Food Science

MANAGING MICROBES

food and nutrition sciences

PREPARATION FOR TOMORROW

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Students apply a second sourdough recipe to the baking process.

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LESSON INTRODUCTION

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 and standard recipe non-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 your new recipes.

Your team will track the shelf lives of the first bread you baked 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.

DAY ONE

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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

Objectives

1. Define expiration date.
2. Define sell by date.
3. Define best if used by date.
4. Define use by date.

Key Question:

How do you know if food is spoiled?

Bell Work:

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:

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.

DAY ONE

Middle:

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:

Provide each student with the weekly Exit Slip handout (Appendix 2)

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

"Summarize what you learned today."

Collect the Exit Slip 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

APPENDIX THREE

The NASA diet: It's food, but not as we know it

By Samantha Bresnahan and Thomas Page, for CNN
Updated 8:16 AM ET, Wed February 4, 2015
http://www.cnn.com/2015/02/04/tech/nasa-diet-space-food/

(CNN) Around 400 kilometers above the Earth's surface, the International Space Station continues its orbit of the planet.

Since the first crew arrived in November 2000, more than 200 astronauts from 15 different countries have visited the ISS. At its core, it's a floating lab, where for six months at a time six crew members work, exercise, sleep -- and eat.

Providing NASA astronauts with a nutritious diet is the job of food scientists at the Johnson Space Center, in Houston. There, Maya Cooper is part of the team responsible for about 40% of the food sent to the astronauts. She says her team tries to strike a delicate balance between providing home comforts and healthy food.

"There are many items that we've had on the menu that were great tasting items but recently we've had a big sodium reduction, trying to get the sodium content on the space menu down," Cooper says. "So we've had to reformulate a lot of those items, preserving the taste and the homely comfort food aspects of the food, while making sure that the nutrition is right where we need for it to be."

If Cooper makes space food sound like a science, that's because it is. Weightlessness requires more energy; your body is never truly at rest at zero gravity, so astronauts must eat accordingly, consuming 3,000 calories a day.

In the controlled environment of the ISS, scientists are able to study the astronauts' physiological processes with great accuracy. "We know exactly what they're eating," Cooper says, "so we have better data in terms of how food actually impacts the body."

Likewise, food is affected by the requirements of space. Food sent into orbit has to be preserved by heat processing which, paired with its long-term storage, causes food to lose some of its nutritional value due to vitamin degradation.

Overcoming these obstacles is one of the challenges facing Cooper, along with how to make such adulterated food appetizing.

Meals through a straw?
Space food in popular culture ranges from liquid meals of various viscosities -- think Stanley Kubrick's "2001: A Space Odyssey" -- to a miracle pill containing a day's worth of nutrition.

In the space program's early days, NASA's Project Mercury did indeed experiment with "semi-liquids" in toothpaste-style tubes, and coated bite-sized cubes of solids with

APPENDIX FOUR

MODULE 3 PROCESSING AND TRANSPORTATION

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 experiment introduces students to the effect of temperature on reducing and controlling the growth of bacteria. The video will be used to introduce food processing and transportation. Students will use pasteurized and ultra high temperature (UHT) milk, and observe how different temperatures (heat, room temperature, chilling, 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-tube 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*

DAY TWO

Time:

Workshop Length: 50 minutes

Materials Needed:

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

Objectives

1. Conduct research using the Internet.
2. Identify methods of food processing.

Key Question:

What is food processing?

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:

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:

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.

DAY TWO

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 6 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:

Students will turn in their Exit Slip for that day. They 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 Slip for the day as students leave the classroom.

APPENDIX FIVE

Name: _____

Date: _____ Period: _____

Credible Source Writing Lab

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 this 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? _____

DAY THREE

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computers
- Internet
- Flip chart
- Markers
- Ingredients for kimchi (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

Objectives

1. Describe types of fermented foods.
2. Make a fermented food product.

Key Question:

What foods are fermented?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"What foods are fermented?"

Opening:

Read the Bell-Work question and solicit responses from the students.

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:

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:

DAY THREE

- Where kimche 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 crispy.

Teacher TIP! Feel free to do this step either the day before or at home and bring the cabbage to class ready to go.

- **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.

DAY THREE

Closing:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom

DAY FOUR

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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
- 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

Objectives

1. Evaluate commercial yogurt using sensory analysis.

Key Question:

What commercial yogurt products are available?

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:

Read the Bell-Work question and solicit responses from the students. Discuss the quote with 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:

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.

DAY FOUR

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

APPENDIX SEVEN

Name _____ Date _____ Class _____

EXPERIMENT 23-2

Making Yogurt

SAFETY FIRST
Review these safety guidelines before you begin this experiment.

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 lets 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. Mix 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?

_____

_____

_____

(Continued on next page)

APPENDIX SEVEN

EXPERIMENT 23-2 (Continued)

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

DAY FIVE

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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
- 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**

Objectives

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

Key Question:

How is yogurt made?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"How is yogurt made?"

Opening:

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:

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.

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.

DAY FIVE

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:

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

"In one sentence, summarize how yogurt is made."

Collect the Exit Slip for the day as students leave the classroom.

APPENDIX EIGHT

Name _____ Date _____ Class _____

Evaluation of Commercial Yogurts

EXPERIMENT 23-3

SAFETY FIRST
Review these safety guidelines before you begin this experiment.

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 unpleasant 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 lactose 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 microorganisms.

Equipment and Materials

yogurt samples	masking tape	spoon
paper plate	marking pen	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?

_____

_____

(Continued on next page)

APPENDIX EIGHT

EXPERIMENT 23-3 (Continued)

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?							

DAY SIX

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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
- Guest Speaker – baker from a local bakery

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.

Objectives

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

Key Question:

Do you understand our project?

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:

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 the previous day, food processing involves many different methods, but this project will focus on fermentation.

Middle:

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.

As students finish, they should make observations for Day 3 of their milk samples.

Also, today is the day to taste the kimchi!

DAY SIX

Closing:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

APPENDIX NINE

PROJECT MANAGEMENT LOG: **TEAM TASKS**	
Project Name:	
Team Members:	

Task/Notes	Who Is Responsible	Date	Status	Done
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐

APPENDIX TEN

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 and standard recipe non-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 your new recipes.

Your team will track the shelf lives of the first bread you baked 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.

DAY SEVEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computers
- Internet
- Sourdough bread baked by the students
- Napkins
- Graphing Pretest – Appendix 11 – One per student

Objectives

1. Summarize the cultural history of sourdough bread.
2. Compare sourdough recipes from different regions.
3. Explain flavor differences based on the presence of different bacteria and yeasts.

Key Question:

How did sourdough come to be a common food? How and why does sourdough differ across regions?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"What do you know about the history of sourdough bread?"

Opening:

Read the Bell-Work question and solicit responses from the students.

As students share their responses, create a list on the board.

Middle:

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.

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.

DAY SEVEN

Students should work on this independently.

This will be revisited Day 11.

As students finish, they should make observations for Day 4 of their milk samples.

Closing:

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

"Based on your research, list three new things you have learned about the history of sourdough bread."

Collect the Exit Slip for the day as students leave the classroom.

Students should complete the four questions about their milk lab for homework.

APPENDIX ELEVEN

Graphing Pre-Test

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

DAY EIGHT

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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 Journal – Appendix 12 – One per student

Objectives

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

Key Question:

How do we detect mold on breads? How is sourdough different from other breads?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"Observe the moldy bread and describe what you see."

Opening:

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 (Appendix 9.1).

Use Appendix 12 to remind students how to properly take notes in their research journals.

Middle:

Briefly have a class discussion about the class 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.

DAY EIGHT

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

APPENDIX TWELVE

Name: Project: Date:

Research Notes

Question: _____

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:

DAY NINE

Time:

Workshop Length: 50 minutes

Materials Needed:

- Flour (rye or whole wheat)
- Water
- Measuring cups
- Scales
- Containers
- Plastic wrap
- Thermometers

Objectives

1. Define starter culture.
2. List the steps in creating a starter culture.

Key Question:

What is a starter culture? How do we create a starter culture?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"How do we know how many calories are in food?"

Opening:

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:

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).

DAY NINE

Closing:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

DAY TEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computer access with YouTube: **https://www.youtube.com/watch?v=FqxkMqsEQI0**
- Flour
- Water
- Measuring cups
- Scales
- Starters from yesterday
- Per Group for the Lab:
- 6 tbs flour
- 3 tbs sourdough starter
- 5 Ehrlymeyer 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

Objectives

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

Key Question:

What do yeast and lactobacilli do in fermentation? How does one encourage yeast and lactobacilli growth?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"How is fermentation in sourdough different than in other breads?"

Opening:

Read the Bell-Work question and solicit responses from the students.

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=FqxkMqsEQI0** (Good Eats Dr. Strangeloaf 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:

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 tbs flour
    b. sourdough starter - 3 tbs sourdough starter from your group's mother, 100 mL water
    c. yeast - 1 tsp yeast, 100 mL water
    d. flour - 3 tbs 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.

DAY TEN

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

DAY ELEVEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computers
- Internet
- Spoiled starters (e.g., stored too cold/hot, didn't replenish flour & water, used bleached flour, didn't start with whole grain, used chlorinated water) Note: Prepare these leading up to the beginning of the project.

Objectives

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

Key Question:

What can go wrong in creating a starter culture? What can go wrong in fermentation?

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:

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:

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.

DAY ELEVEN

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

DAY TWELVE

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computers
- Internet

Objectives

1. Select a procedure for creating a starter.
2. Apply the procedure to begin a starter.

Key Question:

What other methods exist for starting sourdough bread?

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:

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:

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:

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

"What questions do you still have about your chosen starter procedures?"

Collect the Exit Slip for the day as students leave the classroom.

DAY THIRTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- Sourdough pre-made starter
- Article – Appendix 13: **http://www.sourdoughhome.com/index.php?content=storingastarter**
- Ovens
- Baking supplies

Objectives

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

Key Question:

How do we bake sourdough bread? How do we store remaining starter for future use?

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:

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:

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

DAY THIRTEEN

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

APPENDIX THIRTEEN

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.

DAY FOURTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- Computers
- Excel
- Graphing post-test – Appendix 14
- Data from Day 3 Mold Lab

Objectives

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

Key Question:

How do we represent data?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"What are some different ways to represent data?"

Opening:

Read the Bell-Work question and solicit responses from the students.

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.

DAY FOURTEEN

Middle:

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:

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 Slip 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 Slip for the day as students leave the classroom.

APPENDIX FOURTEEN

Graphing Post-Test

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

DAY FIFTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

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

Objectives

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

Key Question:

What do yeast and lactobacilli do in fermentation?

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:

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:

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…

DAY FIFTEEN

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:

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

"What did you learn from today's demonstrations?"

Collect the Exit Slip for the day as students leave the classroom.

DAY SIXTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

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

Objectives

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

Key Question:

How do we bake a sourdough bread recipe?

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:

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:

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.

DAY SIXTEEN

Closing:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

DAY SEVENTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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

Objectives

1. Describe their process for developing a starter culture.
2. Describe their process for developing a sourdough bread.
3. Critique their process and product.

Key Question:

How can we create starter culture and sourdough bread?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"What must be included in your presentation? List the information required."

Opening:

Read the Bell-Work question and but don't solicit responses from the students. The questions should be saved for the presentations.

Instruct students to keep their questions safe until the presentations begin.

Middle:

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:

Students will turn in their Exit Slip 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 Slip for the day as students leave the classroom.

APPENDIX FIFTEEN

Team: _____

Date: _____ Period: _____

Fermentation Final Rubric

Lab Data (20 points)	
☐ Includes a section for each lab and a summary of the data. (0-20 points)	
Recipes (20 points)	
☐ All recipes are included with a reference of where they were found. (0-20 points)	
Research Summary (20 points)	
☐ Includes all background information collected throughout the project. (0-10 points)	
☐ Includes a reference list and proper citations. (0-10 points)	
Concept Map (20 points)	
☐ Clearly outlines the process of fermentation as it relates to baking sourdough bread. (0-20 points)	
Proposed Solution (20 points)	
☐ Recommendation for new and improved recipe is clear and the reason is supported with evidence. (0-20 points)	
Final Total	

Total points for project: _____/100

APPENDIX SIXTEEN

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

(for secondary and upper elementary grades)

	Below Standard	Approaching Standard	At Standard	Above Standard
Responsibility for Oneself	▸ 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	▸ 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	▸ 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	*In addition to* ***At Standard*** *criteria:* ✚ 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	▸ 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	▸ 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	▸ 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	*In addition to* ***At Standard*** *criteria:* ✚ 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	▸ does not pay attention to what teammates are talking about ▸ does not show respect for teammates (may interrupt, ignore ideas, hurt feelings)	▸ usually listens to teammates, but not always ▸ is polite and kind to teammates most of the time, but not always	▸ listens carefully to teammates ▸ is polite and kind to teammates	*In addition to* ***At Standard*** *criteria:* ✚ encourages the team to be respectful to each other ✚ recognizes everyone's strengths and encourages the team to use them

DAY EIGHTEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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

Objectives

1. Describe their process for developing a starter culture.
2. Describe their process for developing a sourdough bread.
3. Critique their process and product.

Key Question:

How can we create starter culture and sourdough bread?

Bell Work:

Provide students with the weekly Bell-Work sheet (Appendix 1)

"What questions do you have about your presentations?"

Opening:

Read the Bell-Work question and solicit responses from the students.

Answer any questions students have about their presentations..

Middle:

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:

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

"How much progress has your team made working on your presentation?"

Collect the Exit Slip for the day as students leave the classroom.

DAY NINETEEN

Time:

Workshop Length: 50 minutes

Materials Needed:

- 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 in/owning a bakery.

Objectives

1. Describe their process for developing a starter culture.
2. Describe their process for developing a sourdough bread.
3. Critique their process and product.

Key Question:

How can we create starter culture and sourdough bread?

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:

Read the Bell-Work question and solicit responses from the students.

Then, give students about one minute to discuss within their teams.

Middle:

Finish presentations.

Students should use Appendix 14 to select one team to evaluate.

The teacher should use Appendix 15 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

DAY NINETEEN

team in each class period and display it in the room where everyone can see it.

This can be done if 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:

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

"How can you improve your bread?"

Collect the Exit Slip for the day as students leave the classroom.

DAY TWENTY

Time:

Workshop Length: 50 minutes

Materials Needed:

- Poster paper
- Markers
- Other art supplies for making posters
- Self Reflection Sheet – Appendix 18 – One per student

Objectives

1. Summarize the topic of fermentation.
2. Summarize the topic of food processing.

Key Question:

What have you learned about fermentation?

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:

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:

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.

DAY TWENTY

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:

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

"How will you use what you learned from this project?"

Collect the Exit Slip for the day as students leave the classroom.

APPENDIX EIGHTEEN

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:	

food and nutrition sciences

PREPARATION FOR TOMORROW

This curriculum was created as a joint project between the University of Nebraska Lincoln and Kansas State University with funds from the USDA and support from ConAgra Foods.

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