Grade 5 It's All in the Mix

What does it take to make a Dairy Product?

A Science and Social Studies Inquiry

Adding Value to our Natural Resources

What dairy products are made from milk?

What happens when milk is mixed with other substances?

What happens to milk at the dairy?

Liquids and Solids

Properties of Milk

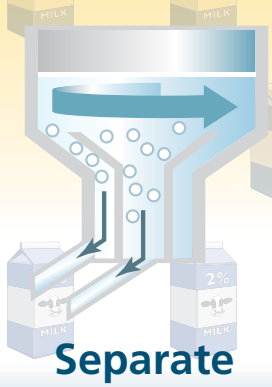

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Table of Contents

What does it take to make a dairy product?

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A Science and Social Studies Inquiry Grade 5

Introduction

The Canadian dairy industry is diverse, ranging from family farms to partnerships, and includes regular and organic dairy farms. Dairy cattle are an important feature of many Canadian and Alberta landscapes, and provide a range of products that many people depend upon daily. The dairy industry also provides a range of jobs and occupations. Dairy farmers take their responsibilities seriously, including those for the animals in their care, as well as the impact their industry has on the environment. Milk and dairy products play an important role in a healthy and balanced diet.

Alberta Milk's *Moo2You* resources and website, accessed at **www.moo2you.ca**, provide an innovative and curriculum-focused program that encourages students to explore the importance of agriculture, the workings of dairy farms, and how farmers and processors get milk from the "moo" to you. The *Moo2You* resources have been designed to meet and reinforce learning across Alberta programs of study, including Social Studies and Science, with suggestions for integrating outcomes from Health and Life Skills, Mathematics, and Language Arts.

The *Moo2You* resources include the following components.

1. This *Moo2You* print-based teaching and learning resource, which integrates and extends learning with the *Moo2You* website and engages students' multiple intelligences and natural sense of curiosity about where some of the food they eat daily comes from.
2. The *Moo2You* website, which includes interactive activities and student articles that encourage students to act as "investigative" and active online journalists and researchers.

The Moo2You Website

The *Moo2You* website provides students with a series of inquiries centred on agricultural practices, dairy farming, and the dairy industry. Each inquiry is self-contained, but also provides a sequenced exploration of concepts related to agriculture, and specifically dairy farming, that supports the Alberta curriculum. In addition, the *Moo2You* website can be used independently of the inquiry-based units.

It's All in the Mix

What does it take to make a dairy product?

Milk and dairy products are one of the most regulated and tested foods that are made and provided for sale in stores. The dairy industry is part of Canada's agricultural resources and the products that come from milk are manufactured into a wide range of products that many people use daily. Dairy processors add "value" to the agricultural products that Canadian farms produce by making them into different types of foods. Milk is a good example of a product that is produced and consumed locally.

What does it take to make a dairy product?: It's All in the Mix encourages students to explore what happens when milk goes from "moo" to ice cream, yogurt, butter, cheese, and other dairy foods. Students find out what the connections are between the chemistry and production of milk.

The *Moo2You* inquiries are part of a series of resources that are designed to be used either in sequence or concurrently. The activities in each inquiry are research-based, and can be combined as well as taught independently. For example, students can use the articles in more than one inquiry for their research, and then create a product that shares their learning and insights.

Students can find articles from all inquiries by clicking on the **Researcher's Corner** and **Scientist's Corner** icons. They can explore all question and answers by clicking on the **Question Corner** icon.

- Ask students to browse and find questions that interest them or that connect to this inquiry.
- Introduce students to a research portfolio by using the *Sort Portfolio* tab to cluster questions for this inquiry.
- Encourage students to build their own portfolio of articles, questions, and answers by searching for keywords, such as dairy product and milk, on the *Moo2You* website.

Each inquiry-focused page also includes an interactive app that can be accessed by clicking the **Games Corner** icon.

Students can also search with topics in the Word Cloud on the *Moo2You* home page or with their own search terms. Have students identify search terms they think are connected to this inquiry.

It's All in the Mix can be challenging to complete without prior knowledge of the processes and ingredients involved in making different dairy products. **Mix It Recipe Cards** are provided, in PDF format, on the **It's All in the Mix** inquiry page and the **Game Corner** on the *Moo2You* website at **www.moo2you.ca**. The **Recipe Cards** can be copied or printed, laminated, and cut out to be provided to students. Review all instructions and remind students to look for clues in text boxes that appear with each process and ingredient!

The *Moo2You* website, found at **www.moo2you.ca**, provides information to students on inquiry-focused pages. Access the **It's All in the Mix** inquiry by scrolling through the illustration panel or by clicking it at the top of the home page.

Each inquiry page includes a series of related questions with interesting and informative answers as well as a set of *Student Research Articles*. These articles are duplicated in this *Moo2You* teaching resource. Some articles can be displayed on an interactive whiteboard, facilitating large group or whole class discussions.

The Moo2You It's All in the Mix Interactive App

This *Moo2You It's All in the Mix Interactive App* encourages students to explore different processes that are used to produce a wide range of dairy products, including heating and cooling, blending, freezing, and separating. The interactive activity supports learning through the following process:

- Students start with a dairy processing plant screen. They are challenged to find out how different dairy products are made by mixing different processes and ingredients together.
- Students can mix their dairy products in two different ways:

  1. They can pick a specific product to mix by selecting a dairy product icon and clicking the "OK!" button.
  2. They can leave the "Dairy Product" box empty, select different processes and ingredients, and add them to the processing screen to find out what type of dairy product their "mix" creates.

- Icons represent each of the processes and ingredients. As students select each process or ingredient icon, a text box provides information and clues.
- To mix a dairy product, students "Add" the process and/or ingredient to the processing screen.
- At any time, or once they have selected processes and ingredients for a product, students can click on the "Check Your Mix" button. They will be prompted with a message if they select a process or ingredient that doesn't belong or is in the incorrect order. They can then clear the icons and start again.
- After students finish their mix, they can click on the "Print" button that appears. The screen will print, including the processes and ingredients they used to make their dairy product.

The interactive activities are session-based. This means that students must complete the activity before they leave the site or they must start over.

The Learning Context

Inquiry is a natural and innate learning process that engages individuals in seeking information and building understandings through questioning. Learners gather information and data throughout their lives through their senses – seeing, hearing, touching, tasting, and smelling. The *Moo2You* inquiry process encourages students to use their senses to ask questions, explore information, develop understandings, find connections, draw conclusions, and share learning.

The Moo2You Inquiry Model

Learning activities are organized around each of the four stages of the *Moo2You Inquiry Model*. Learning activities include the following features:

- **Differentiate** provides suggestions for adapting activities to meet a range of different learning needs and interests.
- **Integrate** provides options to make connections to other subject areas, including Science, Language Arts, and Health and Life Skills.
- **Assess** includes approaches to assess and evaluate student learning and progress.
- **Timing** includes estimated minutes of instruction for each step in the model.
- **Teacher Background Information** provides an overview of the context of the inquiry. Additional sources, including website links, are provided to support learning activities.
- **Student Research Articles** include *Researcher's Corner* and *Scientist's Corner* features, which focus on different research and inquiry strategies, including the use of primary sources, first-hand accounts, maps, artifacts, and photographs, as well as hands-on lab experiments. These *Student Research Articles* are also available in PDF format in the **It's All in the Mix** inquiry on the *Moo2You* website aat **www.moo2you.ca**.
- **Inquiry Templates** are accessible in the **Teacher's Corner** on the *Moo2You* website at **www.moo2you.ca**. These templates provide a range of graphic organizers that students use to gather, organize, and synthesize their research.

Ways to Integrate Moo2You

Each *Moo2You* inquiry is designed to take one to three weeks of classroom time, depending on how activities are selected or adapted. Suggested class times are provided in each section of the *Moo2You* inquiry learning process.

What is Included	What You Supply
• Teaching and learning suggestions • Student resources, presented as research articles • Research and learning activity templates • The *Moo2You* website page and *It's All in the Mix Interactive App*	• Photocopies of *Student Research Articles* • Poster paper • Web access for groups of students • Materials for Labs in *Student Research Articles* 3, 5, and 6 **Article 3** ◦ Milk ◦ Tea ◦ Water ◦ Sugar ◦ Vinegar ◦ Optional substances of your choice to mix with milk ◦ Measuring cup or dropper ◦ Bowls or jars to mix the liquids **Article 5** ◦ 125 ml of whipping cream ◦ Glass or plastic jar with a lid ◦ Colander ◦ Salt **Article 6** ◦ Whole milk ◦ Skim milk ◦ Coffee cream or half and half (cereal cream) ◦ Three shallow bowls ◦ Red, green, yellow, and blue food colouring ◦ Eye dropper ◦ Cotton swabs or toothpicks ◦ Liquid dish detergent

- Integrate the inquiry as a mini-unit or focused case study, and as a means of making connections and reinforcing learning about concepts related to products that are part of everyday life. This inquiry provides an excellent opportunity to encourage students to develop understandings of where dairy foods come from, how they are part of the "bigger picture" of agricultural resources, and how everyday chemistry is connected to the production of these products.
- Create a bulletin board display that summarizes processes involved in heating, cooling, mixing, and separating household items and foods, including dairy products. Challenge students to "fill" the bulletin board as they complete their research and post examples that illustrate "everyday" chemistry.
- Make connections to other areas and topics that are part of the Grade 5 Social Studies program, including Canada's regions, human activities, and natural resources. Encourage students to see the relevance of agriculture, using dairy production as one example, to ways and quality of life.
- Make connections to Health and Life Skill concepts and nutrition. Create a display that highlights different dairy products. Ask students to bring in empty containers of dairy products. Create facsimiles of nutritional labels to add to the display and have students analyze the nutritional content of different products.
- Create a learning centre that provides information and the student research articles. Adapt the learning activities in this inquiry to provide independent, paired, or group research tasks that students complete as they progress through their study of Alberta. Use the **It's All in the Mix** inquiry page on the *Moo2You* website at **www.moo2you.ca** as a starting point for student research tasks.
- Focus on ways that information is shared through different forms of media. Encourage students to explore how stories about Alberta and ways of life in urban and rural communities are shared through both print and digital media. Use the learning activities in this inquiry to create a digital or print magazine that includes articles that students create about agriculture as an important resource that connects Albertans and their communities, change and growth, and urban and rural ways of life. Encourage students to add their own points of view, opinions, and examples to their media stories. Analyze how perspectives presented in different forms of media are similar or different.

Students can be encouraged to compare articles and advertisements in urban and rural newspapers. Ask students to bring newspapers from home and find examples of articles or advertisements that have agricultural content or connections. Have students find and explore examples of articles from online newspapers, including those with a rural focus. Some examples are listed below.

Small Farm Canada can be accessed at **www.smallfarmcanada.ca**.

Country Guide can be accessed at **www.country-guide.ca**.

A comprehensive list of, and links to, newspapers across Canada can be found at **www.onlinenewspapers.com/canada.htm**. Links that students are asked to use should be checked in advance, as some may not be current.

Use examples from rural or urban-focused media publications to discuss and explore different perspectives that are represented by groups or communities, as well as to discuss current events and concepts such as media bias.

The Learning Outcomes

The following chart provides an overview of the learning outcomes from Alberta programs of study that are supported and reinforced in this inquiry. These learning outcomes can be used as the basis of student assessment during the inquiry. Use the checklist that follows, as well as assessment tips in the learning and teaching notes, to develop an assessment plan for students.

Science

Understandings Outcomes	Skills and Process Outcomes	Values and Attitudes Outcomes
5–7 Describe the properties and interactions of various household liquids and solids, and interpret their interactions. (1) Recognize and identify examples of the following kinds of mixtures: • two or more solids; e.g., sand and sugar • a solid and a liquid; e.g., sugar and water • two or more liquids; e.g., milk and tea (2) Apply and evaluate a variety of techniques for separating different materials. (7) Distinguish reversible from irreversible changes of materials, and give examples of each. (8) Recognize and describe evidence of a chemical reaction. Explain how the products of a reaction differ from the original substances.	5–1 Design and carry out an investigation, using procedures that provide a fair test of the question being investigated. 5–2 Recognize the importance of accuracy in observation and measurement; and, with guidance, apply suitable methods to record, compile, interpret and evaluate observations and measurements. Focus • (1) ask questions that lead to exploration and investigation • (2) identify one or more possible answers to questions by stating a prediction or a hypothesis Explore and Investigate • (3) identify one or more ways of finding answers to given questions • (4) plan, with guidance, and carry out procedures that comprise a fair test • (7) work individually or cooperatively in planning and carrying out procedures • (8) identify sources of information and ideas and access information and ideas from those sources. Sources may include library, classroom, community and computer-based resources Reflect and Interpret • (9) communicate with group members to share and evaluate ideas, and assess progress • (10) record observations and measurements accurately, using a chart format where appropriate. Computer resources may be used for record keeping and for display and interpretation of data • (11) state an inference, based on results. The inference will identify a cause and effect relationship that is supported by observations • (13) identify possible applications of what was learned • (14) identify new questions that arise from what was learned.	5–4 Demonstrate positive attitudes for the study of science and for the application of science in responsible ways. *Students will show growth in acquiring and applying the following traits:* • (1) curiosity • (7) a willingness to use evidence as the basis for their conclusions and actions • (8) a willingness to work with others in shared activities and in sharing of experiences • (9) appreciation of the benefits gained from shared effort and cooperation

Social Studies

Knowledge and Understandings Outcomes	Skills and Process Outcomes	Values and Attitudes Outcomes
5.1.3 Analyze how people in Canada interact with the environment by exploring and reflecting upon the following questions and issues: • (2) How are natural resources used, exchanged and conserved in Canada? (ER, LPP)	5.S.1 develop skills of critical thinking and creative thinking: • (3) re-evaluate personal opinions to broaden understanding of a topic or an issue • (4) generate original ideas and strategies in situations of individual and group activities ➢ (5) seek responses to inquiries from various authorities through electronic media 5.S.4 demonstrate skills of decision making and problem solving: • (2) collaborate with others to apply strategies for decision making and problem solving • (3) select and use technology to assist in problem solving • (4) use data gathered from a variety of electronic sources to address identified problems • (5) solve problems requiring the sorting, organizing, classifying and extending of data, using such tools as calculators, spreadsheets, databases or hypertext technology • (6) use graphic organizers, such as mind mapping/webbing, flow charting and outlining, to present connections between ideas and information in a problem-solving environment • (7) generate alternative solutions to problems by using technology to facilitate the process 5.S.5 demonstrate skills of cooperation, conflict resolution and consensus building: • (3) work collaboratively with others to achieve a common goal 5.S.7 apply the research process: • (2) use graphs, tables, charts and Venn diagrams to interpret information • (3) draw and support conclusions, based on information gathered, to answer a research question ➢ (6) access and retrieve appropriate information from the Internet by using a specific search path or from given uniform resource locators (URLs) ➢ (7) navigate within a document, compact disc or other software program that contains links ➢ (10) use a variety of technologies to organize and synthesize researched information 5.S.8 demonstrate skills of oral, written and visual literacy: ➢ (4) create visual images for particular audiences and purposes ➢ (7) communicate effectively through appropriate forms, such as speeches, reports and multimedia presentations, applying information technologies that serve particular audiences and purposes	5.1.1 Value Canada's physical geography and natural environment: • (1) Appreciate the variety and abundance of natural resources in Canada (ER, LPP) • (4) Appreciate how the land sustains communities and the diverse ways that people have of living with the land (GC, LPP)

Assessment

The following assessment tools can be used to assess student learning and progress. The **Assessment Checklist** provides learning criteria statements that are correlated to the learning outcomes from the Alberta Social Studies program of study. This checklist can provide the basis for the construction of rubrics for assessment of student projects and products. The **Self-Assessment Checklist** includes "I Can" statements, based on the learning criteria, which students can use to self-assess or monitor their learning. The **Rubric** can be used to assess a final product that students complete to demonstrate their learning in this inquiry.

Adapt the learning criteria statements, "I Can" statements, and rubric criteria to best meet the needs of students. These statements can also be adapted for reporting and sharing student growth and progress.

I Can statements can be used in a number of ways to support student learning and metacognition:

- Use the I Can statements with the inquiry question to introduce the *Moo2You Inquiry Model*. Discuss the I Can statements with students at the beginning and close of each lesson or activity.
- Make a large poster with the I Can statements. Once students believe they can demonstrate the understanding or skill, have them record their name under the statement.
- Provide students with the I Can checklist on page 8. Encourage them to monitor their own progress as they complete and share their research and learning.
- Use self-assessment check-in strategies, such as Fist to Four and Thumbs, to check for understanding throughout the *Moo2You* inquiry.
- Use each I Can statement as a starting point to have students write or complete a descriptive sentence that represents evidence of their learning.

Planning for Assessment with Whole Class Activities

Check in strategies, such as Fist to Four and Thumbs provide an effective approach to ongoing, formative assessment during whole class or large group activities.

- In Fist to Four, students are asked to use their fists or fingers to self-assess their understanding:
  - A fist says "I don't understand."
  - One finger says "I'm not sure."
  - Two fingers say "I'm starting to understand."
  - Three fingers say "I understand!"
  - Four fingers say "I really understand this!"
- Thumbs Up, Sideways, and Down can be used to indicate agreement. Up says "yes"; Down says "no"; and Sideways says "not sure."

What does it take to make a dairy product?

Assessment Checklist

Learning Criteria Statement This student _____ is able to:	Yes	Some of the time	Not Yet
Describe how agriculture uses Canada's natural resources for food production [Social Studies 5.1.3.2; 5.1.1.1; 5.1.1.4]			
Describe the properties of dairy products as liquid or solid [Science 5.7.1; 5-1/5-2-4]			
Describe the chemical effects of combining milk solids and liquids [Science 5.7.2; 5.7.7; 5.7.8; 5-1/5-2-4]			
Use and create graphs, charts, maps and graphic organizers to describe agricultural activities and products [Science 5.2.10] [Social Studies 5.1.3.2; 5.1.1.4; 5.S.4.6; 5.S.7.2; 5.S.8.4]			
Find and organize information from different sources to develop conclusions [Science 5-1/5-2-3; 5-1/5-2-8; 5-1/5-2-13] [Social Studies 5.S.1.5; 5.S.4.4; 5.S.7.3; 5.S.7.6; 5.S.7.7; 5.S.7.10]			
Generate and share original ideas, opinions, questions, and solutions with others [Science 5-1/5-2-1; 5-1/5-2-2; 5-1/5-2-14; 5-4-1] [Social Studies 5.S.1.3; 5.S.1.4]			
Investigate and experiment with different variables to develop conclusions [Science 5-1/5-2-1; 5-1/5-2-2; 5-1/5-2-4; 5-1/5-2-7; 5-1/5-2-10]			
Solve problems by organizing information, identifying patterns, and drawing conclusions [Science 5-1/5-2-10; 5-1/5-2-11; 5-1/5-2-13; 5-4-7] [Social Studies 5.S.4.3; 5.S.4.5; 5.S.4.6; 5.S.4.7; 5.S.7.3]			
Work collaboratively and cooperatively in a group setting [Science 5-1/5-2-7; 5-1/5-2-9; 5-4-8; 5-4-9] [Social Studies 5.S.4.2; 5.S.5.3]			
Communicate, using different forms, to support ideas and conclusions [Social Studies 5.S.8.7]			

What does it take to make a dairy product?

Self-Assessment Checklist

My Learning I, _____ , can:	Yes	Some of the time	Not Yet
Describe how natural resources are used to produce food			
Identify whether a dairy product is a liquid or solid			
Describe the chemical reaction that occurs when milk solids and liquids are combined			
Use and make graphs, maps, and charts to organize information about agricultural activities and products			
Find information from different sources and organize it to make a conclusion			
Share, by talking or in writing, my own questions, ideas, opinions, and conclusions about what I am learning			
Investigate and experiment, using different variables, to find answers or solutions to questions or problems			
Organize information and identify patterns to develop my own conclusions			
Work collaboratively and cooperatively with others in my group and class			
Share, through presentations or products I create, my ideas and conclusions			

What does it take to make a dairy product?

Rubric

Criteria Statements	Wow	Yes	Not Yet
Describe how agriculture uses Canada's natural resources for food production	Illustrates, using a comprehensive range of examples, how agricultural activities depend on Canada's natural resources to produce food	Uses different examples to describe how agricultural activities depend on Canada's natural resources to produce food	Identifies food products, but makes limited connections to natural resources
Describe the chemical properties and effects of mixing liquids and solids to make different dairy products	Makes conclusions that recognize how the chemical properties of liquids and solids affect the reaction that occurs when they are mixed	Clearly describes the chemical properties of liquids and solids and the reaction that occurs when they are mixed	Identifies the differences between liquids and solids, but makes limited conclusions about their interactions
Find and organize information from different sources to develop conclusions	Organizes information and ideas from research and investigations and combines them to present an insightful conclusion	Selects and organizes information and ideas from research and investigations to present a clear conclusion	Selects information and ideas related to an investigation, but does not present a clear conclusion
Experiment and investigate with different variables to develop conclusions	Manipulates variables to test ideas and develop relevant conclusions	Uses different variables to carry out an investigation	Identifies how different variables can be used in an investigation
Communicate, using different forms, to support ideas and conclusions	Purposefully selects and applies a comprehensive range of examples from different types of media to effectively share different points of view and beliefs	Thoughtfully selects and uses examples from different types of media to clearly share different points of view and beliefs	Selects examples from different types of media, but does not use them to share different points of view and beliefs

The Vocabulary

Students will encounter vocabulary that they may find challenging throughout the *Student Research Articles* in this inquiry. Explore the vocabulary with students in advance to support learning of concepts and development of deeper understandings of content. Vocabulary definitions are embedded in sentences or provided in brackets beside the term.

The vocabulary terms that follow are grouped around each *Student Research Article*. The first group of vocabulary terms are only found in the teaching notes.

Teaching Notes

Milk and dairy products are one of the most **regulated**, or monitored by law and tested, foods that are made and provided for sale in stores.

Article 1 *Adding Value to our Natural Resources*

Food processing is a method used to change food ingredients into a product.

Before it is milked, each cow's **teats**, or nipples, are cleaned either by hand or with a mechanical milking machine.

At the dairy, a **separator**, or a machine that removes the fat from the milk, is used.

Dairy farming is a **primary industry**, as it changes natural resources into an ingredient or material that is used to make other products.

A **secondary industry** uses materials or ingredients made by primary industries. Secondary industries change these materials or ingredients into products.

Pasteurization is the process of heating a food to a high temperature and then cooling it quickly.

Milk is also **homogenized**, which means breaking up the fat into very small particles, so that the fat and milk can then be blended together in a smooth mixture.

All table milk is **fortified** with vitamin D to make sure that Canadians get enough of this important nutrient.

Every five years, the government conducts a **census**, which is a survey that gathers information about people living and working in Canada.

Article 2 *What dairy products are made from milk?*

When **rennet**, an enzyme found in animal's stomachs, or a lactic acid is added to milk, it **curdles**, or separates the solids from the liquids.

These **curds**, or solids, are then used to make cheese. The liquid that is left over is called **whey**. It is drained from the curds.

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.

Article 4 *What happens to milk at the dairy?*

A French scientist, Louis Pasteur, discovered that quickly heating and then quickly cooling milk kills harmful bacteria without changing the milk's nutrient value. This process is called **pasteurization**, after the man who invented it.

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

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.

Today, milk is pasteurized using the **HTST** (**H**igh **T**emperature, **S**hort **T**ime) process. The milk is heated to at least 72°C for 16 seconds and then cooled to 4°C.

Another way to pasteurize milk is called **UHT** (**U**ltra **H**igh **T**emperature). In this process, the milk is heated to at least 138°C for 2 seconds. Then it is quickly cooled to 2°C.

Article 5 *Liquids and Solids*

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

Almost all milk is **homogenized** to keep the milk fat from separating and floating to the top. 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 evenly suspended.

The main protein in milk is called **casein**.

The main carbohydrate is called **lactose**.

An **enzyme** is a protein that is produced by cells in the body. **Lactase** is the enzyme that breaks down lactose.

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.

When cream is **churned**, or mixed very hard, the fat separates from the milk mixture and forms a small ball.

Canadian milk processors add a nutrient, **vitamin D**, to all table milk.

When we add nutrients to food, we say that food has been **enriched** or **fortified**.

Teacher Background Information

Milk and products made from milk have been part of people's diets for thousands of years. Milk and honey are the only substances whose only natural function is food.

> ***"The role of milk is to provide nourishment and protection for young mammals. Milk also has been a food source for humans since the dawn of history. Milk is a very complex food with over 100 000 molecular components. Therefore, only an approximate composition of milk is usually given.***
>
> ***Milk is composed of water, carbohydrate, fat, protein, minerals, and vitamins. It is important to remember that milk is secreted as a complex mixture of these components. The properties and importance of milk are greater and more complex than the sum of its components."***

From *An Overview of Milk*. Biology of Lactation Course, McGill University. http://animsci.agrenv.mcgill.ca/courses/460/topics/2/text.pdf

In 2009, dairy production in Canada generated total net farm receipts of $5.5 billion and generated sales of $13.6 billion. This dairy production made up 15% of Canadian food and beverage production. The dairy industry is the third most valuable in Canada's agricultural activities and production, following grains and meats.

Canada's dairy farms are spread across the country:

- Most Canadian dairy farms – about 81% - are found in Ontario in Quebec.
- The Western provinces have 13.2% of dairy farms.
- The Atlantic provinces have 5.5% of Canadian dairy farms.
- There are about 1.4 million dairy cows in Canada. The typical Canadian dairy farm has 72 cows and produces an average of 5 579 hectolitres, or 557 900 litres, of milk per year.

The *Dairy Goodness* website provides descriptions of processes involved in making dairy products at **www.dairygoodness.ca**.

The Government of Alberta, on their *Healthy U* link at **www.healthyalberta.com**, provides information on food processing in *Processing Foods to Benefit Your Health*.

Feature: The Story of Milk can be found on the Canadian Public Health Association website, at **www.cpha.ca/en/programs/history/achievements/09-shf/milk.aspx**.

The Government of Canada provides access to a range of Canadian dairy facts and statistics at **www.dairyinfo.gc.ca/index_e.php**.

Detailed information on the chemistry of milk can be found in a University of Guelph article on *Dairy Chemistry and Physics* at **www.foodsci.uoguelph.ca/dairyedu/chem.html**.

Canada's dairy processing industry includes 452 dairy processing plants, including 272 that are federally-inspected. These dairy processing plants create more than 22 730 jobs across Canada. Federally-inspected plants are those involved with interprovincial or international trade or movement of all dairy products.

The Canadian dairy sector operates under a supply management system, which is based on planned levels of production, administered pricing, and dairy product import controls.

Canada's dairy products are diverse, and range from aged cheddar cheese to specialty cheeses, ice cream, and dairy drinks in addition to table milk, cream, and butter. In 2010, 14% of Canadian plants were owned by the three largest processors in the country – Saputo, Agropur, and Parmalat. These plants process approximately 75% of the milk produced in Canada.

Fluid milk products, which include table milk and fresh cream, represent 38.5% of milk production, or 29.4 million hectolitres, while manufactured dairy products such as butter, cheese, yogurt, and ice cream represent 61.5% of production, or 47 million hectolitres of milk.

Canada's dairy industry also relies on research and development Scientists in Canada work on improving and developing new dairy technologies. For example, new products such as probiotic yogurts, ultra filtered milk, and dairy products containing Omega-3 fatty acids, are recognized dairy products available to consumers. The Canadian cheese industry has developed extensive cheese making traditions and 667 varieties of cheese, including goat, ewe, and cow. Many of these cheeses are recognized the world over for their quality and taste. Out of these 667 distinct varieties of Canadian cheese:

- 477 varieties are produced in Quebec (71.5%)
- 125 varieties are produced in Ontario (18.7%)
- 65 varieties are produced in other Canadian provinces (9.8%)

Organic milk production is steadily increasing in Canada. It reached 73.4 million litres in 2008-2009, which represents less than 1% of total dairy output. Locally produced and processed organic milk launched in Alberta grocery stores in November 2010.

Adapted from *The Canadian Dairy Industry at a Glance*. Canadian Dairy Information Centre, Government of Canada. **www.dairyinfo.gc.ca/index_e.php?s1=cdi-ilc**

The *Inquiry Templates* referenced in the learning strategies can be accessed in the **Teacher's Corner** on the *Moo2You* website at **www.moo2you.ca**.

ASSESS by...

- Providing students with **Inquiry Template 1: Inquiry Self-Check**. Have them monitor their progress through the inquiry model and describe steps they take and resources they use.
- Monitoring student progress throughout the inquiry by using the **Assessment Checklist (p. 9)**.
- Asking students to monitor their learning throughout the inquiry by providing them with the **Self-Assessment Checklist (p. 10)**.

DIFFERENTIATE by...

- Using an interactive whiteboard to display the *Moo2You* website home page at **www.moo2you.ca**. Go to the **It's All in the Mix** inquiry page and use the questions to introduce concepts and vocabulary.

DIFFERENTIATE by...

- Providing students with choices about working as a class, individually, with a partner, or in a small group to brainstorm examples of dairy products.

The Inquiry Learning Process

The activities in this inquiry would be best taught after or with the Classroom Chemistry topic in Science. The activities also assume that students have some knowledge of Canada's regions, geography, and natural resources.

1 Consider the Inquiry

Activity	Timing
• Introduce the inquiry • Explore the question • Brainstorm research questions	One 50-minute class period

A. If this is students' first *Moo2You* inquiry, introduce them to the concept of the "journey of milk." Discuss how the idea of "journeys" can help illustrate how agricultural products like milk move through different stages of production and come from the land, natural resources, and human activities. Introduce students to the *Moo2You* website homepage at **www.moo2you.ca**. Tell students that they will be working much like reporters do to explore the different journeys that milk takes from farms, to processors, to stores, and finally to homes.

Pose the question, "What different forms of media do you think reporters work with?" Brainstorm ideas – print, radio, television, Internet – and ask students to also think about the wide range of information that is communicated through different forms of media. Tell students that their classroom learning and work can be similar to reporter's work. They ask questions, research to find information, and then share that information in one form or another. The inquiry that they are about to start asks them to continue to "work like reporters," and gather information, facts, and perspectives in response to an inquiry question. Provide students with an opportunity to explore some of the questions in the **Question Corner** of the *Moo2You* website.

Share the inquiry with students by writing the inquiry question on the board or posting it in the classroom on poster paper.

What does it take to make a dairy product?

B. Invite students to explore the inquiry question, using the following steps:

- Ask students to brainstorm as many products as they can think of that start with milk. Make a word list on poster paper and keep it posted in the classroom. Encourage students to share examples of their favourite dairy foods or recipes.

- Ask students if they have thought about how so many different products can be made from this one basic ingredient. Students may find this question challenging, so prompt them by asking them if they know what milk is composed of, what form it is (liquid), and how this form is changed as different dairy products are made. Encourage students to use their own "dairy" examples to discuss the differences between liquids and solids.
- Ask students to consider where they think the production of dairy foods "start" and how these food products eventually get to their lunch bags or on their dinner tables. Depending on their background and experiences, students may have a range of knowledge about how dairy products "start" with dairy farmers and cows on a dairy farm.

C. With the class, introduce the idea that milk and dairy products are one of the most **regulated**, or monitored by laws and rules, foods that are made and provided for sale in stores. The Government of Canada provides a list of the regulations and acts that govern dairy production at **www.dairyinfo.gc.ca/index_e.php?s1=dr-rl&page=canada**. Dairy products are also regularly and frequently tested, including when milk is picked up from farms, at processing plants, and when final products leave the processing plant.

The dairy industry is an important part of Canada's agricultural resources and milk is produced, transported, and processed into a wide range of products that many people use daily. Dairy processers add "value" to the agricultural products that Canadian farmers produce by making them into different types of foods. Tell students that milk is also a good example of a product that is produced and consumed locally.

D. Work with students to brainstorm and create a list of research questions that will help them explore the inquiry question. Encourage students to make connections between what they have learned about other liquids and solids, the principles of simple chemistry, mixtures and processes, and the inquiry. Examples of research questions may include:

- Is milk a natural resource? Why or why not?
- What is milk made out of?
- What are the nutrients in milk?
- What steps are taken to make sure milk is safe?
- How are solid dairy products like butter and cheese made?
- What is yogurt? Is it a solid or a liquid? Why?
- How are frozen products like ice cream made? Is ice cream a solid or liquid? Why?

INTEGRATE by...

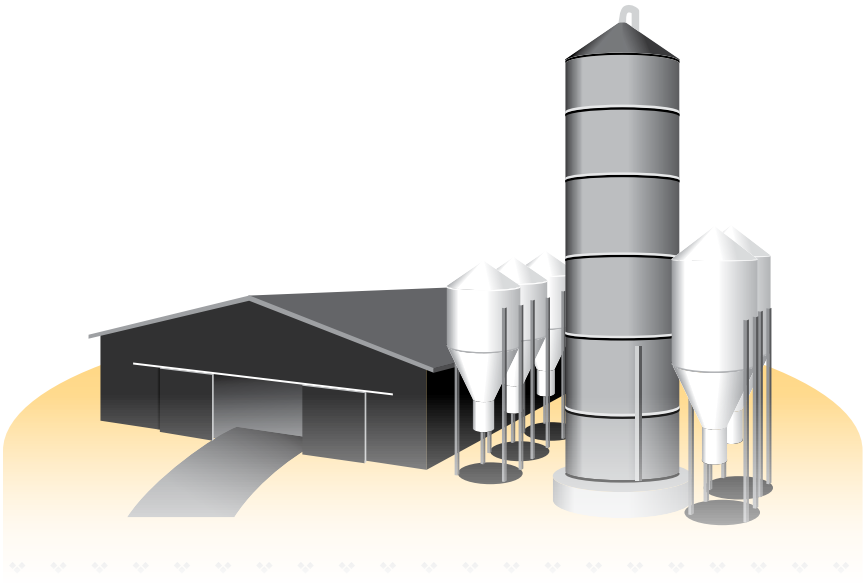
- Encouraging students to make connections between what they are learning in Science and Social Studies. The example of milk can be used as an example to connect these two subject areas. Dairy farming and production involves natural resources and environments, economics and quality of life, and chemistry!

DIFFERENTIATE by...

- Using an interactive whiteboard to circle questions on the **It's All in the Mix** inquiry page that interest students, identify key terms or concepts, and record additional questions that students brainstorm.

- What different processes are used to make milk into dairy products?
- Is milk changed when it is made into different products?
- What effect do acids have on milk?
- What is added to milk to make different dairy products?

Post these research questions in the classroom so they are visible to students.



2 Research and Explore

Activity	Timing
• Establish research process • Explore research articles	Three 50-minute class periods

A. Remind students that, as reporters, their research can be carried out with different types of sources and activities, such as reading and reviewing media, talking with or listening to people, and viewing pictures or photographs. Establish the research process with students using the following steps:

- Group students into research teams.
- Organize and select research questions on which to focus. Work with students to group similar research questions together. Decide which question or questions each research team will be responsible for.
- Identify sources of information that students will use for their research. The *Moo2You Student Research Articles* and website will provide a base of research information that students can use. Additional sources that students can consult may include library resources, classroom textbooks, people, or the Internet.

B. Provide students with **Student Research Article 1: Adding Value to Our Natural Resources (pp. 27-31)**. Invite students to read the article and explore the information on the Canadian dairy industry. Provide students with **Inquiry Template 11: Picture Frame** to analyze a photograph they select from the suggested website link. As a class, ask students to respond to discussion questions such as:

- What effect do you think the dairy industry has on Canada's environment and resources? How does the dairy industry contribute resources and products and affect ways and quality of life?
- How does dairy production compare with other important industries? *(Encourage students to revisit what they have learned about the use of resources in different regions of Canada. Students should be asked to make comparisons between industries in order to develop an understanding of the range of agricultural uses for Canada's resources. Deeper connections can be made when students study Canada's regions in more depth.)*

Encourage students to add any additional questions they might have to their research question list.

DIFFERENTIATE by...

- Grouping students by interest, learning strengths, or learning needs.
- Assigning different research questions to groups of students, according to their interests or learning needs.
- Establishing learning centres in the classroom that students can consult for additional information or structured research tools. Use **Inquiry Template 6: Research Tracker** to provide students with additional structure for their research.

INTEGRATE by...

- Reinforcing Mathematics skills by asking students to analyze the graphs and charts, as well as the statistics and patterns in the research articles. Encourage students to identify additional questions they could research using mathematical skills.
- Providing some additional time in Health and Life Skills classes for students to research the nutritional values of different dairy products.

DIFFERENTIATE by...

- Demonstrating the lab experiments with the class and discussing results together.
- Assigning the two lab experiments to different research teams in the classroom. Assign one lab to half of the research teams, and the other lab to the remaining teams. Provide each team with the opportunity to share their results. To share, individual students can be paired to discuss and compare their conclusions.

ASSESS by...

- Observing students` research skills as they work together in groups. Ask students to individually "report" on the types of sources they used in their research and the different information they gained from each.
- Having students set up and maintain a research log in which they keep track of the sources they have used.

C. Provide research teams with the following articles:

- **Student Research Article 2: What dairy products are made from milk? (pp. 32-34)**
- **Student Research Article 3: What happens when milk is mixed with other substances? (p. 35-37)**
- **Student Research Article 4: What happens to milk at the dairy? (pp. 38-40)**
- **Student Research Article 5: Liquids and Solids (pp. 41-43)**
- **Student Research Article 6: Properties of Milk (pp. 44-45)**

Each *Student Research Article* provides additional information that supplements and supports the information on the **Dairy Drive** inquiry page at **www.moo2you.ca**. Have research teams approach the inquiry question by first exploring the *Moo2You* website and their *Student Research Articles*. Remind students to focus on the information they think is appropriate for their research team's task. Provide students with graphic organizers that are referenced in the articles, including **Inquiry Template 2: T-Chart** and **Inquiry Template 11: Picture Frame**.

Organize areas in the classroom at which research groups can conduct the two lab experiments. *Student Research Articles 3* and *6* are centred on labs that illustrate and reinforce the concepts in the research articles. *Student Research Article 5* includes instructions for making butter out of heavy cream. Create a schedule that allows each research team to complete one or more of the lab experiments.

The *It's All in the Mix Interactive App* provides students with an opportunity to investigate and manipulate the processes and ingredients that are used to create different dairy products. Students are encouraged to explore how dairy products can be liquid or solid, as well as when and how ingredients are heated, cooled, frozen, evaporated, or blended to make different products. The information that students access on the link and through the interactive should be part of their data collection.

Ensure that students have access to the **Mix It Recipe Cards** on the **It's All in the Mix** inquiry page and the **Game Corner** on the *Moo2You* website at **www.moo2you.ca**. Clues are provided in the text boxes that appear with each process and ingredient. Remind students to read each text box carefully before adding it to the processing screen!

Note: When students complete the lab experiment in *Student Research Article 6*, they should find that food colouring reacts differently when added to different types of milk. Students are asked to use all four food colours, as the colours will mix and swirl to make secondary colours. The food colouring in the skim milk should spread quickly and become faint in colour. The colouring in the whole milk spreads faster and does not lose as much colour. The colouring in the cream or half and half will not spread as quickly as the skim or whole milk. This happens because food colouring is water-based. It diffuses, or spreads, faster through milk that has a higher water content and lower fat content. When soap is added to the mixture, the soap reacts with the fat, which is spread throughout the milk as a result of homogenization. The soap breaks up the fat globules, causing movement in the milk.

3 Organize and Draw Conclusions

Activity	Timing
• Organize research • Summarize and compare findings • Write summary article	Three to four 50-minute class periods

INTEGRATE by...

- Asking students to further categorize key words in their research word banks into categories such as descriptive words, items, places, and people.
- Using the word banks and categories to construct descriptive paragraphs about topics connected to concepts such as agriculture, natural resources, environment, properties of products, chemical changes, and technology. Encourage students to add imagery to their paragraphs by adding descriptive language.

A. With the class or with each research team, identify ways that research data can be organized.

- Select research templates that students will use to gather and organize information. Appropriate research templates for this inquiry may include **Inquiry Template 3: Retrieval Chart**, **Inquiry Template 8: Mind Map**, **Inquiry Template 9: Bubble Map**, and **Inquiry Template 10: Cause and Effect Chart**.
- Suggest that students initially identify important information from the website and articles on research cards, using index or handmade cards. These cards can then be organized and grouped around specific research questions or around topics that students identify.
- Have students practise identifying key words from their research. These words can be compiled into a word bank that students can draw on as they complete their research.

B. Work with students to discuss ways that research data can be compared and analyzed. This may include the following strategies:

- Organizing the research cards around questions or topics, and then working together to write a summary of the information for each group of cards. The summary can be transferred onto the **Retrieval Chart Template**. The **Retrieval Chart** provides four columns in which students can organize information. Multiple **Retrieval Chart Templates** can be used to record information on the range of different milk products.

  Students can also be asked to colour code products according to whether they are liquids or solids. The columns can be used to separate data around four research questions or dairy products. It can also be used to organize data around the dairy products identified in the *It's All in the Mix Interactive App* and the *Student Research Articles*.
- Using the **Mind Map Template** to organize facts, ideas, and examples around research topics. Students can alternatively be encouraged to organize their collection of research data around different dairy products or production processes, such as heating, cooling, mixing, separating, and evaporating.

- Summarizing and recording key ideas, facts, and examples to construct an outline on the **Bubble Map Template**. Each key idea can be supported with a paragraph or bulleted list that includes facts and examples.
- Summarizing processes used to product dairy products using the **Cause and Effect Chart Template**.

C. Have research teams use their organized research data to develop a group media article in response to the inquiry, "What does it take to make a dairy product?"

DIFFERENTIATE by...

- Providing students with choices in their group media article. The group article can be constructed using a shared writing process. Alternatively, groups can be asked to create a response, using visual examples and captions, on poster paper.
- Encouraging students to explore different forms of media articles, including editorials, news reports, feature articles, or headline stories.
- Asking students to construct an individual response.

INTEGRATE by...

- Focusing on the development or reinforcement of communication skills through different forms of media.

4 Share

Activity	Timing
• Construct final product • Share	Three to four 50-minute class periods

ASSESS by...

- Working with students to create a rubric to assess their final product and sharing. Start with the **Rubric** provided on **page 11**. Use the **Assessment Checklist** on **page 9** or the **Self-Assessment Checklist** on **page 10** to customize criteria statements for the rubric.

A. Provide research teams with an opportunity to construct a final product that demonstrates and shares what they have learned.

- Construct a series of illustrated flowcharts to demonstrate the processes used in dairy production.
- Create a collage or photo essay of different dairy products. Identify whether products are liquids or solids, the effect of adding different ingredients, and the chemical reactions that happen when dairy foods are produced. Students can also be asked to take photographs during their lab experiments to add to this collage. Challenge students to ensure that their photographs help record and explain the process and results of the lab experiments.
- Develop a PowerPoint presentation, focused on the topic, "It's All in the Mix," that identifies and demonstrates the chemistry involved during different food production processes, such as pasteurization and homogenization.
- Create a skit that dramatizes the processes and ingredients used to make a dairy product. For example, the skit could start with a character who begins as milk and then interacts with different processes and ingredients to become a final product.
- Creating a "biography" of a dairy product, starting with its connections to Canada's natural resources *(land and agriculture)*, and describing how it "grows up" to become a product on a grocery store shelf.
- Develop a series of 10-second television or radio advertisements or public service announcements that "educate" the public about the importance of dairy farming and agriculture across Canada. A website such as **www.animoto.com** can be used to construct a video advertisement, using photographs, music, and video clips that students produce. This website allows free access for the production of 30-second video clips.

B. Use a carousel strategy to have students share their research and learning with other students or groups in the class. Ask each group to organize a display of their research results on a table. Place a comment sheet on each group table. Have groups rotate through the displays at timed intervals. One group member can remain with his or her display to present group research. Encourage visiting groups to record questions or comments. Alternatively, groups can stay together and be asked to record their comments or questions on the comment sheet on each table.

Student Research Articles

1 Consider the Inquiry

2 Research and Explore

3 Organize and Draw Conclusions

4 Share

Article 1

Adding Value to our Natural Resources

Many agricultural products are processed in some way before they are used. **Food processing** is a method used to change food ingredients into a product. For example, grains are processed into flour and made into many different foods, such as bread, cereals, crackers, and pasta. Timber is processed when it is made into woods that are used for furniture and floors. Milk is also processed into many different dairy products.

About Canadian Milk

The processing of milk takes no more than two days from beginning to end. At the dairy farm, cows are milked at least twice or even three times a day by machine. Before it is milked, each cow's **teats**, or nipples, are cleaned either by hand or with a mechanical milking machine. The machine is attached to the teats and the milk is then squeezed into a holding container. The milk flows into pipes that go directly into a large refrigerated holding tank. Some barns have a robotic system where the cows enter the milking stall individually; the machine positions itself and milks the cow automatically.

Approximately every other day, a special insulated tanker truck arrives at the farm to collect the milk and take it to a dairy. Before it leaves the farm, the milk is tested for quality and a sample is taken by the milk hauler for more testing. The milk is tested to make sure it has been stored at the correct temperature. The milk is taken directly to the dairy where it is processed into milk, cream, and other milk products.

Whole milk straight from the cow contains 3.8 % to 4 % fat. At the dairy, a **separator**, or a machine that removes the fat from the milk, is used. The fat is then added back to the milk in specific amounts, depending on the desired fat content of the final milk product.

Many different dairy products are produced in Canada and distributed to local communities. What different dairy products do you like to eat or drink?

Dairy Farming – One of Canada's Primary Industries

Dairy farming is a **primary industry**, as it changes natural resources into an ingredient or material that is used to make other products. Dairy farming starts with natural resources, as cows need land, soil, water, and sunlight to produce milk. When milk is transported to a dairy processing plant, it is made into many different products.

Dairy processing adds value to Canada's natural resources because farmers use these resources to raise cows and produce milk. There are many different types of jobs that are created by the dairy industry.

A Secondary Industry, Too

The production of food products is an important part of Canada's secondary industries. A **secondary industry** uses materials or ingredients made by primary industries. Secondary industries change these materials or ingredients into products. When milk is transported to the dairies, it is pasteurized. **Pasteurization** is the process of heating a food to a high temperature and then cooling it quickly. The heating process kills any harmful bacteria.

Milk is also **homogenized**, which means breaking up the fat into very small particles, so that the fat and milk can then be blended together in a smooth mixture. All table milk is **fortified** with vitamin D to make sure Canadians get enough of this important nutrient. Partly skimmed and skim milk also have vitamin A added, and other fortifying or enriching ingredients may be added to specialty milk products.

After it is homogenized, milk is quickly chilled. It is then transferred into bags, cartons, jugs, or bottles. These containers are stamped with the date and sealed. They are then ready to ship to stores and restaurants.

Dairy Farming has a History!

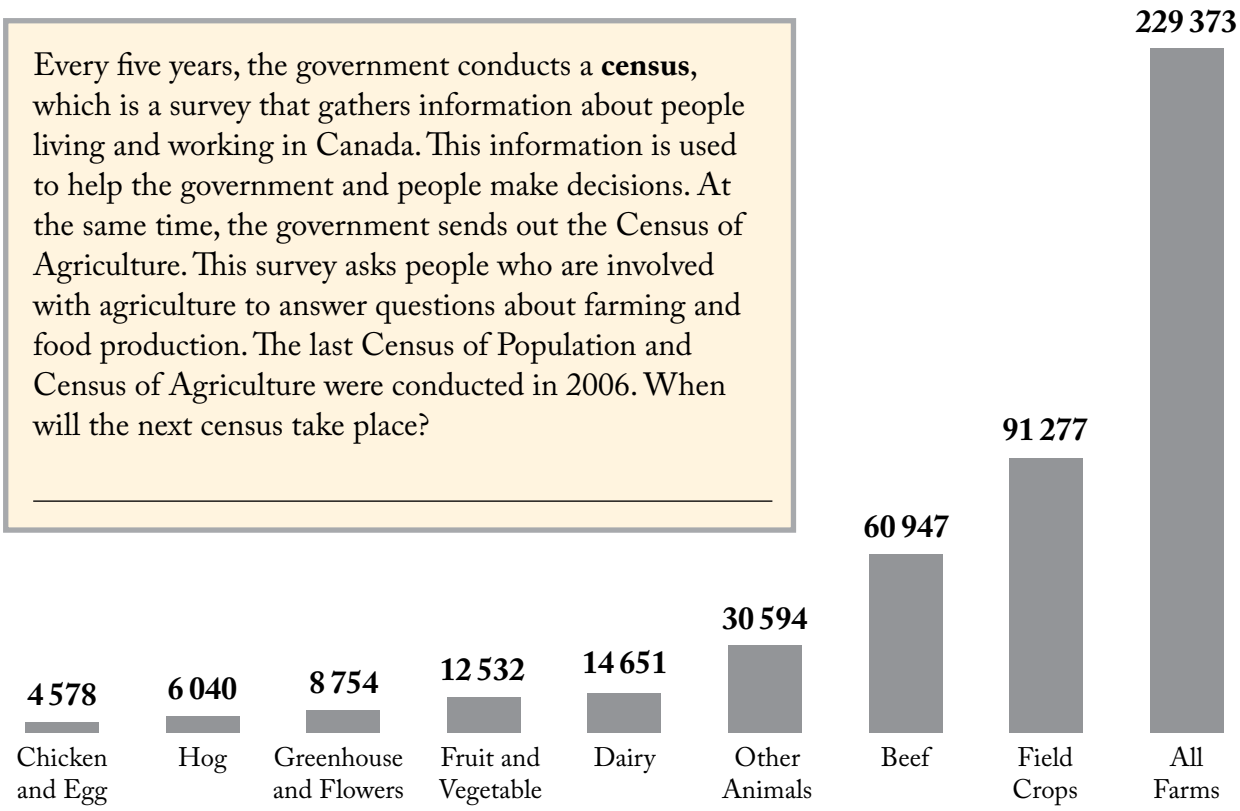
How did the dairy industry and agriculture develop in Canada? Go to the CN Image of Canada Gallery at **www.imagescn.technomuses.ca/** and click on the Agriculture and Natural Resources links to find photograph evidence. Use a **Picture Frame** to analyze one of the photographs. Share what you found out with a partner.

Dairy farming is an important human activity in Canada. Here's why:

- The dairy industry is the third largest agricultural activity in Canada, in terms of the total value of the products it creates.
- In 2010, about 30 000 people were working on 13 587 dairy farms across Canada.
- There are over one million dairy cows in Canada.
- These dairy cows produce a combined total of about 7.6 billion litres of milk every year.

Every five years, the government conducts a **census**, which is a survey that gathers information about people living and working in Canada. This information is used to help the government and people make decisions. At the same time, the government sends out the Census of Agriculture. This survey asks people who are involved with agriculture to answer questions about farming and food production. The last Census of Population and Census of Agriculture were conducted in 2006. When will the next census take place?

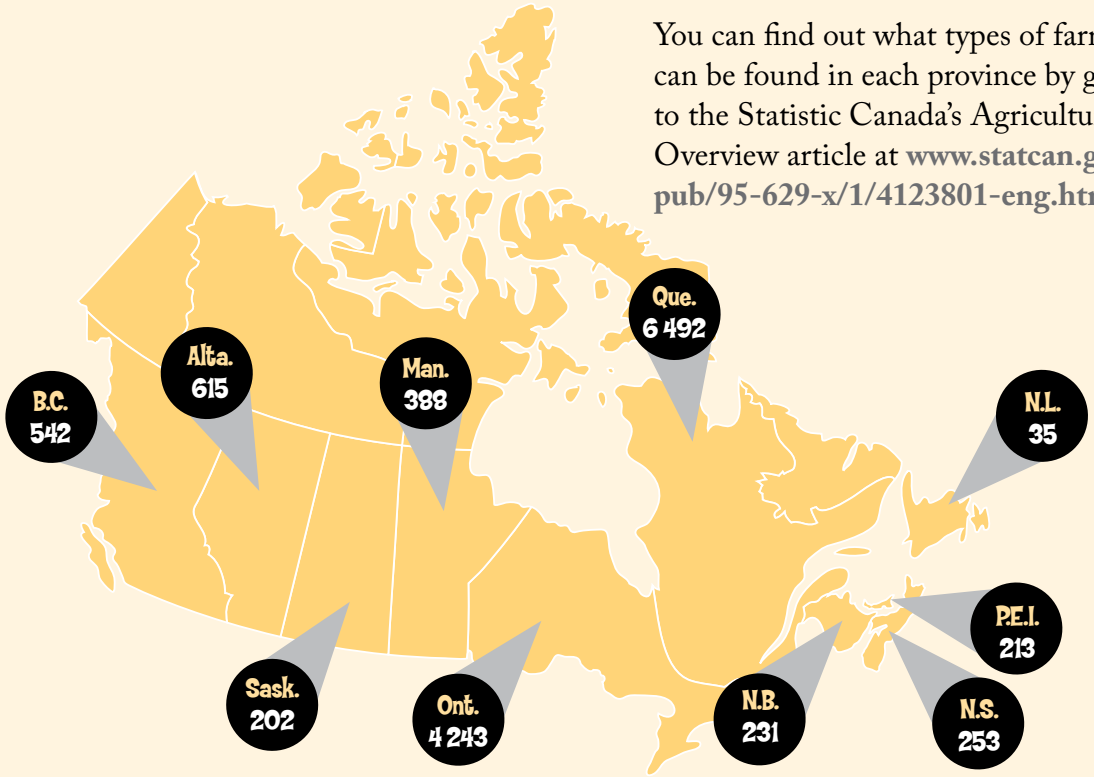
_____



Types and Number of Farms across Canada in 2006

"The financial picture of farms in Canada (2006)." *2006 Census of Agriculture:* Statistics Canada.
www.statcan.gc.ca/ca-ra2006/articles/finpicture-portrait-eng.htm

Number of Dairy Farms across Canada in 2010



You can find out what types of farms can be found in each province by going to the Statistic Canada's Agricultural Overview article at **www.statcan.gc.ca/pub/95-629-x/1/4123801-eng.htm.**

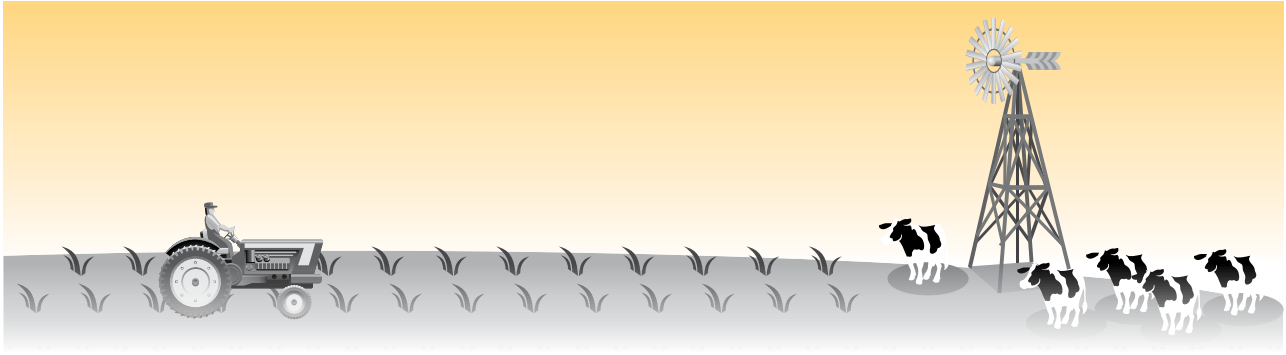
The Real Dirt on Farming (2006). Ontario Farm Animal Council.
www.farmissues.com/pdf/dirtFinal.pdf

Exploring Resources

Agriculture is an important human activity, and Canada's agricultural products are sold all over Alberta, Canada, and the world.

What natural resources do agricultural activities depend on? Use the **T-Chart** below or make one of your own to list the different agricultural activities in Canada. Then, predict which natural resources you think each type of agricultural activity needs.

Types of Agricultural Activities	Natural Resources



Use the data displayed in the graphs in this article to answer the following questions.

A. Which province has the most dairy farms? Which has the least?
Why do you think these provinces have the most or least number of dairy farms?

	Most Dairy Farms	Least Dairy Farms
PROVINCES		
WHY		

B. Are there any businesses in your community involved with the dairy industry?
What are they?

Go to **Weblinks** on **www.moo2you.ca** to select and explore the *A Source of Pride* website at **www.asourceofpride.ca**.

What did you learn about dairy production in Canada that you didn't know before?

Article 2

What dairy products are made from milk?

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

- 87.5% water
- 5% lactose, which is a form of sugar found in milk
- 3.75% fat
- 3.25% protein
- 0.7% minerals, including calcium

When it's time for milking, cows are moved into a milking parlour, a part of the barn where farmers keep the milking machines. Modern milking machines use computer technology and robotics to milk each cow once or twice a day. Some machines even let the cows decide when they are ready to be milked.

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 are the guidelines for healthy eating with this food group?

_____

_____

_____

_____

_____

Do you ever wonder who builds the machines that make our lives easier? The people who design and build these specialized machines need to know about computers and robots, as well as have a good understanding of how to milk a cow.

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

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

There are many dairy products that are made from milk. Cheese, yogurt, ice cream, and butter all have their beginnings with milk.

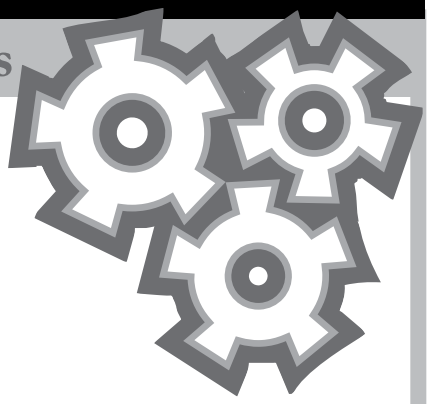
Cheese is made from the protein in milk. When **rennet**, an enzyme found in animal's stomachs, or a lactic acid is added to milk, it **curdles**, or separates the solids from the liquid. These **curds**, or solids, are then used to make cheese. The liquid that is left over is called **whey**. The whey is drained from the curds. The curds are then pressed into blocks or rounds.

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.

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.

Researcher's Corner

Exploring Numbers and 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 gone down.
- The amount of lower-fat milk has increased.
- The amount of ice cream and butter has gone down.
- The amount of cream, yogurt, and cheese has increased.

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

_____

_____

_____

What do the numbers below tell you about Canada's dairy production? Use the graph on the following page to fill in the proportion of each type of dairy product. You can also create your own graph on chart paper. Make a legend with the names of the products and colours. Add it to the graph. You can also add illustrations of each product to your legend. Make a title for your graph. Use these steps:

1. Choose a colour to represent each product.

2. Make a legend. List the dairy products. Choose a colour for each product and show it in a box or line beside each product name.

3. Express each decimal as a fraction out of 100. Then, colour in the correct number of blocks in the graph to represent the fraction for each product until all the squares in the graph are coloured in. For example, 7 blocks should be coloured with the colour you choose for ice cream and concentrated milks!

- 0.35 of Canada's total milk supply is made into milk and cream
- 0.30 is made into butter
- 0.28 is made into cheese
- 0.07 is made into ice cream and concentrated milks

Title: _____

Interview an adult in your life, such as your parents or grandparent, to find out whether their milk consumption patterns have changed over time. What did you find out?

_____

_____

_____

_____

Play the *It's All in the Mix Interactive App* in the **It's All in the Mix** inquiry page or the **Game Corner** on the *Moo2You* website at **www.moo2you.ca**. Use the **Mix It Recipe Cards** if you need help to make different dairy products.

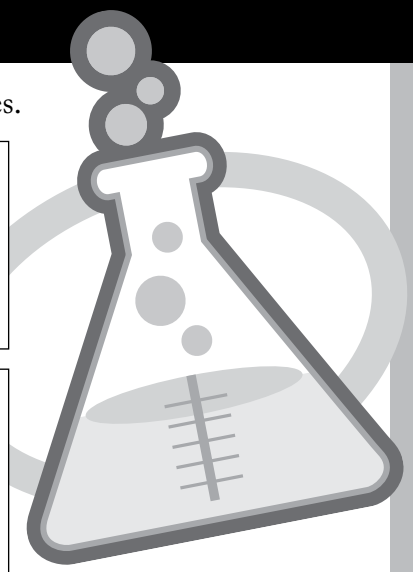
How many different dairy products can you find?

Article 3

What happens when milk is mixed with other substances?

Scientist's Corner

Milk is a liquid that is often mixed with other foods or beverages.



What to Use

- Milk
- Tea
- Water
- Sugar
- Vinegar
- Other substances to mix with milk
- Measuring cup or dropper
- Bowls or jars to mix the liquids

What to Do

Try mixing milk with equal amounts of each of the four other substances in the *What to Use* box. Add one other substance. In the chart, record your observations and inferences.

Mixture (Milk + _____)	My Observations	My Inferences (Why I Think This Happened)

Which of your mixtures were liquid? Which were solid?

Were there different reactions when you added solid substances and acidic substances? Explain why.

What effect do you think heat has on the mixture of milk and a substance like tea?

Which of your mixtures resulted in irreversible changes?
Why were these changes irreversible?

Which mixtures resulted in reversible changes?
Why were these changes reversible?

Play the *It's All in the Mix Interactive App* in the **It's All in the Mix** inquiry page or the **Game Corner** on the *Moo2You* website at **www.moo2you.ca**. Use the **Mix It Recipe Cards** if you need help to make different dairy products.

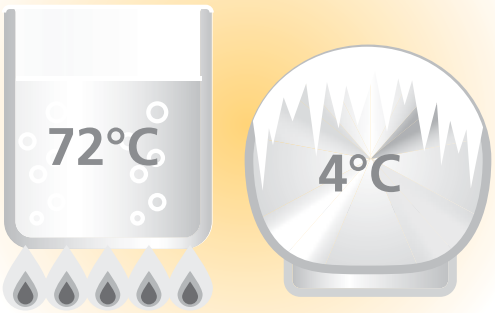
What types of ingredients are mixed with milk to make different products?

Create your own equation sheet. Write equations to show the processes and ingredients that you used to make each product. Try using an organizer like the example below:

Add extra boxes to your equation if you use more processes or ingredients.

Article 4

What happens to milk at the 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.

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 the man who invented it. When Pasteur conducted his experiments, he was looking for a way to make foods and beverages safer for people.

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

Did You Know?

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 40° 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.

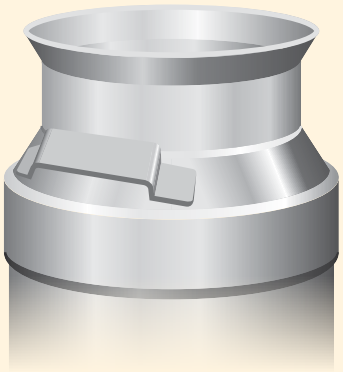
It only takes about 2 days from the time milk leaves the cow until it's on the grocery store shelves. Why do you think milk *moooves* so quickly?

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 will not change colour.

Today, milk is pasteurized using the **HTST** (**H**igh **T**emperature, **S**hort **T**ime) process. In most dairies, the milk is heated to at least 72˚C for 16 seconds and then cooled to 4˚C. Some dairies use pasteurization processes that use different temperatures and timing. Most milk sold in Alberta has gone through HTST pasteurization.

Another way to pasteurize milk is called **UHT** (**U**ltra **H**igh **T**emperature). 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. The milk is packaged under germ-free conditions, in a spotlessly clean plant. Therefore, the milk can be stored safely in the unopened container, at room temperature, for up to six months. Once opened, it too needs to be kept in the refrigerator.

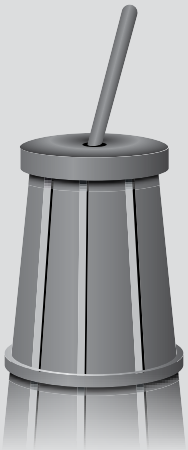
Did You Know?



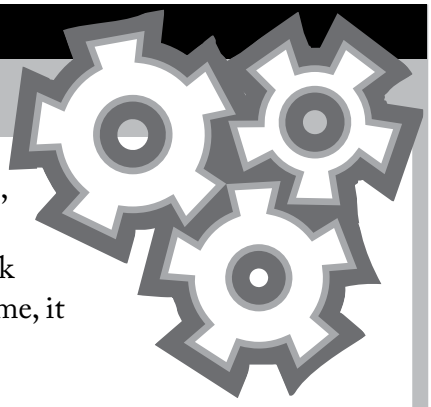
Food processors use special airtight containers to store milk and juices after they have been pasteurized by UHT. Bacteria need air to grow and cannot grow in UHT packages.

Did you know that 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, and, in turn, the ability to store and distribute milk 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.



Best Before



Dairy processors use machines to put the cold milk into cartons, plastic jugs, glass bottles, or plastic bags. You will notice a "Best Before" date on containers of milk. The store cannot sell the milk after this date. If the milk has been kept refrigerated in your home, it should still be good for a few days after the best before date.

Why do all dairy products have a "Best Before" date? If you went into a grocery store today, what "Best Before" date would you expect to find on a carton of milk? Why?

Learn from Others

Find out about a student in the United States who did an experiment to compare how quickly pasteurized and ultra-pasteurized milk spoiled.

Go to **Weblinks** on **www.moo2you.ca** to select and explore the weblink **www.selah.k12.wa.us/SOAR/SciProj2005/MichelleU.html**.

What variables and constants did Michelle use in her experiment?

Variables	Constants

What were her results for pasteurized and ultra-pasteurized milk?

	Pasteurized	Ultra-Pasteurized
RESULTS		

Did you know? By law, all milk in Canada must be pasteurized. It is illegal for anyone to sell or distribute raw milk and raw milk products. Why do you think the government passed this law?

_____

_____

_____

_____

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When is pasteurization used to process milk?

_____

_____

Article 5

Liquids and Solids

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 that 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.

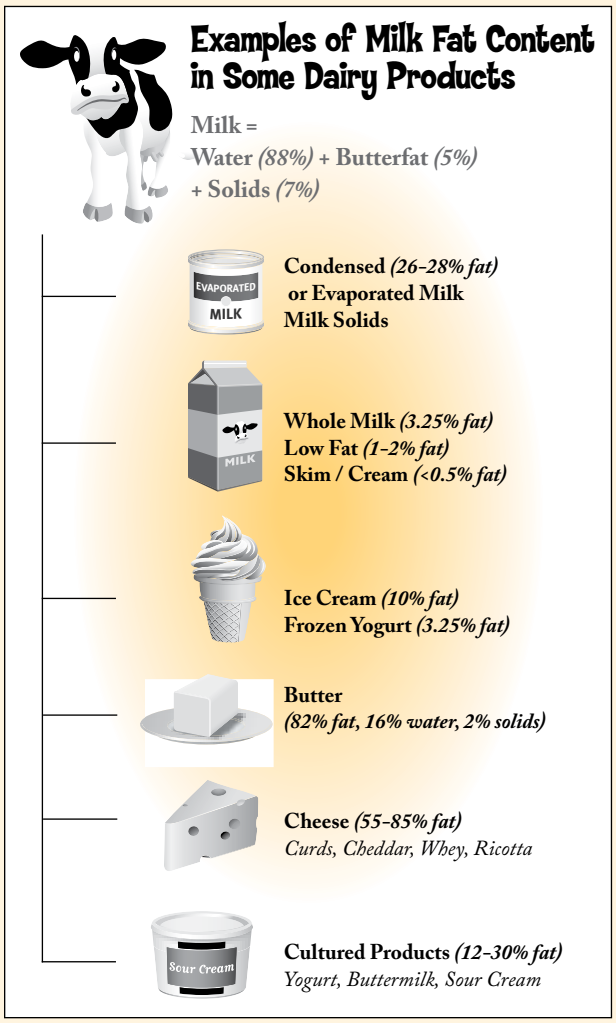
Raw milk has 3.7 % milk fat. When raw milk is processed, the milk fat is separated from the milk and then added back in to make products with different milk fat contents. Milk that has 3.25 % milk fat is labelled homogenized milk. In 1% and 2% milk, some of the fat has been removed, but the remaining 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 % milk fat.

Milk is a Mixture

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 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.



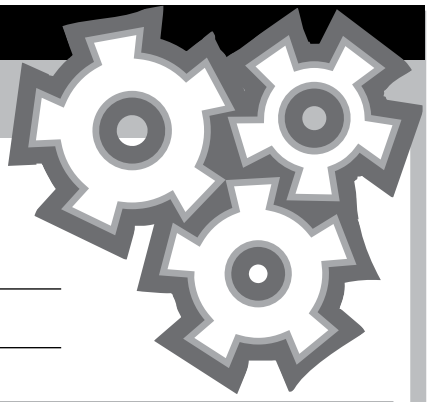
Enriching Milk

Canadian milk processors add a nutrient, **vitamin D**, to all table milk. We need it, along with calcium, to grow strong, healthy bones and teeth. When we add nutrients to food, we say that food has been **enriched** or **fortified**. The law in Canada requires all fluid milk products to be fortified with vitamin D.

Sometimes, dairy processors need to add a nutrient that is taken out when they remove the fats. Partly skimmed and skim milk are fortified with vitamin A, which is good for our eyes. Homogenized milk is not fortified with vitamin A because it contains enough naturally in the milk fat.

Researcher's Corner

Exploring Mixtures



1. What different ingredients is milk mixed with? What products do these mixtures create?

2. What difference does the fat content make to different types of milk? Why?

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Use what you learned to help you answer these questions.

3. Why do you think it is important for Canadian milk processors to add vitamin D to milk?

_____

_____

_____

_____

4. Did you know that Vitamin D can also be added to orange juice and some cereals? Check how much Vitamin D is added to orange juice or a cereal you eat at home and record the quantity below:

_____

_____

Scientist's Corner

What to Use

- Salt
- 125 ml of whipping cream
- Colander
- Glass or plastic jar with a lid

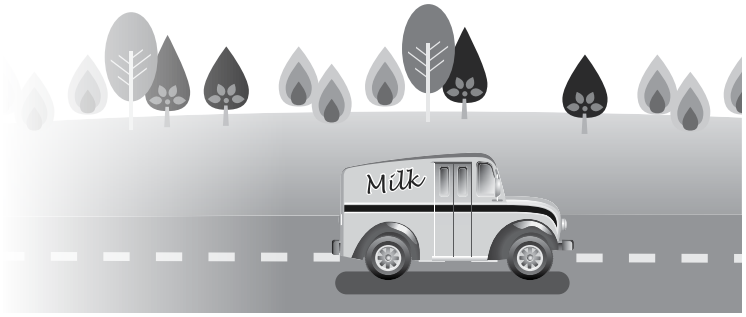
What to Do

Place 125 ml of whipping cream into a glass or plastic jar with a lid. Take turns with a partner shaking the jar. Shake it for at least ten minutes. At first, the cream will start to look like whipped cream. Keep shaking!

When a lump of butter forms, pour the contents of the jar into a colander to separate the butter. You can add a little salt to the butter, mix it well, and spread it on a cracker to try it!

Article 6

Properties of Milk



Scientist's Corner

What are the properties of milk? What happens when it goes through the process of homogenization? How does milk mix with other substances?

What to Use

- Whole milk
- Skim milk
- Coffee cream or half and half (cereal cream)
- Three shallow bowls
- Red, green, yellow, and blue food colouring
- Eye dropper
- Cotton swabs or toothpicks
- Liquid dish detergent

What to Do

1. Pour an equal amount of each type of milk and cream into each bowl. Wait for the milk or cream to stop moving.
2. Add one drop of each of the four food colourings, one at a time, to each bowl. The different colours will help you see how the food colouring mixes with the milk and cream.
3. Observe what happens. Record your observations in the **T-Chart** below, or make one of your own.

What I Observed

Type of Milk	Observations

4. How did each type of milk or cream react to the food colouring? Why do you think the milk and cream reacted this way?

5. Now dip a cotton swab or toothpick into the dish detergent. Touch the swab or toothpick into the middle of the bowl of milk. Keep adding more dish detergent with the swab.

6. Observe what happens and record your observations in the **T-Chart** below, or make one of your own.

What I Observed

Type of Milk	Observations

7. Describe what happened when the dish detergent was added to each type of milk or cream. Explain the reactions you observed.

_____

_____

_____

8. Why do you think there was a difference between the way milk and cream reacted with the food colouring and dish detergent?

_____

_____

_____

_____

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What reactions occur when different ingredients are added to milk?

_____

_____