

Learning Sources



PROJECT Agriculture
Project-Based Learning and
Teaching Series

Everyday Chemistry

Why is it important to know what we eat?



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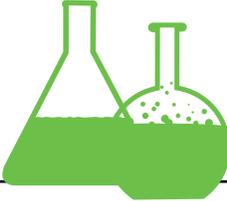
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Dairy Products

How much do you know about the milk you may drink every day? Milk has many nutrients. Its composition, or the elements that are part of milk, can vary depending on the breed of cow used to produce it. However, milk is generally:

- About 88 percent water
- 5 percent **lactose**, which is a form of sugar found in milk
- About 4 percent fat
- About 3 percent protein
- About 1 percent minerals, including calcium



Canada's Food Guide



Eating Well with Canada's Food Guide identifies Milk and Alternatives as one of the four essential food groups.

Do a web search using the terms "Canada's Food Guide" and "Milk and Alternatives." What did you find?

Government of Canada. *Eating Well with Canada's Food Guide*. www.canada.ca/en/health-canada/services/food-nutrition/canada-food-guide/get-your-copy.html

What is one guideline for healthy eating from the Milk and Alternatives food group?

Sixteen essential nutrients are found in milk. These nutrients include:

- Protein
- Vitamin B6
- Calcium
- Niacin
- Potassium
- Folate
- Phosphorus
- Pantothenic Acid (Vitamin B5)
- Magnesium
- Riboflavin
- Selenium
- Vitamin A
- Thiamin
- Vitamin D
- Zinc
- Vitamin B12



Making Yogurt



The sugar, or carbohydrate, in milk is called **lactose**. Lactose goes through **fermentation**, the process that converts sugar into an acid.

When it ferments, it makes an acid called **lactic acid**. This acid combines with the protein in milk to give yogurt its tangy taste and thicker texture.





Made from Milk



There are many dairy products that are made from milk. Cheese, yogurt, ice cream, and butter all have their beginnings with milk. Cheese is made from the protein in milk. When **rennet**, an enzyme found in animal's stomachs, or a lactic acid is added to milk, it changes. The milk **curdles**, or separates the solids from the liquid.

These **curds** are solids. They are then used to make cheese. The liquid that is left over is called **whey**. The whey is drained from the curds. The curds are then pressed into blocks or rounds.

Do you think cheese making involves a chemical reaction?
Why do you think this?

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Make it Ice Cream



Ice cream is made from cream. When the cream is combined with other ingredients, including fruit flavours and sugar, and then frozen, it makes ice cream.

What are two examples of mixtures found in foods made from dairy products?

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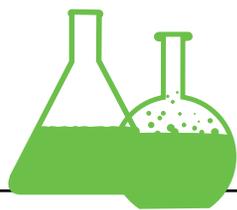
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What Happens to Milk at a Dairy

Milk and other dairy products are an important way for us to get nutrients we need to live and grow. Many people also enjoy the taste of dairy products.

But milk hasn't always been as safe to drink as it is today. Before the twentieth century, food producers did not have refrigerators and stainless steel tanker trucks to help them get food to consumers.

Even though dairy farmers took great care to keep their animals clean, harmful bacteria found in the milk sometimes made people ill. Serious diseases could be contracted from drinking milk that was spoiled by coming into contact with harmful bacteria during milking or transportation.

Milk naturally contains bacteria that feed and grow on the nutrients in the milk. Some of the bacteria might make people sick, so raw milk must first be pasteurized before a dairy processor uses it to make dairy products.





Milk Has a History



Thousands of years ago, people changed from tribes that moved around to those who settled in communities. With this came domesticated animals and the use of products such as milk.

- In ancient Egypt, milk and other dairy products were reserved for royalty, priests and the very wealthy.
- By the 5th century, cows and sheep in Europe were prized for their milk.
- By the 14th century, cow's milk became more popular than sheep's milk.
- European dairy cows were brought to North America in the early 1600s.
- Louis Pasteur, a French microbiologist, conducted the first pasteurization tests in 1862. Pasteur is credited with making milk safe to drink. This also allowed milk to be stored and distributed well beyond the farm. Commercial pasteurization machines were introduced in 1895.
- In 1884, the first milk bottle was invented in New York State.
- In the 1930s, milk cans were replaced with large on-farm storage tanks and plastic coated paper milk cartons were invented, which allowed for wider distribution of fresh milk.

Photo Credit: Glenbow Archives ND-3-6981b





Warm Milk

Milk comes out of the cow warm, at the cow's body temperature. It is quickly cooled on the farm when farmers move it to refrigerated storage tanks. These tanks keep the milk's temperature at 4°C.

Milk is never touched or handled. Pipelines move the milk to the storage tank, where it is stored until the tank truck comes to pick it up. A tank truck is like a giant thermos. It keeps milk cool on its way to the dairy processing plant. It only takes about 2 days from the time milk leaves the cow until it's on the grocery store shelves.



This photo shows the pipe that goes from the milking equipment to the milk storage tank.

Why do you think milk has to be transported so quickly? What does this have to do with the chemistry of milk?

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More About Pasteurization

A French scientist, Louis Pasteur, discovered that quickly heating and then quickly cooling milk killed harmful bacteria without changing the milk's nutrient value. This process is called **pasteurization**, after him. He was looking for a way to make foods and beverages safer for people.

Pasteur worked with fermentable liquids. These **fermentable liquids** are substances, such as milk, that allow bacteria to grow. The growth of bacteria causes fermentable liquids to spoil.

Milk will spoil because bacteria breaks down the lactose. **Lactose** is a sugar molecule that is found in the milk of animals.

If milk is not kept cold enough, the bacteria breaks the lactose down and forms lactic acid. This acid is what causes milk to sour. Soured milk smells bad but does not change colour.

Today, milk is pasteurized using the **HTST** (High Temperature, Short Time) process. In most dairies, the milk is heated to at least 72°C for 16 seconds and then cooled to 4°C. Most milk sold in Alberta has gone through HTST pasteurization.

Another way to pasteurize milk is called **UHT** (Ultra High Temperature). In this process, the milk is heated to at least 138°C for 2 seconds. Then it is quickly cooled to 2°C. This milk is almost sterilized by the high heat, which kills most bacteria.

This milk is packaged under germ-free conditions. Therefore, the milk can be stored safely in the unopened container, at room temperature, for up to six months. Once opened, it must be kept in the refrigerator.



How many examples of chemical can you find in the description of milk?





Although we think of milk as something to drink, it is really a liquid that also contains solids. Milk is made up of water, fat and milk solids.

The **milk solids** are made of carbohydrates and protein. These milk solids are **dispersed**, or evenly spread out, within the milk.

The **fat**, also called milkfat or butterfat, tends to gather at the top of the milk, unless it has been homogenized.

Almost all milk is homogenized to keep the milk fat from separating and floating to the top. Milk fat is what makes milk creamy, rich, and flavourful.

A **homogenizer** is a machine that forces the milk at high pressure through tiny holes. This process breaks up the milk fat globules into particles one-eighth their original size. When the milk fat particles are that tiny, they stay mixed in the milk.

Raw milk has 3.7 percent milk fat. When raw milk is processed, the milk fat is separated from the milk and then added back in to make products with different milk fat contents.

Why do you see different types of milk cartons in grocery stores?

Milk that has 3.25% milk fat is labelled homogenized milk.

In 1% and 2% milk, some of the fat has been removed, but the remaining fat has been homogenized back into the milk.

Skim milk has had almost all the milk fat removed. To be called skim milk, it must have less than 0.3 percent milk fat.





Milk is a Mixture

Examples of Milk Fat in Dairy Products

Milk (88% Water + 5% Butterfat + 7% Solids)



Condensed (26-28% fat) or Evaporated Milk
Milk Solids



Whole Milk (3.25% fat)
Low Fat (1-2% fat)
Skim / Cream (<0.5% fat)



Ice Cream (10% fat)
Frozen Yogurt (3.25% fat)



Butter (82% fat, 16% water, 2% solids)



Cheese (55-85% fat)
Curds, Cheddar, Whey, Ricotta



Cultured Products (12-30% fat)
Yogurt, Buttermilk, Sour Cream

Milk is a mixture of solids and liquids. Milk solids are made of proteins and carbohydrates. The main protein in milk is called **casein**. The casein is found throughout the milk. The main carbohydrate is called **lactose**. Lactose is broken down in your body by an enzyme. An **enzyme** is a protein that is produced by cells in the body. Lactase is the enzyme that breaks down lactose.

Enzymes react with substances you eat. People who do not have an adequate amount of the lactase enzyme are "**lactose intolerant**." This means that they have trouble digesting milk and dairy products.



Butter



Butter is a very concentrated form of milk fat. Butter is composed of milk fat, water and milk solids. The fat in milk is part of the milk mixture. When cream is **churned**, or mixed very hard, the fat separates from the milk mixture and forms a small ball. The fat solids can usually be seen and are about the size of a grain of rice.

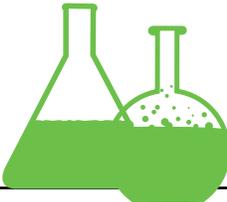
Why do you think cream, not skim or lower fat milk, is used to make butter?

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Dairy Patterns

What quantities of dairy products do Canadians consume? The dairy products that Canadians consume have changed over time:

- The amount of whole milk has decreased.
- The amount of lower-fat milk has increased.
- The amount of ice cream and butter has decreased.
- The amount of cream, yogurt and cheese has increased.

Why do you think the consumption of these products has changed?

An individual in Canada consumes about 1.7 servings of milk products per day.

- Total fluid milk = 70.64 L (194 mL per day)
- Total cheeses = 14.08 Kg (39 g per day)
- Yogurt = 10.53 L (29 mL per day)





Cheese, Please



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Of the total fluid milk consumption, 2% milk represents the largest intake:

- 2% Milk = 34.44 L
- 1% Milk = 13.99 L
- Whole Milk (3.25%) = 10.08 L
- Skim milk = 5.58 L
- Chocolate and other flavoured milk = 6.23 L
- Buttermilk = 0.33 L

What are some other food products that are liquids? What food products are solids?