COURSE 1:

Food Production, Nutrition and Health

SPACE FOOD

food and nutrition sciences

PREPARATION FOR TOMORROW

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Project Overview

DAY	CONCEPT/DESCRIPTION
1	Students define food preservation and compare food preservation techniques.
2	Students describe the impact of zero gravity on the human body. Students explain the nutritional needs of astronauts living in space.
3	Students describe the purpose of the project. Students list the tasks and products related to the project. Students describe the project in one sentence.
4	Students describe foods based on their nutritional value. Students Identify foods that combat common deficiencies in the diets of explorers.
5	Students describe the effects of microorganisms on food. Students describe the mechanisms by which foods degrade.
6-8	Students plan a step-by-step procedure to preserve a food. Students justify the selection of a food and a perseveration method. Students develop and present a design brief for a new processed food product.
9	Students test food for the presence of E. coli.

DAY	CONCEPT/DESCRIPTION
10-11	Students apply the recipe and procedure they developed to preserve a food.
12	Students compare the nutritional value of foods that have been processed to the nutritional value of their original states.
13-14	Students compare the flavor and texture of processed foods to their original states through a sensory evaluation. Students compare sensory evaluation results using a t-test.
15	Students test preserved food for the presence E. coli.
16-17	Students apply the sensory evaluation procedure to test their food. Students analyze sensory evaluation data.
18-19	Students summarize the results of their preservation, nutritional calculations, and sensory evaluations. Students support claims with evidence.
20	Students deliver presentations arguing for the inclusion of each team's food in the NASA program.

DAY 1

Key Questions of the Day:

What is food preservation? What food preservation methods exist?

(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 food preservation.
- Compare food preservation techniques.

Required Materials

- Computers
- Internet access
- Flip chart paper
- Markers
- Large index cards
- Food packages for foods that have been processed by different methods (e.g., canned, dried, etc.)
- Article – Appendix 3 – 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)
- ***"What is food preservation?"***

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 prevent food from going bad
  - To give food a long shelf life
  - Be able to eat food longer without risk of illness
- Make a list of student responses.
- Share the correct definition of food preservation.
  - Food preservation involves the use of processes to allow a substance or food to keep its useful properties for a longer than normal period of time. For example, a can of tuna could stay fresh on the shelf for a year, whereas fresh tuna would have to be consumed within days.
- Explain that, ***"Food preservation has been around for centuries. Early explorers preserved food for long excursions using a variety of techniques, such as salting and curing meats. We eat preserved foods all the time. What are some foods you eat that have been preserved?"***
  - ✓ **TEACHER TIP!** Have the food packages displayed somewhere in the room. Reveal the packages after students share their responses about foods they eat that have been preserved.
  - Solicit responses from students. Possible responses may include:
    - *Jam/jelly*
    - *Canned fruits, vegetables, or meats*
    - *Frozen fruits, vegetables, or meats*
    - *Dried fruits*

- Explain that, ***"That's right! When it comes to space exploration, food preservation is especially important due to the conditions astronauts face in space, not only because of the impact on their health, but because of general safety concerns. Today, we are going to learn more about different methods of food preservation."***

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.****)*

- Using small slips of paper, write a different method of food preservation on each index card.
  - Canning, freezing, freeze-drying, dehydrating, curing, smoking, fermentation, irradiation, pasteurization, rehydratable (and any others you would like to include).
- Drop the preservation method slips into a small container. Each student should select a method from the container.
- Give each student an index card.
- Students should write the name of the method on one side of the card. They will use the other side of the card to document key information about that method.
- Explain to the class that they will be researching different methods of food preservation. They will have 20 minutes to use the Internet to research their preservation method:
  - The history of the technique
  - Specific procedures to follow
  - Foods typically preserved in this manner
  - Cautions to follow – what safety and food safety processes are critical to this process
  - Nutrients typically lost/preserved
  - Commercially available foods preserved in this manner
- Remind students that they should note the resources where they found the information.
- When time is up, give students a new index card and ask students to find a partner in the room who has a different method than they have.
- Students should take 30 seconds to explain their method to the partner. When time is up, they should switch and the other person will share their method.
- When time is up, have students find a new partner and do this again.
- Students should take notes on the new index card while the students are teaching them about their methods.
- Repeat this activity until everyone has taught each other about the different methods.
  - ✓ **TEACHER TIP!** Be sure to time the students and give cues for when time is starting and ending so that they stay on track.
- Bring the class back together and have a brief discussion to summarize the different methods of preservation.
- Ask the class, "So, how does this apply to space food?"
  - Solicit responses from the students and brainstorm how food preservation applies to creating space food.
- Give each student a copy of Appendix 3.
- Give the class about 5 minutes to read the article silently.
  - While they are readying, students should highlight or underline any information that they either find interesting or want to know more about.
- Bring the class back together and discuss the article.

- Answer any questions from the students.
- If time permits, project the article and show the pictures and captions to the class via the web link (http://www.cnn.com/2015/02/04/tech/nasa-diet-space-food/).

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: ***"Which method of food preservation sounds the most interesting to you? Why?"***
- Collect the Exit Ticket for the day as students leave the classroom.
- If students don't finish their research in class, ask them to finish for homework.

DAY 2

Key Question of the Day:
Why is food important for astronauts?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Describe the impact of zero gravity on the human body.
- Explain the nutritional needs of astronauts living in space.

Required Materials

- Research notes from Food Diary project
- Computers
- Internet access
- Projector
- Article – Appendix 4 – One per student
- Video – Space Food
- Flip chart paper
- Markers

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"True or False? Astronauts have the same nutritional needs in space as they do on Earth?"***

OPENING — *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Take a poll and write down how many students say true and how many say false.
- Explain that, ***"Now that we know about the different methods of preserving foods, we're going to switch gears and think about the needs of astronauts when living in space. Keep your Bell-work responses in mind, because our goal is to determine the correct answer by the end of the day today."***

MIDDLE — *40 minutes*

- Divide the class into three teams.
- Assign one question to each team. Teams will have about 20 minutes to use the Internet to research and document the answers to the following questions:
  - What happens to the human body when living in space?
  - How is food/eating kept interesting in space? (so that astronauts don't become bored with their food choices)
  - What are the nutritional needs of astronauts living in a zero gravity environment?
- Give students a copy of the article (Appendix 4) as a resource to read while they conduct their research.

  ✓ **TEACHER TIP!** This is a great article with important information about nutritional needs of astronauts and the impacts of space on the human body. If time permits, take a moment to briefly discuss the article with students. Either way, it's an excellent resource for students to use throughout the project for background information.

- Give each team a sheet of flip chart. Students will use the flip chart paper to write the question and compile their answers.
  - These will serve as reference materials for the remainder of the project. Be sure the students include the citations for where their information was found.

- When teams are done, hang the flip charts around the room.

- Give students one minute to walk around the room and read the posters.

- Bring the class back together for a discussion about the nutritional needs of astronauts.

- Show the video about space food (in the "Videos" folder).

- While watching the video, ask students to make a list of the following:
  - What are the restrictions on food for astronauts in the International Space Station?
  - What characteristics does the food have to have?
  - What is prohibited or impossible to have in space?

- When the video is over, ask students to visit their posters and add any additional information they learned from the video to their posters.

- Then, debrief the video by having students share answers from their lists with the class.

- Lead a discussion by asking students, "So, are the nutritional needs of astronauts the same in space as on Earth?"

- Take another poll to see how many votes for true and false. Compare the responses to the first poll.

- Wrap up by asking the class, "Which of the food preservation methods discussed yesterday might meet NASA's guidelines?"

✓ **TEACHER TIP!** There is an additional video in the "Additional Resources" folder that provides great information about the history of space food. It's around 19 minutes long, so this video can be shown as time permits, if you would like to provide the extra information for students.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What are your initial thoughts on the type of food you'd like to make for the astronauts for a long mission?"***

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

DAY 3

Key Question of the Day:
(Project Roll-out)
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:

- Describe the purpose of the project.
- List the tasks and products related to the project.
- Describe the project in one sentence.

Required Materials

- Computer (access)
- All rubrics – Appendix 9, 10, 11, 12 – One per student
- Post-It notes
- Engagement Scenario – Appendix 5 – One per student
- Lab supplies (Adapted from Space Food and Nutrition from NASA)
  - 1 package of instant pudding mix
  - 1 package of instant drink mix
  - Sugar
  - Artificial sweetener
  - Nonfat dry milk
  - Water
  - Straws
  - Plastic spoons
  - Plastic zip-lock sandwich bags

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"Identify an explorer from the past. Who were they and what were they exploring?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
  - Possible responses may include:
    - *Christopher Columbus*
    - *Lewis and Clark*
    - *Marco Polo*
    - *Ferdinand Magellan*
- Ask students, ***"Who are the modern day explorers? Who explores new frontiers and takes long journeys without access to fresh food?"***
- Have a brief discussion as students share their responses.
- Explain that, ***"Astronauts on the space station and someday on manned missions to Mars and beyond are explorers who will have to travel without access to the same fresh foods we have at home."***

MIDDLE *40 minutes*

✓ **TEACHER TIP!** Students will create a portfolio at the end of the project (on the last day) where they will compile the bodies of evidence they have created throughout the project. Remind students to save important artifacts as they complete different tasks throughout the project. Feel free to determine the best way for students to create their portfolios based upon your particular situation (e.g., if your school/district has any specific requirements, etc.).

- Explain that, ***"You can imagine that life in space is quite different from life on Earth. That includes food options for meals. Between space limitations, zero gravity, lack of trash service, and weight restrictions, there are many factors that influence the types of foods that can consumed in space. Let's do a little experiment to see what this could be like."***

- Share some background information with the class: "***Travelers have known for a long time that condensing food will make their journey easier. It is no different in the space program. Hikers use rehydratable foods so they do not have to carry very much weight with them. This makes it easier to travel. All weight going into space raises the fuel consumption at liftoff. It is important to eliminate as much weight as possible. Because the fuel cells on the Space Shuttle produce water as a byproduct, water is easily attainable. Therefore, taking foods along that can be rehydrated with this water make sense because this reduces the amount of weight on liftoff. The rehydrated foods also take up much less space, and space is a valuable commodity onboard the Space Shuttle."***

- Divide the class in half.

- Half of the students will practice rehydrating a food product:
  - › Read the recipe label on the instant pudding package.
  - › Calculate the amount of dry mix ingredients necessary for a single serving (weight by number in group).
  - › The recipe for instant pudding calls for low-fat milk. Record the amount necessary for a single serving.
  - › Read the recipe label on the nonfat dry milk package and calculate the amount necessary for a single serving of instant pudding (amount by number in group).
  - › Measure the dry instant pudding ingredients and the proper amount of nonfat dry milk, and place both into the zip-lock bag.
  - › Shake and stir the dry ingredients until thoroughly mixed.
  - › Pour the correct amount of water necessary to dissolve the mixture.
  - › Close the zip-lock bag and knead the package in your hands until thoroughly mixed.

- Half of the students will practice rehydrating a beverage:
  - › Read the recipe label on the instant drink package.
  - › Calculate the amount of dry mix ingredients necessary for a single serving (amount by number of single servings).
  - › Measure the dry ingredient and place it into a zip-lock sandwich bag.
  - › Calculate the amount of water necessary for a single serving (amount by number of single servings).
  - › Measure the amount of water and pour into the zip-lock bag.
  - › Close the bag and knead the package with your hands until thoroughly mixed.
  - › Calculate the amount of sugar or artificial sweetener for an individual serving and add.

  ✓ **TEACHER TIP!** Students may be curious to taste the food items once they are prepared. It is safe to allow them to taste the food and beverage samples. This could lead to some interesting discussion as well.

- When each team is finished preparing their items, ask the following questions to debrief the exercise:
  - › What changes did you observe?
  - › Would the temperature of the water make a difference?
  - › Why did you use a zip-lock bag instead of a bowl?
  - › How would being in space affect the way you eat and prepare food?

- Provide students with copies of the essential question and project scenario (Appendix 5).

- Provide students with copies of all rubrics.
- Give each student a few Post-It notes.
- Students will read the engagement scenario and use the Post-It notes to document any questions, surprises, or needed definitions from the text.
- When finished reading, students can find a partner and share the information they wrote on their notes.
- Bring the class back together and answer any questions. Then, review the rubrics and expectations with the class.
- Students form teams of 3-4 people.
    - ✓ **TEACHER TIP!** Either form them intentionally or allow them to form the teams. Remind students that they will work with their teams for the entire project and their grade will depend upon their success as a team.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"Write one sentence that could be used to describe the project to a friend."***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 4

Key Question of the Day:
What foods should we preserve?

Estimated Time

One 50-minute class period

Learning Objectives

As a result of this lesson, students will be able to:
- Describe foods based on their nutritional value.
- Identify foods that combat common deficiencies in the diets of explorers.

Required Materials

- Food Diaries from previous project
- Project Management Log – Appendix 6 – One per student
- Computers
- Internet
- Flip chart
- Marker

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What were common illnesses of adventurers that were caused by nutrient deficiencies?"***

OPENING *10 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Students may take a guess at an answer, but if they don't know, give them about 5 minutes to quickly research the answers either using their smartphones (if allowed in your school) or computers via the Internet.
  - Possible answers may include:
    - *Scurvy – vitamin C deficiency*
    - *Rickets – vitamin D deficiency*
    - *Anemia – iron deficiency*
    - *Goiter – iodine deficiency*
    - *Beriberi – thiamin deficiency*
    - *Pellagra – niacin deficiency*
- Compile student responses on a sheet of flip chart paper.
- Have students read through their food diaries.
- Ask the class, ***"What foods have you eaten that can be grouped into the same categories on MyPlate? Why is it important to eat a variety of foods?"***
- Have students Think-Pair-Share, and find a partner to discuss their responses with.
- Bring the class back together and explain that, ***"In order to have a balanced diet and prevent nutrient deficiencies, we need to eat different foods in order to get the variety of nutrients that we need. All foods contain a variety of nutrients."***

MIDDLE *35 minutes*

- Working with their project teams and using their notes from the Bell-Work exercise, students create a chart with each of the nutrient deficiencies faced by adventurers as a heading.
  - Each student should have his or her own copy of the chart.

- Categorize the foods the astronauts discussed in the video on Day 2.

- Give students access to the video again and allow them to research the foods discussed.

- Students should form new pairs within their teams, share their charts, and fill information so that the partnership has the same information.

- Ask the class, ***"What foods might be good sources of nutrients for explorers?***

- Have each team choose a food they will preserve. This can be a single or multiple ingredient food but if it's a multiple ingredient food, each team will need to agree on a recipe.

- Students should research their recipes and create a list of the ingredients they will need.

- Collect the lists when students are done, and include the name of a commercially available product that is similar to the one they intend to create.

- Students should then revise their Project Management Logs (Appendix 6) to address the preservation technique they chose.
  - ✓ **TEACHER TIP!** Food preservation can take a lot of time depending upon the recipe and method selected. Be sure that students select a method that will have quick results. For example, making a fermented food like kimchi could take several days. Also, consider the fact that the recipe and procedures will have to be followed exactly. Dangerous foodborne illnesses like botulism can result from improperly prepared home preserved foods.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What nutrients are vital? Why?"***

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

DAY 5

Key Question of the Day:
Why do we need to preserve food?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Describe the effects of microorganisms on food.
- Describe the mechanisms by which foods degrade.

Required Materials

- Resources about food deterioration – Chapter 8 in Parker's Introduction to Food Science
- Flip charts
- Markers
- Spoiled food – moldy bread, rotting/bruised/punctured fruit, etc. – in clear containers
- ✓ **TEACHER TIP!** Prepare the spoiled foods ahead of time, especially if showing moldy bread to the class.
- Lab supplies (from Activity 5: Ripening of Fruits and Vegetables from Space Food and Nutrition by NASA):
  - Distilled water
  - Fruits such as apples and bananas
  - Vegetables such as carrots and celery sticks
  - Vitamin C tablets
  - Small deep plastic bowls
  - Knife
  - Large spoons
  - Paper plates
- Camera

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"Describe rotten food you have seen in the past. How did it get that way?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
  - Possible responses may include:
    - *Improper storage*
    - *Microbes*
    - *Damage to the package or food item (e.g., broken skin on a banana)*
- Put spoiled food in clear containers – jars, plastic bags – so that students aren't in direct contact with molds.
- Display spoiled food and allow students to examine it.
- Discuss the characteristics of the spoiled food.
- Ask the class, ***"So, why should we preserve food?"***
- Discuss student responses.
- Explain that, ***"There are a number of causes of food spoilage. They include microorganisms, food enzymes, insect/parasite/rodent infestations, gain or loss of moisture, reaction with oxygen, light, physical stress/abuse, time, and inappropriate temperature. Today we are going to do an experiment to see what happens to food as a result of reacting with oxygen."***

MIDDLE *40 minutes*

- Share the background information with the class: ***"Food for the Space Shuttle is packaged and stowed in food lockers at Johnson Space Center in Houston, Texas, approximately a month before each launch and is kept refrigerated until shipped to the launch site. About 3 weeks before launch, the food lockers are sent to Kennedy Space Center in Florida. There, they are refrigerated until they are installed in the Shuttle 2 to 3 days prior to launch. Besides the meal and supplemental pantry food lockers, a fresh food locker is packed at Kennedy and***

installed on the Shuttle 18 to 24 hours before launch. The fresh food locker contains tortillas, fresh bread, breakfast rolls, fresh fruits such as apples, bananas, and oranges, and fresh vegetables such as carrots and celery sticks. During space flight, fresh fruits and vegetables have a short shelf life because of the absence of a refrigerator and must be consumed within the first 7 days of flight. Carrots and celery sticks are the most perishable items in the fresh food locker and must be consumed within the first 2 days of flight. Onboard the ISS, refrigerators will be present, and refrigerated foods for the Station will include fresh and fresh-treated fruits and vegetables. Certain types of fruits and vegetables can have an extended shelf life of up to 60 days.

When certain fruits or vegetables are sliced open and exposed to air, the exposed cut surface turns brown in color. This is due to a reaction called enzymatic browning. There are a number of processing techniques that can be employed to fresh-treat fruit and vegetables: irradiation, a wax coating, an ethylene inhibitor (ethylene is a plant hormone that causes ripening), controlled atmosphere packaging, modified atmosphere packaging, and the use of a chemical inhibitive.

This activity focuses on one of these processes the use of a chemical inhibitive as a way of packaging sliced fruits and vegetables as a single-serving, nonwaste food item. Slicing eliminates the weight and waste of a core and peelings."

- Students should divide their project teams into teams of two for the lab.

- Each team will conduct the experiment with a different fruit or vegetable.

- They will follow this procedure:
  - › Pour water into two small deep bowls. Dissolve a vitamin C tablet into one bowl and leave the second bowl as plain water.
  - › Cut a piece of fruit into 6 equal wedges.
  - › Place two wedges into each of the prepared liquids. Be sure that each wedge is completely immersed in the liquid for about 10 minutes.
  - › Remove each wedge with a spoon and place on separately labeled paper plates (label each plate "Vitamin C Water" and "Distilled Water").
  - › Place the last two wedges on a paper plate labeled "Untreated."
  - › Arrange the piece so that all of the cut surfaces are exposed to air.
  - › Let all three plates sit for an hour and observe for any browning.
  - ✓ **TEACHER TIP!** Since class is only 50 minutes, use a camera to take pictures of everyone's samples when time is up. Be sure that students write their names on their plates so that it's visible in the pictures.

- Plan to discuss the findings during the next class period. Feel free to save the fruit and vegetable samples even though they will likely appear different from the images at 1 hour.

- Ask the class, "As a result of spoilage, we become at risk for foodborne illness. What foodborne illnesses could potentially infect spoiled food?"
  - › Possible responses may include:
    - » *E. coli*
    - » *Salmonella*
    - » *Listeria*
    - » *Botulism*

- Explain that, ***"We know from our previous work that E. coli is a dangerous microorganism that is a common foodborne illness. Our goal is to ensure we prevent our food products from becoming contaminated with E. coli."***

- Ask the class, ***"So, why do recipes call for specific ingredients in specific amounts?"***
  - › Ask volunteers to share their responses.

- Next, ask the class, "What happens to these ingredients during the baking process?"

- Each team should research the ingredients that they found for their category on the matrix. So, for example, if the category is "Strengthens or

Toughens" and eggs and flour are under that category, those are the ingredients they should research.

- Give each team a clean sheet of flip chart paper and a marker. Teams will document their responses on the flip charts and hang them in the room near the matrix poster.

- Once everyone has found the answers, bring the class together and have a volunteer from each team share their findings.

- Explain that the class will be using this information to help with tomorrow's tasks.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"Now that you know the key causes of food deterioration, what do you think we can do to prevent and/or slow it?"***

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

DAY 6

Key Question of the Day:

How are food preservation methods selected?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Plan a step-by-step procedure to preserve a food.
- Justify the selection of a food and a preservation method.

Required Materials

- Highlighters
- Internet access
- Cookbooks

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What food preservation technique does your team want to use to preserve the food item you selected?"***

OPENING *5 minutes*

- Ask students to visit with their teams.
- Students will have 5 minutes of Bell-Work time to determine which preservation methods will work best for the food item they wish to preserve.
  - ✓ **TEACHER TIP!** This decision should be made based upon the resources you have available and the research that was conducted at the beginning of the project. Obviously, they won't be irradiating food. But, canning, drying, dehydrating, or fermenting will likely be the best and most realistic options.
- Visit with each team as they chat to answer any questions and check progress.

MIDDLE *40 minutes*

- Debrief the lab from the previous day by showing the class the pictures of the fruits and vegetables.
- After taking a few minutes to compare and examine the images, ask the class the following questions:
  - › Which fruit and which vegetable turned browner than the others?
  - › Which fruit and which vegetable did not turn as brown as the others?
  - › Can you think of another chemical inhibitive that could be used to preserve fruits and vegetables? (e.g., orange juice, lemon juice, anything with vitamin C, etc.)
  - › What would be the best way to pack fruits and vegetables for space flight?
- Have a discussion as students share their responses.

- Transition by asking the class, “So, how are food preservation methods selected?”
- Teams sort through the procedures they have collected for their preservation technique and develop their own step-by-step process.
- Students must include a list of ingredients and supplies they will need to preserve their food based upon the method they selected.
- They must also include the amount of time they anticipate it will take before their food product is ready for consumption once it has been prepared.
- Students should include one paragraph explaining why they selected their preservation method.
- When finished, each team will present their procedures to the class for feedback from the teacher and their peers.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“What do you still need to know? Create a list.”***
- Collect the Exit Ticket for the day as students leave the classroom

DAY 7

Key Question of the Day:
(Continuation of Day 6)
How are food preservation methods selected?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Develop a design brief for a new processed food product.

Required Materials

- Any feedback received from previous work
- Processing method proposal from previous day

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"How can you justify the procedures you want to follow? What kind of information would you need to provide?"***

OPENING — *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Ask the class to find their teams, and within their teams, discuss what feedback they received that they plan to incorporate.

MIDDLE — *40 minutes*

- Post the components of a design brief on the board:
  - Client and context
  - Problem statement or description
  - Goals
  - Resources and budget
  - Constraints
  - Time needed
  - Solution analysis
- Teams should decide how to break up the work. Remind students that the instructions for this are in the project description: ***After reading informational texts on nutritional value and food preservation and participating in enabling learning activities intended to assist you in designing, creating, and testing a long-term food preservation product, write a design brief in which you discuss the merits of your food product and evaluate its potential use for astronauts. Be sure to support your position with evidence from the texts and from participation in enabling learning activities.***

CLOSING — *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"Which cause(s) of food spoilage do you think your preservation technique will prevent?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 8

Key Question of the Day:

(Continuation of Day 7)
How are food preservation methods selected?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Develop a design brief for a new processed food product.
- Present a design brief for a new processed food product.

Required Materials

- Any feedback received from previous work
- Processing method proposal from previous day
- Guest speaker
    - ✓ TEACHER TIP! It will obviously be very challenging to find an actual NASA representative. In this case, it would be great to find anyone who works in food service, maybe someone with an expertise in processed foods. One idea is to see if there is a local person who is known for preparing preserved foods.

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"How can you justify the procedures you want to follow? What kind of information would you need to provide?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Ask the class to find their teams, and within their teams, discuss what feedback they received that they plan to incorporate.

MIDDLE *40 minutes*

- Teams will continue to work on their design briefs if they didn't finish the previous day.
- When teams are finished, each team will present their design brief to the class.
- The audience should ask questions and provide feedback when appropriate.
- If able to find a guest speaker, have them in the audience to listen to the design briefs and provide any feedback.
- If time permits, and you're able to secure a guest speaker, give them time after the presentations to speak to the class about food preservation.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"Which cause(s) of food spoilage do you think your preservation technique will prevent?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 9

Key Question of the Day:
Is E. coli present in our ingredients?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Test food for the presence of E. coli.

Required Materials

- Lab instructions – Appendix 7 – One per student
- Food ingredients for each team
- Lab supplies:
  - Gloves
  - 2 g your food product(s)
  - 2 g of the commercially available alternative
  - 4 Ziploc Bags
  - Forceps or tongs
  - Water
  - 120 mL sterile peptone water (PW)
  - Pipette
  - Pipette tips
  - Aerobic Plate Counts Petrifilms
  - E. coli Petrifilms
  - 8 test tubes to hold 10 mL each

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What would happen if an astronaut became infected with E. coli in space?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Explain that, ***"Since astronauts are in space, they don't have access to the medical attention they would need if they became infected with a foodborne illness such as E. coli. That's why it is so important that the food they take on their missions is properly preserved and safe to eat. Today we are going to test food samples for the presence of E. coli."***

MIDDLE *40 minutes*

- Take a moment to review lab safety.
- Students will work in their project teams for the lab.
- Give each student a copy of Appendix 7.
- Review the purpose of the lab: ***Shiga toxin-producing Escherichia coli (STEC-8) creates a health risk when it contaminates beef and other food products. Researchers at University of Nebraska-Lincoln and several other research and educational institutions across the country are working together to develop procedures to identify STEC contamination and decontaminate food. You will follow the procedure developed by these scientists – outlined below – to identify the presence of E. coli and other pathogens in your food item and the commercially available alternative.***
- Have students develop a hypothesis (as described on Appendix 7).
- Follow the lab procedures:
  - Put your gloves on and wear them for the entire lab. Do not touch your face, eyes, or mouth. Do not eat during this lab. Wash your hands thoroughly after the lab.
  - Place 1 g samples of your food product in 2 different Ziploc – each

labeled as" our product 1", "our product 2" - bags using forceps or tongs.
- Add 10mL of sterile peptone water (PW) to each sample bag and seal the bags.
- Stomach the samples in the sealed bags manually, or use the stomacher. Manual stomaching is done by "squishing" the sample in the water and swirling gently. This creates the 4 rinsates for your food product.
- Prepare 8, 9 mL blanks – PW only – in test tubes in racks. Put them in 4 rows of two and label each row with "our product 1", "our product 2", "commercial 1", "commercial 2".
- Pipette 1 mL of the rinsate from sample "our product 1" into your first blank labeled "our product 1".
- Mix for 30 seconds by drawing and emptying the rinsate into/out of the pipette.
- Withdraw 1 mL from the rinsate + blank test tube and place into the other blank in this row. You have created a dilution of 10-1 .
- Transfer 1 mL of the sample to an E. coli Petrifilm and 1 mL of the sample to an Aerobic Petrifilm. Label them with the same label as the Ziploc containing the sample.
- Change pipette tips.
- Repeat for "our food product 2" rinsate.
- Repeat the entire process for "commercial 1", and "commercial 2".
- You will have 2 Aerobic and 2 E. coli Petrifilms for your food product and 2 of each for the commercially available version.
- Incubate the films at room temperature:
  - *24 hours for E. coli*
  - *48 hours for Aerobic*
- Look for colonies on the films. Blue colonies with gas (will look like gnats) on your E. coli Petrifilm indicate that the food product is contaminated with a strain of E. coli. It is not necessarily STEC. Red colonies on your Aerobic Petrifilm indicate that your product contains another pathogen, such as Salmonella (further testing would be required to determine what the exact pathogen is).
  - *Photograph your Petrifilms to include in your reports and explain the absence or presence of pathogens.*

- Students should create a lab report and respond to the processing questions on Appendix 7.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"How do you know if there is E. coli in your ingredients?"***

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

DAY 10

Key Question of the Day:
How do we preserve food?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Apply the recipe and procedure they developed to preserve a food.

Required Materials

- Ingredients requested by students
- Kitchen equipment as requested by students
- Balance
- Weigh boats

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"List three things you should do before you handle food to demonstrate food safety."***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include:
  - Wash hands
  - Wash all food prep surfaces
  - Wash all fruits and vegetables
- Have a brief discussion about safe food handling while students share their responses.

MIDDLE *40 minutes*

- Teams should review their procedures and separate them into what they will do today and what they will do tomorrow.
- Remind them of how much time they will have in class today and tell them to divide the tasks based on what can be done ahead of final preservation and what must be done immediately before.
- Students should take a small sample of the main ingredient(s) in their preserved food and weigh it. This way they will be able to compare the before weight to the after weight. They should also record any notes about the color, texture, and aroma. They will collect this data again once the preserved food is ready for consumption.
- Teams follow their procedure and recipe to develop their foods.
- Reconvene teams to review their plan and list the steps they must follow tomorrow to complete their preservation.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"How did your food preparation go today? Is there anything you could have done to make the process go more smoothly?"***

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

DAY 11

Key Question of the Day:
(Continuation of Day 10)
How do we preserve food?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Apply the recipe and procedure they developed to preserve a food.

Required Materials

- Ingredients requested by students
- Kitchen equipment as requested by students

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What do you need to accomplish today?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Use this opportunity to check student progress and answer any questions.

MIDDLE *40 minutes*

- Teams should review steps they need to follow and assign each other tasks.
- Next, they will follow their procedure and recipe to develop their foods.
- When they are finished preparing their foods, they should pack and store the preserved foods.
  - ✓ **TEACHER TIP!** Be sure that students keep track of their food items so that they know exactly when they will be safe for consumption.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What did you learn about preparing preserved foods?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 12

Key Question of the Day:
What does processing do to the nutritional value of foods?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Compare the nutritional value of foods that have been processed to the nutritional value of their original states.

Required Materials

- Computers
- Internet
- Excel and Word (or similar software, if available)
- Resource: http://fnic.nal.usda.gov/food-composition/usda-nutrient-data-laboratory

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What nutritional value do you hope your food will provide for the astronauts?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Possible responses may include (but not limited to):
  - › Provide a source of iron
  - › Source of protein
  - › Source of calcium
- Explain that, ***"Processing food changes the nutritional value, but just how much does it change?"***

MIDDLE *40 minutes*

- Ask the class, ***"What is a hypothesis?"***
- Collect students' ideas about hypothesis, then share the types and definitions:
  - › Hypothesis: a proposed explanation for a phenomenon. Must be testable.
- Students will work in teams of two (so if their project team is a group of 4, they will split in half).
- Each team should develop a hypothesis for each ingredient in the preserved food they made and its nutrient concentrations in the preserved and fresh state.
- Explain that we develop hypotheses based on information we know. Then we collect data and test the hypotheses. We'll graph the results to see if our hypothesis are correct.
- Each pair will use: http://ndb.nal.usda.gov/ to gather the nutrient data for the fresh and preserved versions of the ingredients used to make their preserved foods.

- Explain that, “We have to collect consistent data in order for a hypothesis test to be valid and reliable. Thus, they must always use the same USDA classification – raw v. canned-water-packed – for example and the same measurement – value per 100 mg for example.

- Pairs must choose and confirm that each is collecting the same type of data.

- If you have access to Excel or a similar spreadsheet program, students will create a spreadsheet they will use to enter their data. They will have a column for “Fresh” and a column for “Preserved.”
  - ✓ **TEACHER TIP!** If Excel is not available, this can be done by creating a table in Word, or by creating a t-table on a sheet of paper.

- Once all of the nutrient data is collected, students should determine what type of graph to create to display the data.
  - › This can be done by hand or by using software like Excel.

- When students finish, bring the class back together.

- Ask the class, “Is there a difference in the nutritional value?”

- Each team should share their results with the class.

- Ask the class to respond to the following question, “Based on your hypothesis, do you expect there to be a difference between the nutrient concentration of the fresh and preserved version of your food?”

- Conclude by discussing the results.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“What did you learn about the nutritional value of fresh versus preserved foods?”***

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

DAY
13

Key Question of the Day:
What does processing do to the flavor and texture of foods?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Compare the flavor and texture of processed foods to their original states through a sensory evaluation.

Required Materials

- Flip chart
- Markers

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What foods did astronauts say they like to eat on the International Space Station?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Ask students to think back to the video about the astronauts on the space station, and anytime they have ever eaten a preserved food.
- Pose these questions to the students, asking them to respond to each as they are shared. Capture their responses on a sheet of flip chart paper.
  - How do you, and the astronauts, want your preserved foods to taste?
  - How do they usually taste?
  - What do you like best about preserved foods?
  - What do you like least?
  - What do you like best about fresh foods?

MIDDLE *40 minutes*

- Remind students that they conducted sensory evaluations in previous projects.
- Give each team a sheet of flip chart paper and a marker.
- Since each team has prepared a different preserved food, each team should determine the list of attributes that are important for that particular type of food. (e.g., if canning peaches, crunch is likely not a factor that should be evaluated).
  - Use the list from the previous projects as a starting point.
- Once each team has a list of attributes, they can create their sensory evaluation form.
- Students will create the list of attributes on the sheet of flip chart paper.

- Explain that the sensory evaluation forms will be used with the preserved food they create and with a fresh counterpart. For example, if they are canning peaches, they will ask people to taste the fresh peaches and complete a sensory evaluation form for them. Then they will taste their canned peaches and complete a form.

- When the teams are finished, they will hang their papers around the room and each team will share their list with the rest of the class.

- After the presentations, teams can take a few minutes to implement any revisions that may be needed based upon feedback.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What are the key attributes of your food?"***

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

DAY 14

Key Question of the Day:

(Continuation of Day 13)
What does processing do to the flavor and texture of foods?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Compare the flavor and texture of processed foods to their original states through a sensory evaluation.
- Compare sensory evaluation results using a t-test.

Required Materials

- Sensory evaluation forms – blank and created by students
- Rulers
- Sensory Evaluation spreadsheet – Appendix 8 – One per student
- Preserved and fresh versions of the same food (e.g., peaches)
- Plates labeled according to sensory evaluation protocol

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What is the purpose of a sensory evaluation?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Use this opportunity to review the purpose of a sensory evaluation.
- Explain that, ***"The purpose of the sensory evaluation today is to confirm the attributes that you selected for your sensory evaluation form. Based on today's sensory evaluation, you'll be able to determine if any additional revisions are needed before sampling the preserved food you prepared."***

MIDDLE *40 minutes*

- Distribute a fresh food to the class – such as sliced fresh peaches – and have them taste it and complete the sensory evaluation form – labeled with an "A" – for it.
- Collect the forms.
- Provide each student with a preserved version of the food they tasted and have them complete a sensory evaluation – labeled with a "B"- form for it. Collect these.
- Distribute blank evaluation forms and give teams a few minutes to revise them based on yesterday's sensory evaluation. They can remove, modify, or add items based on their use of the sensory evaluation today.
- Give each student a completed sensory evaluation form for the preserved food and one for the fresh food.
- Project a completed one onto the board and demonstrate measuring the distance from the left end of the line to the mark the student made.

- Write this measurement – in centimeters – next to the item.
- Have students measure the mark for each item and note it in the margins.
- Each team should collect all of their results in the spreadsheet (Appendix 8).
- Put the fresh food results in the cells for "Original" and the preserved food in the cells for "Healthy."
- Email your team's file to the teacher.
- Give each team a copy of the spreadsheet Sensory Evaluation.xls and project the data on the board.
- Have students work with their teams to enter the data in the spreadsheet and interpret the t-test results.
- Is the preserved food different from the fresh food? On which factors are they different? Students MUST refer to the data in this discussion.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"On what attributes did the preserved food score well?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 15

Key Question of the Day:

(Continuation of Day 13)
What does processing do to the flavor and texture of foods?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Test foods for the presence of E. coli.

Required Materials

- One sample of each team's preserved food
- Commercially available preserved food similar to each team's product
- Lab instructions – Appendix 7 – One per student
- Lab supplies:
  - Gloves
  - 2 g your food product(s)
  - 2 g of the commercially available alternative
  - 4 Ziploc Bags
  - Forceps or tongs
  - Water
  - 120 mL sterile peptone water (PW)
  - Pipette
  - Pipette tips
  - Aerobic Plate Counts Petrifilms
  - E. coli Petrifilms
  - 8 test tubes to hold 10 mL each

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What should we do before asking anyone to taste our preserved food?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Explain that, ***"We have to check the food for E. coli that may have grown while it was in storage."***

MIDDLE *40 minutes*

- Each team claims one sample of their preserved food and one of the commercially available similar products.
- Each team will follow the lab procedures to test the commercially available product and the product they made for E. coli
  - ✓ **TEACHER TIP!** To save time, each team can split so that half of the team is testing one product and the other half is testing the other product.
- Have students develop a hypothesis (as described on Appendix 7).
- Follow the lab procedures:
  - Put your gloves on and wear them for the entire lab. Do not touch your face, eyes, or mouth. Do not eat during this lab. Wash your hands thoroughly after the lab.
  - Place 1 g samples of your food product in 2 different Ziploc – each labeled as" our product 1", "our product 2" - bags using forceps or tongs.
  - Add 10mL of sterile peptone water (PW) to each sample bag and seal the bags.
  - Stomach the samples in the sealed bags manually, or use the stomacher. Manual stomaching is done by "squishing" the sample in the water and swirling gently. This creates the 4 rinsates for your food product.

- Prepare 8, 9 mL blanks – PW only – in test tubes in racks. Put them in 4 rows of two and label each row with "our product 1", "our product 2", "commercial 1", "commercial 2".
- Pipette 1 mL of the rinsate from sample "our product 1" into your first blank labeled "our product 1".
- Mix for 30 seconds by drawing and emptying the rinsate into/out of the pipette.
- Withdraw 1 mL from the rinsate + blank test tube and place into the other blank in this row. You have created a dilution of 10-1.
- Transfer 1 mL of the sample to an E. coli Petrifilm and 1 mL of the sample to an Aerobic Petrifilm. Label them with the same label as the Ziploc containing the sample.
- Change pipette tips.
- Repeat for "our food product 2" rinsate.
- Repeat the entire process for "commercial 1", and "commercial 2".
- You will have 2 Aerobic and 2 E. coli Petrifilms for your food product and 2 of each for the commercially available version.
- Incubate the films at room temperature:
  - *24 hours for E. coli*
  - *48 hours for Aerobic*
- Look for colonies on the films. Blue colonies with gas (will look like gnats) on your E. coli Petrifilm indicate that the food product is contaminated with a strain of E. coli. It is not necessarily STEC. Red colonies on your Aerobic Petrifilm indicate that your product contains another pathogen, such as Salmonella (further testing would be required to determine what the exact pathogen is).
  - *Photograph your Petrifilms to include in your reports and explain the absence or presence of pathogens.*

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"Do you think your prepared food items contains E. coli? Why or why not?"***

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

DAY 16

Key Question of the Day:
How does your food taste in comparison to the commercially available alternative?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Apply the sensory evaluation procedure to test their food.

Required Materials

- Plates students can label
- Preserved foods prepared by each team
- Commercially available alternatives of the preserved foods
- Sensory evaluation forms – Appendix 8 – One per student
- Access to other teachers' classes for the test

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"Does your preserved food item contain E. coli?"***

OPENING *5 minutes*

- Each team should examine their petri dishes from the previous day to determine if E. coli is present in their preserved food item.
- Teams share what they found.
- Any team whose product has E. coli MAY NOT conduct a sensory evaluation with it. Instead, they will use the commercially available product and compare it to a fresh ingredient.
- Ask the class the following questions to debrief the lab:
  - What was your team's result?
  - If you had E. coli, how did it get into your food?
  - If you don't have E. coli, what steps did you take that prevented contamination?

MIDDLE *40 minutes*

- Review the sensory evaluation procedure with the class.
- Teams should label plates and forms according to their procedure (all of their recipe is labeled with one letter or number and all of the commercial is labeled with another).
- Assign each team a class to visit. The assigned class will conduct the sensory evaluation on their preserved food.
- Teams serve 1-2 bites of the food onto the appropriate plates.
- Students should explain the sensory evaluation procedure to the class, and have the students complete the forms and return them.

- Ask students to write comments in addition to marking the scales.

- This process will likely take the entire class period, so the analysis of the data will continue the next day.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"How do you think people liked your new preserved food product? Why?"***

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

DAY 17

Key Question of the Day:

(Continuation of Day 16) How does your food taste in comparison to the commercially available alternative?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Analyze sensory evaluation data.

Required Materials

- Plates students can label
- Preserved foods prepared by each team
- Commercially available alternatives of the preserved foods
- Sensory Evaluation Spreadsheet – Appendix 8 – One per student
- Access to other teachers' classes for the test
- Balance (or scale)
- Weigh boats (wax paper or tin foil would work too)

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What is different about your preserved food product?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Students should share their initial responses just based upon visual observations of their preserved foods.

MIDDLE *40 minutes*

- Students should take a small sample from their preserved food item to weigh.
- Since they weighted the ingredients prior to making the preserved food product, they will be able to compare any physical changes such as weight now that the preservation process is complete.
  - › Students should also note any other changes such as smell, color, or texture (without tasting).
- Students should find the data they recorded in their notebooks from Day Ten and mark the data from today.
- Next, they should add the data gathered today to compare the before and after results.
  - ✓ **TEACHER TIP!** An extension activity here would be to have students create a visual (e.g., an infographic or table) to illustrate the before and after data, including the color, texture, smell, weight of the ingredients, and nutritional value of the ingredients. This would be a great way to explore how processing changes the composition of food. This exercise could be added to the project as time permits.
- Upon returning to class, students should enter their sensory evaluation results and calculate the p-value using the spreadsheet (Appendix 8).
  - › They should use their notes and previous tests to guide them.

- Each team should respond to the following question, “Is your food significantly different that the commercial option?”

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***“How is your product different from the commercially available option? Is it better or worse?”***

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

DAY 18

Key Question of the Day:
How can you create a preserved food product?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Summarize the results of their preservation, nutritional calculations, and sensory evaluations.
- Support claims with evidence.

Required Materials

- PowerPoint
- All data collected by students from the project

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"Do you have what you need to present your preserved food product to the food scientists and nutritionists?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Use this opportunity to answer any questions about the project.
- Review the project description with the students.
  - › They should highlight the component of the project that must be included in their presentations.
  - › Ensure that everyone in the team has the same data.

MIDDLE *40 minutes*

- Teams will work on their presentations.
- Monitor their progress and remind them to use data in tables and use appropriate vocabulary.
- Their presentation should be written as an argument for their preserved food, explaining why it would be a good product for the astronauts to consume in space.
- Students will have the entire class period to work on their reports.
- Remember to visit with each team while they are working to check progress and answer questions.
- Upon returning to class, students should enter their sensory evaluation results and calculate the p-value using the spreadsheet (Appendix 8).
  - › They should use their notes and previous tests to guide them.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What did you accomplish today?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 19

Key Question of the Day:

(Continuation of Day 18)
How can you create a preserved food product?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Summarize the results of their preservation, nutritional calculations, and sensory evaluations.
- Support claims with evidence.

Required Materials

- PowerPoint
- All data collected by students from the project

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"What questions do you have about your projects?"***

OPENING *5 minutes*

- Read the Bell-Work question and solicit responses from the students.
- Use this opportunity to answer any questions about the project.

MIDDLE *40 minutes*

- Teams will continue to work on their presentations.
- Monitor their progress and remind them to use data in tables and use appropriate vocabulary.
- Their presentation should be written as an argument for their preserved food, explaining why it would be a good product for the astronauts to consume in space.
- Students will have the entire class period to work on their reports.
- Remember to visit with each team while they are working to check progress and answer any questions.

CLOSING *5 minutes*

- Students will turn in their Exit Ticket for that day. They will respond to the following prompt: ***"What do you still need to accomplish?"***
- Collect the Exit Ticket for the day as students leave the classroom.

DAY 20

Key Question of the Day:
How can you create a preserved food product?

Estimated Time

One 50-minute class period

Learning Objectives

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

- Deliver presentations arguing for the inclusion of each team's food in the NASA program.

Required Materials

- PowerPoint
- Projector
- Nutrition expert
- Project Rubric – Appendix 9 – One for the teacher per team
- Presentation Audience Feedback Form – Appendix 10 – One per student per presentation
- Self-Reflection Form – Appendix 11 – One per student
- Collaboration Rubric – Appendix 12 – One per team

Bell-Work

- Provide students with the weekly Bell-Work sheet (Appendix 1)
- ***"Write two questions you would like to ask each group about their projects."***

OPENING *5 minutes*

- Ask students not to share their questions and to save them for the actual presentations.
- Introduce the guest speaker/expert.
  - ✓ **TEACHER TIP!** This should be the same person that was invited to visit earlier in the project.

MIDDLE *40 minutes*

- Distribute Appendix 10 and remind students that they will evaluate each other and provide feedback after teach team presents.
- Each team will prepare a sample of their preserved food for the nutrition expert to taste.
- Each team will present, and after the presentations, they answer questions and receive feedback.
- To save time, while the feedback process is occurring, the next team prepares for their presentation.
- Following the presentations, the guest can share some general feedback/comments with the group before class is over. They should also share which products will be chosen.
- Students will complete the self-reflection form (Appendix 11).

- Next, students collect their evidence for this project and add it to their portfolio with their captions and descriptions for each item. Portfolios are due to the teacher at the end of the day. Their portfolios are now complete for Course 1. Celebrate!

ITEM	DESCRIPTION

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 the presentations today?"***

- 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

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

(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 gelatine to stop crumbs escaping. Unsurprisingly, astronauts reported that "the food was unappetizing."

Today, space food is more "cordon bleu" than blender.

"We've have the suggestion that people should just have a liquid, they should take a pill to consume all the vitamins and minerals that they need," says Cooper. "The issue with that is that there's a psychological experience that comes with eating. And people don't want to take all their meals through a straw, they don't want to swallow a pill for all their nutrition, and the pill wouldn't be as bioavailable as the food itself. So it's necessary, in terms of the human experience, that people eat."

That being said, astronauts' meals aren't identical to those served on Earth.

There are no freezers on the ISS so food has to be stored carefully to prevent spoilage. Items are freeze-dried on Earth then rehydrated in space. "Portion sizes are determined generally by two factors," Cooper explains. "We're limited by the size of the pouch [the meals come in] ... you can't actually have more in the package, that's just what it holds."

Secondly, and more useful to Cooper, are calories. "We know how many calories we want an entrée to have, and how many calories we expect for a dessert ... that all factors in to what is placed into the pouch."
That's right, desserts. Alongside such healthy dishes as Indian fish curry and crab cakes, the NASA menu includes chocolate pudding, lemon curd cake and apricot cobbler. NASA has even been known to send birthday cakes to astronauts. And Cooper's reasons for providing all those treats will resonate with anyone with a sweet tooth: "You can't live without dessert!" she says. "It's a psychological experience!"

http://www.cnn.com/2015/02/04/tech/nasa-diet-space-food/

NASA Food Technology Commercial Space Center

Nutrition in Space

by Jean Anderson

Background

It is critical to maintain the health of the astronaut in prolonged space travel. Health is sustained in part as a result of the astronaut's nutritional intake. Complete nutritional intake is simplest if the astronaut merely takes a pill or a nutritional supplement. Historically, the space program has utilized bite- sized cubes of a product that is high calorie and nutrient dense as well as products in a tube shape (ex: Space Food Sticks). During the early US missions (such as Gemini and Apollo) although there was enough food product on board to provide each astronaut ample calories and nutrients, the food products were not palatable, the astronauts stopped eating enough during the flight and, thus, lost weight. As space missions have become longer in duration, a great deal of research and testing have gone into the foods, product packaging, and retort methodology utilized in these missions to enhance palatability, acceptability, and variety resulting in increased nutritional health of the astronauts.

There are physiological changes the astronauts experience during space travel. These include:

1) Gastrointestinal changes occur that may impact appetite or nutrient absorption. For example, many experience gaseous stomach due to the inability of gases to rise. Chronic inactivity increases transit time in the gut.

2) Taste and odor sensitivity changes occur in most as a result of the nasal congestion that occurs during the flight. Although specific research on Earth does not support changes in taste and odor sensitivity, many crews report changes which could affect appetite and eating habits.

3) Fluid shifts have been noted in head congestion, in plasma volume (decreases during the early phase of the flight) and red blood cell concentration (increases due to decreased plasma volume; hematocrit).

4) Musculoskeletal changes occur related to lack of gravity and physical inactivity. The greatest amount of loss of muscle mass occurs during the first month, then levels off. However, skeletal loss appear to be related to length of flight.

The menus are planned in a six to eight day cycle with enough food on board the shuttle to ensure that the shuttle does not run out of food between launch-resupply-re-entry; in fact, the goal is to have a 45 day supply of food and beverages on board at all times. Each astronaut selects his/her entire menu of three meals per day plus snacks prior to launch; then the selected products are prepared and packaged according to strict sanitary guidelines and stored in locker trays labeled arranged in order they are to be consumed. Fresh food is supplied (includes breads, some fruits and vegetables, tortillas, and breakfast rolls) but as you might imagine it does not last for the entire trip. Astronauts also are allowed to bring along some favorite foods like M&Ms, cookies, chips that they might desire during the trip. Many find that the menu items they enjoyed and selected prior to the space flight, taste different or are not satisfying once they are in flight—therefore, many will season foods with spicy condiments (A-1 Steak sauce, Picante Sauce, etc.) or trade foods with others or make up intriguing food combination casseroles.

A computerized inventory management system is in use to keep track of food and beverage supplies on the space craft. This system also serves potentially as a method to track out of date items. The items are scanned as they are brought aboard both at the initial loading and during re-supply. Once a food container is emptied, a crewmember scans it, so the NASA ground crew can track the number of food containers emptied by each crew and thus obtain a close approximation of the quantity of food remaining on orbit. NASA makes no attempt to inventory each individual food package, as this would require far too much crew time.

The psychology of eating is a critical component in prolonged space travel. Eating includes the aroma, the texture, the sounds, and the preparation of a food in addition to chewing and swallowing the food. Many of the space foods are soft and free of crumbs. The foods are prepared by reconstituting with water or micro-waving to heat through. Because the living environment is small and confined, strongly aromatic foods are problematic. Some topics of concern related to the psychology of eating include:

1) How to keep eating pleasurable?

2) How to sustain interest in eating?

3) How to keep from feeling bored or routine with the meals and snacks (This is somewhat related to the lack of choice; although we really only eat a few of the bijillions of foods we have to choose from here on Earth—we do have a choice)

4) How to incorporate celebration or holiday foods?

At the beginning of prolonged space travel, astronauts were told exactly what to eat and exactly when to eat. For a variety of reasons, including lack of free choice in other aspects of living in space, the astronauts revolted. Now, the foods are merely labeled (and expiration dated so that the FIFO method will be used) and there is no longer the emphasis on meal/snack times or actual intake.

Instructor

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http://ftcsc.ag.iastate.edu/media/anderson.pdf

Essential Question:

How do we make food safe for a long period of time and still maintain sufficient nutrient levels?

Engagement Scenario:

One of the limits to exploring deep into space is the amount of time it would take. It takes nine months to get to Mars, one of the closest destinations. In that time, fresh food would spoil but astronauts require healthy food for the entire trip and the return mission. You are a (food scientist or nutritionist make half of project scenarios for each and distribute randomly) with the _______ Food Company and you and your team have been asked to develop and propose preserved foods for the astronauts. The food selection team at NASA will choose some of the presented foods to be included in the meals for their Mars mission program.

With your team, you will research methods of food preservation, healthful foods for long journeys, and typical food preferences of NASA astronauts. Your team will research the preservation technique you choose in detail including the role it plays in a healthy diet, its history, and the anticipated nutritional changes to the source food. This research will be included in your final presentation and written report.

You will test two hypotheses - one about the nutrient content and one for the sensory evaluation – and develop a third – shelf life – based on your research that can be tested later in the semester. After reading informational texts on nutritional value and food preservation and participating in enabling learning activities intended to assist you in designing, creating, and testing a long-term food preservation product, write a design brief in which you discuss the merits of your food product and evaluate its potential use for astronauts. Be sure to support your position with evidence from the texts and from participation in enabling learning activities.

You will present your product to food scientists or nutritionists who will decide which product(s) will be sold to NASA. You will deliver an oral presentation that covers the content of your written report and includes the opportunity for your audience to taste your product.

Project Management Log: Team Tasks

Project Name ____

Team Members ____

TASK	WHO IS RESPONSIBLE	DUE DATE	STATUS	DONE

Detecting E. coli Lab Instructions

How does food become contaminated with STEC? How do we detect it?

Your food product might be a source of pathogens such as E. coli 0157:H7 and other shiga-toxin producing E. coli (STECs), Salmonella app., and others. Testing food products for pathogens is an important step in the development and sale of foods. To test your food product and commercially available alternatives for contamination, follow the procedure below.

Purpose

Shiga toxin-producing Escherichia coli (STEC-8) creates a health risk when it contaminates beef and other food products. Researchers at University of Nebraska-Lincoln and several other research and educational institutions across the country are working together to develop procedures to identify STEC contamination and decontaminate food.
You will follow the procedure developed by these scientists – outlined below – to identify the presence of E. coli and other pathogens in your food item and the commercially available alternative.

Hypothesis Development

You will have the food product you developed and the commercially available version of it. Develop a hypothesis for each food and the two different types of microorganisms – aerobic and anaerobic - in the form of "(Food product) (will/will not) have E. coli present in detectable levels." Write these in your research journal.

Materials:

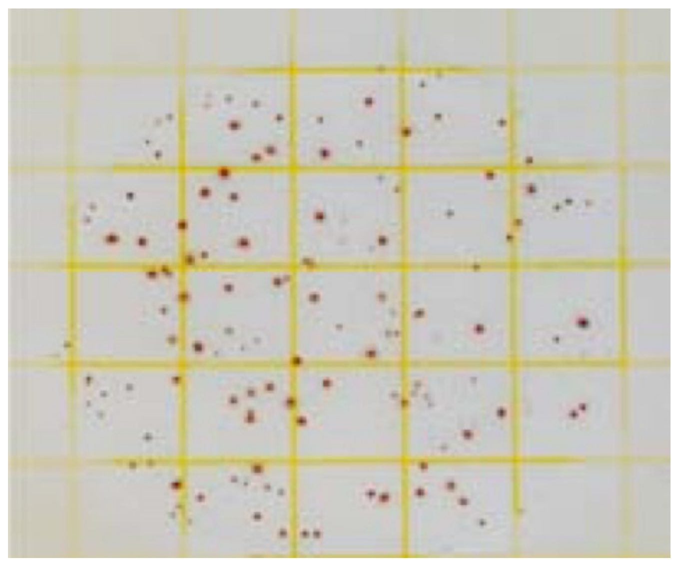
- Gloves
- 2 g your food product(s)
- 2 g of the commercially available alternative
- 4 Ziploc Bags
- Forceps or tongs
- Water
- 120 mL sterile peptone water (PW)
- Pipette
- Pipette tips
- Aerobic Plate Counts Petrifilms
- E. coli Petrifilms
- 8 test tubes to hold 10 mL each

Procedure

1. Put your gloves on and wear them for the entire lab. Do not touch your face, eyes, or mouth. Do not eat during this lab. Wash your hands thoroughly after the lab.
2. Place 1 g samples of your food product in 2 different Ziploc – each labeled as" our product 1", "our product 2" - bags using forceps or tongs.
3. Add 10mL of sterile peptone water (PW) to each sample bag and seal the bags.
4. Stomach the samples in the sealed bags manually, or use the stomacher. Manual stomaching is done by "squishing" the sample in the water and swirling gently. This creates the 4 rinsates for your food product.
5. Prepare 8, 9 mL blanks – PW only – in test tubes in racks. Put them in 4 rows of two and label each row with "our product 1", "our product 2", "commercial 1", "commercial 2".
6. Pipette 1 mL of the rinsate from sample "our product 1" into your first blank labeled "our product 1".
7. Mix for 30 seconds by drawing and emptying the rinsate into/out of the pipette.
8. Withdraw 1 mL from the rinsate + blank test tube and place into the other blank in this row. You have created a dilution of 10-1 .
9. Transfer 1 mL of the sample to an E. coli Petrifilm and 1 mL of the sample to an Aerobic Petrifilm. Label them with the same label as the Ziploc containing the sample.
10. Change pipette tips.
11. Repeat for "our food product 2" rinsate.
12. Repeat the entire process for "commercial 1", and "commercial 2".

13. You will have 2 Aerobic and 2 E. coli Petrifilms for your food product and 2 of each for the commercially available version.
14. Incubate the films at room temperature:
    a. 24 hours for E. coli
    b. 48 hours for Aerobic
15. Look for colonies on the films. Blue colonies with gas (will look like gnats) on your E. coli Petrifilm indicate that the food product is contaminated with a strain of E. coli. It is not necessarily STEC. Red colonies on your Aerobic Petrifilm indicate that your product contains another pathogen, such as Salmonella (further testing would be required to determine what the exact pathogen is).
16. Photograph your Petrifilms to include in your reports and explain the absence or presence of pathogens.

E. coli present



Aerobic microorganisms present

Processing Questions

1. Why did the lab call for you to use two samples of the same product?
2. Why did you use two blanks for each sample?
3. If your food product has pathogens, how might they have gotten there?
4. What if some samples are contaminated and others are not?
5. If we can test food for pathogens, how do outbreaks happen?

Sensory Evaluation Spreadsheet

Download: Appendix 8 Sensory Evaluation Spreadsheet and edit in Microsoft Excel

Participant	Example	Item 1	Item 2	Item 3	Item 4	Item 5
Original 1	1.8					
Healthy 1	0.7					
Difference 1	**1.1**	**0**	**0**	**0**	**0**	**0**
Original 2	5.6					
Healthy 2	4.8					
Difference 2	**0.8**	**0**	**0**	**0**	**0**	**0**
Original 3	2.9					
Healthy 3	3.6					
Difference 3	**-0.7**	**0**	**0**	**0**	**0**	**0**
Original 4	6.5					
Healthy 4	7.8					
Difference 4	**-1.3**	**0**	**0**	**0**	**0**	**0**
Original 5	4.5					
Healthy 5	5					
Difference 5	**-0.5**	**0**	**0**	**0**	**0**	**0**
Original 6	6.5					
Healthy 6	8					
Difference 6	**-1.5**	**0**	**0**	**0**	**0**	**0**
Original 7	9					
Healthy 7	8.6					
Difference 7	**0.4**	**0**	**0**	**0**	**0**	**0**
Original 8	5.8					
Healthy 8	6.3					
Difference 8	**-0.5**	**0**	**0**	**0**	**0**	**0**
Original 9	7.5					
Healthy 9	4.6					
Difference 9	**2.9**	**0**	**0**	**0**	**0**	**0**

Project Rubric

CATEGORY	EXCELLENT (15)	PROFICIENT (10)	SATISFACTORY (5)	UNSATISFACTORY OR NO ATTEMPT MADE (0)
ORGANIZATION	Includes all of the project components in an organized manner.	Missing one project component but somewhat organized.	Missing two project components and content is somewhat unorganized.	Missing three or more project components and content is unorganized.
CONTENT KNOWLEDGE	Detailed explanation of the topic. Explains the key components of the topic and can support findings with background information.	Contains a good description of the fundamentals of the topic and can somewhat support the findings with a little background information.	General to vague description of the fundamentals of the topic and has difficulty supporting the findings with background information.	Missing information regarding the description of the fundamentals of the topic, and unable to support the findings with background information.
COMPLETENESS	Project components are complete and demonstrate strong depth and breadth.	Project components are mostly complete, only moderately lacking in depth and/or breadth.	Project components are generally incomplete and lack in depth and/or breadth.	Some project components are incomplete and others completely lack depth and breadth.
SYNTHESIS	Responses are well organized, cohesive, and team components flow as a whole.	Responses are somewhat organized, cohesive, and team components sometimes lack flow as a whole.	Responses are lacking organization and cohesion and/or team components do not flow as a whole.	Responses are poorly organized, not cohesive, and the team components fail to create a whole coherent response.
REFERENCES	Thorough reference list included. References are in proper APA form and all inclusive of the citations in project.	References are missing one or two pieces of information.	References are included but not in proper form. Three or more references that are cited are missing.	No reference list included.
MECHANICS	No capitalization, spelling, punctuation or grammatical errors.	2 or less capitalization, spelling, punctuation or grammatical errors.	3-5 capitalization, spelling, punctuation or grammatical errors.	6+ capitalization, spelling, punctuation or grammatical errors.
VISUAL	Visual aids are neat, creative, and easy to follow.	Visual aids are somewhat neat, creative, and easy to follow.	Visual aids are somewhat messy, lacking creativity, and not as easy to follow.	Visual aids are messy, not creative, and difficult to follow.

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?

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:	

Collaboration Rubric

	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