



COURSE 2:

Food Production, Nutrition and Health

MANAGING MICROBES



**food and
nutrition sciences**

PREPARATION FOR TOMORROW





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Project Overview



CONCEPT/DESCRIPTION

- 1 Students will define expiration date, sell by date, best if used by date, and use by date.
- 2 Students will explore different food processing methods. Students will conduct research using the Internet.
- 3-4 Students describe types of fermented food, and demonstrate the process of making kimchi.
- 5 Students evaluate commercial yogurt using sensory analysis.
- 6 Students demonstrate how to make yogurt.
- 7 Students determine the scope and meaning of the project.
- 8 Students summarize the cultural history of sourdough bread. Students compare sourdough recipes from different regions. Students explain flavor differences based on the presence of different bacteria and yeasts.
- 9 Students define starter culture and list the steps in creating a starter culture.
- 10 Students make observations of mold growth. Students compare sourdough bread to other breads. Define qualitative and quantitative data.
- 11 Students describe the role of yeast in fermentation. Students compare fermentation by yeast to fermentation by yeast and lactobacilli.



CONCEPT/DESCRIPTION

- 12 Students compare starters kept in different conditions. Students examine the factors influencing fermentation.
- 13 Students will select a procedure for creating a starter, and apply the procedure to begin a starter.
- 14 Students apply a procedure for baking sourdough bread, and apply their understanding of the requirements for fermentation to store a starter in a way that slows the process and keeps the microorganisms healthy.
- 15 Students apply a procedure for graphing data over time, and compare their graphs to other teams and make adjustments.
- 16 Students describe the process of fermentation that involves yeast and lactobacilli.
- 17-19 Students apply a second sourdough recipe to the baking process. Describe the differences between the first recipe and the second.
- 20 Students describe their process for developing a starter culture and their process for developing sourdough bread. Students critique their process and product.
- 21 Students summarize the topic of fermentation and the topic of food processing.



Key Question of the Day:

How do you know if food is spoiled?

(Each day the key question should be prominently displayed and used to open the lesson.)



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Define expiration date.
- Define sell by date.
- Define best if used by date.
- Define use by date.



Required Materials

- Computers
- Internet
- Article – [Appendix 3](#) – One per team - <http://www.cnn.com/2013/09/19/health/sell-by-dates-waste-food/>
- Optional Resource – [Appendix 3.1](#) - http://www.fsis.usda.gov/wps/wcm/connect/19013cb7-8a4d-474c-8bd7-bda76b9defb3/Food_Product_Dating.pdf?MOD=AJPERES
- Lab adapted from *Science and Our Food Supply* by NSTA and the FDA, page 36-41 – [Appendix 4](#)
- Lab materials
 - › 60 mL Pasteurized whole milk (10 mL/test tube)
 - › 60 mL Ultra high temperature whole milk (10 mL/test tube)
 - › Methylene blue dilute solution (1 drop per test tube)
 - › 6 Sterile test tubes
 - › 6 Sterile test tube caps or aluminum foil to cover the top of the tubes
 - › 2 Sterile 10 mL pipets
 - › 1-2 Sterile 5 mL pipettes or eye droppers
 - › Sterile pipette bulbs
 - › Permanent markers
 - › Test tube rack
 - › Refrigerator
 - › Freezer
- Copies of the data table from [Appendix 4](#) - One per student



Bell-Work

(Each day the Bell-Work question should be prominently displayed and used to open the lesson)

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“Why do foods have expiration dates? What do these dates mean?”**

OPENING

(Designed to **prepare** students for learning. Students are prepared for learning by activating an **overview** of the **upcoming** learning experience, their **prior knowledge**, and the **necessary vocabulary**.)

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include:
 - › To tell the consumer when to throw the food away
 - › Tell the consumer how long the food will be fresh
- Explain the meaning of each term:
 - › Expiration date: indicates the shelf-life of a food product
 - › Sell by date: Tells the store how long the product should be displayed, and the consumer should buy the product before that date expires
 - › Best if used by date: Date recommended for best flavor or quality; not related to food safety
 - › Use by date: Last date recommended for the use of the product while at peak quality; date is determined by the manufacturer of the product
- The point to be made: **“Food product dating helps consumers keep track of the quality of their food. They are indicators of when foods should be consumed versus discarded, and help us understand the appropriate amount of time that food can be stored.”**
- Have students break into teams of two or three. These will be the teams they work with for the duration of the project.
 - › You can randomly assign teams or strategically place students in groups. Feel free to make the decision based on the class size and student dynamics.

MIDDLE

(Designed to provide a **structure** for learning that actively promotes the **comprehension and retention** of knowledge through the use of **engaging strategies** that acknowledge the brain's limitations of **capacity and processing**.)

- ✓ **TEACHER TIP!** Feel free to use the resource ([Appendix 3.1](#)) as supplemental materials for this lesson. Also, use the lab ([Appendix 4](#)) to prepare for this lesson (you will not be using the video referenced in the lab instructions). This appendix is intended to be a teacher guide, and the only page from the lab that students should ever see is page 41, which is the data table they will use to document their observations. Some of the supplies will have to be purchased and prepared ahead of time.
- When teams are finished, give them a copy of the article ([Appendix 3](#)) to read within their groups.
 - › Split the article so that each person in the team has a section to read and explain to their teammates.
 - › After the class has the opportunity to read the article, have a brief reflection discussion about food product dating and what the dates actually mean and the implications on the food supply.
- Following the discussion, prepare students for the processing lab by explaining that in order for food to be safe for us to eat and maintain high quality while on the shelf, it goes through various forms of processing in order to be able to meet those dates, or stay fresh long enough for the consumer to use the product. To explore this concept of processing foods to maintain freshness, we're going to explore milk as an example.
- The lab calls for teams of 3-4, but teams of 2-3 are recommended, especially for smaller class sizes.
- Students will observe their milk samples for three days following this initial set-up.

CLOSING

(Designed to promote the **retention of knowledge** through the use of engaging strategies designed to **rehearse** and **practice skills** for the purpose of **moving knowledge into long-term memory**.)

- Provide each student with the weekly Exit Ticket handout [Appendix 2](#).
- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: **"Summarize what you learned today."**
- Collect the Exit Ticket for the day as students leave the classroom
- ✓ **TEACHER TIP!** You will need to make a culture at some point in the project for Day 12 (or whatever day it becomes) (see Day 12 in the curriculum for further details).



Key Question of the Day:

What is food processing?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Conduct research using the Internet.
- Identify methods of food processing.



Required Materials

- Computers
- Internet
- Credible Sources – [Appendix 5](#) – One for each student
- Flip charts or Post-It flip charts
- Markers
- Tape



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- ***“If you were to research the term food processing using the Internet, how would you know the information you found was accurate?”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Possible answers may include:
 - › The URL/website
 - › Authors
 - › The source (magazine, newspaper, news station)
- Explain that there are resources that are not reliable and just because something is on the Internet, it does not always mean it can be trusted. Examples of non-reliable resources would include:
 - › .com sources that are not reputable
 - › Some .org sources which could be biased depending on the organization
 - › Date of the publication
 - › Lack of citations on the website – there should be citations to indicate where the information on that site came from
- The point to be made: ***“The Internet is a wonderful source of information, but as a researcher you have to be able to identify quality resources among the information that does not come from reliable sources.”***

MIDDLE

40 minutes

- ✓ **TEACHER TIP!** [Appendix 6](#) and [Appendix 6.1](#) are additional resources with supporting content for this project. Feel free to adapt and integrate information as you see fit.
- Students should be in pairs for this activity, which is to research different methods of food processing.

- Assign each student a method to research. For smaller classes, students can research more than one method.
 - › Methods could include: drying, cold storage, extrusion, microwave, irradiation, fermentation, meats processing, canning, dehydration/freeze-drying, etc.
- Students should write a few sentences to summarize the key points about their assigned method, as well as their own definition of food processing.
- Students will have the class period to complete their research.
- Students will use [Appendix 5](#) to collect information to determine if the sources they are using to find information are credible.
- When students are finished, in the same teams, they should compare the food processing methods they found and compile a master list by team. The list should be created as a poster using flip chart or poster paper and makers. The web resources should be included as a class reference of resources.
- These lists will become a class resource of food processing methods and Internet resources.
- When students are finished making their posters, have each team share their definitions of food processing and a brief summary of the methods they researched.
- **As students finish, they should make observations for Day 2 of their milk samples.**

CLOSING

5 minutes

- Provide each student with the weekly Exit Ticket handout [Appendix 2](#).
- Students will respond to the following prompt:
“Based on your research, list three new things you have learned about food processing.”
- Create a class list to revisit throughout the project.
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

What foods are fermented?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Describe types of fermented foods.
- Make a fermented food product.



Required Materials

- Computers
- Internet
- Flip chart
- Markers
- Ingredients for kimchi (from [Appendix 19](#)):
 - › 2 ½ pounds napa cabbage
 - › ½ cup kosher salt
 - › a walnut-sized knob of ginger, grated
 - › 4 cloves garlic, crushed
 - › 1 bunch scallions, minced
 - › 2 tablespoons sugar
 - › 2 tablespoons crushed red chili pepper
 - › 2 jalapenos, minced fine
- Glass or plastic bowl
- 2 to 3 1-pint glass canning jars (sterilized) <http://www.foodnetwork.com/how-to/photos/how-to-sterilize-jars-for-canning-jam.html>
- Plastic wrap
- Rubber bands



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- “*What foods are fermented?*”

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include:
 - › Sauerkraut
 - › Pickles
 - › Bread
 - › Cheese
 - › Yogurt
 - › Ketchup
- If students don’t know of any fermented foods, now would be a great time to give them a couple of minutes to do a quick Internet search.
 - › They could use their cell phones, if allowed, or class computers if easily available.
- Compile a list of responses from the students when time is up.
- Explain that, “*There are all kinds of fermented foods. We are going to spend the next few days exploring types of fermented foods so that we can understand more about the fermentation process. Today, we are going to start with kimchi.*”

MIDDLE

40 minutes

- Divide the class into three teams.
- Give students about 5-10 minutes to research the background of kimchi.
 - › Assign one of the following topics to each team:
 - » *Where kimchi originated*
 - » *Cultural significance*
 - » *How it’s made*
 - › Students should document the key points on a sheet of flip chart paper.

- When time is up, bring the class back together and ask each team to share the information they found.
- As students are sharing, the rest of the class should take notes in their research journals.
- Depending on the information the students find, when they are done presenting, share this with the class:
 - › ***“Kimchi is a traditional spicy pickled vegetable dish from Korea. It’s usually made with cabbage, but there are more than a hundred varieties using everything from cucumbers and radishes to eggplants and pumpkin blossoms. Today, we are going to make our own kimchi, which is fermented through the process of pickling.”***
- Review the pickling tips from <http://www.exploratorium.edu/cooking/pickles/tips.html>:
 - › Always follow the exact recipe because any changes to the recipe can result in spoiling-causing bacteria.
 - › Clean all utensils with hot, soapy water.
 - › Use crisp, blemish-free, fresh produce and wash thoroughly in running water.
 - › Always use pickling salt (or kosher salt), not table salt. Table salt contains iodine, which is a chemical that can cause cloudiness in brine.
 - › Use commercial white vinegar with at least 5% acidity.
 - › It’s best to use soft water (water that has been boiled for 15 minutes, then left to stand for 24 hours), which will reduce food safety risks.
 - › Use fresh spices, whole, crushed, or ground. Avoid spices that have sat in the pantry for more than a year.
 - › Glass containers are best. Avoid containers and utensils that are made of copper, iron, zinc, or brass because these materials react with acid and salt.
 - ✓ **TEACHER TIP!** If you have enough supplies, it would be ideal to have each team make one jar of kimchi. If supplies/budget are limited, make the kimchi as a class by either demonstrating how to make it or by assigning students small tasks while the rest watch.
- Follow these instructions to make the kimchi:
 - › Be sure anyone handling food ingredients washes their hands with soap and water.
 - › Use a clean cooking surface.
 - › Wash the cabbage, then chop it coarsely. Toss it in a glass bowl with the salt and let it sit overnight. The salt will draw the moisture out of the cabbage, which makes it wilted. **Since this takes 24 hours, making kimchi will continue the next day.**
 - ✓ **TEACHER TIP!** Completely submerge the salted cabbage in water to remove salt (better than just rinsing)
 - ✓ **TEACHER TIP!** Only allow students to eat fermented kimchi between days 3 and 5. Otherwise cannot guarantee safety.
- **As students finish, they should make observations for Day 3 of their milk samples.**

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“Write one sentence describing something new that you learned about making fermented foods.”***
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

(Continuation of Day 3)
What foods are fermented?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Describe types of fermented foods.
- Make a fermented food product.



Required Materials

- Computers
- Internet
- Flip chart
- Markers
- Ingredients for kimchi ([Appendix 19](http://www.exploratorium.edu/cooking/pickles/recipe-kimchi.html)) (from <http://www.exploratorium.edu/cooking/pickles/recipe-kimchi.html>):
 - › 2 ½ pounds napa cabbage
 - › ½ cup kosher salt
 - › a walnut-sized knob of ginger, grated
 - › 4 cloves garlic, crushed
 - › 1 bunch scallions, minced
 - › 2 tablespoons sugar
 - › 2 tablespoons crushed red chili pepper
 - › 2 jalapenos, minced fine
- Glass or plastic bowl
- 2 to 3 1-pint glass canning jars
- Plastic wrap
- Rubber bands



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- “*Make your Day 4 observations for your milk samples.*”

OPENING

10 minutes

- Read the Bell-Work question and ensure that students had enough time to evaluate their milk samples.
- Ask students to complete the questions at the bottom of their lab sheets.
- When they are finished, take a few minutes to debrief the milk lab and discuss the findings.
 - › Use page 40 of [Appendix 4](#) to share any additional details about the results of the experiment.

MIDDLE

35 minutes

- Students will continue to make their kimchi for the rest of the class.
- Drain the water off the cabbage and rinse it very well to remove the excess salt.
- In a large glass or plastic bowl (don't use metal), mix together the ginger, chili peppers, garlic, and jalapenos, and then add the well-drained cabbage. Toss the ingredients thoroughly to coat the vegetables. Save the juice that accumulates in the bottom of the bowl.
- Pack the mixture tightly into sterile glass jars and cover with the juice. Add water if necessary to achieve ¾ inch headroom. Cover the tops of the jars with plastic wrap, secured with a rubber band. Keep the kimchi in the refrigerator for three days before eating.
- The kimchi will keep in the refrigerator for a week.
- Remind students that pickled vegetables are fermented in salt brine, which allows the growth of bacteria that eat the vegetable's sugars and produce tart-tasting lactic acid.
- Explain that the kimchi will be ready to taste in three days.

CLOSING*5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“Why is kimchi fermented in salt brine?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

What commercial yogurt products are available?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Evaluate commercial yogurt using sensory analysis.



Required Materials

- Lab instructions and data sheets adapted from the book *Food Science: The Biochemistry of Food and Nutrition* 2006 by Mehas and Rodgers – [Appendix 8](#) – One per student
- Flip charts
- Markers
- Materials for yogurt analysis:
 - › Any yogurt samples (greek, regular, fat free, with and without live bacteria cultures, etc.)
 - › Paper plate or small paper/plastic cups
 - › Masking tape
 - › Marking pen
 - › Spoon
 - › Saltine crackers



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- *“Do you like yogurt? If you do, what’s your favorite type and why? If you don’t like yogurt, why not?”*

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Take a class poll to compare the number of students who like yogurt, the number of students who don’t like yogurt, and for those who do like yogurt, their favorite types.
 - › List the data you collect during the discussion on a surface (board, flip chart, etc.)
- Explain that, **“As you learned in this project, fermentation is a food process required to create a variety of different foods. Now that we are experts in the fermentation process of sourdough bread, we’re going to spend a little bit of time exploring the fermentation process of another common food, yogurt.”**

MIDDLE

40 minutes

- ✓ **TEACHER TIP!** Upon reviewing the lab procedures and materials for the evaluation of commercial yogurt, feel free to adjust or modify the materials used based on the resources you have available or if you have a more efficient method for setting up the experiment.
- To prepare for the lab, give each yogurt sample a number. Then, place labels around the edge of the paper plate or on the cups with a number that corresponds with each yogurt sample.
- Ask students to perform a sensory analysis of each yogurt sample.
 - › Using the [Appendix 7](#), students should evaluate the yogurt color, aroma, flavor, and texture.
- Between tasting each sample, students should eat a piece of cracker to cleanse their pallets.

- After all of the students have finished the sensory evaluation, show the class the containers and the price of each yogurt sample.
 - › Students should record the following information in their data tables:
 - » *Brand name*
 - » *Any coloring for flavorings*
 - » *Whether the sample contained live bacteria*
- In the same teams that they worked with for the sourdough bread project, students should answer the corresponding lab questions in their teams.
 - › First give students a few minutes to think about their responses to the questions independently and write down any thoughts. Then allow them to move into their teams to share their thoughts and discuss their opinions of the yogurt.
- Each team should use a flip chart to create a master list of their responses to the questions about the yogurt.
- Once each team is finished recording their responses, allow each team to share with the rest of the class.
- As the teams are sharing their responses, use a flip chart or other writing surface to create a master list of information that represents the class as a whole.
- Have a brief discussion to debrief the lab and student feedback about the yogurt they sampled.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“Based on today’s experiment, has your opinion of yogurt changed? Why or why not?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

How is yogurt made?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Demonstrate the process of making yogurt.
- Describe how other fermented foods are made.



Required Materials

- Lab instructions and data sheets adapted from the book *Food Science: The Biochemistry of Food and Nutrition* 2006 by Mehas and Rodgers – [Appendix 7](#) - One per student
- Flip charts
- Markers
- Lab materials:
 - › Yogurt base (at least three)
 - › Saucepan or double boiler
 - › Safety glasses
 - › Lab thermometer in a stopper
 - › Ring stand and clamp
 - › Yogurt maker or a setting pan apparatus
 - › Yogurt culture
 - › 50 mL beaker
 - › Spoons
 - › Yogurt containers with lids
 - › pH indicator paper
 - › Ice and pan (optional)
 - › Refrigerator
 - › Small cups or paper plates
- Reference about yogurt: <http://nchfp.uga.edu/publications/nchfp/factsheets/yogurt.html>



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“According to FoodAllergy.org, approximately 3 million people in the U.S. have allergies to tree nuts or peanuts. Describe what you know about tree nuts and peanuts.”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- It’s okay if students don’t exactly know how yogurt is made. They are welcome to guess. The idea is to get them thinking about making yogurt.
- Explain that, **“Yogurt is made by adding *Streptococcus thermophilus* and *Lactobacillus bulgaricus* into heated milk. After this inoculation the milk is held at 110°F ± 5°F until firm. The milk is coagulated (thickened) by an increase in acidity from lactic acid produced by the bacteria. We are about to see this process live in action.”** – from the National Center for Home Food Preservation, written by Brian A. Nummer, Ph.D
- Review the lab safety procedures for using heat.

MIDDLE

40 minutes

- ✓ **TEACHER TIP!** Feel free to adapt this lab based on your own knowledge or research on making yogurt. If you have a different or more efficient method you would like the students to use, feel free to make changes to the procedures and/or materials.
- ✓ **TEACHER TIP!** A slow cooker with a thermometer can be used to make yogurt if a yogurt maker is not available
- Be sure to have at least three different yogurt bases and assign a different base to each team.
 - › Students will work with the same team from the previous day.
- Each team will heat the yogurt base assigned to their team in a saucepan or double boiler to 82°C. This temperature should be

maintained for 15-20 minutes.

- Cool the yogurt base to 43°C.
 - Add 30 mL of yogurt culture to the 43°C yogurt base. Mix gently to avoid adding any air into the mixture.
 - Fill yogurt containers and cover.
 - › Students should mark their containers with the code number of the yogurt base they used.
 - Place the filled containers into the yogurt maker or setting pans, and maintain the temperature at 43°C.
 - › Students will have to check frequently because temperatures of 46°C or higher will kill the culture.
 - When the milk has coagulated and formed a firm gel, remove the yogurt containers. Cool them immediately by setting them in ice or in the refrigerator.
- Take a small sample of each yogurt from each team for the other groups to use.
 - › First, students should measure the pH of each yogurt sample and record the data on [Appendix 8](#).
 - › Next, students should conduct a sensory analysis of each sample by testing the flavor, texture, and color and record the data on [Appendix 8](#).
 - Give students a few minutes to respond to the questions on [Appendix 8](#) independently, and when they are finished, students should reconvene as a team to compare their responses.
 - › Using a sheet of flip chart paper and markers, each team should create a master list of their responses from the lab.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“In one sentence, summarize how yogurt is made.”***
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

Do you understand our project?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Separate the project description into tasks to be completed.
- Develop questions to be answered about the knowledge and skills necessary to complete the project.



Required Materials

- Project Management Log – [Appendix 9](#) – One for each student
- Project Description – [Appendix 10](#) – One for each student
- Highlighters
- Sourdough bread and non-sourdough bread that you have baked ahead of time



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- Provide students with samples of sourdough bread and a non-sourdough bread.
- ***“Taste each sample of bread. Describe what you are tasting.”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Ask students if they know what they are tasting. Allow some guessing.
- Explain that one is sourdough and the other is (whatever kind of bread you baked). Also, explain that as they learned previously, food processing involves many different methods, but this project will focus on fermentation.

MIDDLE

30 minutes

- ✓ **TEACHER TIP!** This is a great opportunity to invite a guest speaker to speak with the class about baking with fermented ingredients. If there is a local bakery, consider inviting a baker to visit with the class. If not, any professional who works in the food industry and is familiar with fermentation would be a great option. This is not required, but if it's possible, would be a nice addition.
- Distribute copies of the project description ([Appendix 10](#)) and give students time to read.
- Distribute highlighters. Have students highlight everything that is a task they will have to complete.
- As a class, list the tasks each team will have to complete.
- Create teams – you can do this purposefully or allow the students to choose. Give each team time to review the project description again and answer:

- › What will your team need to accomplish?
 - › What terms or phrases do you not know?
 - › What do you have to present?
- Circulate and monitor team's progress on this.
 - Today is the day to taste the kimchi!
 - › Have a quick discussion about the results and have students share their thoughts about the final product.

CLOSING

5 minutes

- Provide each student with the weekly Exit Ticket handout [Appendix 2](#).
- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“List our unknown terms and phrases with the class.”
- Create a class list to revisit throughout the project.
- Teams share their lists of what they have to accomplish and create a class list. Teams use this to begin their project management logs.
- Collect the Exit Ticket for the day as students leave the classroom



Key Questions of the Day:

How did sourdough come to be a common food?

How and why does sourdough differ across regions?



Estimated Time

Two 50-minute class periods



Learning Objectives

As a result of this lesson, students will be able to:

- Summarize the cultural history of sourdough bread.
- Compare sourdough recipes from different regions.
- Explain flavor differences based on the presence of different bacteria and yeasts.
- Select and apply a procedure to begin a starter.



Required Materials

- Computers
- Internet
- Sourdough bread baked by the students
- Napkins
- Graphing Pretest – [Appendix 11](#) – One per student



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“What do you know about the history of sourdough bread?”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
 - › As students share their responses, create a list on the board.

MIDDLE

40 minutes

- Explain that students will be researching the history of sourdough bread and post the following questions to guide their research:
 - › How did sourdough bread come into being?
 - › Why has sourdough bread remained popular?
 - › What important roles has sourdough played in history?
 - › Where else in the world sourdough breads occur and what makes them different?
 - › How do sourdough recipes differ among regions?
 - › What factors influence the flavor of sourdough bread?
- Each team should develop a list of search terms and divide them among the team members.
- Through their research, each team should identify and select a recipe they would like to try, including the ingredients list.
 - ✓ **TEACHER TIP!** Be sure that students give you their ingredients list so that everything is ready for making the starter the next day.
- As they complete their research, each team will create a timeline with the history of sourdough bread.
- Teams will have the rest of the class period to work on this.
- When they are finished, each team will post their timeline around the room.
- Have a gallery walk where students can walk around the room to review each other’s timelines.



- Once the class is finished and has reviewed each other's work, have a brief reflection discussion to review what they have learned.
- Give the class the graphing pre-test ([Appendix 11](#)) to complete. Students should work on this independently.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“Which recipe did you select? Why?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Questions of the Day:

What is a starter culture?

How do we create a starter culture?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Define starter culture.
- List the steps in creating a starter culture.



Required Materials

- Ingredients requested by students
- Measuring cups
- Scales
- Containers
- Plastic wrap
- Thermometers



Bell-Work

- Provide students with the weekly Bell-Work sheet – [Appendix 1](#)
- **“Make a prediction: what is a starter culture?”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Expect students to seem confused or not completely understand what this term means.
- Explain to students that, **“A starter culture is also known as a pre-ferment, chief, or head. It’s a mix of flour and water plus proper time, temperature, and nutrients. Starter cultures develop colonies of bacteria and yeast that will be introduced to the bread recipe.”**

MIDDLE

40 minutes

- ✓ **TEACHER TIP!** The creation of a starter culture will take approximately 7 days. A weekend will occur during this time so students will need to decide which team member will take the culture home and tend to it over the weekend. That person will need to collect supplies to take home as well and to find a 68°-70°F place in their home to allow fermentation to continue. Develop a starter culture that you keep in the classroom so that students can compare theirs to it (also gives you a back-up in case one of theirs fails).
- Each team will follow this procedure: **Today is starter culture day 1.**
 1. Teams mix 4 ounces of whole* rye flour or whole* wheat flour and 4 ounces of non-chlorinated cool water in a non-reactive (glass, crockery, stainless steel or food-grade plastic) container.
 - a. Ask students why they think they need whole grain. (It has more nutrients and sourdough-friendly microorganisms than all-purpose flours do).

2. Stir thoroughly until there are no dry patches.
3. Cover loosely for 24 hours at 70°F.
 - a. Ask students why it needs to be kept at 70°F. Ask them to connect this to the prevention of microorganism growth (Colder temperatures slow fermentation).

CLOSING

5 minutes

- Provide each student with the weekly Exit Ticket handout [Appendix 2](#).
- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“What steps did you take today to develop a starter? Why was each step important?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Questions of the Day:

How do we detect mold on breads?

How is sourdough different from other breads?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Make observations of mold growth.
- Compare sourdough bread to other breads.
- Define quantitative and qualitative data.



Required Materials

- Computer
- Projector
- Samples of different breads with different levels of mold (in plastic bags)
- Fresh sourdough and other breads
- Zipper plastic bags
- Graduated cylinders or beakers
- Graph paper
- Sharpie markers
- Research Notes – [Appendix 12](#) – One per student



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“Observe the moldy bread and describe what you see.”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Share descriptions with class. How are they describing the mold?
- Differentiate between quantitative (40% of the bread was moldy) and qualitative (blue mold).
- Ask students what they think they can do to get more quantitative data and brainstorm as a class. If the students develop an idea that you think will work, let them try it.
- Ask students to make a few notes from this exercise in their research journals
 - › Use [Appendix 12](#) to remind students how to properly take notes in their research journals.

MIDDLE

40 minutes

- Briefly have a class discussion about the results from the milk lab and collect the data sheets.
 - › Be sure to explain that fermentation is a method of processing used not only to preserve foods and extend or stabilize the shelf-life, but also to create the flavor and texture of certain foods such as pickles, or in this case, sourdough bread.
- Provide each team with four Ziploc bags, sharpies, and pieces of graph paper.
- Each team should trace the graph paper onto the bags so that they have a grid through which to measure the mold growth. Explain that they can count the cells with mold in them each day.

- Ask students what environmental factors allow mold to grow.
 - › The point to be made is that mold will grow most rapidly in warm, wet environments.
- Next, give each team one slice of sourdough and one slice of another type of bread. Each team should measure 10ml of water with their graduated cylinder and pour the water onto one slice of bread. Repeat with the other slice.
- Put each slice of bread in a plastic bag with a grid and seal.
- Each team should label the Ziplocs with the names of the types of bread.
- Ask students to think of a good place to put the bread based on what they know about mold (warm!). Explain that they will check the bags every day and record the number of squares that have mold in them.
- Set a standard for how much of the cell must be covered in mold for it to count. This may depend on the size of the cells in your graph paper.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“Based on what you now know about sourdough, which bread do you think will have the most rapid mold growth? Why?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Questions of the Day:

What do yeast and lactobacilli do in fermentation?

How does one encourage yeast and lactobacilli growth?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Describe the role of yeast in fermentation.
- Compare fermentation by yeast to fermentation by yeast and lactobacilli.



Required Materials

- Computer access with YouTube: <https://www.youtube.com/watch?v=FqxkMqsEQ10>
- Flour
- Water
- Measuring cups
- Scales
- Starters from yesterday
- Per Group for the Lab:
 - › 6 tbsp flour
 - › 3 tbsp sourdough starter
 - › 5 Erlenmeyer flasks
 - › 500 mL water
 - › 5 balloons large enough to fit over the mouth of the flasks
 - › 2 large buckets, one enough smaller to fit inside the other with space around it
 - › 1 graduated cylinder



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- ***“How is fermentation in sourdough different than in other breads?”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- It is completely okay for students to not necessarily have the correct answer. The purpose was to get them thinking about the topic.
- Show the video: <https://www.youtube.com/watch?v=FqxkMqsEQ10> (Good Eats Dr. Strangeload Yeasts) Alton Brown about yeast, bacteria, and sourdough.
- Pose this question to the class, ***“What are we doing to make a good environment for yeast and lactobacilli in our starter culture? (whole grains, warmth, water)”***
- Then, revisit this question, ***“How is fermentation in sourdough different than in other breads?”***

MIDDLE

40 minutes

- Let's examine the differences between sourdough fermentation and yeast only fermentation:
 1. Label your flasks and fill them accordingly:
 - a. yeast + flour - 100 mL water, 1 tsp yeast, 3 tbsp flour
 - b. sourdough starter - 3 tbsp sourdough starter from your group's mother, 100 mL water
 - c. yeast - 1 tsp yeast, 100 mL water
 - d. flour - 3 tbsp flour, 100 mL water
 - e. water only - 100 mL water
 2. Affix one balloon to the opening of each flask.
 3. Carry out today's starter culture procedures.

- Today's starter culture procedures: **Today is starter culture day 2.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - » *Why are we removing some starter and replacing it?*
 - Keep the volume down
 - Balance the pH
 - Continuing to add new food for the increasing population of microorganisms so that there is not more competition for existing food source.
 - » *Mix well, cover, and let rest for 24 hours at 70°F.*
 - How is the microorganism population growing if we cover it? (reproduction)
- With at least 10 minutes left in class, tie off each and label each balloon.
- Fill the smaller bucket with water to the brim and set inside the larger bucket.
- Submerge one balloon in the bucket and water will overflow into the larger bucket.
- Collect the overflow from the bucket and pour into a graduated cylinder. The amount of water overflow is the volume of the gas produced by each flask.
- Refill the bucket and repeat with each balloon pushing them to the same depth in the water.
- Pose the following questions:
 - › Which flask created the most gas? Why?
 - › Why are they different?
 - › What do you know about fermentation?
- Have students list a few things they think or know about fermentation.
- Replay the Alton Brown video from the beginning of the class and add to the list.
- Compare the information from the video to your notes from yesterday.
- Remind students that someone from each team will need to take the starter home tomorrow or over the weekend.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“Summarize what you learned today about fermentation in three sentences or less.”***
- Collect the Exit Ticket for the day as students leave the classroom



Key Questions of the Day:

What can go wrong in creating a starter culture?

What can go wrong in fermentation?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Compare starters kept in different conditions.
- Research the factors influencing fermentation.



Required Materials

- Computers
- Internet
- Spoiled starters (e.g., stored too cold/hot, didn't replenish flour & water, used bleached flour, didn't start with whole grain, or used chlorinated water)

Note: Prepare these leading up to the beginning of the project.



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- List the environmental requirements for yeast and lactobacilli on the board. The students have these from their work yesterday.
- ***“What would happen if we kept the temperature too low? Too high? What would happen if we didn't add fresh flour? Water?”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Have a brief discussion with the class about their responses.
- **Starter day 3 – teams are on a 12-hour discard/replace schedule.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - › Mix well, cover, and let rest for 24 hours at 70°F.

MIDDLE

40 minutes

- Put spoiled starters out. Don't label them with their cause.
- Have students view and smell the spoiled starters and take notes on their observations in their journals.
 - › Students should then compare the spoiled starter to a good starter.
 - › What is different? (Possible answers: spoiled starter lacks bubbles, doesn't smell acidic, isn't rising, has mold)
- Assign each team a cause of spoilage and have them research the symptoms.
- Each team should identify the spoiled starter that matches their symptoms and create a “How-To” poster.
 - › The goal of the poster would be for someone who is new to this process to read and understand how to identify if the starter is spoiled.



- › The poster should include key characteristics to identify and causes of spoilage.
- Students will share their posters with the class when they are finished.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:

“Why is it important to handle our starter carefully? What procedures must we follow?”

- Collect the Exit Ticket for the day as students leave the classroom



Key Question of the Day:

What other methods exist for starting sourdough bread?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Select a procedure for creating a starter.
- Apply the procedure to begin a starter.



Required Materials

- Computers
- Internet



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“Summarize what’s been happening with your starter. Be prepared to share your summary with the class.”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Each team should report about their starter. They can share pictures and should discuss the differences.
 - › Prompt the discussion with questions about volume generated each day, temperature storage, presence of bubbles, odor, etc.
- **Starter day 4 – teams are on a 12-hour discard/replace schedule.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - › Mix well, cover, and let rest for 24 hours at 70°F.

MIDDLE

40 minutes

- Students review the project description and their task list. Have students identify the tasks they have yet to complete. One should be developing their own starter.
- Students have 20 minutes to research different sourdough starter recipes and procedures. Each student should choose one or two he/she would like to try.
- Teams should re-form and choose one to attempt, which must be different from the one they have already created. Highlight or underline differences.
- Each team should:
 - › Have mini-meetings with the teacher to review the recipe and procedure they have chosen. Be sure that the recipes are different among the groups. This should be monitored on a first come first serve basis. If a team finds a recipe and has it approved, and then another team comes with the same recipe, they will have to find a

different one. This will ensure that each team has a different recipe.

- › Develop a supply list and submit it to the teacher.
- › Assign roles for the development of their next starter and write them in their research journals.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“What questions do you still have about your chosen starter procedures?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Questions of the Day:

How do we bake sourdough bread?

How do we store remaining starter for future use?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Apply a procedure for baking sourdough bread.
- Apply their understanding of the requirements for fermentation to store a starter in a way that slows the process and keeps the microorganisms healthy.



Required Materials

- Sourdough pre-made starter
- Article – [Appendix 13: http://www.sourdoughhome.com/index.php?content=storing_astarter](http://www.sourdoughhome.com/index.php?content=storing_astarter)
- Ovens
- Baking supplies



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- “*What food safety tips should we keep in mind as we prepare to bake our bread?*”

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include:
 - › Wash hands
 - › Keep hair pulled back
 - › Roll up sleeves
 - › Clean any cooking surfaces
- Briefly discuss food safety tips with the class.
- **Starter day 5 – teams are on a 12-hour discard/replace schedule.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - › Mix well, cover, and let rest for 24 hours at 70°F.

MIDDLE

40 minutes

- ✓ **TEACHER TIP!** As you can see, it takes much longer than one class period to bake sourdough. Your school’s schedule will dictate how you handle the baking process. If you teach multiple sections of the same course, you can have each section do part of the process. If students are available at different times of the day, you can have them return during their free periods or lunches to continue the baking process. If your class meets at the end of the day, students may start the process in class and take the bread home – carefully – to complete baking.
- Distribute recipes to teams and have them prepare their workstations and gather their ingredients and supplies.

- Explain the baking plan to the teams. Teams review the steps for preparing the bread and assign each to a team member by writing the team member's name next to the task.
- Students prepare and bake the sourdough bread using some of your pre-made a starter following as many steps as they can in this class period.
- While the dough is rising or baking, ask students, "Based on what you've learned over the last few days, what does starter need in order for the yeast and bacteria colonies to grow?"
- After reviewing these factors, ask, "**How can we store a starter to slow its growth but keep it alive?**"
- Solicit suggestions from students.
 - › Someone will say refrigerate.
- Have students read <http://www.sourdoughhome.com/index.php?content=storingastarter> (Appendix 13) and write a step-by-step procedure in their research journals to follow based on what they've read.
- Each team should store some of the starter.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: "**Summarize the steps you have taken in baking the bread and explain what someone would have to do to finish the process.**"
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

How do we represent data?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Apply a procedure for graphing data over time
- Compare their graphs to other teams and make adjustments



Required Materials

- Computers
- Excel
- Graphing post-test – [Appendix 14](#)
- Data from Day 3 Mold Lab



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“What are some different ways to represent data?”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Possible answers may include:
 - › Bar graph
 - › Pie graph
 - › Line graph
 - › Charts
 - › Infographic
- Explain that, “All of your examples are correct! There are many different ways to represent data. Today, you will be challenged with the task of identifying the best way to represent the data you collected from the mold lab.”
- Then, students can taste and describe the sourdough they baked.
- Ask volunteers to share their opinions about their bread.
- **Starter day 6 – teams are on a 12-hour discard/replace schedule.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - › Mix well, cover, and let rest for 24 hours at 70°F.
- ✓ **TEACHER TIP!** Score pre-tests before class and pair students based on graphing pre-test.

MIDDLE

40 minutes

- Students work with a partner (assigned by you) to graph the following data:

FIBER IN SOURDOUGH BREAD	
GRAMS OF BREAD	GRAMS OF FIBER
100	2.4
75	1.8
180	4.3
230	5.5
5	0.1

- Once the pairs are finished with the first graph, have a brief discussion with the class about their experience graphing the data.
- Teams enter their mold data (from the lab on Day 3) into a spreadsheet.
 - The data is the number of boxes that are filled in with mold each day the students make observations.
- Students will format the spreadsheet to suit their data.
- Students should change the days to match the actual number of days lapsed.
 - For example, they didn't collect data on the weekends so they need to alter the days on the data table.
- To select a format, highlight the columns containing their data and the column headings.
- Choose "Insert" then "Line" then any of the 2D options.
- Check your graph, does it match your data? If there is more mold on one bread than the other, does the graph represent that?
- Print one copy of the graph for each team member.
- Students should paste the graphs into their research journals and label the x-axis with "Days" and the y-axis with "cells covered by mold."
- Pose the following questions to the class:
 - "Do the two breads differ in their mold growth? How? Why?"
- Following the discussion, have students complete the Graphing Post-test ([Appendix 14](#)).

CLOSING

5 minutes

- Teams should review the recipes from around the world that they discovered the previous day. As a team, they should select a recipe to attempt and give it to the teacher, along with a supply list.
- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:

"Your team will be attempting to bake a new recipe. Which recipe did your team select? What are the ingredients needed to bake the bread?"
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

What do yeast and lactobacilli do in fermentation?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Describe the process of fermentation that involves yeast and lactobacilli.



Required Materials

- Computers
- Internet
- Poster paper
- Markers
- Any additional props or art/craft supplies



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- ***“What have you seen in your starter? What did you look for as evidence that it was doing something?”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include:
 - › Bubbles
 - › Odor
 - › Increase in volume
- Have a brief discussion with the class about their observations and why they saw these things happening.

MIDDLE

40 minutes

- **Starter day 7 – teams are on a 12-hour discard/replace schedule.**
 - › Discard 4 oz of the starter and add 4 oz unbleached all-purpose flour and 4 oz cool to lukewarm water (balance the temperature of the room with the temperature of the water).
 - › Mix well, cover, and let rest for 24 hours at 70°F.
- Teams should develop a demonstration of fermentation with yeast alone and with yeast and lactobacilli.
 - › The demonstration should be based on a combination of information they have collected throughout the project as well as additional research that might be necessary to have a complete explanation.
 - › The demonstration should clearly depict the process and highlight any key terms.
 - › Teams have the freedom to select the format of the demonstration – cartoon, skit, puppet show, poster with chemical reaction...
 - › Craft/art supplies and computers with Internet should be available for students to use.

- Students will have the rest of the class period to create and present their demonstrations.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“What did you learn from today’s demonstrations?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

How do we bake a sourdough bread recipe?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Apply a second sourdough recipe to the baking process.
- Describe the differences between the first recipe and the second.



Required Materials

- Recipe ingredients – based on teams' supply lists
- Ovens
- Baking supplies



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- ***“Let’s review the food safety tips for baking. List the first three tips that come to mind.”***

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Responses will vary and may include:
 - › Wash hands
 - › Keep hair tied back/wear a hairnet
 - › Clean all food prep surfaces
- Have a quick discussion with the class to remind them about food safety and sanitation.

MIDDLE

40 minutes

- Teams should decide how they plan to manage the long baking process. Each team member will be responsible for a step of the process.
- Teams should write their management process for baking the second bread.
- Next, each team should mix their recipe and follow as much of the procedure as they can in the time allowed.
- Save any extra starter.
- Once the bread is baked, start a mold test on this recipe and a regular piece of bread by following the same procedure as the previous mold test.
 - › Teams should develop a hypothesis for what they expect to see happen with this second bread recipe in comparison to the first recipe they baked.

CLOSING*5 minutes*

- Students will determine the responses to the prompt in their teams, but they will each turn in individual Exit Tickets.
- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“Summarize the main difference between the recipe you baked today and the first bread recipe you baked.”
- Collect the Exit Ticket for the day as students leave the classroom



Key Question of the Day:

How can we create starter culture and sourdough bread?



Estimated Time

Two 50-minute class periods



Learning Objectives

As a result of this lesson, students will be able to:

- Describe their process for developing a starter culture.
- Describe their process for developing a sourdough bread.
- Critique their process and product.



Required Materials

- Presentation Rubrics – [Appendix 15](#) – One per team
- Project Presentation Audience Feedback – [Appendix 16](#) – One per student
- Collaboration Rubric – [Appendix 17](#) – One for the teacher
- Recipes
- Breads
- Computers



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- *“List three questions you would like to ask the presenting team about their reports.”*

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Instruct students to keep their questions safe until the presentations begin.

MIDDLE

40 minutes

- Give students time to work on their presentations.
 - › This may take more than three class periods depending on the class size and how quickly students work. Adjust accordingly.
- Remember that the presentations should include:
 - › All data collected from labs
 - › Recipes
 - › A research summary of information they have collected throughout the project
 - › Concept map demonstrating knowledge of fermentation and sourdough bread
 - › A proposed solution for the bakery owner (the presentation)
- When teams are finished, they will present to their classmates and the baker who is seeking to improve their bread making.
- Everyone should taste the team’s bread and asks their questions to the presenting team.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: *“How has what you learned today from the presentations influenced your thoughts on your own creations?”*
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

(Continuation of Day 18)

How can we create starter culture and sourdough bread?



Estimated Time

One 50-minute class period



Learning Objectives

As a result of this lesson, students will be able to:

- Describe their process for developing a starter culture.
- Describe their process for developing a sourdough bread.
- Critique their process and product.



Required Materials

- Presentation Rubrics – [Appendix 15](#) – One per team
- Project Presentation Audience Feedback – [Appendix 16](#) – One per student
- Collaboration Rubric – [Appendix 17](#) – One for the teacher
- Recipes
- Breads
- Computers



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- **“What questions do you have about your presentations?”**

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Answer any questions students have about their presentations

MIDDLE

40 minutes

- Use this class period for students to continue working on their presentations.
- Remember that the presentations should include:
 - › All data collected from labs
 - › Recipes
 - › A research summary of information they have collected throughout the project
 - › Concept map demonstrating knowledge of fermentation and sourdough bread
 - › A proposed solution for the bakery owner (the presentation)

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: **“How much progress has your team made working on your presentation?”**
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

(Continuation of Day 19)

How can we create starter culture and sourdough bread?



Estimated Time

Two 50-minute class periods



Learning Objectives

As a result of this lesson, students will be able to:

- Describe their process for developing a starter culture.
- Describe their process for developing a sourdough bread.
- Critique their process and product.



Required Materials

- Presentation Rubrics – [Appendix 15](#) – One per team
- Project Presentation Audience Feedback – [Appendix 16](#) – One per student
- Collaboration Rubric – [Appendix 17](#) – One for the teacher
- Recipes
- Breads
- Computers
- Guest judge

✓ TEACHER TIP!

Remember to invite the person who is the “bakery owner” to judge the presentations. This is a great opportunity to invite a real local baker. Following the presentations, they can also discuss careers and their experiences working



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- *“What in your bread worked well? What did you do to facilitate it going well? What didn’t work well? What could you change?”*

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- Then, give students about one minute to discuss within their teams.

MIDDLE

40 minutes

- Finish presentations.
- Students should use [Appendix 16](#) to select one team to evaluate.
- The teacher should use [Appendix 17](#) to evaluate team collaboration.
- Remember that the presentations should include:
 - › All data collected from labs
 - › Recipes
 - › A research summary of information they have collected throughout the project
 - › Concept map demonstrating knowledge of fermentation and sourdough bread
 - › A proposed solution for the bakery owner (the presentation)
- Each team will present to their classmates and the baker who is seeking to improve their bread making.
- Everyone should taste the team’s bread and asks their questions to the presenting team.
- Following the presentations, each team should make revisions to their recipe and process based on what they think would make their bread better and explain why.

- Compile the data about the sourdough bread recipes from each team in each class period and display it in the room where everyone can see it.
 - › This can be done in the form of a bar graph or other method that works for the data you are working with.
- Analyze the data with each class and discuss the results.
 - › Compare the different recipes and using the data that's being displayed, ask students what conclusions they can make about shelf-life and the variables that are different.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“How can you improve your bread?”
- Collect the Exit Ticket for the day as students leave the classroom.



Key Question of the Day:

What have you learned about fermentation?



Estimated Time

Two 50-minute class periods



Learning Objectives

As a result of this lesson, students will be able to:

- Summarize the topic of fermentation.
- Summarize the topic of food processing.



Required Materials

- Poster paper
- Markers
- Other art supplies for making posters
- Self-Reflection Sheet – [Appendix 18](#) – One per student



Bell-Work

- Provide students with the weekly Bell-Work sheet ([Appendix 1](#))
- *“We’ve learned a lot about food processing and fermentation. What have you enjoyed learning the most?”*

OPENING

5 minutes

- Read the Bell-Work question and solicit responses from the students.
- As students share their thoughts, have a brief discussion and provide feedback.
- Explain that, *“That’s right! We have learned so much about food processing, especially fermentation, and now that this topic is coming to a close, it’s time to reflect on our experience.”*

MIDDLE

40 minutes

- Students will work independently to create a reflection poster. The poster can represent anything they learned about the topic.
 - › They can select one single topic, summarize the entire topic, it doesn’t matter what they pick as long as they are highlighting something that was important to them.
- The goal for this exercise is for students to really think about what they learned and reflect on what they will take away from the experience.
- The poster can use pictures, pictures and text, it could be a mind map, a list, just about anything that will help students communicate their thoughts.
 - ✓ **TEACHER TIP!** Try to be vague when explaining this to the class and let students run with their ideas.
- When students are finished with the posters, hang them around the room and have a gallery walk where the entire class can take a look at the different posters.

- Then, do the walk again, but this time each student should stand by their poster and take 30 seconds to summarize what they did and why.
- Give each student a copy of [Appendix 18](#) to complete.

CLOSING

5 minutes

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt:
“How will you use what you learned from this project?”
- Collect the Exit Ticket for the day as students leave the classroom

Daily Bell-Work Journal

MONDAY

DATE _____

TUESDAY

DATE _____

WEDNESDAY

DATE _____

THURSDAY

DATE _____

FRIDAY

DATE _____

Daily Exit Tickets



DAY EXIT TICKET Name: (First, Last) _____
Date: _____ Period: _____
Topic: _____



Continue your answer on the back if necessary

DAY EXIT TICKET Name: (First, Last) _____
Date: _____ Period: _____
Topic: _____



Continue your answer on the back if necessary

DAY EXIT TICKET Name: (First, Last) _____
Date: _____ Period: _____
Topic: _____



Continue your answer on the back if necessary

DAY EXIT TICKET Name: (First, Last) _____
Date: _____ Period: _____
Topic: _____



Continue your answer on the back if necessary

DAY EXIT TICKET Name: (First, Last) _____
Date: _____ Period: _____
Topic: _____



Continue your answer on the back if necessary

Food expired? Don't be so quick to toss it

By Alexandra Sifferlin, *TIME.com*
updated 5:52 PM EDT, Thu September 19, 2013

STORY HIGHLIGHTS

- Expiration dates on food aren't related to the risk of food poisoning or foodborne illness
- Dates solely indicate freshness, and are used by manufacturers to convey when it's at its peak
- Eggs, for example, can be consumed three to five weeks after purchase

(TIME.com) – Use-by dates are contributing to millions of pounds of wasted food each year.

A new report from the Natural Resources Defense Council and Harvard Law School's Food Law and Policy Clinic says Americans are prematurely throwing out food, largely because of confusion over what expiration dates actually mean.

Most consumers mistakenly believe that expiration dates on food indicate how safe the food is to consume, when these dates actually aren't related to the risk of food poisoning or foodborne illness.

Food dating emerged in the 1970s, prompted by consumer demand as Americans produced less of their own food but still demanded information about how it was made. The dates solely indicate freshness, and are used by manufacturers to convey when the product is at its peak. That means the food does not expire in the sense of becoming inedible.

For un-refrigerated foods, there may be no difference in taste or quality, and expired foods won't necessarily make people sick.

But according to the new analysis, words like "use by" and "sell by" are used so inconsistently that they contribute to widespread misinterpretation — and waste — by consumers. More than 90% of Americans

throw out food prematurely, and 40% of the U.S. food supply is tossed--unused--every year because of food dating.

Eggs, for example, can be consumed three to five weeks after purchase, even though the "use by" date is much earlier. A box of mac-and-cheese stamped with a "use by" date of March 2013 can still be enjoyed on March 2014, most likely with no noticeable changes in quality.

"We are fine with there being quality or freshness dates as long as it is clearly communicated to consumers, and they are educated about what that means," says study co-author Emily Broad Leib, the director of Harvard Food Law & Policy Clinic. "There should be a standard date and wording that is used. This is about quality, not safety. You can make your own decision about whether a food still has an edible quality that's acceptable to you."

Because food dating was never about public health, there is no national regulation over the use of the dates, although the Food and Drug Administration and U.S. Department of Agriculture technically have regulatory power over the misbranding of products. The only federally required and regulated food dating involves infant formula, since the nutrients in formula lose their potency as time goes on.

What regulation does exist occurs at the state level — and all but nine states in the United States have food dating rules but these vary widely.

"What's resulted from [the FDA letting states come up with regulation] is really a patchwork of all sorts of different rules for different products and regulations around them," says study co-author Dana Gunders, a staff scientist with the NRDC's food and agriculture program. "Sometimes a product needs a date, sometimes it doesn't. Sometimes a product cannot be sold after a different date. Or there is no requirement at all. Even with different categories there is so much variability."

The result is a confused public — and tons of wasted food.

Correcting these entrenched misconceptions, however, won't be easy. The report authors say the re-education could start with a clearer understanding of what the dates mean.

"Use by" and "Best by": These dates are intended for consumer use, but are typically the date the manufacturer deems the product reaches peak freshness. It's not a date to indicate spoilage, nor does it necessarily signal that the food is no longer safe to eat.

"Sell by": This date is only intended to help manufacturers and retailers, not consumers. It's a stocking and marketing tool provided by food makers to ensure proper turnover of the products in the store so they still have a long shelf life after consumers buy them. Consumers, however, are misinterpreting it as a date to guide their buying decisions. The report authors say that "sell by" dates should be made invisible to the consumer. Jena Roberts, vice president for business development at the food testing firm, National Food Lab, studies "shelf-stable" properties of foods to help manufacturers determine what date indicates when their products are at their best.

"The food has to be safe, that's a given," says Roberts. "[The manufacturers] want to make sure the consumer eats and tastes a high quality product."

But she acknowledges that even if the food is consumed after its ideal quality date, it's not harmful. A strawberry-flavored beverage may lose its red color, the oats in a granola bar may lose its crunch, or the chocolate clusters in a cereal may start to 'bloom' and turn white. While it may not look appetizing, the food is still safe to eat.

"It's a confusing subject, the difference between food quality and food safety. Even in the food industry I have colleagues who are not microbiologists who get confused," she says.

The report authors aren't against food date labeling. The system was created to provide more information to consumers, but it's important that people know how to use that data.

"The interest is still there on the part of the consumers, but we want this to be clearly communicated so consumers are not misinterpreting the data and contributing to a bunch of waste," says Gunders.

While the food industry could make changes to date labels voluntarily — such as having the dates read when food is most likely to spoil — the study authors also call for legislation by Congress to develop national standards that would standardize a single set of dating requirements.

Such standards may already be in the works; following the release of the report, Congresswoman Nita Lowey, the senior Democrat on the House Appropriations Committee and author of the Freshness Disclosure Act says she will be reintroducing legislation to Congress that calls for establishing a consistent food dating system in the United States.

"I look forward to reintroducing this legislation this Congress and working with colleagues on both sides of the aisle to fix this glaring gap in our nation's food safety laws so that American consumers have the information they need," Lowey said in a statement.

This story was originally published on TIME.com



United States Department of Agriculture
Food Safety and Inspection Service

Food Safety Information



USDA Photo

Food Product Dating

"Sell by Feb 14" is a type of information you might find on a meat or poultry product. Are dates required on food products? Does it mean the product will be unsafe to use after that date? Here is some background information which answers these and other questions about product dating.

What is dating?

"Open Dating" (use of a calendar date as opposed to a code) on a food product is a date stamped on a product's package to help the store determine how long to display the product for sale. It can also help the purchaser to know the time limit to purchase or use the product at its best quality. It is not a safety date. After the date passes, while it may not be of best quality, refrigerated products should still be safe if handled properly and kept at 40 °F (4.4 °C) or below for the recommended storage times listed on the chart (see below). If product has a "use-by" date, follow that date. If product has a "sell-by" date or no date, cook or freeze the product by the times on the chart below.

Is dating required by federal law?

Except for infant formula (see below), product dating is not generally required by Federal regulations. However, if a calendar date is used, it must express both the month and day of the month (and the year, in the case of shelf-stable and frozen products). If a calendar date is shown, immediately adjacent to the date must be a phrase explaining the meaning of that date such as "sell by" or "use before."

There is no uniform or universally accepted system used for food dating in the United States. Although dating of some foods is required by more than 20 states, there are areas of the country where much of the food supply has some type of open date and other areas where almost no food is dated.

What types of food are dated?

Open dating is found primarily on perishable foods such as meat, poultry, eggs and dairy products. "Closed" or "coded" dating might appear on shelf-stable products such as cans and boxes of food.

Types of Dates

- A **"Sell-By"** date tells the store how long to display the product for sale. You should buy the product before the date expires.
- A **"Best if Used By (or Before)"** date is recommended for best flavor or quality. It is not a purchase or safety date.
- A **"Use-By"** date is the last date recommended for the use of the product while at peak quality. The date has been determined by the manufacturer of the product.
- **"Closed or coded dates"** are packing numbers for use by the manufacturer.

Safety After Date Expires

Except for "use-by" dates, product dates don't always pertain to home storage and use after purchase. "Use-by" dates usually refer to best quality and are not safety dates. Even if the date expires during home storage, a product should be safe, wholesome and of good quality if handled properly. See the accompanying refrigerator charts for storage times of dated products. If product has a "use-by" date, follow that date. If product has a "sell-by" date or no date, cook or freeze the product according to the times on the chart below.

Foods can develop an off odor, flavor or appearance due to spoilage bacteria. If a food has developed such characteristics, you should not use it for quality reasons.

If foods are mishandled, however, foodborne bacteria can grow and, if pathogens are present, cause foodborne illness — before or after the date on the package. For example, if hot dogs are taken to a picnic and left out several hours, they will not be safe if used thereafter, even if the date hasn't expired.

The Food Safety and Inspection Service (FSIS) is the public health agency in the U.S. Department of Agriculture responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged.

USDA Meat & Poultry Hotline
1-888-MPHotline
(1-888-674-6854)

Food Product Dating

Other examples of potential mishandling are products that have been: defrosted at room temperature more than two hours; cross contaminated; or handled by people who don't practice good sanitation. Make sure to follow the handling and preparation instructions on the label to ensure top quality and safety.

Dating Infant Formula

Federal regulations require a "use-by" date on the product label of infant formula under FDA inspection. If consumed by that date, the formula must contain not less than the quantity of each nutrient as described on the label. Formula must maintain an acceptable quality to pass through an ordinary bottle nipple. If stored too long, formula can separate and clog the nipple.

The "use-by" date is selected by the manufacturer, packer or distributor of the product on the basis of product analysis throughout its shelf life, tests, or other information. It is also based on the conditions of handling, storage, preparation, and use printed on the label. Do not buy or use baby formula after its "use-by" date.

What do can codes mean?

Cans must exhibit a packing code to enable tracking of the product in interstate commerce. This enables manufacturers to rotate their stock as well as to locate their products in the event of a recall.

These codes, which appear as a series of letters and/or numbers, might refer to the date or time of manufacture. They aren't meant for the consumer to interpret as "use-by" dates. There is no book or Web site that tells how to translate the codes into dates.

Cans may also display "open" or calendar dates. Usually these are "best if used by" dates for peak quality.

Canned foods are safe indefinitely as long as they are not exposed to freezing temperatures, or temperatures above 90 °F (32.2° C). If the cans look ok, they are safe to use. Discard cans that are dented, rusted, or swollen. High-acid canned foods (tomatoes, fruits) will keep their best quality for 12 to 18 months; low-acid canned foods (meats, vegetables) for 2 to 5 years.

Dates on Egg Cartons

Use of either a "Sell-by" or "Expiration" (EXP) date is not federally required, but may be State required, as defined by the egg laws in the State where the eggs are marketed. Some State egg laws do not allow the use of a "sell-by" date.

Many eggs reach stores only a few days after the hen lays them. Egg cartons with the USDA grade shield on them must display the "pack date" (the day that the eggs were washed, graded, and placed in the carton). The number is a three-digit code that represents the consecutive day of the year starting with January 1 as 001 and ending with December 31 as 365. When a "sell-by" date appears on a carton bearing the USDA grade shield, the code date may not exceed 45 days from the date of pack.

Always purchase eggs before the "Sell-By" or "EXP" date on the carton. After the eggs reach home, refrigerate the eggs in their original carton and place them in the coldest part of the refrigerator, not in the door. For best quality, use eggs within 3 to 5 weeks of the date you purchase them. The "sell-by" date will usually expire during that length of time, but the eggs are perfectly safe to use.

UPC or Bar Codes

Universal Product Codes appear on packages as black lines of varying widths above a series of numbers. They are not required by regulation but manufacturers print them on most product labels because scanners at supermarkets can "read" them quickly to record the price at checkout.

Bar codes are used by stores and manufacturers for inventory purposes and marketing information. When read by a computer, they can reveal such specific information as the manufacturer's name, product name, size of product and price. The numbers are not used to identify recalled products.

Storage Times

Since product dates aren't a guide for safe use of a product, how long can the consumer store the food and still use it at top quality? Follow these tips:

- Purchase the product before the date expires.
- If perishable, take the food home immediately after purchase and refrigerate it promptly. Freeze it if you can't use it within times recommended on chart.
- Once a perishable product is frozen, it doesn't matter if the date expires because foods kept frozen continuously are safe indefinitely.
- Follow handling recommendations on product.
- Consult the following storage charts.

Food Product Dating**Refrigerator Home Storage (at 40 °F [4.4 °C] or below) of
Fresh or Uncooked Products**

If product has a "use-by" date, follow that date. If product has a "sell-by" date or no date, cook or freeze the product by the times on the following chart.

Product	Storage Times After Purchase
Poultry	1 or 2 days
Beef, Veal, Pork and Lamb	3 to 5 days
Ground Meat and Ground Poultry	1 or 2 days
Fresh Variety Meats (Liver, Tongue, Brain, Kidneys, Heart, Chitterlings)	1 or 2 days
Cured Ham, Cook-Before-Eating	5 to 7 days
Sausage from Pork, Beef or Turkey, Uncooked	1 or 2 days
Eggs	3 to 5 weeks

Food Product Dating

Refrigerator Home Storage (at 40 °F [4.4 °C] or below) of Processed Products Sealed at Plant

If product has a “use-by” date, follow that date. If product has a “sell-by” date or no date, cook or freeze the product by the times on the following chart.

Processed Product	Unopened, After Purchase	After Opening
Cooked Poultry	3 to 4 days	3 to 4 days
Cooked Sausage	3 to 4 days	3 to 4 days
Sausage, Hard/Dry, shelf-stable	6 weeks/pantry	3 weeks
Corned Beef, uncooked, in pouch with pickling juices	5 to 7 days	3 to 4 days
Vacuum-packed Dinners, Commercial Brand with USDA seal	2 weeks	3 to 4 days
Bacon	2 weeks	7 days
Hot dogs	2 weeks	1 week
Luncheon meat	2 weeks	3 to 5 days
Ham, fully cooked	7 days	Slices, 3 days; Whole, 7 days
Ham, canned, labeled “keep refrigerated”	9 months	3 to 4 days
Ham, canned, shelf stable	2 years/pantry	3 to 5 days
Canned Meat and Poultry, shelf stable	2 to 5 years/pantry	3 to 4 days

Food Safety Questions?

Call the USDA Meat & Poultry Hotline

If you have a question about meat, poultry, or egg products, call the USDA Meat and Poultry Hotline toll free at **1-888-MPHotline (1-888-674-6854)**.



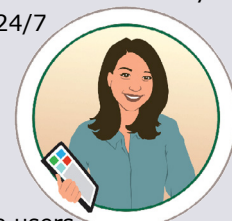
The hotline is open Monday through Friday from 10 a.m. to 4 p.m. ET (English or Spanish). Recorded food safety messages are available 24 hours a day. Check out the FSIS Web site at

www.fsis.usda.gov

Send E-mail questions to MPHotline.fsis@usda.gov.

AskKaren.gov

FSIS’ automated response system can provide food safety information 24/7 and a live chat during Hotline hours.



Mobile phone users can access m.askkaren.gov

PregunteleaKaren.gov

FSIS encourages the reprint and distribution of this publication for food safety education purposes. However, USDA symbols or logos may not be used separately to imply endorsement of a commercial product or service.

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Revised August 2013

Blue's the Clue

Time: One 45-minute class period, plus observation time over the next 2 to 3 days

Lab at a Glance

This lab introduces students to the effect temperature has on reducing and controlling the growth of bacteria. Students will use conventionally pasteurized and ultra-high-temperature (UHT) milk to observe how different temperatures (hot, room temperature, cool, and freezing) affect the growth of spoilage bacteria. They will also learn about the importance of pasteurization in keeping food safe.

Food Safety Connection

By learning about the effect of temperature on bacterial growth, students will be able to relate these findings to how they prepare and store food at home to help reduce bacterial growth.

Getting Started

ADVANCE PREPARATION

- Order methylene blue. **Note:** This experiment was designed using methylene blue chloride 1% (Educational Reagent Aqueous Solution from Fisher Scientific – catalog #S71326).
- Mix 1 ml of methylene blue 1% solution in 25 ml of water.
- Sterilize the test tubes, test-tube caps, pipettes, and pipette bulbs (see page 9).
- Purchase pasteurized whole milk and ultra high temperature (shelf stable) whole milk. (Shelf stable milk can usually be found in the juice aisle. Ask your store manager to order it if it isn't available in your supermarket.)
- Place all the equipment on a lab table.
- Photocopy pages 31-33 (Pasteurization), page 41 (Shelf Stable), and page 46 (Ultra High Pressure Treatment) of the *Food Safety A to Z Reference Guide*.
- Photocopy the *Blue's the Clue Data Table* (page 41) for each team.

ABOUT UHT AND PASTEURIZED MILK

UHT milk is heated to at least 280° F (138° C) for 1 or 2 seconds, then packaged in sterile, airtight containers. Because of the high heat and special packaging, UHT milk contains fewer bacteria than conventionally pasteurized milk, and can be stored without refrigeration for up to 90 days. After opening, spoilage time for UHT milk is similar to that of conventionally pasteurized milk. Therefore, after opening, it should be refrigerated just like pasteurized milk.

Pasteurized milk is heated to at least 161° F (72° C) for 15 seconds. This process kills the pathogenic bacteria found in milk; however, it may not kill all the spoilage bacteria.

Materials

FOR THE CLASS

- 3 to 6 test-tube racks, depending on the number of teams. Teams can share test-tube racks.
- Refrigerator with freezer compartment, if possible
- *Food Safety A to Z Reference Guide*, (see pages above).
- *Dr. X and the Quest for Food Safety* video/DVD, Module 3 – Processing and Transportation

FOR EACH TEAM OF 3 TO 4 STUDENTS

- 60 ml of pasteurized, whole milk (10 ml/test tube)
- 60 ml of ultra high temperature (shelf stable) whole milk (10 ml/test tube)
- Methylene blue dilute solution (1 drop per test tube)
- 6 sterile test tubes
- 6 sterile test tubes with caps or aluminum foil to cover the test tubes
- Two sterile 10 ml pipettes
- One or two sterile 5 ml pipettes or eye droppers
- Sterile pipette bulbs or pipette aids
- Permanent marker to label test tubes
- *Blue's the Clue Data Table*

Introduction

Explain to the students that later in Module 3, they'll learn more about irradiation and ultra high pressure treatment, but in this activity, they'll focus on pasteurization. Now ask students:

- ***Have you ever wondered why your parents are always asking you to put the milk back in the refrigerator? What might happen to that milk if it's left out at room temperature overnight?***
- ***In the video Module 1 – Understanding Bacteria, Dr. X talked about the Danger Zone. What precautions did he give about the "Zone"? What might be present in milk that has been left in the Danger Zone for more than 2 hours?***

SAFETY FIRST

- DO NOT DRINK THE MILK USED IN THE LAB.
- Never pipette by mouth. Always use a pipette bulb or aid.
- Wash test tubes and other materials in hot, soapy water after the lab.
- Before leaving the lab, wash your hands with hot, soapy water.
CAUTION: Be careful not to spill methylene blue on the countertops or clothes; it may stain.

Time to Tune In ...

MODULE 3 – PROCESSING AND TRANSPORTATION

Introduce the video by explaining that on our next stop along the Farm-to-Table-Continuum, students are going to learn about processing. Dr. X will beam them into the research lab of one of his scientist friends who looks at new ways to reduce the bacteria in our food through processing. Here are some things to think about while they watch the video:

- **What do cows, astronauts, and elephants have to do with food safety and food processing?**
- **What is pasteurization?**
- **How can an egg be pasteurized in the shell without cooking it?**
- **How can some types of milk stay safe without being refrigerated?**
- **What process keeps food safe in outer space?**

Show video/DVD Module 3 – Processing and Transportation (Time: 7 minutes).

Instant Replay

Time to review and summarize.

1. **What's the relevance of cows, astronauts, and elephants to food safety and food processing?** (Cows refer to pasteurization, astronauts refer to irradiation, and elephants refer to ultra high pressure treatment.)
2. **What is pasteurization?** (Pasteurization uses heat to kill harmful bacteria in foods.)
3. **What is the time/temperature relationship?** (Pasteurized milk is heated for a longer time at a lower temperature, and UHT milk is heated for less time at a higher temperature.)
4. **How can an egg be pasteurized in the shell without cooking the egg or breaking the shell?** (Manufacturers use a time/temperature relationship to pasteurize eggs in the shell without cooking them. Heating eggs above 140° F (60° C) will cook them. Thus, using a lower temperature of 130° F (54° C) for a long time, 45 minutes, kills bacteria without cooking.)
5. **How can some types of milk stay fresh and safe without being refrigerated?** (UHT milk contains fewer bacteria than conventionally pasteurized milk because it's heated to a higher temperature. It's also packaged in sterile, airtight containers. Therefore, UHT milk can be stored without refrigeration for up to 90 days.)
6. **So ... what prevents astronauts from getting foodborne illness in outer space?** (Irradiation of their food)

Procedure

LAB 1: DESIGN AND CONDUCT EXPERIMENT

1. Ask students to form teams of 3 or 4 and encourage each team to develop a hypothesis on how temperature affects bacterial growth. Then ask them to design an experiment to test their hypothesis.
2. Introduce the three materials teams must use for their experiment: regular pasteurized milk, ultra high temperature (shelf stable) milk, and methylene blue.
3. Ask: **How might you use methylene blue to help with your experiment?** Students can research methylene blue and discover that it's an indicator dye used to determine the presence of bacteria in milk. Tell them they can use any of the other materials on the lab table. Also, there's a refrigerator and freezer they can use.
4. Let teams discuss their hypotheses and experimental designs for 10 to 15 minutes. Then, begin posing the following questions to help students design well-thought-out experiments:
 - **What are some ways you could test the effect of temperature on bacteria? What is the effect of temperature on bacteria? What did you learn about the effect of temperature on bacteria in Module 1 – Understanding Bacteria of the video/DVD?** (Heating is a way to kill bacteria, whereas chilling and freezing are ways to retard the growth of bacteria.)
 - Explain that one container of milk came from the refrigerated dairy case of the supermarket and the other from an unrefrigerated shelf. Let students examine each container.
 - **What's an important difference between the two milk products? Is there any information on the labels that relates to our question about the effect of temperature on bacterial growth?** (Students should discover that one is pasteurized and the other is treated using ultra high temperature.)
 - **What are the similarities and differences between pasteurized and ultra high temperature treatments?** (Both pasteurization and ultra high temperature use heat to kill bacteria. Ultra high temperature methods use higher temperatures than regular pasteurization. Also, products treated at ultra high temperatures are packaged in special airtight containers to prevent bacteria from getting into the product.)
 - **Could there be differences in the growth of bacteria between the two milks? What do you think the differences might be?** (The regular pasteurized milk should show bacterial growth sooner than the UHT milk because the pasteurized milk has more bacteria in it.)
 - **Should you consider these differences when you design your experiments? Why?** (Yes, both milks should be tested in all conditions.)

ABOUT METHYLENE BLUE

Methylene Blue is an indicator dye that, in anaerobic conditions, becomes colorless and is reduced to leucomethylene. Methylene blue loses its color in the absence of oxygen because bacteria use up the oxygen present in the milk. The rate at which it loses its color is a relative measure of bacteria present in milk.

TIPS

- Carefully label all test tubes and test-tube racks.
- The methylene blue will mix better if the milk is added to the test tubes before the methylene blue. Mix thoroughly by lightly tapping the test tubes with your fingers.
- Gas will be produced, so don't close the test-tube caps tightly.

- **How can you tell if bacteria are growing in the test samples?** (Add methylene blue to each sample. If bacteria are growing, the methylene blue will become colorless and the milk will change from blue to white. This is not immediate, but happens over a few days.)

5. Have each group present their hypothesis and experimental design to the class. Encourage students to discuss the merits of each suggested test. (One effective experimental design is to test pasteurized milk and UHT milk at three temperatures: room temperature, chilled, and frozen.)
6. After the group discussions, give the teams time to revise their hypotheses and experimental designs.
7. Let teams conduct experiments according to their designs. **Note:** The test tubes must be checked each day after the experiment is conducted. Since the color change happens over time, you could miss important findings if you don't check every day.

LAB 2: OBSERVE AND RECORD

Option: Students can use the *Blue's the Clue Data Table* to record their results.

1. Students should observe and record the time and any visual changes on day two of this lab activity.
 - Ask: **How did the the data support or reject your hypothesis? What might happen if the chilled and frozen samples were left out at room temperature for several hours or overnight? Should we test them to find out?** (Yes, let the chilled and frozen samples stand at room temperature until the following day. As they reach room temperature and remain in the Danger Zone for several hours, the bacteria will begin to grow. As this happens, the methylene blue will become colorless and the milk will change from blue to white. Observe and record the results.)

- **What might happen if the UHT samples were left out at room temperature for another day?** (If you let the UHT samples sit out at room temperature for another day or more, the color will change to white. Observe and record the results.)

LAB 3: OBSERVE, RECORD, AND REPORT

1. Observe and record findings on the third day. Ask students: **What happened to the frozen and chilled samples? What happened to the UHT samples?**
2. Give students 5 to 10 minutes to complete their Data Table.
3. Have teams present their findings to the class. They should report both positive and negative results and discuss ways they would improve their experimental design.
4. Remind students to include the relationship of their findings to food safety.

TIP

- To find the results you can expect from this experiment, see page 58.

FAQ

If bacteria in UHT milk don't grow rapidly, why do I have to keep the milk refrigerated after I open it?

Because there are fewer bacteria in UHT milk than in regular pasteurized milk, the spoilage bacteria in UHT milk take longer to grow. However, they will eventually multiply. You should always practice the safest precautions. Therefore, refrigerate the milk as soon as it is opened.

Instant Replay

Time to review and summarize.

1. **Were bacteria killed at the different temperatures? Why or why not? How could you tell?** (No. Only heat kills bacteria. Room temperature isn't high enough to kill bacteria, and chilling and freezing do not kill bacteria, they just slow their growth. When the chilled and frozen milk reached room temperature, bacteria began to grow again.)
2. **What's a basic difference between conventionally pasteurized and UHT milk?** (UHT milk can be stored on a shelf without refrigeration for up to 90 days.)
3. **Explain the importance of knowing about the Danger Zone in food safety.** (Awareness of the Danger Zone helps people understand the importance of heating and chilling food, thus decreasing the amount of foodborne illness.)
4. **What do chilling, freezing, and heating do to bacteria?** (Chilling and freezing slow down the growth, but heating kills the bacteria.)

Here are the results you can expect from this experiment

ROOM TEMPERATURE SAMPLES

- The **pasteurized milk** will turn white by Lab 2 (day 2), indicating that there are some spoilage bacteria in milk. At a temperature conducive to bacterial growth, they will multiply.
- The **UHT milk** will still be blue by Lab 2 (day 2). This is because the UHT milk has fewer spoilage bacteria than regular pasteurized milk. Thus, it takes longer to see any bacterial growth. Bacteria do not quickly multiply in the UHT milk.
- After leaving the UHT milk at room temperature for another day or two, the color will turn white, indicating that spoilage bacteria will ultimately grow in the UHT milk.

CHILLED AND FROZEN SAMPLES

- Both the pasteurized and UHT chilled and frozen milk samples will still be blue by Lab 2 (day 2), indicating that cold temperatures retard bacterial growth.
- After leaving the chilled and frozen samples at room temperature for another day or two, the color will change to white. This indicates that when the temperature rises into the Danger Zone (room temperature), bacteria can grow. It may take longer for the UHT milk to change to white because there are fewer spoilage bacteria in UHT milk than in regular pasteurized milk.

Summary

Temperature affects the growth of bacteria. Heating kills bacteria and chilling or freezing retards the growth of bacteria. Pasteurization is the process of destroying harmful bacteria that could cause disease by applying heat to a food; however, some spoilage bacteria may still be present. Bacteria grow more quickly in regular pasteurized milk than in UHT milk because the latter uses higher temperatures, thus killing more bacteria. Also, UHT milk is sealed in sterile, airtight containers.

Extensions

- Test UHT milk that has an expiration date that has passed and UHT milk that has an expiration date in the future. See if the "expired" milk changes more quickly than the fresher milk.
- Try this experiment using a variety of milk forms: powdered, skim, 1%, 2%, etc.
- Relate your pathogen to this experiment and record the information in your food safety portfolio.

Resources

- **Food Safety A to Z Reference Guide** (See the following terms – Bacteria, Danger, Zone, Methylene Blue, and Pasteurization.)
- **Dr. X and the Quest for Food Safety** video/DVD Module 3 – Processing and Transportation
- **Laboratory Exercises for Microbiology** by John P. Harley and Lansing M. Prescott, 4th Edition, WCB McGraw-Hill: Boston, 1999 (for additional information on methylene blue)
- **Web sites**
 - › Pasteurization – Dairy Science and Technology/University of Guelph, Canada www.foodsci.uoguelph.ca/dairyedu/pasteurization.html
 - › National Milk Producers Federation www.nmpf.org
 - › SciLinks Keyword: Pasteurization, www.scilinks.org, Code: FS302

Career Connection







See real-life scientists in action!

www.foodsafety.gov/~fsg/teach.html

Food Safety A to Z Reference Guide

Blue's the Clue Data Table

Name _____ Date _____ Class Period _____

DAY 1 ORIGINAL SAMPLE	DAY 2 DESCRIBE VISUAL CHANGES	DAY 3 DESCRIBE VISUAL CHANGES	DAY 4 DESCRIBE VISUAL CHANGES
<p style="text-align: center;">ROOM TEMPERATURE</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>PASTEURIZED MILK</p> </div> <div style="text-align: center;">  <p>UHT MILK</p> </div> </div>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>
<p style="text-align: center;">ROOM TEMPERATURE</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>PASTEURIZED MILK</p> </div> <div style="text-align: center;">  <p>UHT MILK</p> </div> </div>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>
<p style="text-align: center;">ROOM TEMPERATURE</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>PASTEURIZED MILK</p> </div> <div style="text-align: center;">  <p>UHT MILK</p> </div> </div>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>	<p>PASTEURIZED:</p> <p>UHT:</p>

1. How did the data support or reject your hypothesis?

2. What do you predict will happen if the chilled and frozen samples are left out at room temperature for another day?

3. What do you predict will happen if the UHT samples are left at room temperature for another day?

4. Explain the relationship of your findings to food safety.

Credible Source Writing Lab

Name _____ Date _____ Class Period _____

Assign one person to each job role. For a group of four, assign two people to share the reporting out to the class.

What is the phrase or question you searched? _____

How many results did the search engine find? _____

What is the title of the article or source you chose to investigate? _____

Who is/are the author(s) of the article? _____

What is the author's job or position? (Do a search of the author.) _____

What is the author's educational background? _____

After your investigation of the author of your chosen article, do you still wish to use the article?

↑ **If no, go back to your original search and follow the same steps with another article.**

↓ **If yes, prepare your answer to the question, "Why are Calories important?"**

According to your article, why are Calories important? _____

What is the author's purpose for writing the article? _____


When was the article written? _____

Fermented Foods

Download: Appendix 6 Fermented Foods and open in Microsoft PowerPoint

Microbiology of Fermented Foods


- Principles
- Microorganisms
- Starter Cultures
- Fermented Foods



Fermentation Principles

- Spoilage versus Fermentation: a matter of **control**
- Left to their own fate, perishable foods (meat, milk, fruits and vegetables) perish because growth of micro-organisms is not controlled
- In fermentation, conditions are controlled so that only certain microorganisms can grow (only those that bring about positive changes).

Spoilage versus Fermentation: a matter of control



Exert control by:

- Acidity and pH
- Temperature
- Moisture
- Salt
- Substrate availability

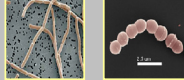
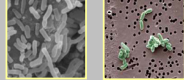

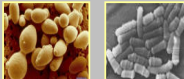
General properties of fermented foods

- Enhanced preservation
- Enhanced nutritional value
- Enhanced functionality
- Enhanced organoleptic properties
- Unique
- Increased economic value

Fermented foods industry: past and present

Traditional	Modern
Small scale (craft industry)	Large scale (in factories)
Non-sterile medium	Heat-treated medium
Exposed and open	Closed and contained
Manual	Automated
Insensitive to time	Time-sensitive
Exposure to contaminants	Contaminants excluded
Varying quality	Consistent quality
Safety a minor concern	Safety a major concern

Microorganisms involved in fermented foods

Lactic acid bacteria <i>(Lactobacillus, Streptococcus)</i> 	Other bacteria <i>(Propionibacterium, Brevibacterium)</i> 
Fungi <i>(Aspergillus, Penicillium)</i> 	Yeast <i>(Saccharomyces)</i> 

Basic Sourdough Bread

Recipe courtesy Emeril Lagasse, 2002

Prep Time: 30 min Inactive Prep Time: 1 min
Cook Time: 1 hr 5 min Level: Intermediate

Ingredients

- 2 cups bread flour
- 1 1/2 cups sourdough starter, recipe follows
- 3/4 teaspoon salt

Directions

In an electric mixer with the dough hook, combine the flour, starter and salt, and knead until it no longer sticks to the sides or bottom of the mixing bowl.

Place a lightly oiled bowl, turning to coat. Cover with plastic wrap and let dough rise in a warm, draft-free place until doubled in size, 1 to 1 1/2 hours. Turn out onto a lightly floured surface. Sprinkle lightly with flour and knead gently, removing any large air bubbles. Knead into a small circle, then shape into a tight ball, pinching the seams together underneath. Place on a well-floured board or baking peel, seam-side down. Cover with a kitchen towel and let rest until doubled in size, about 1 hour.

Preheat a baking stone, if available, on the bottom rack of an oven at 400° F. With a sharp, serrated knife, cut a large "X" or crosshatch pattern into the top of the dough.

Spray lightly with a mister and transfer to the baking stone (or place on a heavy baking sheet lightly dusted with cornmeal) and bake until golden brown and the bread sounds hollow when thumped on the bottom, about 60 minutes. (Sourdough should have a darker crust other breads, so leave in the oven 5 minutes after you think it is done.)

Remove from the oven and let cool on a wire rack for at least 30 minutes before serving.

Basic Sourdough Starter

- 3 cups warm water (110° F)
- 1 1/2 tablespoons active dry yeast
- 1 teaspoon sugar
- 3 cups all-purpose flour

Yield: 5 to 6 cups, Prep time: 10 minutes, Inactive prep time: 12 hours

In a large bowl, combine the water, yeast, and sugar. Let sit until the yeast becomes foamy, about 5 minutes. (If the yeast does not foam, discard the mixture and begin again with a new yeast.)

Add the flour and stir vigorously to work air into the mixture. Cover with a towel, let rest in a warm, draft-free place (an oven with its pilot light or light bulb turned on works well) for 8 to 12 hours. (The mixture should become very bubbly.) Use immediately or cover loosely with plastic wrap and store in the refrigerator.

Preserving the Starter: Each time you remove a portion of the starter for a recipe, reserve at least 1/4 cup and replace the amount you have taken out with equal amounts of flour and water.

For example, if you remove 1 cup of starter, you must replace with 1 cup of flour and 1 cup of warm water. Whisk these ingredients into the starter until blended but not completely smooth, cover loosely, and return to the refrigerator.

Also, the starter must be maintained by feeding it every few days. Refresh by removing 1 cup of the starter (give to a friend or discard it) and adding 1 cup of flour and 1 cup of warm water. Whisk until blended but not smooth. Cover loosely and return to the refrigerator.

If you plan to be away longer than a week, freeze the starter in a sterilized, airtight freezer container. Thaw the starter 2 days before you plan to bake with it. Refresh as indicated above with 1 cup each of flour and warm water. Cover and leave at room temperature 12 hours or overnight before using.

CAUTION: Never keep your starter tightly closed! The gasses expelled by the yeast will build up pressure and may cause the container (such as a glass jar) to burst!

Making Yogurt

Yogurt is a cultured milk product made when lactic-acid bacteria cause milk to ferment. The milk is first heated to kill any undesirable bacteria that may be present and to denature the milk protein. This gives the finished product a firmer body and custard-like texture. Lactic-acid bacteria are then inoculated into the milk, and the milk is incubated. This experiment where you observe the changes caused by lactic-acid bacteria in making yogurt.

Equipment and Materials

- Yogurt base
- Saucepan or double boiler
- Safety goggles
- Laboratory thermometer in stopper
- Ring stand and clamp
- Yogurt maker or a setting pan apparatus
- Yogurt culture
- 50-mL beaker
- Spoon
- Yogurt containers and covers
- pH indicator paper
- Ice and pan (optional)

Procedure

1. Obtain a yogurt base (kind of milk) from your instructor. Three different yogurt bases will be used in this experiment.
2. Heat the base assigned to your group in a saucepan or double boiler to 82° C. Maintain this temperature for 15-20 minutes. Wear safety goggles while heating.
3. Cool the yogurt base to 43° C.
4. Add 30 mL of yogurt culture to the 43° C yogurt base. Mixx with a gentle stirring motion to minimize the addition of air.
5. Fill yogurt containers and cover. Mark your containers with the code number of your base.
6. Put filled containers in either a yogurt maker or setting pans. Maintain the temperature at 43° C. Check frequently, as temperatures of 46° C and above will kill the culture.
7. When the milk has coagulated and formed a firm gel, remove the yogurt containers. Cool them immediately by setting them in ice or refrigerating.
8. Measure the pH of a sample of each yogurt base and record in your data table.
9. Test a sample of each yogurt base for color, texture, and taste. Record your observations in your data table.

Analyzing Results

1. Were there differences in color among the fermented samples? If so, which looked most appealing?

2. What textural difference, if any, did you note among the samples?

3. Which of the samples, if any, had an unpleasant taste?

4. Which sample was the most acidic? _____

5. Is there any correlation between the degree of acidity and taste?

6. All factors considered, which base produced the best yogurt? _____

7. Which do you prefer, the best homemade yogurt or the best commercial brand? Why?

DATA TABLE

YOGURT BASE NO.	pH	COLOR	TEXTURE	TASTE

Evaluation of Commercial Yogurts

Several factors figure prominently in judging the quality of yogurt. Yogurt should have a smooth, uniform texture. No graininess, lumpiness, or liquid whey should be present. Good yogurt has no aftertaste. In this experiment, you will evaluate the quality of commercially prepared yogurt.

Note that some yogurt contains live bacteria that have the enzyme lactase, which may aid in digestion. Other yogurt is heat-treated to destroy the bacterial culture. While extending the shelf life, this heat-treatment eliminates any health benefits that might result from the live micro organisms.

Equipment and Materials

- Yogurt samples
- Paper plate
- Masking tape
- Marking pen
- Spoon
- Paper cup

Procedure

1. Attach equally spaced labels around the edge of a paper plate, identifying the numbers of all yogurt samples. Place a bite-size amount of each yogurt sample beside the correct identification number.
2. Evaluate each sample on color, texture, and taste. Using a paper cup, rinse your mouth with water between samples. Record your observations in your data table. Also mark one sample as your favorite.
3. After all students have finished the taste test, your teacher will display the container and the unit price of each sample. In your data table, record the price and the following information from the container:
 - a. Brand name
 - b. Any colorings and flavorings
 - c. Whether the sample contained live bacteria

Analyzing Results

1. Read the list of ingredients for the sample that you judged best in appearance. Which ingredients do you think contributed to this effect?

2. Read the list of ingredients for the sample with the best flavor. What ingredients do you think contributed to its taste?

3. Read the Nutrition Facts panel of the yogurt you liked best. Is it also a nutritious choice? Explain your answer.

4. Compare the number of kcalories per serving among the different brands. Does the brand you favor provide a reasonable number? Explain.

5. Did the yogurt with the highest unit price seem worth the added cost? If so, in what qualities is it superior?

6. For what reasons would you buy yogurt with or without live bacterial cultures?

DATA TABLE

	YOGURT SAMPLES						
Color							
Texture							
Taste							
Favorite							
Brand							
Unit price							
Colorings							
Flavorings							
Live bacteria?							

Project Management Log: Team Tasks

Project Name _____

Team Members _____

TASK	WHO IS RESPONSIBLE	DUE DATE	STATUS	DONE

Essential Question:

How can we create a fermented baked good that will be successful in a local bakery?

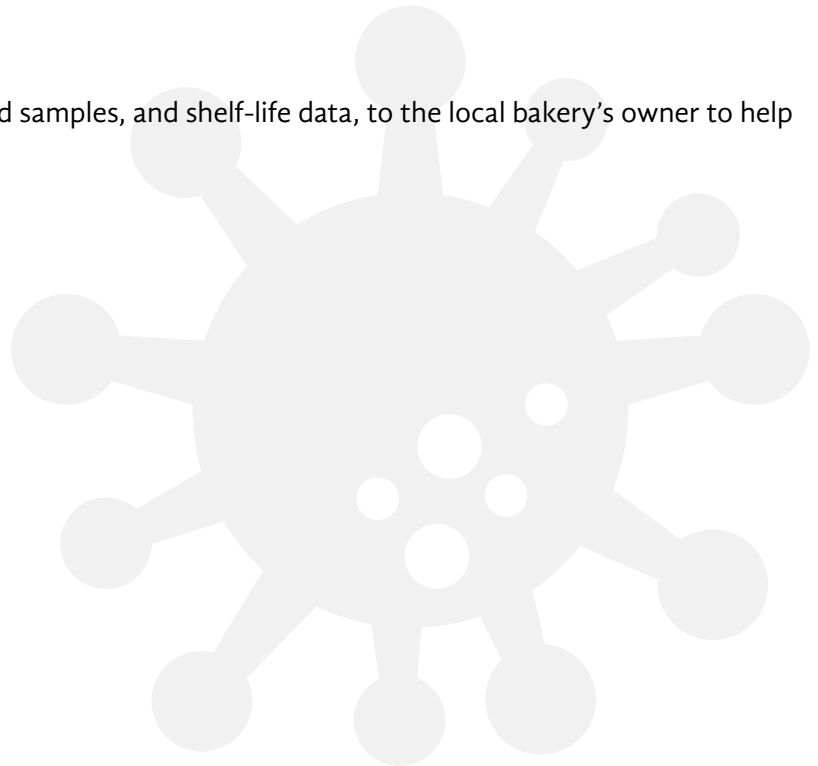
Engagement Scenario:

A typical loaf of bread will last approximately 5-7 days on the shelf. With American families getting smaller, families are throwing out uneaten bread as it spoils before they can eat it. A local bakery believes that sourdough breads have a longer shelf-life and an excellent flavor and they want to develop one to sell. While some stores have created a “quick sourdough” using vinegar to create a sour flavor, a local bakery wants you to create a traditional sourdough bread for them. Their customers are interested in traditional and artisan products and love to understand how their food was made. She has asked you to develop a sourdough bread recipe and a starter culture for them and help them explain to their customers how this bread is different from other breads.

Your team will bake standard recipe sourdough bread. You will research the process of developing a starter culture and recipes for different breads. Once you have chosen a starter culture process and a recipe, you will bake the recipes.

Your team will track the shelf lives of the bread and graph the mold appearance on each. This data will be used to test your hypothesis about shelf life.

Your team will present your recipes with baked samples, and shelf-life data, to the local bakery’s owner to help them find a new recipe for sourdough bread.



Graphing Pre-Test

Name _____ Date _____ Class Period _____

1. Input the following data into an Excel Sheet and create a scatterplot with a best fit line. Print and turn in with your quiz.

Grams of Orange	Milligrams of Vitamin C
100	45
50	22.5
150	67.5
205	92.2

2. Input the following data into an Excel Sheet and create a scatterplot with a best fit line. Print and turn in with your quiz.

Day	Mold coverage (% of bread)
1	0
3	3
4	7
5	10

3. Match the data sets with the graphs:

a.

Grams Flour	Grams of Bread
3	12
5	16
12	48
16	56

d.

b.

Grams of Flour	Grams of Bread
2	54
13	12
20	35
25	62

e. Where are the graphs?
None were shown in
Word doc

c.

Grams of Flour	Grams of Bread
5	25
10	20
15	15
20	10

f.

Research Notes

Name _____ Project _____ Date _____

Question

Search Terms

Enter all search terms you intend to use here. Circle any that result in a good reference:

Reference (Not all sections apply to all sources)

Author(s): _____

Title: _____

Website: _____

Publisher: _____

City/State: _____

Year: _____ Pages: _____

Notes

Storing a Starter

Our romantic image of days of yore suggests that the hard working mother of a family of 12 to 14 baked several times a day to feed herself, her hubby and the kids. And, if she was really lucky, she might also be feeding the ranch hands, the miners and the posse. (After all, what Western movie would be complete without ranch hands, miners and a posse?) In such a picture, the starter would be fed and used several times a day, and it would be very healthy. A similar situation would apply in a commercial bakery.

However, today few of us bake that often, and it's hard to justify twice-a-day maintenance of a starter we use once a week or once a month. Surely, there has to be a better way.

Well, maybe not a better way, but certainly a viable way. The answer is the refrigerator.

Some people feel refrigeration destroys a starter. Several sourdough experts feel that if a starter gets below 46F, it should be discarded and you should start over. I have not had that experience, though I will say you have to be careful when refrigerating starter.

Dr. Sugihara, the scientist who discovered how San Francisco sourdough works also studied freezing sourdough. His studies seem to transfer over to refrigerating starter. In general, a starter that was fed just before it was refrigerated or frozen seems to bounce back faster than a starter that was mature when it was put in storage.

Some people seem to feel that refrigerating their starter is some sort of goal. I can't count how many letters I've received that ask if it's OK to refrigerate their less-than-a-week old starter yet. It is important to understand that a new starter is building in strength and flavor for somewhere between 30 and 90 days, depending on who you read and believe. As a result, I don't recommend refrigerating a starter until it has had time to reach its peak potential.

So, when can you optimally refrigerate a starter? The starter should be at least 30 days old, having been fed twice a day the entire time. It should be able to make bread you like - why store a starter that isn't working for you? A starter you get from a vendor, friend or other source is already more than 30 days old, the 30 days just refers to starters you have started. Next, the starter should be able to double its size between feedings. If it's not healthy, it's not a good idea to refrigerate it. And finally, the best time to refrigerate the starter is when it is freshly fed. So, feed your starter until it will double in size between feedings, feed it one more time and then refrigerate it. I call the starter in the refrigerator my "storage starter."

Refrigeration is not a science-fiction suspended animation. Your storage starter will probably double in size while in the refrigerator over a period of a few days, so remember not to overfill your storage container. Also, when in refrigerated storage, your storage starter will be in a state of slow decline. The storage starter will need to be fed from time to time. I do not suggest leaving a storage starter in the fridge for more than two months without feeding it and reviving it. We'll talk more about how and why to do that in "[reviving a starter](#)."

A common question at this point is, "what sort of container should I use to store my starter?" I like wide-mouthed glass canning jars. They hold a lot, they are covered, they are durable and they are cheap. I usually don't seal the top tightly. I've heard horror stories about a starter building up so much gas pressure in a jar that it explodes. I'd rather not find out if that could happen, so I close the lid loosely. Plastic tends to scratch too easily, so it isn't as easy to clean. While I have no problem with metal utensils and bowls, I'd rather not use metal containers for long term starter storage.

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Graphing Post-Test

Name _____ Date _____ Class Period _____

- Input the following data into an Excel Sheet and create a scatterplot with a best fit line. Print and turn in with your quiz.

Grams of Orange	Milligrams of Vitamin C
100	45
50	22.5
150	67.5
205	92.2

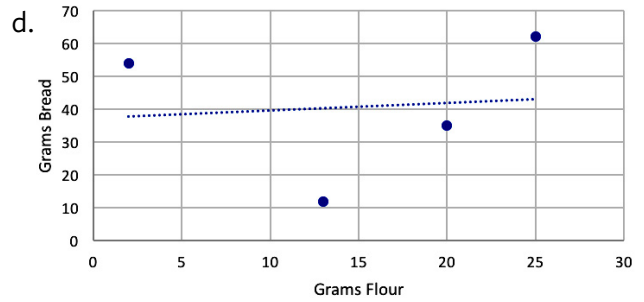
- Input the following data into an Excel Sheet and create a scatterplot with a best fit line. Print and turn in with your quiz.

Day	Mold coverage (% of bread)
1	0
3	3
4	7
5	10

- Match the data sets with the graphs:

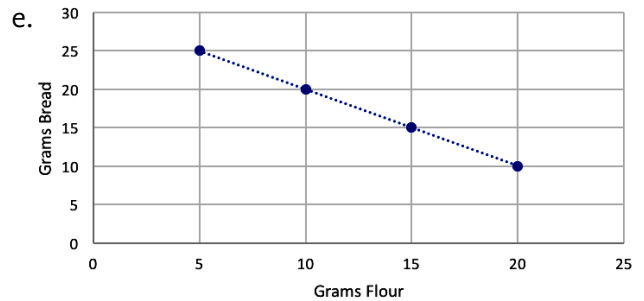
a.

Grams Flour	Grams of Bread
3	12
5	16
12	48
16	56



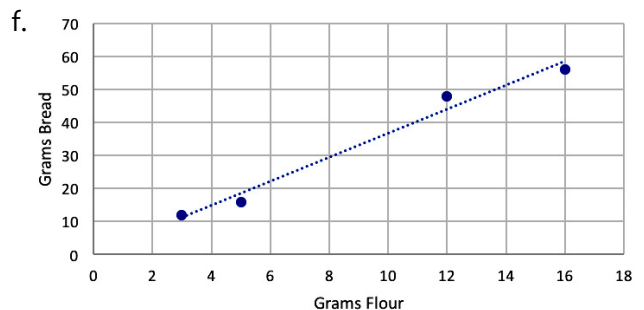
b.

Grams of Flour	Grams of Bread
2	54
13	12
20	35
25	62



c.

Grams of Flour	Grams of Bread
5	25
10	20
15	15
20	10



Fermentation Final Rubric

Team _____ Date _____ Class Period _____

Total Points for Project _____ /100

LAB DATA (20 POINTS)	
<ul style="list-style-type: none"> Includes a section for each lab and a summary of the data. (0-20 points) 	
RECIPES (20 POINTS)	
<ul style="list-style-type: none"> All recipes are included with a reference of where they were found. (0-20 points) 	
RESEARCH SUMMARY (20 POINTS)	
<ul style="list-style-type: none"> Includes all background information collected throughout the project. (0-10 points) 	
<ul style="list-style-type: none"> Includes a reference list and proper citations. (0-10 points) 	
CONCEPT MAP (20 POINTS)	
<ul style="list-style-type: none"> Clearly outlines the process of fermentation as it relates to baking sourdough bread. (0-20 points) 	
PROPOSED SOLUTION (20 POINTS)	
<ul style="list-style-type: none"> Recommendation for new and improved recipe is clear and the reason is supported with evidence. (0-20 points) 	
Final Total	

Project Presentation Audience Feedback

Student Team _____

Project Name _____ Date _____

Thank you for attending our project presentations and taking the time to write thoughtful answers to the following questions:

1. What did you learn from this presentation, or what did it make you think about?

2. What did you like about this presentation?

3. Do you have any questions about the topic or about how the project was done?

4. Any other comments about this presentation?

Collaboration Rubric

	BELOW STANDARD	APPROACHING STANDARD	AT STANDARD	ABOVE STANDARD
RESPONSIBILITY FOR ONESELF	<ul style="list-style-type: none"> is not prepared and ready to work with the team does not do project tasks does not complete tasks on time does not use feedback from others to improve his/her work 	<ul style="list-style-type: none"> is sometimes prepared and ready to work with the team does some project tasks, but needs to be reminded competes some tasks on time sometimes uses feedback from others 	<ul style="list-style-type: none"> is prepared and ready to work with the team; is available for meetings and uses the team's communication system does what he or she is supposed to do without having to be reminded completes tasks on time uses feedback from others to improve his or her work 	<p><i>In addition to At Standard criteria:</i></p> <ul style="list-style-type: none"> does more than what he or she has to do asks for additional feedback to improve his or her work, beyond what everyone has been given
HELPING THE TEAM	<ul style="list-style-type: none"> does not help the team solve problems; may cause problems does not share ideas with other team members does not give useful feedback to others does not offer to help others 	<ul style="list-style-type: none"> cooperates with the team but does not actively help it makes some effort to share ideas with the team sometimes gives useful feedback to others sometimes offers to help others 	<ul style="list-style-type: none"> helps the team solve problems, manage conflicts, and stay focused and organized shares ideas that help the team improve its work gives useful feedback (specific and supportive) to others so they can improve their work offers to help others do their work if they need it 	<p><i>In addition to At Standard criteria:</i></p> <ul style="list-style-type: none"> steps in to help the team when another member is absent encourages others to share ideas, helps to make them clear, and connects them to the team's work notices if a team member does not understand something and takes action to help
RESPECT FOR OTHERS	<ul style="list-style-type: none"> does not pay attention to what teammates are talking about does not show respect for teammates (may interrupt, ignore ideas, hurt feelings) 	<ul style="list-style-type: none"> usually listens to teammates, but not always is polite and kind to teammates most of the time, but not always 	<ul style="list-style-type: none"> listens carefully to teammates is polite and kind to teammates 	<p><i>In addition to At Standard criteria:</i></p> <ul style="list-style-type: none"> encourages the team to be respectful to each other recognizes everyone's strengths and encourages the team to use them

Self-Reflection on Project Work

Think about what you did in this project and how well the project went. Write your comments in the right column.

Student Name:	
Project Name:	
Driving Question:	
List the major steps of the project:	
ABOUT YOURSELF:	
What is the most important thing you learned in this project:	
What do you wish you had spent more time on or done differently:	
What part of the project did you do your best work on:	
ABOUT THE PROJECT:	
What was the most enjoyable part of this project:	
What was the least enjoyable part of this project:	
How could your teacher(s) change this project to make it better next time:	

Kimchi Recipe

Koreans possess a passionate fondness for kimchi, serving this spicy fermented pickled vegetable dish at most meals. While many other types of pickles—such as store-bought cucumber dill pickles—are fermented in a prepared salty solution, kimchi ferments in the vegetable’s own juices. Although there are scores of varieties, kimchi is usually made with cabbage.

What Do I Need?

- 2 1/2 pounds napa cabbage
- 1/2 cup kosher salt
- A walnut-sized knob of ginger, grated
- 4 cloves garlic, crushed
- 1 bunch scallions, minced
- 2 tablespoons sugar
- 2 tablespoons crushed red chili pepper
- 2 jalapeños, minced fine
- A glass or plastic bowl
- 2 to 3 1-pint glass canning jars
- Plastic wrap
- Rubber bands

What Do I Do?

1. Wash the cabbage, then chop it coarsely. Toss it in a glass bowl with the salt and let it sit overnight.
2. Drain the water off the cabbage and rinse it very well to remove the excess salt.
3. In a large glass or plastic bowl (don’t use metal), mix together the ginger, chili peppers, and jalapeños, and then add the well-drained cabbage. Toss the ingredients thoroughly to coat the vegetables. Save the juice that accumulates in the bottom of the bowl.
4. Pack the mixture tightly in sterile glass jars and cover with the juice. Add water if necessary to achieve 3/4-inch headroom. Cover the tops of the jars with plastic wrap, secured with a rubber band. Keep the kimchi in the refrigerator for 3 days before eating.

Did You Know?

- Korean families traditionally store fermented kimchi in large earthenware crocks, burying the containers underground and retrieving them as needed.
- Salt extracts water from kimchi by osmosis, making it crisp.
- The garlic and chili pepper help to preserve kimchi.

Caution

- Kimchi will keep refrigerated for up to a week. Do NOT attempt to heat-process kimchi.