Chapter 5: Milk & Cheese

TRANSFORMATION STATION

Did you know that milk is used to make many different products?

Milk can be transformed into other products because of its complex properties. A few of these products are evaporated milk, sweetened condensed milk, and dry milk.

Lactose is the carbohydrate (sugar) in milk. Lactose is a made of the two sugar molecules, glucose, and galactose. Lactose is a disaccharide. Once lactose is broken down into these single sugar molecules (monosaccharides); it cannot be broken down further in the body. ***Lactase*** is an enzyme produced in the small intestine, which is used to breakdown lactose.

Enzymes are substances that help chemical digestion occur in our digestive system. Without lactase, lactose is broken down by microorganisms (bacteria) in the small intestine producing gas, cramping, and diarrhea. Lactose intolerant individuals do not produce enough lactase to digest lactose causing these problems to occur. You will learn more about the carbohydrate lactose in *Food Lab Explorations Lab I* of this chapter. See below for a list of the disaccharides, their monosaccharide components, the enzymes that help break them down during digestion, and their common food sources. You can find disaccharides in different types of milk. For example, lactose can be found in mammal's milk. This type of milk is produced by the mammary glands of mammals like cows and goats. Rice and soy milk, however, are produced from plant products. They are actually a beverage and not milk. They are considered milk because they have a similar macronutrient (carbohydrate, protein, fat) composition.

Carbohydrate	Single Sugar Molecules	Digestive Enzyme	Common Food Source
Lactose	Glucose + Galactose	Lactase	Milk, Dairy
Maltose	Glucose + Glucose	Maltase	Malt
Sucrose	Glucose + Fructose	Sucrase	Table Sugar

Consuming products like yogurt that have active cultures help maintain and/or restore normal intestinal function.

Using bacteria, milk can also be transformed into other foods. Products formed through this process are called fermented milks. ***Fermentation*** is the breakdown of carbohydrates (sugars), like lactose. When milk is fermented with bacteria, it will make certain dairy products, like yogurt. It can be initiated with the addition of bacteria, yeast or mold. Yogurt is made by mixing two types of bacteria with milk. Once bacteria is added to milk, the mixture is warmed to promote fermentation. This will help develop the desired consistency, flavor, and acidity. Once the desired consistency has been reached, the fermentation process is stopped. The yogurt can then be chilled or heated. Chilling allows the bacterial culture or ***active culture*** to stay alive. If the yogurt is heated, the cultures are destroyed. Consuming these products with active cultures will help maintain and/or restore normal intestinal bacteria. You will learn more about the role of bacteria in yogurt production in *Food Lab Explorations Part II* of this chapter.

Milk, no matter its origin, is a staple drink in the United States that is used for a variety of purposes. Its versatility allows us to consume necessary nutrients from our favorite products. Let's explore some of the different methods used to transform milk!

Think About It

Food Explorations Lab I

1. The name of the sugar in cow's milk is lactose.

2. The enzyme needed to digest that sugar is lactase.

3. Give an example of a disaccharide and the monosacharides that make it up.

lactose (glucose + galactose) multiple answers possible (see chart on page 101)

Food Explorations Lab II

1. Fermentation requires sugar to take place. What else is needed?

bacteria, yeast, or mold

2. What does fermentation do to sugar? breaks it down

3. A warm (cold/warm) environment is best for fermentation.

Food Explorations Lab I:

Explicit Enzymes

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, you will test three types of milk for the sugar glucose before and after adding the digestive enzyme lactase to determine which milk(s) contain the sugar lactose.

Lab Objectives

In this lab, you will learn how to…

1. Explain the chemical digestion of lactose.
2. Differentiate between monosaccharides and disaccharides.
3. Describe the function of enzymes in digestion.
4. Identify milk alternatives for people who are lactose intolerant.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

What types of milk will react with the enzyme lactase?

Soy Milk Rice Milk Cow's Milk

Predictions: I predict the _____milk type will react with the lactase drops because…

Predict if the lactose enzyme (lactase) will increase, decrease, or not change the glucose concentrations of the milk (Circle your answer).

Cow's Milk:	**INCREASE**	**DECREASE**	**NO CHANGE**
Soy Milk:	**INCREASE**	**DECREASE**	**NO CHANGE**
Rice Milk:	**INCREASE**	**DECREASE**	**NO CHANGE**

Observation of an Enzymatic Reaction

MATERIALS

12 glucose strips
2-3 paper napkins
1 ½ crushed lactase enzyme pills
Glucose Reference Color Chart
Kitchen timer or stopwatch
Labeled test tube containing Unknown Milk Sample A
Labeled test tube containing Unknown Milk Sample B
Labeled test tube containing Unknown Milk Sample C
Test tube rack or beaker
Safety goggles
Aprons (optional)

PROCEDURE

1. Obtain three labeled unknown samples of milk from your teacher (Cow's Milk, Soy Milk, Rice Milk). Through observation of enzymatic reactions you will determine the identity of each unknown sample.

2. Measure the glucose concentration of each milk type (before adding the enzyme) by dipping 1 glucose strip into 1 unknown milk sample. Dip the side of the glucose strip that has the colored pad into the milk. *Be sure to keep track of which strip belongs to each milk type.* After dipping, blot each side of the strip onto a paper napkin or towel to remove the excess fluid. Not removing the extra fluid from your strip can result in an incorrect measurement. Wait two minutes for the color of the strip to develop.

3. Compare the color of the strip to the provided color chart. Record your answers in Table A under the column "Before Adding Enzyme."

4. Repeat steps 2 and 3 for the other two milk samples.

5. Add ½ of a crushed lactase pill to each milk type and stir. Then, measure the glucose concentrations of each milk type at 2 minutes, 3 minutes, and 4 minutes using the glucose strips. Record your answers in Table A.

6. Based on your observations, identify each milk sample (Soy Milk, Rice Milk, or Cow's Milk) and provide a brief explanation supporting your answer. Record your answers in Table B.

Table A: Sample Observations

Sample	Before Adding Enzyme	2 Minutes	3 Minutes	4 Minutes
Sample A	Dark Brown	Dark Brown	Dark Brown	Dark Brown
Sample B	Light Blue (negative)	Light Brown	Light Brown	Light Brown
Sample C	Light Blue (negative)	Light Green	Light Green	Light Green

Table B: Sample Identification

Sample	Identity of Substance	Explanation
Sample A	Rice Milk	No change before/after enzyme Rice milk contains glucose naturally
Sample B	Cow's Milk	No glucose before enzyme Glucose present after adding enzyme because the enzyme lactase breaks down the milk carbohydrate lactose
Sample C	Soy Milk	No to slight change before or after enzyme Lactase does not break down sucrose, meaning glucose is not released

Conclusion:

1. Compare and contrast the glucose concentrations PRIOR to adding the lactase enzyme to each sample. Explain any differences observed.

   Sample A should be positive for glucose, but not Sample B or C. This may indicate Sample A is Rice Milk because it contains glucose. Sample B and C are either Cow's Milk or Soy Milk, because they have not been exposed to the enzyme that would break down their disaccharides into monosaccharaides.

2. Compare and contrast the glucose concentrations AFTER adding the lactase enzyme to each sample. Explain any differences observed.

   Sample A did not change. It is Rice milk because it is the only milk that contained glucose prior to adding the enzyme. Sample B darkened, indicating the presence of glucose after adding the enzyme. This sample may be Cow's milk because lactase can break down the milk carbohydrate lactose. No change was observed in Sample C. This sample may be soy milk. Soy milk contains the carbohydrate sucrose. Lactase cannot breakdown sucrose.

3. Infer which of the original milk samples contained monosaccharides and which contained disaccharides.

   Sample A (Rice Milk) contains the monosaccharide glucose. Sample B (Cow's Milk) contains the disaccharide lactose. Sample C (Soy Milk) contains the disaccharide sucrose.

4. Which type of milk needs lactase enzyme in order to be digested? Explain the function of the lactase.

Cow's milk needs the lactase enzyme in order to be digested. Lactase is used to breakdown the lactose molecule into glucose and galactose for easier digestion.

5. Describe why the lactase enzyme is important for human digestion.

Our bodies need to breakdown disaccharides into monosaccharides for easier digestion. Lactase is needed to breakdown lactose into its monosaccharides.

6. If your body doesn't produce the lactase enzyme, what milk should you drink and why?

I should consume milk without lactose like rice or soy milk; otherwise, I might have gas, cramps, and diarrhea.

Student Investigations Lab Extension

As a class, compare your results. Record class totals and percentages in Table C. Circle the correct milk for each sample.

Table C: Class Comparisons

Sample	Class Comparison of Results					
Sample A	Cow's Milk		Soy Milk		Rice Milk	
	_____	_____	_____	_____	_____	_____
	# of groups	% of class	# of groups	% of class	# of groups	% of class
Sample B	Cow's Milk		Soy Milk		Rice Milk	
	_____	_____	_____	_____	_____	_____
	# of groups	% of class	# of groups	% of class	# of groups	% of class
Sample C	Cow's Milk		Soy Milk		Rice Milk	
	_____	_____	_____	_____	_____	_____
	# of groups	% of class	# of groups	% of class	# of groups	% of class

1. Compare and contrast your results to the class results.

Food Explorations Lab II:

Magnificent Microbes

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, you will use bacterial fermentation to produce yogurt. Fat content, sugar content (lactose), and temperature will be the variables tested.

Lab Objectives

In this lab, you will learn how to…

1. Identify environmental conditions (temperature) and nutritional factors (i.e. sugar and fat) that encourages the growth of bacteria.
2. Explain the role of bacteria in yogurt production.
3. Describe fermentation and its purpose for an organism.
4. Explain the importance of an "active" culture for yogurt production.
5. Compare and contrast the effects of good and bad bacteria in food.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

Which of the following milk types will produce the most yogurt?

Lactose-Free Milk (warm storage)

Skim Milk (warm storage)

Whole Milk (cold storage)

Whole Milk (warm storage)

Predictions: I predict _____ will produce the most yogurt because…

Observations of Bacterial Fermentation

MATERIALS

1 Styrofoam cup
1 black permanent marker
1 paper cup containing plain yogurt (active culture)
1 cup heated milk (assigned by teacher)
1 thermometer
Aluminum foil (1 square)
1 tablespoon
1 liquid measuring cup
safety goggles
Aprons (optional)

PROCEDURE

DAY 1

Your teacher will assign you a milk type. Record your assignment below.

My Milk Assignment: _____

1. Label your Styrofoam cup - "Lactose-Free - Warm", "Skim Milk-Warm", or "Whole Milk – Warm".
2. Using a measuring cup, obtain 1 cup of your assigned heated milk (175˚ F) from your teacher: 1 cup Lactose-Free Milk, 1 cup Skim Milk, or 1 cup Whole Milk.
3. Pour the milk into your Styrofoam cup.
4. Using your thermometer, let the cup of milk cool to 120˚ F.
5. Add 1 tablespoon of yogurt to the cup.
6. Record observations (texture, color, odor) for your assigned milk in Table A under the "BEFORE Incubation" column.
7. Share your milk type with the other groups. Be sure to record your observations (texture, color, and odor) for the two milk types you were not assigned in Table A under the "BEFORE Incubation" column.
8. Cover your Styrofoam cup with aluminum foil and place it inside the warm cooler. Leave the cup in the warm cooler overnight.

Your teacher has prepared warm samples of the whole milk. These samples will be placed in cold storage so comparisons of yogurt production can be made for both warm and cold temperatures.

DAY 2

9. On Day 2, record your observations (texture, color, and odor) of each yogurt in Table A under the "AFTER Incubation" column. Use a spoon to stir your yogurt type. Comment on the consistency and amount of excess liquid for each yogurt type.
10. Share your milk type with the other groups. Be sure to record your observations (texture, color, and odor) for the two milk types you were not assigned in Table A under the "AFTER Incubation" column.

Table A: Milk Incubation Observations

Milk	BEFORE Incubation	AFTER Incubation
Lactose-Free Milk		**Warm storage:** Small amount of liquid on top Thick, but less so compared to skim and whole milk
Skim Milk		**Warm storage:** Very little liquid on top Medium thickness (between lactose-free and whole milk)
Whole Milk		**Cold storage:** No yogurt formed Still produced liquid
		Warm storage: No liquid on top Very Thick

Conclusion:

1. Which milk type produced the most yogurt? Why?

The whole milk in warm storage produced the most yogurt. This happened because fermentation requires warm temperatures. More fat makes a thicker product.

2. For each variable tested, explain its importance in the production of yogurt.

a. Temperature

The heating process promotes fermentation and helps the yogurt develop the desired consistency, flavor, and acidity. Once the desired consistency has been reached, the fermentation process is stopped. The yogurt can then be chilled or heated. Chilling allows the active culture to stay alive. If the yogurt is heated, the cultures are destroyed.

b. Lactose

When milk is fermented with bacteria, the sugar in milk, lactose, turns into lactic acid, which causes the milk to curdle and thicken.

c. Fat

The fat content of milk determines the thickness of the yogurt. The more fat, the thicker the yogurt. For example, yogurt made with whole milk is thicker than yogurt made with skim milk.

3. Explain the necessity of fermentation for the bacteria used to produce yogurt.

Fermentation is the breakdown of carbohydrates (sugars), like lactose. When milk is fermented with bacteria, it will make certain dairy products, like yogurt. This can be initiated with the addition of bacteria, yeast, or mold. Yogurt is made by mixing two types of bacteria with milk. Once bacteria is added to milk, the mixture is warmed to promote fermentation. This will help develop the desired consistency, flavor, and acidity. Once the desired consistency has been reached, the fermentation process is stopped. The yogurt can then be chilled or heated. Chilling allows the bacterial culture or active culture to stay alive. If the yogurt is heated, the cultures are destroyed.

4. Does lactose-free milk contain sugar? Support your answer.

Yes, lactose-free milk still contains the sugar lactose. The lactase enzyme is added to lactose-free (lactaid) milk to make it easily digested by lactose intolerant individuals. I can also tell that lactose-free milk still contains sugar by looking at the nutrition facts label.

5. Summarize the ingredients and environmental conditions needed to make yogurt.

To make yogurt you need:

Bacteria, mold, or yeast

Milk

Warm temperatures

Incubator

6. Describe active cultures and explain how they are maintained.

Active cultures are microorganisms that are alive. They must be kept in moderate temperatures and not heated or cooled to extremes.

7. Infer what would happen if yogurt not containing "active cultures" were used in this lab activity.

Yogurt would not form because you need live cultures for fermentation.

8. Compare and contrast the effects of good and bad bacteria in food.

Bacteria can be harmful in raw foods such as poultry because they can cause foodborne illness. Bacteria can be good in foods such as yogurt because they help maintain and/or restore normal intestinal bacteria.

Student Investigations Lab Extension

Directions to Use a Microscope

1. Plug the microscope in (if applicable) and turn it on.
2. Adjust the magnification to the lowest power.
3. Make sure the stage is lowered all the way and place the slide on the microscope stage. Slowly raise the stage using the coarse focus knob (large knob) so you can see the object clearly through the ocular lens. Do not let the slide touch the objective lens.
4. Using the fine focus knob (small knob), adjust the focus so the object looks clear.
5. If the object is too dark or too bright, you can adjust the diaphragm until you can see all the details.
6. Once the object is in focus, you may change to higher powers. However, be sure the lens does not hit the slide.

View Yogurt Bacteria under a Microscope:

1. Obtain a sample of yogurt with active cultures from your teacher or use a sample of yogurt from the *Food Explorations II* investigation.
2. Make a wet mount slide:
   a. Place a drop of water on a clean slide.
   b. Place a small amount of yogurt on the drop and cover with cover slip.
3. Observe using the microscope under 4X power and then 10X power.
4. Draw your observations in high power (10X).
5. In the box on page 118, draw the bacteria. What shape are the bacteria?

Bacteria Drawing

Acid Adventure

Did you know that cheese is made when acid is added to milk?

The production of cheese begins with the curdling of milk, which is the making of **curds** and **whey**. There are several ways to begin this process. Two ways include the heating of milk at high temperatures and adding an acid and enzyme to the milk. For example, when the enzyme rennin is added to milk after the acid, it will speed up the curdling process. These methods will be investigated in *Food Explorations* of this chapter.

According to the Law of Conservation of Mass, matter can change from one form to another, but the total mass must stay the same. In other words, the products of a reaction, in this case curds and whey, must have a total mass equal to the total mass of the reactants, milk and acid (if used).

Curds are formed by the **coagulation** of the milk**. Casein** is a protein that makes up about 80% of milk. When the casein and fat in the milk clump together, the soft, gel-like curds are formed. The remaining liquid is mostly water with other proteins, lactose, and minerals dissolved in it. This liquid is the whey. Heat is applied to the curds to speed up the separation of whey. Once the curds are separated from the whey, they are drained, stretched, salted, and pressed to form a more concentrated cheese.

To give each cheese its own unique properties, it is then ***cured*** or ***ripened*** to complete the process. Cheese that needs to be cured is not ready for consumption after being prepared. Depending on the desired characteristics, the cheese is held for a certain amount of time, temperature, and under certain conditions. Most cheeses are considered ripened, unless they are fresh. Ripening is considered as the changes that occur between the formation of curd and the development of the desired characteristics, such as aroma (smell), flavor, texture, and composition.

Making cheese is a very complex process that varies depending on the desired product. One small change in the type of milk or enzyme, length of time, or temperature may produce an entirely different cheese. It's time to make cheese and discover the differences for yourself!

Think About It

Food Explorations Lab III

1. What forms when milk curdles? _____curds_____ and _____whey_____.

2. Curds are made up of _____protein (casein)_____ and _____fat_____.

3. The main component of whey is _____water_____.

Cheese Production Flowchart

Acid or Enzyme Added to Milk

CURDS **WHEY**

Curds are Drained, Stretched, Salted and Pressed

Cured
TIME, TEMPERATURE, CONDITIONS

Produces hard cheese like Parmesan

Ripened
MONTHS TO YEARS

Produces soft cheese like Brie

Mold added to produce cheeses like Bleu Cheese

Food Explorations Lab III:

Maintaining Mass

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, you will make qualitative and quantitative observations as you test three possible methods of making curds and whey. You will determine if your measurements support the Law of Conservation of Mass.

Lab Objectives

In this lab, you will learn how to…

1. Determine methods that can be used to form curds and whey from milk.

2. Explain the Law of Conservation of Mass using quantitative observations.

3. Describe important environments for cheese-making.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

Which of the following treatments will cause milk to curdle? *You may choose more than one.*

Heat Vinegar Baking Soda

Predictions: I predict _____ will cause milk to curdle because…

Observation of Curdling Proteins under Varying Conditions

MATERIALS

2% milk (for the class)
1 cup containing 1 tbsp baking soda
3 plastic spoons
1 triple beam balance
1 black permanent marker
safety goggles
1 cup containing ½ cup vinegar
1 liquid measuring cup
1 small strainer (very thin mesh)
4 Styrofoam cups
1 medium bowl
Aprons (optional)

PROCEDURE

Before you begin your part of the lab investigation, your teacher will demonstrate how to find the mass of coagulated proteins after milk curdles when exposed to heat. Record the data your teacher determines from the demonstration in Table B.

1. Using the black permanent marker label the empty cups as follows:

   a. 1 Styrofoam cup "Milk with Vinegar"

   b. 1 Styrofoam cup "Milk with Baking Soda"

   c. 1 Styrofoam cup "Curds"

   d. 1 Styrofoam cup "Whey"

2. Using the triple beam balance, mass each of the labeled cups and write their masses below:

Cup	Mass in Grams
Milk with Vinegar	_____ g
Milk with Baking Soda	_____ g
Curds	_____ g
Whey	_____ g

3. Using the liquid measuring cup, obtain 1 cup of 2% milk from the teacher. Pour the milk into the cup labeled "Milk and Vinegar". Using the triple beam balance, mass the cup with the milk in it and write the new mass below.

"Milk with Vinegar" cup plus 1 cup Milk =	**_____ g**

4. Subtract the Mass of "Milk with Vinegar" empty cup from the Mass of "Milk with Vinegar" cup with the Milk to get the mass of the milk alone. Record this mass in Table B on page 125 under the column "Uncoagulated Milk".

Mass of "Milk with Vinegar" cup plus 1 cup Milk	– Mass of "Milk with Vinegar" cup	= Mass of Milk for Vinegar treatment
_____ g	**– _____ g**	**_____ g**

5. Using the liquid measuring cup, obtain another 1 cup of 2% milk from the teacher. Repeat step 4 for the cup labeled "Milk with Baking Soda".

Mass of "Milk with Baking Soda" cup plus 1 cup Milk	– Mass of "Milk with Baking Soda" cup	= Mass of Milk for Baking Soda treatment
_____ g	**– _____ g**	**_____ g**

6. Record descriptions of the milk before adding the vinegar and baking soda in Table A under the column labeled "Milk BEFORE Treatment." *DO NOT smell or taste this substance.*

7. Using the triple beam balance, measure the mass of the cup with vinegar provided by the teacher.

Mass of cup and vinegar =	**_____ g**

8. Add the vinegar just massed to the "Milk with Vinegar" cup. While one team member stirs the sample with a plastic spoon, another team member should mass the now empty cup that the vinegar was in. Calculate the mass of the vinegar used:

Mass of cup and vinegar	– Mass of cup	= Mass of vinegar
_____ g	**– _____ g**	**_____ g**

9. Record the mass of vinegar in Table B under the treatment column.

10. Observe the milk and vinegar mixture. Describe your observations in Table A under the column labeled "Milk AFTER Treatment."

11. Repeat steps 7 through 10 for the cup containing baking soda. Be sure to add the baking soda to the "Milk with Baking Soda" after you mass the cup containing the baking soda.

Mass of cup and Baking Soda	– Mass of cup	= Mass of Baking Soda treatment
_____ g	– _____ g	_____ g

12. Record the mass of baking soda in Table B under the treatment column. Describe your observations in Table A.

13. Select the cup that formed the most curds and whey. Follow these steps to determine the amount of curds and whey that were formed:

STEP 1: Place the strainer over a medium bowl and pour the selected mixture into the strainer. The strainer will catch any coagulated proteins. Using a plastic spoon, scrape the coagulated proteins out of the strainer and place them in the clean Styrofoam cup labeled "curds" measured in #2.

STEP 2: Place the small Styrofoam cup containing the milk proteins that you just scraped from the strainer on your balance and find its mass. The coagulated proteins are called **curd proteins**. Calculate the mass of the curd proteins and write it in Table B under the column labeled "Curd Protein."

Mass of "Curds" cup and Curds	– Mass of "Curds" cup	= Mass of Curds
_____ g	– _____ g	_____ g

STEP 3: The leftover fluid in your bowl is called **whey protein**. Pour the liquid whey protein into the Styrofoam cup labeled "Whey" and find its mass. Calculate and record the mass of the whey in Table B under the column labeled "Whey Protein."

Mass of "Whey" cup and Whey	– Mass of "Whey" cup	= Mass of Whey
_____ g	– _____ g	_____ g

Table A: Coagulation Observations

Milk Type	Treatment	Milk BEFORE Treatment	Milk AFTER Treatment
2% Milk	Vinegar	White & milky	A lot of coagulation You can clearly see whey and curds
	Baking Soda	White & milky	No difference - still white & milky

Table B: Coagulation Measurements

Milk Type	Treatment (grams)		Uncoagulated Milk (grams)	Curd Protein (grams)	Whey Protein (grams)
2% Milk	Vinegar	200g	210g	150g	250g
	Baking Soda	200g	210g	0g	400g
	Heat	200g	210g	100g	300g

TEACHER'S NOTE: Numbers in the tables are estimates only. The values your students obtain may vary.

Conclusion:

1. Explain how your original response compared to the actual results of the investigation.

Student responses will vary.

2. Describe any treatment(s) that did not produce curds and whey. Explain why.

Baking soda did not produce curds and whey. This did not happen because baking soda is a base and it does not provide the acid or heat needed to form curds.

3. Compare the total mass of the uncoagulated milk and its treatment to the total mass of the curds and whey produced. Explain any differences.

Heated:

There were less curds and more whey compared to the vinegar treatment.

Vinegar (acidic):

There were more curds and less whey when compared to the heated treatment

Baking Soda (basic):

No curds formed.

4. Which type of treatment produced the most curdling: Heated, acidic, or basic environments?

Acidic

5. Based on your investigation, which two environments are important in the cheese-making process? Why?

Heat and acidity are important. Heat allows the particles to separate more readily and acidity causes the protein (casein) to clump together and curdle.

Student Investigations Lab Extension

As a class, discuss the observations of each group and complete Table C.

TABLE C. Observations of Milk Types and Treatment Effects

MILK TYPE	TREATMENT TYPE		
	High Heat (teacher demo)	Vinegar	Baking Soda
2% Milk	_____ grams	Group 1: _____ grams	Group 1: _____ grams
		Group 2: _____ grams	Group 2: _____ grams
		Group 3: _____ grams	Group 3: _____ grams
		Class Averages	
		_____ grams	_____ grams

1. Predict what would happen if you use lemon juice as a non-heat treatment. Explain why.

   Lemon juice would produce curdles over time. The lemon juice will create an acidic environment, but because the milk is not heated, it will take more time for the particles to move.

2. As a class, discuss instances in which curdling might be a desirable outcome. List a few examples below.

   Cottage cheese

Investigating Your Health:
Magnificent Milk

Name: _____

Objective: Investigate milk by comparing different kinds, researching important nutrients, and brainstorming ways to add key nutrients to your diet.

Along with cheese and yogurt, milk is in the dairy group. Unfortunately, most Americans do not drink or eat enough foods from the dairy group. It is recommended that you should eat or drink at least 3 cups of dairy products every day. However, whole milk is high in saturated fat, and when not consumed in moderation may cause heart disease and stroke. Therefore, you should choose low-fat or fat-free dairy products. The ***calcium*** found in milk and other dairy products is very important for your bones! Calcium helps your bones become strong. It is not only found in dairy products; some orange juice and cereals have added calcium, making them a good source too. To find out if they are a good source of calcium, you should read the label because not all cereals and orange juice have added calcium.

If you do not get enough calcium, you could develop osteoporosis later in life. ***Osteoporosis*** occurs when bones become weak and break easily. ***Vitamin D*** helps your bones absorb calcium. This vitamin can be found in fish such as salmon and tuna, and it's often added to milk.

Your body also makes Vitamin D from sunlight! ***Phosphorus*** is also an important nutrient for your bones. Phosphorus combines with calcium to build strong bones and teeth. Phosphorus can be found in meat, poultry, fish, dairy, nuts, and cereals. To build strong bones you need calcium, vitamin D, *and* phosphorus. Use the *Try This at Home* recipe to make a calcium-rich snack at home!

Comparing Milk Nutrients

Go to the grocery store and look at the Nutrition Facts labels for whole milk, reduced fat milk (2%), low-fat milk (1%), and fat-free milk. If you are unable to go to the grocery store, use the handout provided by your teacher or access the nutrient database on USDA's website: http://ndb.nal.usda.gov/ndb/search/list. Complete the table below.

	Whole Milk	Reduced Fat Milk	Low-fat Milk	Fat-Free Milk
Calories	150	130	110	90
Total Fat	8g	5g	2.5g	0g
Calcium	30%	30%	30%	30%
Vitamin D	25%	25%	25%	25%
Phosphorus	222mg	276mg	232mg	247mg

TEACHER'S NOTE: Students should find that milk types will have a varying level of fat content, but the same amount of calcium and vitamin D. For this reason, milk types lower in fat may be the healthier option. Additionally, students may be surprised to find that calcium, vitamin D, and phosphorus can be obtained from multiple dietary sources, not just dairy foods.

1. Which milk is the best choice? Why?

Fat-Free milk is the best choice because it has the least fat but the same amount of calcium and vitamin D.

2. Name 3 food sources for calcium, vitamin D, and phosphorus.

Calcium:	**Vitamin D:**	**Phosphorus:**
1. Dairy	1. Milk	1. Dairy
2. Cereal	2. Salmon	2. Cereal
3. Fortified Orange Juice	3. Tuna	3. Nuts

*Multiple answers possible (vegetables, fruits, and fortified foods are also good sources)

3. List 3 ways you can include bone-strengthening foods in your diet.

Drink milk or fortified orange juice during meals; Have yogurt or cottage cheese mixed with fruit as a snack; Eat cereal with milk for breakfast; Have a tuna sandwich for lunch; Eat almonds or peanuts as a snack.

4. Plan 3 meals, including a snack, for 1 day that includes bone-strengthening foods in each.

	Meal	Bone-Strengthening Food(s)
Breakfast		
Lunch		
Dinner		
Snack		

TEACHER'S NOTE: Encourage students to consider multiple sources of low-fat dairy sources.

5. In your own words, explain why you should include sources of calcium, Vitamin D, and phosphorus in your diet? (HINT: What body system is impacted?)

Calcium – bones, teeth, blood clotting, neural function, blood pressure

Vitamin D – helps maintain normal levels of calcium and phosphorus

Phosphorus – growth and repair of body tissues especially bones and teeth

Investigating Your Health:
Charming Cheese

Name: _____

Objective: Investigate cheese by comparing the fat content of different cheese, identifying cheeses of varying moisture content, and comparing their nutritional values.

How a cheese is made impacts its fat and calcium content. Cheese is normally made from cow's milk, but it can be made from goat and sheep's milk too. Cheeses can either be hard, semi-hard, semi-soft, or soft based on their moisture content. ***Hard*** cheeses, like Parmesan, Romano, and Asiago, have the highest amount of calcium compared to other kinds of cheeses. Hard cheeses generally have about 7-8g of fat per ounce. ***Semi-hard*** cheeses are generally the lowest in calcium, but they have more than 10% Daily Value of Vitamin B_{12}. These cheeses generally have 8-9g of fat per ounce. Some examples of semi-hard cheese are cheddar, provolone, and Monterey jack. American, Swiss, and Colby are three examples of ***semi-soft*** cheeses. These cheeses generally rank second for their calcium content and have about 9g of fat per serving. The nutrient content of ***soft*** cheeses, like mozzarella, feta, Brie, and cottage cheese, vary greatly so it is difficult to compare them to hard, semi-hard, and semi-soft cheeses. Soft cheeses can contain between 3-20% Daily Value of calcium and their fat content can range from 5-15g per serving.

Along with milk, yogurt, and ice cream, cheese is part of the dairy group. Unfortunately, most Americans do not drink or eat enough foods from the dairy group each day. The ***calcium*** found in milk and other dairy products is very important for your bones! Calcium helps your bones become strong. The milk used to make cheese can either be whole, reduced-fat, or skim. You should aim to choose low-fat cheese (instead of full-fat cheese made with whole milk) to help you meet the recommended 3 cups of dairy products each day. With hundreds of different kinds of cheeses, trying all of them is nearly impossible! Start with some of the most common kinds of cheese such as cheddar, Monterey jack, American, mozzarella, and Parmesan. Use the *Try This at Home* recipe to make a cheesy sauce that can dress up any meal!

PART A: Fat Content in Cheeses

1. Go to the grocery store and look at the Nutrition Facts labels for shredded cheddar cheese made with whole milk, 2% milk, and fat-free milk. If you are unable to go to the grocery store, use the handout provided by your teacher or access the nutrient database on USDA's website: http://ndb.nal.usda.gov/ndb/search/list. Complete the table below.

CHEESE TYPE			
	Whole Milk	**2% Milk**	**Fat-free Milk**
Calories			
Total Fat			
Saturated Fat			
Sodium			
Calcium			

2. Look at the Nutrition Fact labels for Parmesan, cheddar, Swiss, and mozzarella cheese. Try to find labels for each cheese with the same serving size. If you are unable to go to the grocery store, use the handout provided by your teacher or access the nutrient database on USDA's website: http://ndb.nal.usda.gov/ndb/search/list. Complete the Nutrition Facts labels on following page.

Parmesan

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____% Vitamin C ____%

Vitamin E ____% Calcium ____%

Iron ____% Thiamin ____%

Niacin ____% Folate ____%

Vitamin B_{12} ____% Zinc ____%

Magnesium ____%

Cheddar

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____% Vitamin C ____%

Vitamin E ____% Calcium ____%

Iron ____% Thiamin ____%

Niacin ____% Folate ____%

Vitamin B_{12} ____% Zinc ____%

Magnesium ____%

Swiss

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____% Vitamin C ____%

Vitamin E ____% Calcium ____%

Iron ____% Thiamin ____%

Niacin ____% Folate ____%

Vitamin B_{12} ____% Zinc ____%

Magnesium ____%

Mozzarella

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____% Vitamin C ____%

Vitamin E ____% Calcium ____%

Iron ____% Thiamin ____%

Niacin ____% Folate ____%

Vitamin B_{12} ____% Zinc ____%

Magnesium ____%

3. Which cheese is the best choice to include in a healthy diet? Why?

The cheese made from 2% milk (most calcium) or the cheese made from fat-free milk (less fat) are the healthier choices. The cheese made from whole milk is not the best choice because it has the least amount of calcium and the highest in fat and calories.

If the serving sizes are different use the space below to standardize each label so that you can compare their nutritional content. Ask your teacher for help if you have to standardize your labels.

Nutrition Facts	**Nutrition Facts**	**Nutrition Facts**
Serving Size _____	**Serving Size** _____	**Serving Size** _____
Calories _____	**Calories** _____	**Calories** _____
Total Fat _____	**Total Fat** _____	**Total Fat** _____
Sodium _____	**Sodium** _____	**Sodium** _____
Total Carbohydrates _____	**Total Carbohydrates** _____	**Total Carbohydrates** _____
Dietary Fiber _____	Dietary Fiber _____	Dietary Fiber _____
Sugars _____	Sugars _____	Sugars _____
Protein _____	**Protein** _____	**Protein** _____
Vitamin A ____% Vitamin C ____%	Vitamin A ____% Vitamin C ____%	Vitamin A ____% Vitamin C ____%
Vitamin E ____% Calcium ____%	Vitamin E ____% Calcium ____%	Vitamin E ____% Calcium ____%
Iron ____% Thiamin ____%	Iron ____% Thiamin ____%	Iron ____% Thiamin ____%
Niacin ____% Folate ____%	Niacin ____% Folate ____%	Niacin ____% Folate ____%
Vitamin B_{12} ____% Zinc ____%	Vitamin B_{12} ____% Zinc ____%	Vitamin B_{12} ____% Zinc ____%
Magnesium ____%	Magnesium ____%	Magnesium ____%

TEACHER'S NOTE: Regardless of the source used to obtain the food labels, students should seek labels that use identical serving sizes. If students choose a cheese with different serving sizes listed on the label, they will need to mathematically standardize each label before comparing them. To standardize serving size across nutrition labels, students will need to convert each serving size into the same value (cups, tablespoons, etc.). Students will then need to convert all fractions to a decimal. Finding the largest decimal, the students will then divide it by one of the others. Multiply each number in the nutrition facts label using this answer. For example: ¾ = .75, .75 ÷ .5 = 1.5. Repeat these steps with the other labels. Please reference the Sample Nutrition Facts Standardization Worksheet found at www.foodmaster.org.

PART B: Comparing Cheese

1. List 3 cheeses that are hard, semi-hard, semi-soft, and soft.

Hard:	Semi-hard:	Semi-Soft:	Soft:
1. Parmesan	1. Cheddar	1. American	1. Mozzarella
2. Romano	2. Provolone	2. Colby	2. Feta/Brie
3. Asiago	3. Monterey Jack	3. Swiss	3. Cottage Cheese

2. Using your answers from question #1 in Part A, rank the cheeses based on their calcium content, with 1 being the highest and 4 being the lowest.

1. Parmesan
2. Swiss
3. Mozzarella
4. Cheddar

3. Using your answers from question #1 from Part A, rank the cheeses based on their fat content, with 1 being the lowest and 4 being the highest.

1. Mozzarella
2. Parmesan
3. Swiss
4. Cheddar

4. In your own words, describe the potential health benefits of eating cheese.

Student answers will vary.

TRY THIS AT HOME:

Fresh Yogurt

Makes about 4 cups

You will need:

Prep time: 20 minutes

4 cups low-fat or skim milk
4 tablespoons yogurt (with active cultures)
1-2 Tablespoons honey
1 cooler
4 glass jars with lids

INSTRUCTIONS:

1. Pour the milk into a pot and add the honey. Heat to 200˚F, stirring to prevent burning.
2. Let the milk mixture cool until it is about 115˚F.
3. Once the milk mixture has cooled, add about 1 cup of it to a small bowl with the yogurt.
4. Whisk together until the yogurt and milk have smoothly blended.
5. Add the mixture to the milk and whisk until blended.
6. Pour warm water (110˚F) into water bottles, and place in cooler. Leave just enough room for the 4 glass jars.
7. Pour the yogurt mixture into glass jars and place in cooler for 4-6 hours.
8. When the yogurt has thickened, it is ready to be refrigerated.
9. One the yogurt has been cooled, it is ready to eat!

TRY THIS AT HOME:

Simple Cheese Sauce

Makes 4 – ½ cup servings

You will need:

8 ounces low-fat cottage cheese
3 ounces evaporated skim milk
½ cup shredded American or cheddar cheese

INSTRUCTIONS:

1. Combine cottage cheese and evaporated milk in a blender and process until smooth.

2. Heat the mixture in a medium saucepan over low-medium heat. Stir constantly.

3. Add cheese.

4. Stir until the cheese melts and until sauce thickens.

5. Pour over your favorite cooked pasta or vegetables and enjoy!