PLAN "K": CHEESE CULTURES

The Culture of Cheese:

explores the cheese making process and the history of cheese making, including bacteria, enzymes, and fermentation.

- History of Cheese
- Science behind the cheese making process
  - Fermentation, lactic acid, the role of bacteria
  - Enzymes and proteins

Name: _____ Date: _____

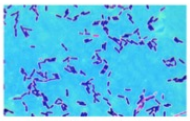
THE CULTURE OF CHEESE



Cheese is simply a means of controlled spoilage (and what many people would argue to be a delicious controlled spoilage). In some major cheese plants found in North America, up to 3.5 million pounds of milk are used to make 400,000 pounds of cheese every day!

Making cheese can be described as a science and art. The science portion comes from the timing, the temperature, the enzymes and the microbes. The art comes from the designing portion of making cheese such as Swiss, Brie, American, cheddar, Havarti, Gouda, Parmesan, mozzarella, and more!

There are so many different types of cheese that depend on a number of factors such as bacteria used, temperature, and time- but they all start as one thing: milk. Cow and goat milk are the most popular, but any mammal is capable of producing milk. The milk must first be fermented to make any cheese product. Fermentation occurs when bacteria break down sugar. The sugar found in milk is lactose, and bacteria break it down into a product called lactic acid.



Lactobacilli acidophilus

"Lactose intolerance" is typically a genetic condition in which an individual cannot properly digest lactose, which is the sugar found in milk and any milk products. Lactose intolerant individuals do not produce enough of the enzyme lactase, which breaks down lactose into a smaller, simpler form.

Because bacteria are crucial for the cheese-making process, the milk must first be free of any antibiotics (drugs that eliminate bacteria). The bacteria used to start the cheese making process in milk are called the "starter culture." Not just any bacteria are used; this is the "good" bacteria that will not harm us, or more specifically: lactic acid bacteria. Examples include *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Lactococcus* and *Streptococcus*. These bacteria begin to digest the lactose, which is the sugar found in milk. The milk is heated into bins and slightly agitated while this process occurs to help speed it up.

As the bacteria break down the lactose, they produce lactic acid in a process known as anaerobic respiration. As this process occurs, the bacteria naturally cause the milk to become more acidic, thus lowering the pH of the milk. The acidity gives cheese that "sharp", tangy flavor. The pH drop also has another side effect: it causes the proteins in milk to coagulate, or in other words, clump together. However, the coagulation caused by the bacteria does not occur quickly enough. Therefore, an enzyme is used to speed things up. (Recall enzymes are catalysts: they speed up chemical reactions). Rennet is the enzyme used. Most cheese makers today use the rennet that can naturally be found in vegetables. However, it was originally taken from the stomach linings in animals such as cows and sheep (more on that later).

Once the rennet has been added, the coagulated milk can be formed relatively quickly. This solid milk, which starts off as a yogurt-like consistency, is known as curd. The curd is high in milk proteins, known as casein. The liquid, which has separated from it, is known as whey. The whey is drained and discarded, and the curd is cut into tiny bits. The more the curd is cut, the harder the cheese will be, as more moisture and liquid will leave the curd with more cutting.



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The cheese is then pressed to shape the curd, and in the process more whey is pressed out. For cheeses such as cheddar, which have a medium consistency, this does not take very long. The bacteria are still eating up the lactose and releasing acid. As time goes on, the cheese becomes more flavorful. We call this the "aging" process. Depending on the type of cheese, this can take as little as 7-10 days. However, if a more pungent cheese is desired, the cheese may age for up months or even up to a year.

Salt is almost always applied to the cheese towards the end of the cheese making process. The earliest being after whey is drained from the curds as salting prior to this point will prematurely inhibit the growth of the starter culture and act as a major preservative of cheese. Depending on the type of cheese, salt will be added in different ways. Salt is used in cheese for several reasons, including: slowing down bacterial growth, preservation, slowing down lactic acid formation, texture, moisture control, and flavor.



Swiss cheese starter cultures include multiple types of bacteria; one species being *Propionibacter shermani* which produces CO_2 (carbon dioxide) while it breaks down lactose. The carbon dioxide creates bubbles, which form holes in Swiss cheese.

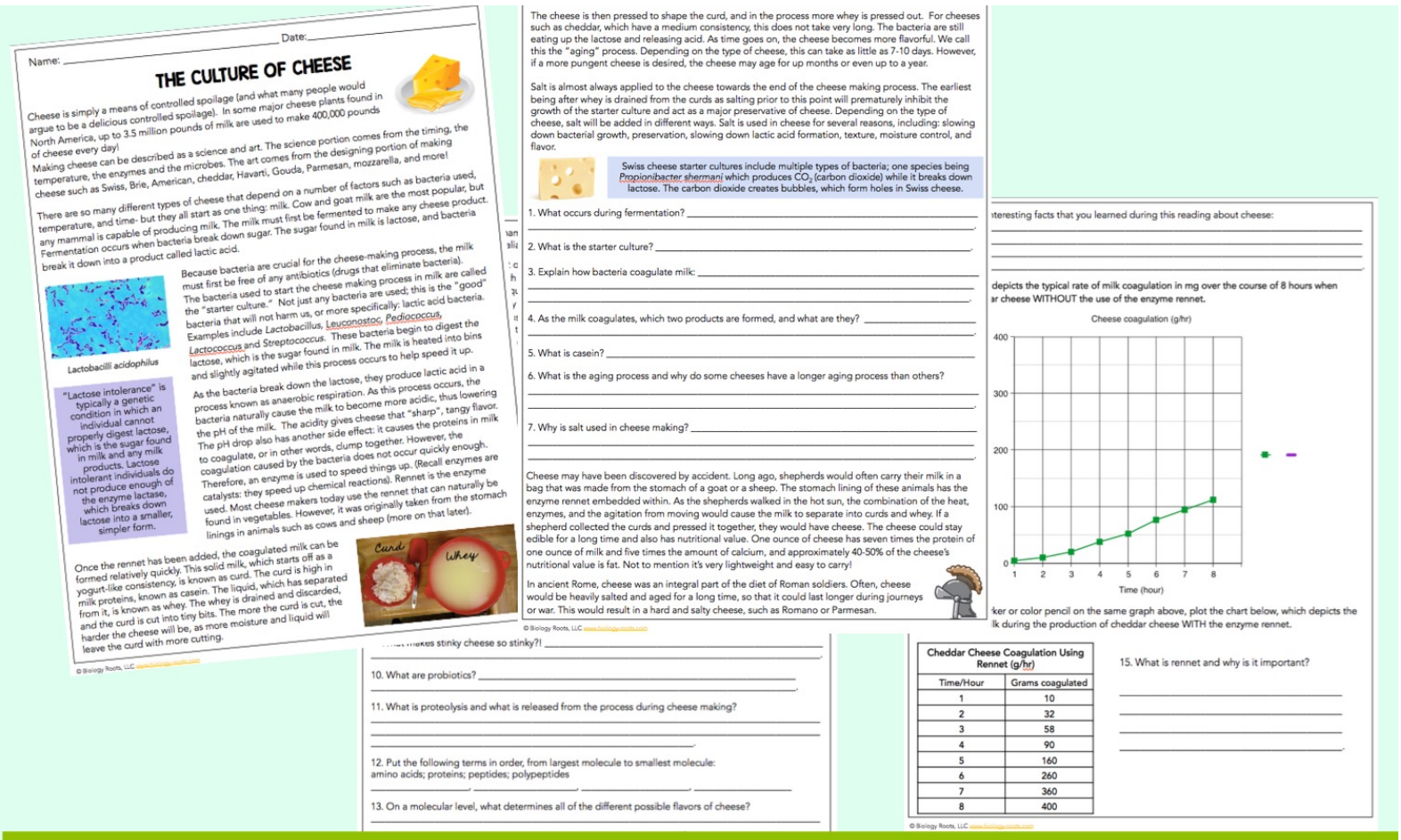
1. What occurs during fermentation? _____
_____.
2. What is the starter culture? _____.
3. Explain how bacteria coagulate milk: _____
_____
_____.
4. As the milk coagulates, which two products are formed, and what are they? _____
_____.
5. What is casein? _____
6. What is the aging process and why do some cheeses have a longer aging process than others?
_____
_____.
7. Why is salt used in cheese making? _____
_____
_____.

Cheese may have been discovered by accident. Long ago, shepherds would often carry their milk in a bag that was made from the stomach of a goat or a sheep. The stomach lining of these animals has the enzyme rennet embedded within. As the shepherds walked in the hot sun, the combination of the heat, enzymes, and the agitation from moving would cause the milk to separate into curds and whey. If a shepherd collected the curds and pressed it together, they would have cheese. The cheese could stay edible for a long time and also has nutritional value. One ounce of cheese has seven times the protein of one ounce of milk and five times the amount of calcium, and approximately 40-50% of the cheese's nutritional value is fat. Not to mention it's very lightweight and easy to carry!

In ancient Rome, cheese was an integral part of the diet of Roman soldiers. Often, cheese would be heavily salted and aged for a long time, so that it could last longer during journeys or war. This would result in a hard and salty cheese, such as Romano or Parmesan.



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Curd Whey

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...makes stinky cheese so stinky?! _____

10. What are probiotics? _____
11. What is proteolysis and what is released from the process during cheese making? _____
12. Put the following terms in order, from largest molecule to smallest molecule: amino acids; proteins; peptides; polypeptides _____
13. On a molecular level, what determines all of the different possible flavors of cheese? _____

...teresting facts that you learned during this reading about cheese: _____

...depicts the typical rate of milk coagulation in mg over the course of 8 hours when ...ar cheese WITHOUT the use of the enzyme rennet.

...ker or color pencil on the same graph above, plot the chart below, which depicts the ...lk during the production of cheddar cheese WITH the enzyme rennet.

Cheddar Cheese Coagulation Using Rennet (g/hr)	
Time/Hour	Grams coagulated
1	10
2	32
3	58
4	90
5	160
6	260
7	360
8	400

15. What is rennet and why is it important? _____

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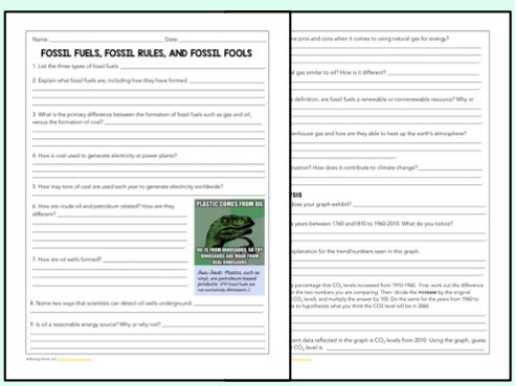
5 pages- the last page is a graphing exercise "Coagulation over time" that can be omitted if you'd prefer to cut it down to 4 pages.

This lesson covers the basics behind cheese-making: bacteria, lactose, fermentation, lactic acid, proteolysis, coagulation.

ANSWER KEY AND CLASS PACKET VERSION INCLUDED

Example of packet versions


FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS


FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS

Classroom set (print once)

Student answer sheets

biology roots

Classroom resources to promote *scientific literacy* and curiosity.

Thank you so much for supporting biology roots

I am so excited that you will be using my resources to *benefit* your classroom. Listed below are some categories of products that I offer in my TpT store:

Digital Interactive Notebooks	Complete Units- No prep!
Paper Interactive Notebooks	Super Duper Science Sub Plans
Captivating Presentations	Terrific Task Cards

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