades butter quality based on flavor, body, texture, color and salt. The grades are AA, A, B, C. It takes 21 pounds of fresh, cow's milk to make each pound of butter.

Before modern factory butter making, cream was usually collected from several milkings and was therefore several days old and somewhat fermented by the time it was made into butter. Butter made from a fermented cream is known as *cultured butter*. Today, cultured butter is usually made from pasteurized cream and the fermentation is produced by adding *Lactococcus* and *Leuconostoc* bacteria. Another method for producing cultured butter, developed in the early 1970s, is to produce butter from fresh cream and then incorporate bacterial cultures and lactic acid. Using this method, the cultured butter flavor grows as the butter is aged in cold storage. For manufacturers it is more efficient, since aging the cream used to make butter takes significantly more space than simply storing the finished butter product.

### **Extension Activities:**

1. Watch a video on how butter is made commercially. The Oregon AITC YouTube [playlist](#) has a number of them. A good option is from the How Its Made: Bread and Butter. Also, the [Butter vs. Margarine video](#) on the Asap SCIENCE channel briefly compares the chemical composition and nutritional value of butter and margarine.
2. Conduct a short research project. Does the butter form in the same way if the cream is heated up first? What if it is chilled first? Write a summary on the effects of temperature on butter formation.