SAFE FOOD-HANDLING PRACTICES

FOOD SAFETY CURRICULUM
FOR
HIGH SCHOOL STUDENTS

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INTRODUCTION

RATIONALE

Background

Foodborne illness is an economic burden to public health in America. Foodborne illness is caused by eating or drinking food or beverages that are contaminated with microbes or pathogens. In America, foodborne illness is responsible for approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths each year. In other words, 1 in 6 Americans becomes ill from consuming contaminated foods or beverages.

Need for Food Safety Education

There are three main factors that strongly support the need for extensive focus on student food safety education.

1. The number of teenagers involved in food handling is increasing (cooking or grocery shopping). This is due, in part, to an increase in the number of mothers entering the workforce. Larson and colleagues reported that in Minnesota 49.8% of teenagers shopped for groceries, and 68.6% assisted in preparing dinner (Larson and others 2006).

2. Students can be current and future foodservice employees. Consequently, students receiving food safety education in their middle/high school curriculum will have a potentially positive impact on the food service industry.

3. Multiple previous studies reported that middle/high school students can lack food safety knowledge, which has the potential to put themselves and others at risk for the development of illness due to contaminated food or beverages. This lack of food safety knowledge in conjunction with poor food safety practices and attitudes among students supports the need for enhanced student food safety education as students are consumers and potential foodservice employees.

Need for Teacher Involvement

Teachers can foster excitement for learning about science related to food. They are in a position where they can deliver key safe food handling messages to students, provide compelling examples of the challenges of foodborne illness, and encourage student participation in a learning module designed to better help them understand safe food handling practices. Teachers also can lead engaging discussions that show the practical nature of food safety, and thereby potentially influence students for a life-time.

UNIT DESIGN AND PEDAGOGICAL THEORIES

Safe Food Handling Practices is a food safety curriculum that targets middle and high school students. The objective of this curriculum is to provide middle and high school teachers with food safety resources that can be used with students to identify high-risk populations and promote safe food handling practices.

A Positive Deviance approach is utilized in which safe food handling recommendations are delivered through a structured discussion lead by a trained teacher. During the discussion, those students who are practicing the recommended behavior are identified as “positive deviants.” Positive deviants are identified as role models, and the other students are encouraged to practice the recommended

behavior. Evaluation research has shown that participants tended to learn more and practice more recommended safe food handling via a Positive Deviance approach, compared with conventional reading materials [2, 3]. People are more willing to try advice from their peers who are like themselves. The curriculum content is based on the USDA Fight BAC! Campaign, which is a food safety initiative designed to educate consumers about the four food safety principles: clean, separate, cook, and chill. A fifth principal, choose safe food, is also included to address the 'myths' related to food choices with greater safety risk.

Contents

Unit Information

Grade Levels: Recommended for grades 9–12

Prerequisites: Students should have foundational knowledge of microbiology, chemistry, and mathematics, including surface area, volume, and ratio calculations. Students will need basic laboratory skills, including safely heating and mixing substances, and basic plating techniques.

Duration: This curriculum requires a minimum of 8 50-minute class periods. Additional time may be required based on student experience and engagement.

Required Materials:

Lesson	Materials List	Special Recommendations
Day 1: Cooking Lab (Pre)	**Cheeseburger** (*per group)* 1 pound ground beef 1 tsp salt 1 tsp black pepper 8 slices American cheese 4 burger buns <u>Garnish</u> Ketchup Mustard Mayonnaise Sliced tomatoes Sliced pickles Fresh lettuce **Zucchini Crisps** *(per group)* 2 medium zucchinis sliced into 1/8” rounds ½ tsp salt ½ tsp pepper 1 ½ cups parmesan cheese	
Day 2: Clean	No items to purchase.	

Day 3: Cook and Chill	***Activity 1: pH Experiment*** *(per group)* 3 5-oz red cabbage juice containers 0.5 oz (15 ml) vinegar 1 tsp (3.5 g) baking soda 2 stirring rods 3 pH test strips ***Activity 2: Heat Transfer Experiment*** *(per batch)* *Color-changing dough. 1 batch yields enough dough for approximately 3 groups.* 4 cups flour 1 ½ cups salt 2 tbsp oil 1 cup water 5–10 grams color-changing powder (add until the desired color is reached)	Color-changing powder may be purchased from Atlanta Chemical Engineering. https://www.atlantachemical.com/ Color-changing powder is classified as "Thermochromic Powder Pigments." The powder comes in various colors and temperature-change thresholds.
Day 4: Cross-Contamination	No items to purchase.	
Day 5: Choose	***Activity 2: Introduction Activity*** 3 to 7 food products that have been processed using UHT. Possible food products include: • Salad dressing • Guacamole • Yogurt • Fruit jams • Pasteurized juice • Soup ***Activity 2: Juice Experiment*** Growth media (enough for class) Pasteurized juice (enough for class) Unpasteurized juice (enough for class) 5 sterile swabs (per group) 2 beakers (per group) 2 stirring rods (per group)	Pharmaceutical-grade, black pepper essential oil can be purchased at retail stores. This can be used in place of black pepper oleoresin.

	Parafilm (enough for class) Nitrile gloves (enough for class) 5 petri dishes containing nutrient agar (per group) ***Activity 2: Spices vs. Oleoresin*** 5 salt pretzels (per group) 5 salt and pepper pretzels (per group) 1 9-oz food/pharmaceutical-grade black pepper oleoresin (or substitute black pepper essential oil) 1 dropper to dispense the oleoresin (or essential oil). Depending on the setup, students can share droppers, or each group can have a dropper.	
Day 6: HACCP	No items to purchase.	
Day 7: Presentations	Camera or other technology for students to take pictures.	
Day 8: Cooking Lab (Post)	**Cheeseburger** (*per group)* 1 pound ground beef ¼ cup mild or spicy nacho cheese sauce ½ tsp salt ½ tsp pepper 4 hamburger buns, split and toasted <u>Garnish</u> Shredded lettuce (cut lettuce into thin strips) 4 green onions, sliced **Salsa** *(per group)* 2 large plum tomatoes, diced (yields 1 cup) $^{1}/_{8}$ cup chopped white onion 1 ½ tbsp chopped fresh cilantro 1 tsp minced jalapeño (remove seeds for lower heat) ¾ tsp fresh lime juice ¼ tsp kosher salt (or to taste)	

Glossary

Term	Description
ATP	**ATP (adenosine triphosphate) – "**energy-carrying molecule found in the cells of all living things. ATP captures chemical energy obtained from the breakdown of food molecules and releases it to fuel other cellular processes . . . ATP is a nucleotide that consists of three main structures: the nitrogenous base, adenine, the sugar, ribose; and a chain of three phosphate groups bound to ribose. The phosphate tail of ATP is the actual power source which the cell taps. Available energy is contained in the bonds between phosphates and is released when they are broken, which occurs through the addition of a water molecule (a process called hydrolysis)." [4]
Cleaning Verification	Action by which the cleanliness of a surface is confirmed. This can include visual inspection and environmental swabbing.
Coliform	"Of, relating to, or being gram-negative rod-shaped bacteria (such as *E. coli*) normally present in the intestine." [5]
Critical Control Point (CCP)	"A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level." [6]
Cross-contact	"Inadvertent transfer of bacteria or other contaminants from one surface, substance, etc., to another especially because of unsanitary handling procedures." [7]
Cross-Contamination	"Cross-contact happens when one food comes into contact with another food and their proteins mix." [8]
Hazard Analysis Critical Control Point (HACCP)	"A systematic approach to the identification, evaluation; and control of food safety hazards." [6]
Heat Transfer	"The process of transfer of heat from high temperature reservoir to low temperature reservoir. In terms of the thermodynamic system, heat transfer is the movement of heat across the boundary of the system due to temperature difference between the system and the surroundings. The heat transfer can also take place within the system due to temperature difference at various points inside the system. The difference in temperature is considered to be 'potential' that causes the flow of heat and the heat itself is called as flux." [9]
Microorganism	"An organism (such as a bacterium or protozoan) of microscopic or ultramicroscopic size." [10]
Pasteurization	"Partial sterilization of a substance and especially a liquid (such as milk) at a temperature and for a period of exposure that destroys objectionable organisms without major chemical alteration of the substance." [11]
Pathogen	"A specific causative agent (such as a bacterium or virus) of disease." [12]
Radiological Hazard	"The uncontrolled release of radioactive material that can harm people or damage the environment." [13]
Zone 1	Area of a processing facility in direct contact with food, known as a food-contact surface.
Zone 2	Area of a processing facility next to the food-contact surface.
Zone 3	Area of a processing facility farthest from food-contact surfaces including walls and drains.
Zone 4	Area of a processing facility outside of the food-processing area, including lunchrooms and breakrooms.

Lesson Plan

Scope and Sequence		
Before beginning the unit, have the students complete a food-safety pre-survey and participate in a cooking activity to establish a baseline of students' food safety knowledge, attitudes, and practices prior to receiving food-safety education. Teacher students food safety using 5 days of food-safety lessons and have students present what they have learned during 1 presentation day. At the end of the 5-day unit and 1-day presentation, have the students complete a food-safety post-survey and participate in a cooking activity to evaluate changes in students' food-safety knowledge, attitudes, and practices after receiving food-safety education.		
Day	**Principle(s)**	**Unit Objective(s)**
1	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Collect data to establish a baseline for student food-safety knowledge, attitudes, and behavior.
	Suggested Pre-Knowledge	
	N/A	
	State Standards Addressed	
	N/A	
	Learning Activities	**Materials List**
	1. ***Activity 1: Pre-Survey Administration*** 1.1. Teacher/Discussion leader informs students they will be starting a new unit of study. Teacher/Leader says, "I would like to know what you already know before we start the unit, so I'm going to ask you to take a pre-survey. Remember when you take a pre-survey, I am just looking for what you already know." If students ask if the pre-survey is graded, assure them it is ungraded and encourage them to try their best. 1.2. Teacher/Leader distributes pre-survey (which is almost the same as the post-survey administered at the end of the unit). Teacher/Leader allows students time to complete the pre-survey and monitors them as	***1. Activity 1*** 1.1 Pre-survey ***2. Activity 2*** 2.1 Hamburger for each group 2.2 Hamburger buns

they work to deter them from sharing information with one another. Teacher/Leader collects students' pre-survey after 15 minutes.

2. *Activity 2: Cooking Activity*

2.1. Cooking station setup:

2.1.1. Label the cooking stations from 1 to 6.

2.1.2. Store the temperature-sensitive ingredients (meat, cheese, and vegetables) in the refrigerator. Non-temperature-sensitive ingredients may be stored on a common table or at the stations.

2.1.3. Place a copy of the recipe at each station.

2.1.4. Ensure students have the necessary equipment (i.e., skillet, spatula, cutting boards, knives, food thermometer, etc.)

2.2. Before going to the cooking lab:

2.2.1. Teacher/Leader assigns students (or allows students to pick) their lab groups and their lab stations (1 to 6). There should be approximately 4 students per group. Teacher/Leader says, "We are going to do a cooking activity in which you will make hamburgers."

2.2.2. Teacher/Leader leads students to the kitchen lab. Students should not bring their books or other materials to the lab unless there are places to store these items away from food-preparation areas.

2.3. In the lab:

2.3.1. Once in the lab, the teacher/leader assigns groups to lab stations labeled 1 to 6. Group 1 should be assigned to station 1, group 2 assigned to station 2, etc.

2.3.2. Once all students are at their cooking stations, the teacher/leader says, "You may begin cooking using the recipe at each of your stations. Once you are finished cooking, you may eat what you have made, but you do not have to eat the food you prepared. You will have 30 minutes to prepare your food. I will keep track of time and let you know how much time you have left to cook."

2.3.3. Teacher/Leader monitors students to ensure they are using the kitchen equipment safely. The teacher/leader should not offer cooking advice or help students cook the food. When students are finished cooking and cleaning up the kitchen for the next class, the teacher/leader will dismiss the students.

2.3.4. Teacher/Leader can use video recordings or the included Student Cooking Observation Checklist to record student food-handling behaviors. The information in the videos and checklists can be shared with students to help them identify which food-handling behaviors they are performing correctly and which behaviors require improvement. If the students' food-handling behaviors are recorded using video, the teacher/leader can have students review the footage for their group and discuss the food-handling behaviors they noticed. If students' food-handling behaviors are

2.3 Garnish: Lettuce, tomato, pickles, mustard, ketchup, etc.

2.4 Cheese (2 slices per burger)

2.5 Salt and pepper

2.6 Food handler's gloves

2.7 Zucchini crisps (per group): 2 medium zucchini, 1 ½ cups grated parmesan cheese.

2.8 Cooking thermometers

Note: Bake zucchini crisps at 450°F for 15 minutes.

	recorded with the checklist, teachers/leaders could have groups pair up and observe one another while cooking. For example, group 1 can watch group 2 cook and make observations during the first part of class. Group 2 can then watch group 1 cook and record observations during the second part of class. For this method, recipes requiring less cooking time are optimal as they ensure both groups will be able to prepare the meal during the class period. Alternatively, two days of cooking can be allotted for both pre- and post-cooking sessions, so each group cooks for one class period and observes during the other class period.	

	Resources	
	Recipes	
Day	**Principle(s)**	**Unit Objective(s)**
2	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Students are able to apply cleaning methods to reduce or eliminate unwanted microorganisms and pathogens on hands, surfaces, and foods. Students are able to define and identify examples of Zones 1–4 in a food-processing environment. Students are able to develop a basic Sanitation Standard Operating Procedure (SSOP) and identify cleaning agents, disinfecting/sanitizing agents, and verification tests to use on the processing equipment and in the processing environment. Students are able to develop a basic Good Manufacturing Practices (GMP) document for a food-processing company. Students are able to compare and contrast cleaning and verification methods utilized in processing facilities and in-home kitchens.
	Suggested Pre-Knowledge	
	Basic knowledge of microbiology.	
	State Standards Addressed	
	Indiana Department of Education, Advanced Life Science: Foods **Domain – Health, Safety, and Microbiology of Food**	

Core Standard 5 Students conduct safe food handling, hygiene, spoilage, and quality control to understand temperature controls, species and structure of microbes, shelf-life, food-poisoning, and the socio-economic impact of the food quality

ALSF-5.2 Explain techniques and procedures for the safe handling of food products

ALSF-5.3 Evaluate food-product handling procedures

ALSF-5.6 Describe the effects foodborne pathogens have on food products and humans

ALSF-5.7 Explain the importance of microbiological tests in food-product preparation

ALSF-5.8 Characterize the physical, chemical, and biological properties of microbes

ALSF-5.13 Develop personal food-selection and food-handling habits that will minimize the risk of contracting foodborne or waterborne disease (PU – FS 16100)

Core Standard 6 Students draw conclusions about food and food safety

ALSF-6.2 Develop Sanitation Standard Operating Procedures (SSOP) for a food-products and processing company

ALSF-6.3 Implement Good Manufacturing Practices (GMP) for a food-products and processing company

Learning Activities	**Materials List**
1. Activity 1: Building Concepts Related to Safe Food-Handling Practices: Cleaning 1.1. Teacher/Leader introduces the final project students will present in their groups. Teacher/Leader tells students they will take photos to represent ideas they learn about from each unit of study, and students will present these pictures to the class. During or after each unit of study, students should take a photo to include in their final project. 1.2. Teacher/Leader opens the discussion of cleaning concepts by asking students, "What do you think are the most common causes of foodborne illness in the United States?" Answer: bacteria. Answers may include unwashed hands, bacteria, meat (chicken, beef, and seafood), or produce (spinach). 1.3. Teacher/Leader asks students to share thoughts on ways to prevent foodborne illnesses at home. Answers may include washing hands, thoroughly cooking meat, and washing produce. After students answer, teacher/leader asks, "What about in a manufacturing facility? Are the ways to prevent foodborne illnesses the same as home kitchens or different from home kitchens?" 1.4. After students share their thoughts on similarities and differences, ask students to identify where they think microorganisms and pathogens might be located in their homes or at a manufacturing facility. 1.4.1. On food-handler hands and gloves 1.4.2. On reusable towels 1.4.3. On equipment surfaces 1.4.4. In ingredients	***1. Activity 1*** 1.1 Video clip of bacteria, handwashing, and produce washing 1.2 Video clip on drying hands ***2. Activity 2*** 2.1 Pretzel-processing plant video clip 2.2 Zones video clip 2.3 In-Class Activity: Clean GMP Development 2.4 In-Class Activity:

	1.4.5. Environment 1.5. Ask students to identify how to eliminate or reduce pathogens on hands and gloves. 1.5.1. Wash hands for 20 seconds, using soap and warm water. 1.5.2. Follow recommended hand-washing techniques. 1.5.3. Change gloves when they are contaminated or lose elasticity. 1.5.4. Wash hands between glove changes. 1.6. Ask students to identify ways to dry hands. After students provide responses, ask them to identify the best way to dry hands and to provide justifications for their answers. 1.6.1. Disposable paper towels – best method because there is limited opportunity for microorganisms to grow (as with multi-use towels) or circulate (as with hand dryers) 1.6.2. Multi-use towels 1.6.3. Air hand dryers *1.7. Watch the video clip on bacteria, hand washing, and produce washing.* 1.8. Ask students to identify ingredients that could contain pathogens and what pathogens they think could be associated. 1.8.1. Meat – *Campylobacter jejuni, E. coli O157:H7, Listeria monocytogenes, Salmonella spp., Staphylococcus aureus, and Yersinia enterocolitica* 1.8.2. Poultry – *Campylobacter jejuni, Clostridium botulinum (canned chicken), Clostridium perfringens, Listeria monocytogenes, Staphylococcus aureus, and Yersinia enterocolitica* 1.8.3. Seafood – *Campylobacter jejuni, Listeria monocytogenes, Yersinia enterocolitica* 1.8.4. Eggs – *Salmonella spp. and Staphylococcus aureus* 1.8.5. Milk – *E. coli O157:H7, Staphylococcus aureus, and Yersinia enterocolitica* 1.8.6. Flour – *Salmonella spp.* 1.8.7. Produce – *Campylobacter jejuni, Clostridium perfringens, Clostridium botulinum (canned produce), E. coli O157:H7 (unpasteurized juice), Listeria monocytogenes, and Salmonella spp.* 1.8.8. Spices – *Clostridium perfringens, Salmonella spp., and Bacillus cereus* 1.8.9. Water – *Shigella spp.* ***2. Activity 2: Applying Cleaning Concepts*** 2.1. Teacher/Leader says, "Now that you know some basics about cleaning, we have an activity to apply these concepts." Teacher/Leader distributes the in-class cleaning activity. Teacher/Leader says, "You are going to assume the role of a quality team member in a pretzel facility. You will be helping to establish some cleaning procedures for the facility. Before we start the activity, we are going to watch a video clip of a pretzel facility so you will have a better understanding of what the facility and equipment look like." *2.2. Have students watch 5-minute video clip of pretzel production facility and record parts of the process*	Clean Pete's Perfect Pretzels SSOP Development ***3. Activity 3*** 3.1 Clean take-home activity

that could be affected and why they think there is a risk at that point in the processing. [*https://pretzels-inc.com/*](https://pretzels-inc.com/)

2.3. After watching the video, ask students to identify equipment surfaces where pathogens might be prevalent.

2.3.1. Equipment used for raw ingredient handling (e.g., belts/compartments carrying raw or uncooked ingredients/products; ingredient storage tank interior; mixers; pumps; etc.)

2.3.2. Areas adjacent to processing (surfaces next to conveyor belts; control panels; handles to storage tanks, ingredient buckets; tools like thermometers, scoops, and scrapers)

2.4. Ask students to identify some areas in a food-processing plant that could be contaminated with pathogens.

2.4.1. Floors

2.4.2. Drains

2.4.3. Common areas – cafeterias

2.4.4. Water leaks from ceiling or pipes

2.5. Have students watch Zones video that describes zones 1–4 in a processing facility.

2.6. Teacher/Leader asks students to look at the in-class activity papers for GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operating Procedures) development. Teacher/Leader explains students are going to become members of the Quality Assurance team for a pretzel company, Pete's Perfect Pretzels. Their job is to develop GMPs (Good Manufacturing Practices) and SSOPs (Sanitation Standard Operating Procedures) for the pretzel facility.

2.6.1. Instruct students to assemble in assigned groups and to take out their In-Class Activity: Clean GMP Development worksheet. Read aloud the instructions, and give the students 5 minutes to complete the worksheet. At the end of 5 minutes, ask each group to contribute ideas to the class GMP policy for Pete's Perfect Pretzels.

2.6.2. While still in their groups, have students take out their In-Class Activity: Clean Pete's Perfect Pretzels SSOP Development worksheet. Read aloud the instructions, and give students 10 minutes to complete the worksheet. Have students identify where the ingredient statement can be found on a bag of pretzels and then list pretzel ingredients that could contain pathogenic microorganisms. Provide students with a list of microorganisms and pathogens commonly associated with food processing, common cleaning agents, and methods for verifying cleaning. At the end of 10 minutes, ask each group to contribute ideas to the class SSOP for Pete's Perfect Pretzels.

3. ***Activity 3: Take-Home Activity to Assess Student Comprehension***

3.1. Teacher/Leader explains they are going to continue their exploration of food-handling practices related

	to following clean practices at home. Teacher/Leader distributes Take-Home Activity: Clean and explains students will answer the questions based on what they learned in class today. Teacher/Leader explains students will be asked to answer two questions comparing and contrasting food-processing facilities and home kitchens and to develop a Good Kitchen Practices policy and Kitchen SSOP. Teacher/Leader reminds students they will need to turn in the assignment the following day. Teacher/Leader reminds students to take a photo to represent something they learned during this unit and to work on their final project.	
	Resources	
	Automated Pretzel Production, Pretzels, Inc. *https://pretzels-inc.com/*	

Day	**Principle(s)**	**Unit Objective(s)**
3	In the United States, foodborne illness resulting from lack of safe food-handling practices is responsible for approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths each year. Practicing the four food-safety principles in the USDA Fight BAC! Campaign can improve safe food-handling practices, which will lessen incidents of foodborne illnesses.	Students are able to identify environmental factors required by microorganisms to survive and multiply and to explain how these factors can be controlled to reduce or prevent the survival and growth of microorganisms. Students identify the temperature at which chicken, beef, pork, and leftovers should be cooked in order to kill pathogens, and students identify the temperature at which refrigerators and freezers should be kept. Students are able to explain heat transfer through a product and can explain how heat-transfer- and surface-area-to-volume ratios relate to cooking and cooling foods. Students are able to identify where foods should be stored. Students are able to identify and justify alternative methods for ensuring food is safe for consumers when taking internal food temperatures is impractical or unfeasible. Students are able to differentiate between safe and unsafe food-handling and storage practices and to propose solutions to correct unsafe practices.
	Suggested Pre-Knowledge	
	Basic knowledge of microbiology and chemistry. Basic knowledge of mathematics to calculate surface area, volume, and ratios.	
	State Standards Addressed	

Indiana Department of Education, Advanced Life Science: Foods

Domain – Health, Safety, and Microbiology of Food

Core Standard 5 Students conduct safe food handling, hygiene, spoilage, and quality control to understand temperature controls, species and structure of microbes, shelf-life, food-poisoning, and the socio-economic impact of the food quality.

ALSF-5.2 Explain techniques and procedures for the safe handling of food products

ALSF-5.3 Evaluate food product handling procedures

ALSF-5.4 Describe the importance of performing quality-assurance tests on food products

ALSF-5.8 Characterize the physical, chemical, and biological properties of microbes

ALSF-5.12 Explain the role of chemical reactions, enzymes, and microorganisms in food spoilage, food preservation, and foodborne disease (PU – FS 16100)

ALSF-5.13 Develop personal food-selection and food-handling habits that will minimize risk of contracting foodborne or waterborne disease (PU – FS 16100)

Learning Activities	**Materials List**
1. ***Activity 1: Introduction of Concepts Related to Safe Food-Handling Practices: Chilling, Cooking, and Food Preparation*** 1.1. Teacher/Leader introduces the unit with the cabbage juice activity. 1.1.1. *Cabbage Juice Activity Setup:* 1.1.1.1. At each station, set out (or have available) the following items: 1.1.1.2. 3 5-oz red cabbage juice containers 1.1.1.3. 0.5 oz (15 ml) vinegar 1.1.1.4. 1 tsp (3.5 g) baking soda 1.1.1.5. Stirring rods 1.2. Teacher/Leader will instruct students to assemble in their groups of four. Have students add 0.5 oz of vinegar to one of the 5-oz containers of red cabbage and 1 tsp of baking soda to another one of the 5-oz containers of red cabbage. Students may need to stir the baking soda mixture. 1.3. Ask students to note their observations and why they thought the color change occurred. When students mention pH, respond that the color change did happen due to changes in pH. Teacher/Leader asks students what each color represents. When students respond that the solutions represent acidic and basic solutions (vinegar added to the cabbage turned pink and is acidic, and baking soda added to cabbage turned green and is basic), distribute the pH strips. Teacher/Leader asks students to verify their answers by measuring the pH using pH strips. Cabbage juice is the pH indicator in this experiment and	***1. Activity 1*** 1.1 3 5-oz red cabbage juice containers (per group) 1.2 0.5 oz (15 ml) vinegar (per group) 1.3 1 tsp (3.5 g) baking soda (per group) 1.4 2 stirring rods (per group) 1.5 pH test strips 1.6 Video clip on bacterial growth 1.7 Video clip on temperature control

	should have a pH of around 7. 1.4. Teacher/Leader asks students what role pH plays in food safety. When students respond that it prevents bacteria growth, the teacher/leader should ask which solution(s) would prevent bacterial growth. When students respond with acids (specifically, pH 4.6 and below for high acid foods), ask them what other methods can be used to decrease, slow, or prevent bacterial growth. Answers may include: cooking, refrigerating, freezing, water activity, and cooking. Allow students to guess and justify their responses for 2 minutes. Tell students that temperature/time (cooling and cooking), moisture, and nutrients also impact bacterial growth rates. 1.5. Teacher/Leader asks students how they know if their food is being cooled to the correct temperature in the refrigerator or freezer. Answers may include: thermometer inside the refrigerator or freezer, contents in the refrigerator are cold, or the air in the refrigerator feels cold. 1.6. Teacher/Leader asks students how they know if their food is safe to eat. For example, how do they know if their chicken, hamburger, and leftovers are safe to eat? Answers may include: juices run clear, checking the color, checking the texture, cooking the food at the correct temperature for the recommended time, and using a cooking thermometer. 1.7. *Have students watch a video on key conditions for bacterial growth.* 1.8. Teacher/Leader asks students about methods for checking pH, moisture, and nutrients. Why are these methods not used frequently? Answers may include: difficult to measure, or people do not have correct equipment at home. ***2. Activity 2: Building Concepts – Heat Transfer*** 2.1. Teacher/Leader distributes the color-changing dough. Have students divide the dough into four pieces. One piece should be the reference piece. The second piece should be approximately half the size of the reference piece along all dimensions. The third piece should have the same mass as the reference piece but should be pressed flat. The fourth piece should be of the same size and shape as the reference piece. Tell the students the dough changes color when the dough's temperature reaches 54°F. Have the students place the dough on a sheet of foil on the hot plate. Heat the dough pieces on the hot plate. Dough pieces 1, 2, and 3 should be heated without flipping, and dough piece 4 should be flipped when the dough has changed color approximately half-way up the side of the dough. Have students note how the heat travels through the dough, indicated by the dough changing color. Temperature change should gradually occur vertically through the dough. For each method, have students calculate the surface-area-to-volume ratios they used and record the time it took for heat to transfer through the dough (students will explain how they determined when heat transfer was complete). Have students briefly share their results with the class. Remind students the color change represents heat transfer, not the color change of the food being cooked. The color of the food being cooked does not indicate if the food is cooked thoroughly.	***2. Activity 2*** 2.1 Color-changing dough. 1 batch: 4 cups flour, 1 ½ cups salt, 2 tbsp oil, and 1 cup water, color-changing powder until the desired color is reached. Combine all ingredients. 2.2 Video clip review of heat transfer activity 2.3 In-Class Activity: Chill Dessert Pretzels 2.4 In-Class Activity: Cook Is it safe to eat? ***3. Activity 3*** 3.1 Take-Home Task: Chill, Cook, and Food Preparation

Alternative Activity: Students can design the experiment themselves. Instead of telling the students what sizes and shapes they should make the dough, have the students design an experiment to demonstrate how cooking times differ for different dough geometries. Have students perform the calculations for surface-area-to-volume ratios and record the time it took for heat to transfer through the dough. As a class, discuss the different experiments students tried and their results.

Note: The dough should be kept chilled until right before use. Instruct students to minimize dough handling because the heat from their hands can cause the color to change. Equipment (e.g., plastic knives) can be used to help separate the dough and minimize handling. The dough will need to be chilled to below 54°F before use in subsequent labs.

2.2. Teacher/Leader asks students what implications the different surface-area-to-volume ratios and heating methods have for cooking food. Answers may include: thin food (higher surface-area-to-volume ratios) heats faster, smaller pieces cook faster when the shape is the same, flipping the food to cook both sides increases the cooking rate.

2.3. *Have students watch the temperature control video.*

2.4. Teacher/Leader asks students how their observations of heating food relate to cooling food. Answers may include: thin layers of food cool faster than thick layers of food, exposing food to cooler temperatures above/below/on the sides of containers will increase the rate of cooling.

2.5. Teacher/Leader will have the students work in their groups on the In-Class Activity: Chill Dessert Pretzels and In-Class Activity: Cook Is it safe to eat?. Tell students they will have the remaining class time (about 20 minutes) to complete the activity, and the class will discuss the answers to this activity at the start of the next class. Groups will complete the worksheets based on the table (below). For the Ingredient Identification activity, each group will work on their own worksheet, but two groups will be working on the same question.

<table>
<tr><th>Activity</th><th>Groups 1 and 2</th><th>Groups 3 and 4</th><th>Groups 5 and 6</th></tr>
<tr><td>Ingredient Identification</td><td>Pete’s Dark Chocolate Peanut Butter Pretzel Bites</td><td>Milk chocolate caramel dipped pretzel rods</td><td>Dessert trail mix</td></tr>
<tr><td>Warehouse Inspection</td><td colspan="3" rowspan="2">All questions</td></tr>
<tr><td>Quality Measurements</td></tr>
</table>

	3. ***Activity 3: Take-Home Activity to Assess Student Comprehension*** 3.1. Teacher/Leader explains to students they will continue their exploration of food-handling practices related to following chilling and cooking practices at home. Teacher/Leader distributes Take-Home Task: Chill, Cook, and Food Preparation and explains students should answer the questions on the sheet based on what they learned in class today. Teacher/Leader reminds students they will turn in the homework tomorrow. Remind students to take a photo to represent something they learned during this unit and to work on their final project.	
	Resources	
	https://www.stevespanglerscience.com/lab/experiments/red-cabbage-chemistry/ Chill Out by Fight BAC! http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/safe-food-handling/fighting-bac-by-chilling-out/CT_Index Go 40 or Below by Fight BAC! http://www.fightbac.org/food-safety-education/40-or-below/ American Meat Institute (AMI): www.meatami.org Color of Cooked Ground Beef as it Relates to Doneness/FSIS: https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/meat-preparation/color-of-cooked-ground-beef-as-it-relates-to-doneness/ct_index The Consumer Control Point Kitchen/Iowa State University: www.extension.iastate.edu/foodsafety/educators/ccp.cfm Gateway to Government Food Safety Information: www.foodsafety.gov Food Safety for Teen Cooks/Kids Health: http://kidshealth.org/teen/food_fitness/nutrition/food_safety.html Food Safety for Your Family/Kids Health: http://kidshealth.org/parent/firstaid_safe/home/food_safety.html National Cattlemen's Beef Association: www.beef.org Partnership for Food Safety Education: www.fightbac.org Ten Steps to a Safe Kitchen/Iowa State University: www.extension.iastate.edu/foodsafety/educators/tensteps.cfm?articleID=48&parent=2 The ThermyTM Campaign/FSIS: https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/teach-others/fsis-educational-campaigns/thermy	

Day	Principle(s)	Unit Objective(s)
4	In the United States, foodborne illness resulting from lack of safe food-handling practices is responsible for approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths each year.	Students define and distinguish between cross-contamination and cross-contact. Students explain ways to prevent cross-contamination and/or cross-contact. Students are able to evaluate the food-handling practices of others and identify cross-contamination and/or cross-contact events and other unsafe food-handling practices.

Practicing the four food safety principles in the USDA Fight BAC! Campaign can improve safe food-handling practices, which will lower the number of foodborne illness incidents.	Students are able to collect and synthesize data and reach conclusions based on collected data.

Suggested Pre-Knowledge

Basic knowledge of microbiology and microbial pathogens.

State Standards Addressed

Indiana Department of Education, Advanced Life Science: Foods

Domain – Health, Safety, and Microbiology of Food

Core Standard 5 Students conduct safe food handling, hygiene, spoilage, and quality control to understand temperature controls, species and structure of microbes, shelf-life, food-poisoning, and the socio-economic impact of the food quality.

ALSF-5.2 Explain techniques and procedures for the safe handling of food products

ALSF-5.3 Evaluate food product handling procedures

ALSF-5.8 Characterize the physical, chemical, and biological properties of microbes

ALSF-5.13 Develop personal food selection and food handling habits that will minimize risk of contracting food-borne or water-borne disease (PU – FS 16100)

Core Standard 6 Students draw conclusions about food and food safety

ALSF-6.6 Demonstrate an ability to critically evaluate the validity of information that commonly appears in newspapers, magazines, radio, and television (PU – FS 16100)

Learning Activities	**Materials List**
1. ***Activity 1: Building of Concepts Related to Safe Food-Handling Practice: Wrap-Up Previous Day's Activities (15 minutes)*** 1.1. Teacher/Leader asks students to take out their Dessert Pretzel In-Class Activity from the previous day. Have Groups 1 and 2 share their ideas for ingredient storage, concerns, and justification of their choices. Then have Groups 3 and 4 share, followed by Groups 5 and 6. Work to generate consensus among students.	1. ***Activity 1*** 1.1 Completed in-class activity from the previous day 2. ***Activity 2***

1.2. After sufficient discussion or students reach an agreement, the teacher/leader will have each group share feedback and suggestions for Decadent Dipped Desserts, related to the warehouse observations. Work to generate consensus among students.
1.3. Teacher/Leader asks students to share their quality control answers. Work to generate consensus among students.

2. Activity 2: Building of Concepts Related to Safe Food-Handling Practice: Cross-Contamination

2.1. Teacher/Leader tells students they will now learn about cross-contamination.
2.2. Teacher/Leader asks students to define cross-contamination based on their current understanding of the term.
2.3. Teacher/Leader asks if cross-contamination is the same as cross-contact. Cross-contact involves unintentionally spreading allergens from one surface to another, whereas cross-contamination involves spreading bacteria from one surface to another.
2.4. Teacher/Leader asks students to identify items in their kitchen that could cause cross-contamination or cross-contact. Students may mention cutting boards, knives, dishtowels, and counters.
2.5. Teacher/Leader asks students how they prevent cross-contamination. Answers may include washing the surface with soap and water or using a disinfectant. Ask students if they wash salt and pepper shakers, refrigerator handles, oven-door handles, sink faucets, or raw meat. Teacher/Leader facilitates discussion and promotes correct cleaning and food-handling practices.
2.6. Have students watch the Do Not Wash Chicken video clip.
2.7. https://www.youtube.com/watch?v=JZXDotD4p9c

3. Activity 3: Practice Identifying Cross-Contamination and Other Unsafe Food-Handling Practices

3.1. Leader/Teacher tells students they will watch a video clip of a professional chef preparing a dish. Ask the students to record the cross-contamination/cross-contact events and any other unsafe food-handling practices they see while watching the clip.
3.2. https://www.youtube.com/watch?v=H_9oM1Y60lU
3.3. After students watch the clip, ask them to share their observations. Teacher/Leader facilitates the discussion and works to generate consensus among students related to food-safety practices.

4. Activity 4: Cross-Contamination Investigation

4.1. Leader/Teacher distributes In-Class Activity: Cross-Contamination Pete's Perfect Pretzels P.I.'s (Pretzel Investigators) and says, “Now you will conduct an investigation to determine the source of a cross-contamination event. You will investigate a series of customer complaints received by Pete’s Perfect Pretzels. To conduct the investigation, you may talk with different Pete’s Perfect Pretzels employees (the instructor will have a list of responses from different Pete’s Perfect Pretzels employees). You may

2.1 *Do Not Wash Chicken* video clip

3. Activity 3

3.1 Cross-contamination video clip

4. Activity 4

4.1 In-Class Activity: Cross-Contamination Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)

4.2 In-Class Activity: Cross-Contamination Pete's Perfect Pretzels P.I.'s (Pretzel Investigators) Teacher Notes

5. Activity 5

5.1 Take-Home Task: Cross-Contamination

interview employees in the following departments: sanitation, quality, processing, packaging, warehouse, and record retention. I (leader/teacher) can talk to a maximum of two groups at one time. When not asking questions of employees, you should discuss the current information you have and determine the next employee with whom you would like to speak. You should record the responses you receive on your worksheet, list the source of contamination, and justify your responses. It might not be necessary to talk to all employees to determine the contamination source."

4.2. Allow students to work for the remaining class time on identifying the source of contamination. Tell students you will discuss their investigation results at the start of the next class period. If students have trouble determining the source, the teacher/leader can remind students of different sources of contamination, including an object in the facility, a person, or an ingredient.

5. ***Activity 5: Take-Home Activity to Assess Student Comprehension***

5.1. Leader/teacher explains to students that they are going to continue their exploration of food-handling practices related to cross-contamination at home. Teacher/Leader distributes Take-Home Task: Cross-Contamination and explains students will answer the questions on the sheet based on what they learned in class today. Teacher/Leader reminds students they will need to turn in this sheet tomorrow. Remind students to take a photo to represent something they learned during this unit and to work on their final project.

Resources

https://www.cdc.gov/niosh/topics/body_art/contamination.html

Day	Principle(s)	Unit Objective(s)
5	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Students are able to identify and describe methods for treating food to reduce or eliminate unwanted microorganisms. Students can choose foods that may decrease their chances of contracting a foodborne illness. Students are able to develop a hypothesis and design an experiment to test their hypothesis. Students analyze data from different sources to reach a conclusion and are able to justify their conclusion. Students learn to judge the credibility and identify potential biases of different information sources.

Suggested Pre-Knowledge

Basic knowledge of microbiology and plating techniques.

State Standards Addressed

Indiana Department of Education, Advanced Life Science: Foods

Domain – Health, Safety, and Microbiology of Food

Core Standard 5 Students conduct safe food handling, hygiene, spoilage, and quality control to understand temperature controls, species and structure of microbes, shelf-life, food-poisoning, and the socio-economic impact of the food quality.

ALSF-5.1 Discuss the issues of safety and environmental concerns about foods and food processing

ALSF-5.2 Explain techniques and procedures for the safe handling of food products

ALSF-5.3 Evaluate food product handling procedures

ALSF-5.7 Explain the importance of microbiological tests in food product preparation

ALSF-5.8 Characterize the physical, chemical, and biological properties of microbes

ALSF-5.9 Explain reasons for detecting microbes and identify sources of microbes

ALSF-5.13 Develop personal food selection and food handling habits that will minimize risk of contracting food-borne or water-borne disease (PU – FS 16100)

Core Standard 6 Students draw conclusions about food and food safety

ALSF-6.4 Articulate a personal set of values related to your decisions pertaining to selection of food products for both your personal and your family's consumption (PU – FS 16100)

Learning Activities	**Materials List**
1. ***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practice: Wrap-up of Cross-Contamination (10 minutes)*** 1.1. Teacher/Leader asks each group to share with the class the source of contamination they identified and justification for their answer. If groups came to different conclusions, try to reach a consensus. Allow 10 minutes for discussion.	1. ***Activity 1*** 1.1 Completed in-class activity from previous day 2. ***Activity 2***

	2. *Activity 2: Discussion of Concepts Related to Safe Food-Handling Practice: Choosing Safe Foods* 2.1. Show the salad dressing, guacamole, yogurt, fruit jams, pasteurized juice, and soup to the students. Ask students what these items have in common. If students do not guess the similarity is in processing methods, tell the students these foods are commonly processed using Ultra High Temperature (UHT). *2.1.1. Have students watch the video clip describing UHT.* 2.1.2. *Video clip: https://www.youtube.com/watch?v=wFkVefQJpfq* 2.2. Teacher/Leader asks students what other ways they think food can be handled or treated to reduce or limit bacterial growth. Students may mention canning, dehydrating food, or picking foods without blemishes or defects. When students contribute answers, ask them why they think those methods make foods safer for consumption (i.e., reduced water activity, heat treatment to kill bacteria, pH below 4.6, etc.) 2.3. Show students video clips covering various foods that they can choose in order to decrease their risk of foodborne illness. 2.4. Raw Milk: https://www.drink-milk.com/common-questions/raw-milk/ Produce: https://www.youtube.com/watch?v=Zy_QuxLkr7c Irradiation: https://www.youtube.com/watch?v=pe6AKh_tLys (start at 0:55 seconds) 2.5. Tell students it is their turn to prove or disprove that pasteurized juice is safer than unpasteurized juice. Have students assemble in their lab groups. Distribute In-Class Activity: Choose Experimental Design. Provide students with a container of pasteurized apple juice, a container of unpasteurized apple juice, five sterile swabs, two beakers, two stirring rods, parafilm, nitrile gloves, and five sterile petri dishes containing nutrient agar. Students can pour the juice they need from the larger containers into beakers to transport back to their lab stations. Have students develop a hypothesis about which juice(s) are safe to consume and design an experiment to test their hypothesis. Allow students 15 minutes to answer lab questions, develop a hypothesis, design the experiment, and complete the experiment. Have students incubate their petri dishes for a maximum of 1 to 2 days (depending on their experimental procedure). When students remove their petri dishes from the incubator, have make observations about what they see on their petri dishes. 2.6. While still in their groups, ask students if food manufacturing facilities also need to make safe food choices. Ask students how they think manufacturers make safe food choices. Allow students to propose answers for a few minutes. 2.7. Relate the discussion back to the cross-contamination investigation activity. Ask students to determine what a safe seasoning choice would be for Pete's Perfect Pretzels. Ask students to complete the In-Class Activity: Choose You Decide: Are Spices Safe? as a group. Allow students to complete the exercise in the remaining class time (approximately 15 minutes). Distribute 5 salt and pepper pretzels (e.g., Snack Factory Pretzel Crisps Sea Salt and Cracked Pepper) to each group to represent the product produced by Pete's Perfect Pretzels. This will be the control. Distribute 5 salted pretzels to each group (e.g., Snack	2.1 Salad dressing, guacamole, yogurt, fruit jams, pasteurized juice, and soup (any item that has been processed using UHT) 2.2 UHT video clip 2.3 Video clips on choosing various other safe foods 2.4 In-Class Activity: Choose Experimental Design 2.5 Juice experiment supplies: growth media (enough for class), pasteurized apple juice (enough for the class), unpasteurized apple juice (enough for class), 5 sterile swabs (per group), 2 beakers (per group), 2 stirring rods (per group), parafilm (enough for class), nitrile gloves (enough for class), and 5 petri dishes containing nutrient agar (per group)

	Factory Pretzel Crisps Original). Make essential oil available to students at a common station. Allow students to experiment with the pretzels and essential oil to determine their formulation and to answer corresponding worksheet questions. Ask students to be prepared to discuss their answers at the beginning of the next class period. 3. ***Activity 3: Take-Home Activity to Assess Student Comprehension*** 3.1. Leader/Teacher explains to students they will continue their exploration of food-handling practices related to choosing safe food at home. Teacher/Leader distributes Take-Home Task: Choose Scavenger Hunt and explains students will answer the questions on the sheet based on what they learned in class today. Teacher/Leader reminds students they will turn in this sheet tomorrow. Remind students to take a photo to represent something they learned during this unit and to work on their final project.	2.6 In-Class Activity: Choose You Decide: Are Spices Safe? 2.7 In-Class Activity: Choose: You Decide: Are Spices Safe? Supplies: 5 salt pretzels and 5 salt and pepper pretzels (per group), food/ pharmaceutical-grade black pepper oleoresin (or substitute black pepper essential oil), droppers to dispense the oleoresin. *Pharmaceutical grade black pepper oleoresin or black pepper essential oil can be purchased at retail stores. ***3. Activity 3*** 3.1 Take-Home Task: Choose Scavenger Hunt
	Resources	
	https://www.youtube.com/watch?v=wFkVefQJpfg	
Day	**Principle(s)**	**Unit Objective(s)**

6	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Students define HACCP and can identify the seven principles of HACCP. Students can recall four hazard categories to be considered when conducting a hazard analysis, provide examples of hazards in each hazard category, and list equipment/procedures used to mitigate identified hazards. Students are able to develop a basic process flow diagram to describe a process from initiation to completion. Students are able to conduct a basic hazard analysis.

Suggested Pre-Knowledge

Basic knowledge of microbiology and chemistry.

State Standards Addressed

Indiana Department of Education, Advanced Life Science: Foods

Core Standard 6 Students draw conclusions about food and food safety

ALSF-6.5 Implement a Hazard Analysis and Critical Control Point (HACCP) program for a food-products and processing facility

Learning Activities	Material List
1. Activity 1: Discussion of Concepts Related to Safe Food-Handling Practice: Wrap-Up Choosing Safe Foods 1.1. Teacher/Leader leads student discussion of answers to the previous day's in-class activity. Teacher/Leader will have students share whether they would use spices or oleoresins and provide justification for their choice. Allow 10 minutes for discussion. ***2. Activity 2: Discussion of Concepts Related to Safe Food-Handling Practice: Begin HACCP*** 2.1. Teacher/Leader tells students they will apply all the concepts they have learned to create a Hazard Analysis Critical Control Point (HACCP) plan. Teacher/Leader tells students they will watch 2 videos to learn about the 7 principles of HACCP and to learn about different hazards related to foods. Teacher/Leader distributes Hazard Analysis Critical Control Point (HACCP) Video Notes and tells students they may use the note sheet to take notes on the details of the 7 principles of HACCP and hazards. These notes can be used during their own HACCP analysis. *2.1.1. Have students watch video clip of Hazard Analysis & Critical Control Points (HACCP)_Fulton County*	***1. Activity 1*** 1.1 Completed in-class activity from the previous day ***2. Activity 2*** 2.1 Hazard Analysis Critical Control Point (HACCP) Video Notes 2.2 *Hazard Analysis & Critical Control Points (HACCP)_Fulton*

and then HACCP Food Safety Hazards.

2.1.2. https://www.youtube.com/watch?v=X2kw40KyVnY

2.1.3. https://www.youtube.com/watch?v=lEZbSaikBTw

2.2. After watching the videos, the teacher/leader will have students brainstorm methods to prevent the hazards listed in each category (biological, chemical, physical, and radiological). Answers may include metal detectors, x-ray machines, checking for chemical residue, having policies that prohibit employees from bringing medication into production areas, and choosing ingredient sources to minimize exposure to radiological hazards.

2.3. Teacher/Leader reviews hazard analysis examples with students.

3. Activity 3: HACCP In-Class Activity

3.1. Teacher/Leader distributes In-Class Activity: Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP). Teacher/Leader reviews the simplified process flow diagram of Pete's Perfect Pretzels with students. Teacher/Leader begins walking students through the HACCP examples on the HACCP note worksheet. After talking through the examples, the teacher/leader asks students to work as a class to begin filling in the Hazard Analysis table on the in-class worksheet for Pete's Perfect Pretzels using the examples as guides. Teacher/Leader will facilitate movement through processing steps, identification of CCPs, and methods to control the identified CCPs. Students may review the pretzel production facility shown during the Clean unit to recall the process and equipment used.

4. ***Activity 4: Take-Home Activity to Assess Student Comprehension***

4.1. Teacher/Leader explains to students they will continue their exploration of food-handling practices related to HACCP at home. Teacher/Leader distributes Take-Home Task: HAACP and explains students will answer the questions on the sheet based on what they learned in class today. Teacher/Leader reminds students they will turn in the sheet tomorrow. Remind students to take a photo to represent something they learned during this unit and to work on their final project. If students are working with a food product involving produce, they may want to reference the following resources for additional information about hazards.

4.1.1. https://www.extension.purdue.edu/extmedia/GP/GP-1-W.pdf

4.1.2. https://www.youtube.com/watch?v=7qQCLMFjRew

4.1.3. https://www.youtube.com/watch?v=wO5miD90wMQ

County video clip

2.3 HACCP Food Safety Hazards

3. Activity 3

3.1 In-Class Activity: Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP)

4. Activity 4

4.1 Take-Home Task: HAACP

	Resources	
	https://www.youtube.com/watch?v=X2kw40KyVnY https://www.youtube.com/watch?v=lEZbSaikBTw https://www.extension.purdue.edu/extmedia/GP/GP-1-W.pdf https://www.youtube.com/watch?v=7qQCLMFjRew https://www.youtube.com/watch?v=wO5miD90wMQ	
Day	**Principle(s)**	**Unit Objectives**
7	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Students present their final projects and explain to the class what they have learned by participating in the food-safety education units.
	Suggested Pre-Knowledge	
	N/A	
	State Standards Addressed	
	Indiana Department of Education, Advanced Life Science: Foods Core Standard 8 Students validate the necessity of leadership skills development in conjunction with participation in the national FFA Organization (FFA) and/or Family, Career and Community Leaders of America (FCCLA) as a critical component of the course ALSF-8.1 Acquire and demonstrate communication skills such as writing, public speaking, and listening while refining oral, written, and verbal skills	
	Learning Activities	**Materials List**
	1. Activity 1: Discussion of Concepts Related to Food-Handling Practices: Evaluate Plates from Choose Experiment	***1. Activity 1*** 1.1 Streaked petri dish

	1.1. Teacher/Leader instructs students to check the plates from the experiment they designed in the Choose unit. Have students record their results on their In-Class Activity: Choose Experimental Design. Allow students 5–10 minutes to record their results, answer the questions on the handout, and clean up. After students have had time to review and record results, ask students to share their experimental design, their results, and their conclusions. Discuss strengths of designs and what could be improved. Allow 10–15 minutes for class discussion. ***2. Activity 2: Final Project Presentations*** 2.1. Teacher/Leader tells students they will begin presentations. Have each group present their projects. Allow time for the class to ask questions of each group. Teachers may choose to grade students using a predefined final presentation rubric.	from In-Class Activity: Choose Experimental Design 1.2 In-Class Activity: Choose Experimental Design for students to complete ***2. Activity 2*** 2.1 Student-prepared presentations and appropriate projection equipment

Day	**Principle(s)**	**Unit Objective(s)**
8	Each year in the United States, an estimated 48 million people are affected by a foodborne illness. Of those affected, approximately 128,000 will be hospitalized, and approximately 3,000 will die. Practicing safe food-handling techniques can help reduce the risk of foodborne illness among consumers.	Collect data] to evaluate changes in student food-safety knowledge, attitudes, and behavior after participating in this unit.

Suggested Pre-Knowledge	
N/A	
State Standards Addressed	
Recipes	
Learning Activities	**Materials List**

	1. ***Activity 1: Post-Survey Administration*** 1.1. Teacher/Leader informs students they will conclude the food-safety unit with a post-survey and final cooking activity. Teacher/Leader says, "I would like you to take a post-survey to help determine how much you have learned from our study of food safety." If students ask if the post-survey is for a grade, assure them it is ungraded and encourage them to try their best. 1.2. Teacher/Leader distributes post-survey. Teacher/Leader allows students time to complete the post-survey and monitors them as they work to deter the sharing of information among one another. Teacher/Leader collects students' post-survey after 15 minutes. ***2. Activity 2: Cooking Activity*** 2.1. The lab should be set up, as noted in Activity 2 from Day 1. Students will be asked again to prepare the hamburger recipe, but the recipe will use different seasoning and topping ingredients. Students will have the same lab station assignments. 2.2. Teacher/Leader leads students to the kitchen lab. Students should not bring their books or other materials unless there are places to store these items away from food preparation areas. Once in the lab, the teacher/leader assigns groups to lab stations that have been labeled 1 to 6. Group 1 should be assigned to station 1, group 2 assigned to station 2, etc. 2.3. Once all students are at their cooking stations, the teacher/leader says, "You may begin cooking using the recipe at each of your stations. Once you are finished cooking, you may eat what you have made, but you do not have to eat the food you prepared. You will have 30 minutes to prepare your food. I will keep track of time, and let you know periodically how much time you have left to cook." 2.4. Teacher/Leader monitors students to ensure they are using the kitchen equipment safely. The teacher/leader should not offer cooking advice or help students cook the food. When students are finished cooking and cleaning up the kitchen for the next class, the teacher/leader will dismiss the students. 2.5. Teacher/Leader uses either video footage or observation-checklist method to record students' food-handling behaviors. Pre- and post-cooking observations can be used to evaluate student growth and to help students identify areas of competency and improvement.	***1. Activity 1*** 1.1 Post-survey ***2. Activity 2*** 1.1 Hamburger for each group 1.2 Hamburger buns 1.3 Garnish: lettuce, tomato, pickles, mustard, ketchup, etc. 1.4 Nacho cheese 1.5 Salt and pepper 1.6 Food-handler's gloves 1.7 Salsa (per group): 2 large diced plum tomatoes, ¼ cup chopped white onion, 1 ½ tbsp chopped cilantro, 1 tsp minced jalapeño, ¾ tsp fresh lime juice, ¼ tsp salt 1.8 Cooking thermometers

Lab Cooking Materials

Student Cooking Observation Checklist

Date:_____ Student Name: _____

Food Safety Behavior	Observed behavior						
Wash hands (how)	Never	Water only	Water + soap	Less than 5 seconds	5 – 10 seconds	Between 10 and 20 seconds	More than 20 seconds
Count							
Dry hands (how)	Did not dry	Dry by shaking	Dry on clothes	Dry on fresh cloth	Dry on used cloth	Dry on paper towel	
Count							
Wash hands (when)	Never	Before preparing meal	After handling raw meat	After touching surfaces	After touching body parts	After sneezing / wiping nose / eyes	After handling garbage
Count							
Wash items that contacted raw food (knife, cutting board, skillet, spatula)	Yes	No	Threw away				
Count							
Used clean plate for cooked item	Plate not washed – used to hold raw meat	Plate rinsed or wiped	Plate washed with soap and water	A new, clean plate was used			
Count							
Used thermometer	Did not use a thermometer	Used thermometer incorrectly	Used thermometer correctly				
Count							
Changed gloves (How)	Did not wear gloves	Did not change gloves	Washed gloves with soap and water	Changed gloves, did not wash hands	Changed gloves, washed hands		
Count							

Changed gloves (When)	Never	After handling raw meat	When gloves were torn	After touching surfaces	After touching body parts	After sneezing / wiping nose / eyes	After handling garbage
Count							
Cleaning and sanitizing (How)	Never	Wiped off work surfaces	Wiped surfaces with water	Cleaned surfaces with soap + water, no sanitizing	Cleaned surfaces with soap + water, sanitized		
Count							
Cleaning and sanitizing (When)	Never	Before beginning meal preparation	Soon after a surface was contaminated	At the end of meal preparation			
Count							
Cleaning and Sanitizing (Where)	Stove	Counter	Sink				
Count							
Leaving the Station While Cooking	No	Yes					
Count							
Washing Vegetables	Veg 1 (Researcher to enter name)	Veg 2 (Researcher to enter name)	Veg 3 (Researcher to enter name)	Veg 4 (Researcher to enter name)	Veg 5 (Researcher to enter name)		
Count							

Recipes for Pre-cooking Lab

Recipe Cheeseburger *(per group)*

Ingredients

1 pound ground beef
1 tsp salt
1 tsp black pepper
8 slices American cheese
4 burger buns

Garnish

Ketchup
Mustard
Mayonnaise
Sliced tomatoes
Sliced pickles
Fresh lettuce

Directions

1. In a large bowl, mix ground beef, salt, and pepper until just combined. Do not over mix, or your burger patties will be tough.
2. Divide mixture into four equal portions and form burger patties, without pressing too hard. The burger patties should be uniform in thickness. Smooth out any cracks using your fingers. Make the burger patties right before you cook them so they stay at room temperature for the least amount of time possible.
3. Preheat your pan to high heat and add the burger patties.
4. Cook the burger patties until the crust that forms on the bottom of the burger patty releases it from the pan or grate. Gently test, but don't flip it until it gets to this point. When burger patties lift up easily, flip the burgers. Cook until the internal temperature of the burger patties reaches 160°F, top with two slices of cheese. Melt the cheese on the burger patties.
5. Remove burger patties with a sturdy metal spatula and transfer to a plate. Allow the burger patties to rest for several minutes, and then transfer the burger patties to the buns.
6. Garnish as desired and serve immediately.

Recipe: Zucchini Crisps *(per group)*

Ingredients

2 medium zucchinis sliced into 1/8" rounds
½ tsp salt
½ tsp pepper
1 ½ cups parmesan cheese

Directions

1. Preheat oven to 400°F. Line a metal baking sheet with parchment paper or foil (if using foil, spray lightly with nonstick cooking spray). Set aside.
2. Slice zucchini into thin (about 1/8") slices.
3. *Optional step:* place zucchini slices on paper towels and place a second paper towel on top of the zucchini slices. Gently pat the top paper towel to remove water from the zucchini. This will help them become crispier during baking.
4. Arrange zucchini in a single layer on the prepared baking sheet. It is okay if they are touching as they will shrink during baking. Season with salt and pepper.
5. Place about 1 tsp of parmesan cheese on top of each slice.
6. Bake at 400°F for 20-22 minutes or until golden brown on top.
7. Cool for a few minutes before transferring to a plate.

Recipes for Post-cooking Lab

Recipe Cheeseburger *(per group)*

Ingredients

1 pound ground beef
¼ cup mild or spicy nacho cheese sauce
½ tsp salt
½ tsp pepper
4 hamburger buns, split and toasted

Garnish

Shredded lettuce (cut lettuce into thin strips)
4 green onions, sliced

Directions

1. Divide ground beef into four equal portions and form burger patties, without pressing too hard. The burger patties should be uniform in thickness. Smooth out any cracks using your fingers. Make the burger patties right before you cook them so they stay at room temperature for the least amount of time possible.
2. Sprinkle one side of each burger patty with salt and pepper.
3. Preheat your pan to high heat and add burger patties, salt and pepper side up.
4. Cook until the crust that forms on the bottom of the burger patty releases it from the pan or grate. Gently test, but don't flip it until it gets to this point. When burger patties lift up easily, flip. Cook until the internal temperature of the burger patties reaches 160°F.
5. During the last minute of grilling, spoon 1 tbsp of cheese sauce onto each patty; spread slightly. Allow the cheese to start melting.
6. Remove burger patties with a sturdy metal spatula and transfer to a plate. Allow the burger patties to rest for several minutes, then transfer the burger patties to the buns.
7. Garnish as desired and serve immediately.

Recipe: Salsa *(per group)*

Ingredients

2 large plum tomatoes, diced (yields 1 cup)
$^{1}/_{8}$ cup chopped white onion
1 ½ tbsp chopped fresh cilantro
1 tsp minced jalapeño (remove seeds for lower heat)
¾ tsp fresh lime juice
¼ tsp kosher salt (or to taste)

Directions

1. Combine all ingredients in a bowl.
2. Serve with tortilla chips or as garnish on burger.

In-Class Activities

In-Class Activity: Clean GMP Development

As Pete's Perfect Pretzels' Quality Assurance team, your group has been tasked with developing guidelines for the GMP policy that will promote proper personal hygiene practices among employees. When developing the GMP guidelines, a few topics to consider are proper hand-washing techniques, hand-washing frequencies, when gloves should be worn, and employee hand conditions (fingernail length, open wounds, etc.). You may use the provided GMP example from the Small Scale Food Processor Association as a guide.

You will have 5 minutes to develop your list as a group. At the end of 5 minutes, each group will share their lists to create a class list. The class should try to reach a consensus on which components should be included on the class GMP list.

Pete's Perfect Pretzels GMP Policy

Pete's Perfect Pretzels is committed to producing safe, quality products for our consumers. To maintain quality and safety standards of Pete's Perfect Pretzels, it is important for all employees to abide by the Good Manufacturing Practices (GMP) established in this document.

To produce a safe, quality product, Pete's Perfect Pretzels employees must

1.

Example from Small Scale Food Processor Association
Good Manufacturing Practices (GMP's) Policy

The purpose of this policy is to ensure compliance with current Good Manufacturing Practice (GMP) regulations for foods.

It is the responsibility of all involved personnel at every level of the organization to act immediately if a risk of violating this policy is detected. Department Managers are accountable for compliance with this policy and the General Manager has final authority concerning any GMP issue.

As food handlers, we have a responsibility to our customers to maintain high standards of food safety. To ensure only safe, high quality products are produced, employees must follow all GMP's listed:

1. Personal Hygiene Requirements

Your personal hygiene is very important. All personnel working in the production area are expected to maintain a high degree of personal cleanliness. The following rules apply to you:

1.1. Cleanliness

1.1.1 Nails

- Keep fingernails clean and neatly trimmed. Dirty nails are a popular place for bacteria to hide and grow.
- Nail polish is not permitted in the production area. The polish may flake off and contaminate the product. Bacteria also hide in cracks in the nail polish.

1.1.2 Hair

- You must wear a protective hair net in the production area. There must be no exposed or loose hair protruding from under a hairnet. Hair carries many microorganisms. (1 hair follicle can contain up to 50,000 germs).
- Men with mustaches or beards must cover them fully with a beard net.

1.1.3 Jewelry

- All jewelry, including watches, must be removed when entering the plant. Plain wedding bands without stones or settings are allowed. This is not only to protect our products from contamination, but also to protect you from injury and/or the loss of a valuable possession. (Skin area underneath jewelry is a warm area and together with moisture and a little air, these are ideal conditions for bacteria to grow at a rapid rate).

1.1.4 Hands

Your hands can be the source of many microorganisms. The following rules apply to you: You must wash your hands with soap and water located at each hand washing station:

- when starting work
- after break time
- after lunch
- after using the washroom (the number of bacteria on your fingertips double after using the washroom)
- after blowing your nose
- after handling garbage, after touching a pallet, skid, floor mat or picking up product from the floor
- or whenever your hands have become contaminated

Always dry your hands using the disposable paper towels provided. Never dry or wipe your hands on your clothing as it may be contaminated with microorganisms.

1.2 Protective Clothing

- The protective clothing provided must be changed daily and when necessary throughout the day.

- All soiled laundry must be placed in the laundry receptacles provided. No soiled or dirty laundry is to be left in the production area.
- You cannot carry personal items such as pens, knives, cell-phones, or other small articles in your uniform pockets.

1.3 Gloves

- Wash hands before putting on new pair of gloves.
- Change gloves at every break, when torn, after touching garbage, and after touching your face or blowing nose.
- Change gloves as often as required to ensure food safety.
- Extra gloves are not to be carried in pockets of work clothes due to the probability of gloves falling unnoticed into equipment or finished products.
- All used gloves must be disposed in the garbage cans provided.

2. Hygienic Handling of Products

These are precautions you must take to prevent the contamination of the product you are working with. These precautions are listed below:

2.1. Conduct

Any behavior that could result in the contamination of product is prohibited. This includes:

- Eating, drinking and chewing in production area,
- Chewing gum,
- Spitting,
- Smoking,
- Coughing or sneezing must be directed away from product and must be blocked by shoulder or upper arm.

2.2. Hands

- Wash your hands frequently with hand soap using warm, running water for 30 seconds.
- Refrain from touching your nose or face. If you do – wash your hands.
- If you wear gloves, the same rules apply.
- Wash your hands after removing gloves and before applying new gloves.
- Hand-washing signs and proper techniques are posted in all employee facilities.

2.3. Floor

- Do not let clean utensils or equipment, or your hands touch the floor unless proper cleaning and sanitizing procedures have been performed.
- Do not let product and or packaging material touch the floor – ever.
- If product makes contact with the floor, it must be deemed inedible and placed in the garbage bins.
- Do not place cardboard boxes or bags on the floor. Keep these on skids, stands or packaging tables.

2.4. Product Contact Surface

- Do not place cardboard boxes on product contact surfaces. They have been handled many times and have sat in unsanitary environments making them a potential source of bacteria and physical contamination.

3. Illness and Injuries

If you are ill or injured, you must report the situation to Production Manager or Supervisor or QA designate immediately. The Production Manager or Supervisor or QA designate will assess each situation. You must comply with the following rules:

- All cuts, sores, scratches or other wounds must be covered with a waterproof covering such as blue band-aid which is firmly secure. The microorganisms from an infected cut are easily transferred to the products you handle. Glove must be worn on top of band-aid or bandage.

- There must be no coughing or sneezing freely in the production area. Microorganisms are readily transferred by the spray droplets and mucous from coughs and sneezes. Block sneezes and coughs by using your shoulder or upper arm.
- If you block a sneeze or a cough with your hands immediately dispose of gloves, then wash and sanitize your hands.
- If you are suffering from or are a carrier of an infectious illness (i.e. vomiting or diarrhea) you must notify your Supervisor immediately. You may not work in a production area and may be assigned to "modified work" in a non-critical area.

4. Cross – Contamination

4.1. Protective Clothing and Hairnets

- Protective clothing is not to be worn in the lunchroom, washrooms or outside the building.
- Production coats are not to leave the production area and should be hung on hooks provided. This is to prevent cross contamination of foreign and potential harmful bacteria to the production area that could cause spoilage and/or food poisoning.

4.2. Limited Access / Traffic and Air Flow

- All doors must be kept closed.

4.3. Housekeeping

- Garbage must be emptied on a regular basis to prevent overflowing.
- The floor must be free of trash, broken pallets, spilled products, etc.
- A dry sweep is to be done if required during production.
- All products must be removed from an area if a wet wash is required during breaks.
- Pallets and plastic crates must be neatly stacked and must not be left up against a wall.

4.4. Tools and Equipment

4.4.1. Squeegees

- Use squeegee to remove water from the floor.
- Never use a squeegee to remove water from food contact surfaces. This action would cause cross-contamination of bacteria from the floor to the food contact surface via the squeegee. Harmful bacteria can come into contact with the mix being handled on that surface resulting in early spoilage and potential food poisoning.

4.4.2. Rags

- Rags are not permitted. Rags harbor bacteria in the cloth material and over a short time the bacteria can multiply and cross contamination can occur resulting in early spoilage and/or food poisoning.
- Disposable paper or jay cloths are the only tools allowed to clean food contact surfaces. Excess water can be removed by tipping the tabletop surface initially and then removing the water left by using the disposable paper towels provided.

4.5. Facilities

4.5.1. Washrooms/Change Rooms

- The washrooms are equipped with clean, modern washroom facilities. You are expected to help keep these facilities clean since they are part of our work home. Prior to using the washroom facilities, you must remove your protective clothing and hang it on the hooks provided at the designated location. This will eliminate any contamination of our work clothes as we enter the washrooms. Do not forget to wash your hands after using the washroom.
- The change room/locker facility is for street clothing and personal belongings and must not store any food, work clothing or equipment (i.e. gloves, aprons, etc.)
- All footwear is to be stored on shoe racks in change rooms.

4.5.2. Lunchroom

- To maintain a food safe environment for employees to enjoy lunch and breaks, the lunchroom should be kept clean and tidy at all times. Personal coffee mugs, containers and utensils must not be left dirty in the sink.

4.6. Access

- Enter building through designated staff entrance.
- Proceed to change room and remove street cloths. Put on work cloths and put on production footwear and then proper uniform. Punch in your timecard and put on hair net.
- Proceed to wash hands (30 seconds).
- Exit is the exact reverse of the entrance procedure.
- Visitors must register at reception desk prior to entry and must be accompanied by authorized employee.

4.7. Chemicals

- Only authorized personnel are allowed to use chemicals.
- When not in use, the chemicals must be stored in chemical storage in the designated area.

Example from Small Scale Food Processor Association [14]

In-Class Activity (10 minutes): Clean
Pete's Perfect Pretzels SSOP Development

As Pete's Perfect Pretzels' Quality Assurance team, you have been tasked with developing a Sanitation Standard Operating Procedure (SSOP) for the pretzel-processing area. The pretzel-processing area includes dry ingredient storage containers as well as all the equipment shown in the video clip. As a group, your task is to determine the points in the process that require cleaning, which pathogen or microorganism will be targeted, the cleaning method, cleaning frequency, potential cleaning challenges, methods to verify the area is clean, and frequency of verification.
You may use any resources you choose to create your SSOP.

Provided Resources

- References have been provided that outline potential pathogens, cleaning agents, and cleaning verification methods to consider. To establish cleaning and cleaning-verification frequencies, you might want to consider the risk of foodborne illness, time to clean/verify, and cost.
- You may use the FSIS USDA SSOP example as a guide.
- A planning table has been provided to help you think through different areas of the facility that must be cleaned.

After 10 minutes, all groups will discuss their SSOP's to generate a class SSOP. Try to reach a consensus when making the class SSOP.

SAMPLE – SANITATION STANDARD OPERATING PROCEDURE (SSOP)

XYZ Meat Packers, Inc. is a red meat processing establishment. This plant receives beef and pork for further processing. This plant cuts and grinds product and also packages it.

MANAGEMENT STRUCTURE Owner – Plant Manager – Team Captains –

The Team Captains are responsible for implementing and daily monitoring of Sanitation SOP and recording the findings and any corrective actions. The Team Captains are responsible for training and assigning specific duties to other employees and monitoring their performance within the Sanitation SOP. All records, data, checklists, and other information pertaining to the Sanitation SOP will be maintained on file and made available to inspection personnel.

1. Preoperational Sanitation – Equipment and Facility Cleaning Objective

1.1. All equipment will be disassembled, cleaned, and sanitized before starting production.

1.1.1 Establishment sanitary procedure for cleaning and sanitizing equipment.

- All equipment will have product debris removed.
- Equipment will be rinsed with water to remove remaining debris.
- An approved cleaner will be applied to equipment and properly cleaned.
- Equipment will be sanitized with approved sanitizer and rinsed with potable water.
- The equipment is reassembled.

1.1.2 Implementing, Monitoring and Recordkeeping

- Team Captains perform daily organoleptic sanitation inspection after preoperational equipment cleaning and sanitizing. The results will be recorded on a Preoperational sanitation form. If found to be acceptable, the appropriate line will be checked. If corrective actions are needed, such actions will be documented.

1.1.3 Corrective Actions

- The Team Captains determines that the equipment on hand does not pass organoleptic examination, the cleaning procedure and inspections are repeated. The Team Captains monitor the cleaning of the equipment on hand and retrains employees if necessary.
- Corrective actions are recorded on pre-operational sanitation forms.

1.2. Cleaning of Facilities including floors, walls, and ceilings.

1.2.1. Cleaning procedures:

- Debris is swept up and discarded.
- Facilities are rinsed with potable water.
- Facilities are cleaned with approved cleaner.
- Facilities are rinsed with potable water.

1.2.2. Cleaning of floors and walls are done at the end of each production day. Ceilings are cleaned as needed.

1.2.3. Establishment monitoring

- The Team Captain performs daily organoleptic inspection before operation begins. Results are recorded on a preoperational sanitation form.

1.2.4. Corrective action

- When the Team Captain finds that the facilities do not pass organoleptic inspection, the cleaning procedures and inspections are repeated. The Team Captain inspects the cleaning of the facilities and retrains employees as needed. Corrective action to prevent direct product contamination or adulteration are Recorded on Pre-operational sanitation forms.

2. OPERATIONAL SANITATION—EQUIPMENT AND FACILITY CLEANING OBJECTIVE

2.1. Processing is performed under sanitary conditions to prevent direct and cross contamination of the product.

2.2.1. Sanitary procedures for processing.

- Employees clean and sanitize hands, gloves, knives, other hand tools, cutting boards, etc., as necessary during processing to prevent contamination of products.
- All equipment, tables and other product contact surfaces are cleaned and sanitized throughout the day as needed.
- Outer garments such as aprons and gloves are hung in designed areas when employees leave processing area. Outer garments are maintained in a clean and sanitary manner and are changed at least daily and more often if necessary.

2.2.2. Monitoring and Recordkeeping.

- The Team Captains are responsible for ensuring that employees' hygiene practices, sanitary handling procedures and cleaning procedures are maintained. The Team Captain monitors the sanitation procedures during the day. Results are recorded on an Operational Sanitation Form daily.

2.2.3. Corrective Action

- The Team Captain identifies sanitation problems and stops production if necessary and notifies processing employees to take appropriate action to correct sanitation problems. If necessary, processing employees are retrained and corrective actions are recorded on Operational Sanitation form.

Example from FSIS USDA [15]

Pathogen References for Students

Campylobacter jejuni

3rd leading cause of bacterial foodborne illness in the U.S.
Disease: Campylobacteriosis
Entry Route: Oral

Organism
- Non-spore forming
- Gram-negative rod
- Curved-shaped or S-shaped
- Many strains have flagellum and display motility
- Microaerophilic with optimum growth in environments with an oxygen concentration of 3-5%
- Fragile in ambient conditions

Sources
- Primarily found in raw poultry, unpasteurized "raw" milk, products derived from unpasteurized milk like cheese, contaminated water.
- Other sources include seafood, vegetables, and other meats.

Symptoms
- Usually last 2-10 days
- Major symptoms: fever, diarrhea, abdominal cramps, and vomiting
- Other symptoms: abdominal and muscle pain, nausea, and headache

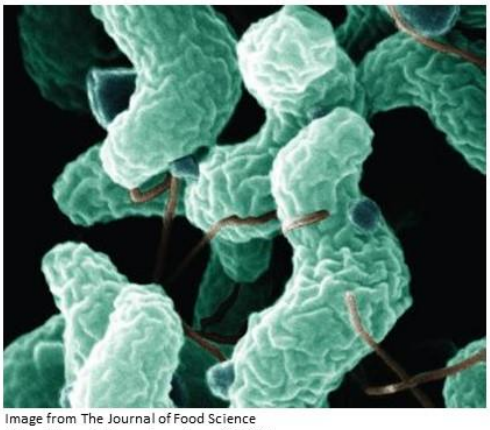


Image from The Journal of Food Science
(https://www.fstjournal.org/news/28-1/3)

Susceptible to
Drying, heating, freezing, acidic environments, disinfectants

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Clostridium botulinum

Found most often in home-canned foods that have not been correctly processed
*Disease: Botulism and *infant botulism (not covered in these notes)*
Entry Route: Oral

Organism
- Spore forming
- Gram-positive rod
- Heat resistant spores
- ng of toxin can cause illness
- Many strains produce a single toxin, but some strains can produce two toxins

Sources
- Variety of foods support growth and toxin production (almost any non-acidic food)
- Examples: canned vegetables, canned soup, lunch meat, tuna fish, and chicken

Symptoms
- Onset usually 18-36 hours after ingesting contaminated food
- Initial symptoms: double or blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, and muscle weakness
- Progressive symptoms: paralysis of arms, legs, trunk, and respiratory muscles

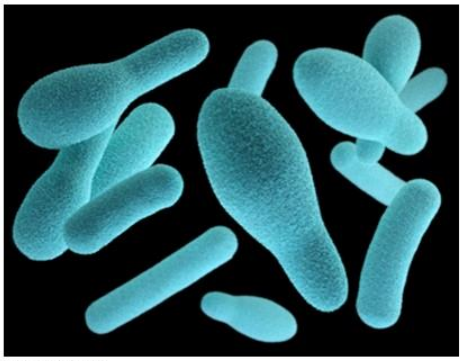


Image from CDC
(https://www.cdc.gov/media/subtopic/library/diseases.htm)

Susceptible to
Heating, acidic environments (pH ≤ 4.6), salt concentrations of 4-5% (5% salt concentrations completely inhibit spore growth)

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Clostridium perfringens

2nd leading cause of bacterial foodborne illness in the U.S.
*Disease: Gastroenteritis and *enteritis necroticans (rare in the U.S.)*
Entry Route: Oral

Organism

- Spore forming
- Gram-positive rod
- Anaerobic (but aerotolerant)
- Produces enterotoxin
- Heat resistant and relatively cold resistant
- Infective dose >10^6 vegetative cells or spores
- High multiplication rate (much faster than most other bacteria)

Image from CDC (https://www.cdc.gov/foodsafety/diseases/clostridium-perfringens.html)

Sources

- Major sources: meat (especially beef and poultry), meat-containing products (gravies and stews)
- Other sources: vegetable products, spices and herbs, raw and processed foods
- Can multiply rapidly on foods, meaning unrefrigerated food that has been contaminated can contain high doses *Clostridium perfringens*.

Susceptible to

Heating (spores can survive) and refrigerating

Symptoms (gastroenteritis form)

- Milder form: usually last 12-14 hours,
- In infants or the elderly: may last 1-2 weeks
- Major symptoms: watery diarrhea and mild abdominal cramps

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Enterohemorrhagic *Escherichia coli* (EHEC) O157:H7

O157:H7 accounts for approximately 75% of EHEC infections in the world
Disease: Hemorrhagic colitis
Entry Route: Oral

Organism

- Gram-negative rod
- Produces (Shiga-toxin)
- Serotype O157:H7 is one of several EHEC strains that causes foodborne illness
- Infective dose is approximately 10-100 cells
- Can develop acid tolerance

Image from CDC (https://www.cdc.gov/ecoli/images/ecoli-1184px.jpg)

Sources

- Ground meats, unpasteurized "raw" milk, unpasteurized fruit juice, lettuce, spinach, sprouts, and commercially produced frozen cookie dough

Susceptible to

Heating, can be removed from food surfaces by washing

Symptoms

- Usually last 2-9 days with an average of 8 days in uncomplicated cases
- Major symptoms: severe cramping (abdominal pain), nausea or vomiting, and diarrhea that initially is watery, but becomes bloody. Fever is typically low-grade or absent. Can progress to Hemolytic uremic syndrome (HUS) and kidney failure.
- May be transmitted from person to person

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Listeria monocytogenes

One of the leading causes of death from foodborne illness
Disease: Listeriosis
Entry Route: Oral

Organism
- Gram-positive rod
- Facultative
- Has flagella and is motile
- Hardy: salt-tolerant and can grow in temperatures below 1°C (34 °F)
- Persistent in food-manufacturing environments

Sources
- Unpasteurized "raw" milk, smoked fish and other seafood, meats (including deli meats), raw vegetables

Symptoms
- Non-invasive gastrointestinal illness: onset usually a few hours to 2-3 days
- Invasive form (more severe): onset can vary from 3 days to 3 months
- Infections tend to be host-dependent and can symptoms can vary. Otherwise healthy people might have mild symptoms or no symptoms. Others may experience fever, muscle aches, nausea, vomiting, and diarrhea. Severe infections can spread to the nervous system and cause headache, confusion, loss of balance, and convulsions.
- Pregnant women are highly susceptible.

Image from CDC (https://www.cdc.gov/listeria/index.html)

Susceptible to
Heating, can be removed from food surfaces by washing

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Salmonella spp.

Has caused large outbreaks in the U.S.
Disease: Nontyphoidal salmonellosis and typhoid fever
Entry Route: Oral

Organism
- Non-spore forming
- Gram-negative rod
- Motile
- Hard to wash off food
- *Salmonella enterica* is the most significant to public health of the *Salmonella spp*.
- Infective dose in for nontypodial Salmonellosis can be 1 cell depending on the strain and the host's age and health
- Infective dose for typhoid fever is fewer than 1,000 cells

Sources
Nontyphodial Salmonellosis: Meat, eggs, fruits, vegetables, spices, tree nuts, cocoa
Typhodial Salmonellosis: usually associated with sewage-contaminated water
Some pets can carry *Salmonella* such as turtles (and other reptiles) and chicks

Symptoms
Nontyphodial Salmonellosis
- Onset usually 6-72 hours and duration is usually 4-7 days
- Major symptoms: nausea, vomiting, abdominal cramps, diarrhea, fever, headache

Typhoid Fever
- Onset usually 1-3 weeks, but may be up to2 months after exposure and duration is usually 2-4 weeks
- Major symptoms: high fever (103°F-104°F), gastrointestinal symptoms, loss of appetite, achiness, and sometimes development of a rash

Image from CDC (https://www.cdc.gov/salmonella/)

Susceptible to
Heating and refrigerating

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Shigella spp.

Humans are the only host of Shigella
Disease: Shigellosis
Entry Route: Oral

Organism
- Non-spore forming
- Gram-negative rod
- Non-motile
- Very sensitive to environmental conditions and die rapidly
- Can survive in (and sometimes can grow in) foods with lo pH
- Some strains produce enterotoxins and Shiga toxin
- Infective dose: 10-200 cells, depending on age and condition of host

Sources
- Spreads from contaminated feces. *Shigella* often spreads through unclean water. Food handlers who have fecal matter contaminated with *Shigella* on their hands can spread *Shigella* to the food and consumer.

Symptoms
- Onset is usually 8-50 hours and duration is usually lasts 5-7 days
- Major symptoms: abdominal pain; cramps; diarrhea; fever; vomiting; and pus or mucus in stools
- Illness is usually mild. Young children, the elderly, and people with weakened immune systems are more likely than others to develop more severe illness.

Image from CDC (https://www.cdc.gov/shigella/index.html)

Susceptible to
Heating and proper washing of hands and food products

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Staphylococcus aureus

One of the most resistant non-spore-forming human pathogens
Disease: Staphyloenterotoxicosis, staphyloenterotoxemia
Entry Route: Oral

Organism
- Gram-positive
- Non-motile
- Mesophilic
- Small, spherical bacterial (cocci) which appear in pairs, short chains, or bunches under the microscope
- Can survive for extended periods in a dry state
- Can make enterotoxins that might not be destroyed during cooking

Sources
- Meat and meat products, poultry and egg products, salads (egg, tuna, chicken, potato, and macaroni), bakery products (cream-filled pastries and cream pies), sandwich fillings, and milk and dairy products

Symptoms
- Usually last 1-7 hours and duration is usually only a few hours to one day
- nausea, abdominal cramping, vomiting, and diarrhea. In mMajor symptoms: ore severe cases, dehydration, headache, muscle cramping, and changes in blood pressure and pulse rate can occur

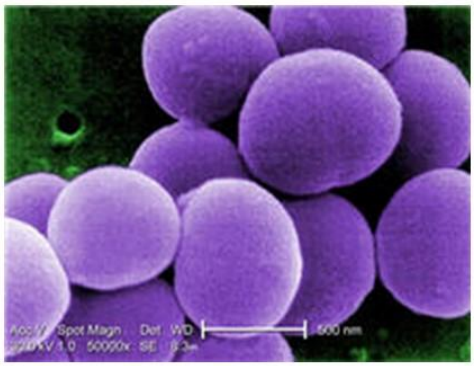


Image from CDC (https://www.cdc.gov/hai/organisms/staph.html)

Susceptible to
Heating, refrigeration, and proper washing of foods, equipment, and hands

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition

Yersinia enterocolitica

Fatalities are extremely rare
Disease: Yersiniosis
Entry Route: Oral

Organism

- Gram-negative rod
- Psychrotrophic and can grow at temperatures below 4°C (39 °F)
- Can withstand freezing and can survive in frozen foods for extended periods
- Persists longer in cooked foods than in raw foods
- Can grow at pH range of 4-10

Image from CDC (https://www.cdc.gov/yersinia/)

Sources

- Meats (pork, beef, lamb, etc.), oysters, fish, crabs, and unpasteurized "raw" milk.
- Passed from contaminated hands.

Symptoms

Onset is usually 1 day to 2 weeks and duration is usually a few days to 3 weeks
Major symptoms: high fever, stomach pain, diarrhea, and vomiting.
Other symptoms: arthritis-like symptoms (joint pains and rashes) or complications that may affect the heart

Susceptible to

Heating, refrigerating slows growth, and washing hands and raw fruits and vegetables

Information from FDA Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins, Second Edition and CDC Yersinia enterocolitica (Yersiniosis) https://www.cdc.gov/yersinia/

Chemical and Testing Reference Sheet

Cleaner/Degreaser

Product	Description	Cost
Chemical A: All-Purpose Liquid Cleaner	▪ Can be applied to concrete, doors, floors, stainless steel, tile, and walls ▪ Biodegradable ▪ Non-toxic if taken orally ▪ Non-flammable and non-corrosive ▪ Safer alternative to caustic cleaners and solvents ▪ Concentrate (must dilute before use)	$18.80/gal (for 5-gallon container) $15.28/gal (for 55-gallon container)
Chemical B: Liquid Cleaner/Degreaser	▪ Use on metal ▪ Biodegradable ▪ Ready to use (no dilution required before use) ▪ Non-toxic	$18.00/gal (for 1-gallon container) $16.88/gal (for 55-gallon container)
Chemical C: Liquid All-Purpose Cleaner	▪ General-purpose cleaner, doors, lockers, stainless steel, tile, walls ▪ Application: hard to remove grease and soil, washable surfaces ▪ Ready to use ▪ Biodegradable ▪ Acute oral toxicity (harmful if swallowed)	$32.69/gal (for 5-gallon container)

Chemical and Testing Reference Sheet

Disinfectants/Sanitizers

Product Name	Description	Cost
Quaternary Ammonium Compounds (QACs or Quats)	▪ Can kill a broad microbial range but cannot effectively eliminate spores ▪ Kills gram-positive bacteria better than gram-negative bacteria ▪ Application involves wiping the solution in food contact surfaces and letting it dry ▪ Usually non-corrosive and relatively non-toxic to users	$16.19/gal (price for 4 gallons)
Hypochlorites	▪ Effective, easily available, and cheap ▪ Cannot kill spores easily ▪ Requires high chemical concentrations and long application times at high temperatures to kill spores ▪ Efficacy reduced when pH is not within 5–7 range ▪ Possibly harmful to health and to the environment ▪ Spontaneous combustion possible when organic materials such as paper, cloth, and sawdust come into contact with hypochlorite	$29.00/gal (price for 1 gallon – 4L) $9.40/gal (price for 53 gallons – 200L)
Peroxyacetic Acid (PAA)	▪ Usually paired with stabilized hydrogen peroxide ▪ Combination more active than hypochlorites ▪ Can kill microbes in cold temperatures ▪ Can kill spores and a wide range of microbes ▪ Safety hazard at high concentration levels due to rapid PPA oxidation ▪ Environmentally friendly and breaks down into water, acetic acid, and oxygen ▪ Less corrosive on equipment than hypochlorites	$90.16/gal (price for 32 oz)
Chlorine Dioxide	▪ Effective against viruses, bacteria, and fungi ▪ Requires on-site solution preparation ▪ Involves use of expensive equipment to prepare solution ▪ Can selectively target compounds found in microbial cells ▪ Decreased efficacy possible as organic material concentrations increase ▪ Not harmful to the environment ▪ Remains effective at higher pH levels between 6 and 10	$24.99/gal (price for 1 gallon)
Iodophors	▪ Effective in slightly acidic to acidic pH levels ▪ Decreased efficacy as pH levels become neutral ▪ Environmentally friendly and has the approval of EPA ▪ Has a sustained release effect (killing microbes steadily over time), which allows surfaces to remain clean and sanitized longer compared to other methods	119.92/gal (price for 16 oz)

[14-16]

Chemical and Testing Reference Sheet

Testing Supplies

Product Name	Description
ATP Swabs for Organic Material	▪ Detects the amount of residue or organic matter, including bacteria, yeast, and mold left on a surface ▪ Provides a near-instant measurement ▪ Reports a numeric value ▪ Testing completed in-house
ATP Swabs for Protein	▪ Provides relatively quick measurement of general cleaning by reporting the amount of protein left on the surface ▪ Color change in protein swabs to indicate presence of proteins ▪ Testing completed in-house
ATP Swabs for Allergens	▪ Can detect the target allergen in ingredients, liquids, finished foods, and on environmental surfaces ▪ Kits available for different allergens (dairy, egg, soy, various nuts, etc.)
Environmental Swabs (Aerobic plate count, coliforms, *Salmonella*, *Listeria*)	▪ Sponge containing nutrient broth ▪ Qualified employee swabs designated areas ▪ Plate in-house for aerobic plate count (one day of incubation) and coliforms (two days of incubation) ▪ Pathogenic swab analysis completed at third-party lab (outside of plant)
Pathogen testing of ingredients and final products	▪ Samples of final product and/or ingredients collected and sent to third-party lab (outside of plant) for analysis ▪ Samples taken by qualified employee

Planning Sheet for Sanitation Standard Operating Procedure

Category (e.g. ingredient storage, processing equipment, area adjacent to equipment)	**Cleaning Method** (e.g. name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying, etc.)	**Cleaning Frequency** (e.g. daily, weekly, monthly, after running a certain product, etc.)	**Potential Cleaning Challenges** (e.g. equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried, etc.)	**Method to Verify Area is Clean** (e.g. ATP swabs, environmental swabbing, visual inspection, etc.)	**Frequency of Cleaning Verification** (e.g. daily, weekly, monthly, after running a certain product, etc.)	**Record** (e.g. cleaning log, pre-operation checklist, etc.)	**Corrective Action if Cleaning is not Properly Completed** (e.g. retrain employees, review chemicals used, have engineering team redesign/adjust equipment, etc.)

Category (e.g. ingredient storage, processing equipment, area adjacent to equipment)	**Cleaning Method** (e.g. name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying, etc.)	**Cleaning Frequency** (e.g. daily, weekly, monthly, after running a certain product, etc.)	**Potential Cleaning Challenges** (e.g. equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried, etc.)	**Method to Verify Area is Clean** (e.g. ATP swabs, environmental swabbing, visual inspection, etc.)	**Frequency of Cleaning Verification** (e.g. daily, weekly, monthly, after running a certain product, etc.)	**Record** (e.g. cleaning log, pre-operation checklist, etc.)	**Corrective Action if Cleaning is not Properly Completed** (e.g. retrain employees, review chemicals used, have engineering team redesign/adjust equipment, etc.)

In-Class Activity: Chill Dessert Pretzels

Pete's Perfect Pretzels would like to work with Decadent Dipped Desserts to produce a line of dessert pretzels. The two companies are working on three different dessert pretzel recipes (below). As a member of the Pete's Perfect Pretzels' Quality Assurance team, you have been asked to inspect the Decadent Dipped Desserts facility to ensure the facility's products will meet quality and safety standards. You have been tasked with completing an evaluation of ingredient storage.

The table below includes a description of each product and a simplified ingredient list. Your task is to complete the ingredient storage conditions column with the proper storage location for each ingredient, concerns that would drive storage location like microbial growth or shelf-life associated with the ingredient, and the justification for your choice of storage conditions.

Name	Description	Ingredients List	Ingredient Storage Conditions (Ambient, Refrigerator, or Freezer)	Concern (Potential Microorganism, shelf-life, bloom, etc.)	Justification
Pete's Dark Chocolate Peanut Butter Pretzel Bites	Lightly salted pretzel rods coated in dark chocolate	Peanut-butter-filled pretzels 1. Pretzel 2. Peanut butter Dark chocolate 1. Unsweetened chocolate 2. Cocoa butter 3. Sugar			
Milk chocolate caramel dipped pretzel rods	Lightly salted pretzel rods dipped in caramel and covered in milk chocolate	Pretzel rods Caramel 1. Brown sugar 2. Sweetened condensed milk 3. Unsalted butter 4. Salt 5. Vanilla Milk chocolate 1. Sugar 2. Cocoa butter 3. Unsweetened chocolate			
Dessert trail mix	Lightly salted mini pretzel twists, dried blueberries, and strawberry- chocolate bites (small squares of milk chocolate with strawberry filling)	Mini pretzel twists Dried blueberries Milk chocolate (same as above) Strawberry filling 1. Strawberry puree 2. High fructose corn syrup 3. Citric acid			

In-Class Activity: Dessert Pretzels (cont.)

While walking around the warehouse at Decadent Dipped Desserts, you make the following observations:

1. Employees responsible for receiving temperature-sensitive ingredients are checking the temperature of the delivery vehicles to make sure the temperature with the vehicle is within the acceptable range for the received product.
2. Full pallets of butter (stacked in cases) have just been delivered and have been placed in the refrigerator until an employee can move them to their new location in the warehouse. The cases of butter are touching one another, both on the pallet and across pallets. All warehouse employees are currently busy or at lunch and will not move or relocate the butter within the next hour.
3. Employees entering and leaving the refrigerator section of the warehouse sometimes forget to close the doors. It is summer, and the warehouse may become hot. You check the temperature data logger in the refrigerated room and see that the temperature has climbed to the acceptable upper-temperature limit twice in the last week.

What feedback would you provide the Quality/Management team at Decadent Dipped Desserts to ensure the products they make for Pete's Perfect Pretzels will be safe and high-quality? Feedback can include what Decadent Dipped Desserts is doing well and areas for improvement.

For identified improvement areas, what are some possible solutions?

In-Class Activity: Cook
Is it safe to eat?

You have been asked to evaluate the safety of your finished product with respect to pathogens such as *Salmonella*, which has been known to contaminate flour. To determine if your product is safe, you review the current tests conducted on pretzels. Identify which tests are beneficial in determining product safety and justify your answer. Propose additional testing or procedures you would use to make sure your pretzels are safe to consume.

Questions to Consider: Can the internal temperature of the final product be determined? If no, what are some ways you can use to justify the safety of your product?

Current Tests Performed	Beneficial to Food Safety	Justification
Moisture analysis on finished pretzel		
Color analysis on finished pretzel		
Salt content on finished pretzel		
pH of finished pretzel (pH results are usually basic due to dipping pretzel in an alkaline solution)		
% Breakage		
Dimensions (diameter, length, width)		

Proposed New Tests	How Test Benefits Understanding of Product Safety	Justification

In-Class Activity: Cross-Contamination
Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)

Pete's Perfect Pretzels' customer service department has recently received customer complaints about consumers feeling ill after eating some of Pete's Perfect Pretzels products. Customers' symptoms have included fever, nausea, vomiting, and stomach cramps. The products consumers have eaten include Pete's Salt and Black Pepper Nuggets, Pete's Sour Cream and Onion Nuggets, and Pete's Dark Chocolate Peanut Butter Pretzel Bites. The table below can be used to organize information from your investigation. Note that the three products all have the same base ingredients (flour, salt, corn oil, yeast, etc.), and are stored in the same area. You may interview employees in the following departments: sanitation, quality, processing, packaging, warehouse, and record retention.

Product Name	Production Date and Time	Ingredient Storage	Processing Equipment/Area	Other Relevant Information
Pete's Salt and Black Pepper Nuggets				
Pete's Sour Cream and Onion Nuggets				
Pete's Dark Chocolate Peanut Butter Pretzel Bites				

In-class Activity: Cross-contamination
Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)

Clues for the teacher to provide to students during the activity.

Sanitation:
Talking with Sanitation employees provided the following information.

1. Nothing out of the ordinary was noticed by the Sanitation employees. Line 5 needed to be recleaned, but the line passed visual inspection and ATP swabbing after the second cleaning and sanitizing attempt.

Quality:
Talking with Quality employees yielded the following information.

1. The lines where the affected products had been produced were visually inspected and ATP swabs were done. Lines 6 and 7 passed on the first inspection and swabbing, but Line 8 did not. There was peanut butter left in the extruder die after cleaning. Sanitation was notified, and the die was recleaned. The die passed Quality visual inspection and ATP swabbing on the second attempt.
2. Quality had also sampled the lot of peanut butter used in the affected peanut butter pretzels and sent the sample to a third-party lab to test for the presence of *Salmonella*. The results indicated that no *Salmonella* was present in the peanut butter. The correct sample size of peanut butter was collected per the company-established ingredient sampling procedure.

Processing:
Talking with Processing employees who worked during the production of the three items provided the following information.

1. The employee working on the peanut butter pretzel line noticed that the employee from the salt and black pepper pretzel line was opening black pepper bags near the peanut butter pretzel line. Black pepper was being released into the air when the employee from the salt and black pepper pretzel line opened the black pepper bags to add more seasoning to the line. The employee on the peanut butter pretzel line did not want black pepper to get on the peanut butter pretzels because the black pepper would change the flavor of the peanut butter pretzels. The employee on the peanut butter pretzel line visually checked the line to make sure no black pepper was on the peanut butter pretzel line.
2. The primary employee on the black pepper pretzel line had a new employee shadowing. The primary employee noticed the new employee was opening the black pepper bags near the peanut butter pretzel line. Black pepper was seen in the air where the black pepper bags were being opened. The primary employee helped the new employee relocate the black pepper bags closer to the salt and black pepper pretzel line and showed the new employee how to reduce black pepper release when opening bags.
3. The employee working on the sour cream and onion pretzel line noticed that there was black pepper on the outside of the sour cream and onion seasoning. The employee had brushed off the black pepper with his hands and did not wash his hands before dumping/scooping the sour cream and onion seasoning onto the processing line.

Packaging:
Talking to the Packaging employees provided the following information.

1. The Packaging employees did not notice anything out of the ordinary during the timeframe in which the affected products were packed. All packaging materials and products being packed looked normal.

Warehouse:
Review of the Warehouse and talking to warehouse employees yielded the following information.

1. Peanut butter was stored correctly. There were no open bags of peanut butter and no tears in the packaging. The area looked clean; there was no evidence of spills.
2. Black pepper was being stored above a partial pallet of sour cream and onion seasoning. It was noted that some black pepper bags were torn, and there was a nail sticking out of the pallet that could have cut the packaging.
3. Some black pepper was noted on the bags of sour cream and onion seasoning. The sour cream and onion seasoning bags were inspected for tears, but no tears were found.

4. The finished product storage area looked well-kept with no apparent potential contamination concerns.

Record Retention:
Review of cleaning paperwork, including cleaning logs and pre-operational checklists, yielded the following information. Based on the data collected by customer service, the starting date of production for each of the three products was 5/31/2018.

1. Peanut butter pretzel bites were run on Line 5 (next to processing Line 6). Line 5 was cleaned 5/31/2018 on night shift. When Quality did a visual inspection and ATP swab, part of the line failed Quality inspection initially. Line 5 started production at 7:00 am on 5/31/2018.
2. Salt and black pepper pretzels were run on Line 6 (next to Lines 5 and 7). Line 6 was cleaned 5/31/2018 on night shift. When Quality did a visual inspection and ATP swab, the line passed Quality inspection. Line 6 started production at 9:30 am on 5/31/2018.
3. Sour cream and onion were run on Line 7 (next to Line 6). Line 7 was cleaned 5/29/2018 on night shift. When Quality did a visual inspection and ATP swab, the line passed Quality inspection. Line 7 started production at 8:15 am on 5/31/2018.

In-Class Activity: Choose Experimental Design

Answer the question, “Is pasteurized juice safer to drink than unpasteurized juice?”

To answer the question, develop a hypothesis and then design an experiment to test your hypothesis. You may use the materials provided to design your experiment. Use the outline to document your hypothesis, procedures, results, and conclusion. To document results, you may want to include written descriptions and pictures. In the conclusion, comment on whether the results were what you expected.

Available Materials

- Petri dishes with growth media
- Sterile swabs
- Pasteurized juice
- Unpasteurized juice
- Beakers
- Stirring rod

Question: Is pasteurized juice safer to drink than unpasteurized juice?

Hypothesis:

Experimental Procedure:

Use next page (back) to document results and conclusions.

In-Class Activity: Choose Experimental Design

Results:

Conclusions:

What went well in your experiment?

What would you improve if you ran the experiment again?

In-Class Activity: Choose
You Decide: Are Spices Safe?

Considering customer complaints about Pete's Perfect Pretzels and the black pepper recall by the FDA, Pete's Perfect Pretzels Management team has decided to revise training procedures and investigate other ingredient options that pose less risk of being contaminated with pathogens. Management has provided the following information on oleoresins and wants your team to determine if using oleoresins is a viable option to replace all or some of the seasonings used in Pete's Perfect Pretzels products. Research and Development will also be working to determine how the change from powder seasoning to oleoresins will impact the product attributes, including flavor, texture, and shelf-life. You will also need to discuss these potential changes with Research and Development before presenting to management.

You have been provided with excerpts from different sources related to spices and/or oleoresins. You may use these sources or sources you find to gather information. If other sources are used, cite your sources and briefly explain the source type (e.g., spice vendor's website, scientific equipment vendor, etc.).

1. Use the space below to list the goals of the new formulation including oleoresin, why the identified attribute is important, and which team(s) would be responsible for this aspect of the product. An example has been provided for you.

Goal	Justification	Team Responsible
New formulation should be the same or lower in price compared to original formulation	Higher prices may result in increased product cost to consumers and could decrease profits.	Procurement: Responsible for finding suppliers and working with suppliers on ingredient pricing. Research and Development: Responsible for formulation and product design. Product design will drive resource needs.

2. Experiment with the pretzels you have been provided. DO NOT EAT the oleoresin or the pretzel containing the oleoresin. Use the space below to calculate the ratio of oleoresin to black pepper needed for the formulation. Then, calculate the cost ratio of oleoresin to black pepper used in the formulation.

Calculate ratio of oleoresin to black pepper needed for the formulation.

Calculate cost ratio of oleoresin to black pepper used in your formulation.

3. What are some of the limitations with the experiments you were able to perform with the materials you have been provided? For each limitation, describe how you would change the procedure you used if you were able to run the experiment in a factory or research lab.

Description of limitation	How would you change the experiment in industry?

4. Based on your calculations, experiments, and article review, complete the below table.

	Spices	**Oleoresin**
Advantages		
Disadvantages		
Potential Pathogens		

Similarities		
Choice	**Justification for Choice**	

How credible were the sources you used? Explain your reasoning.

Excerpts Related to Spices and Oleoresins

Excerpt from Microencapsulation of black pepper oleoresin published in Food Chemistry

Source type: Scientific journal

"Solvent-extracted oleoresins exhibit a flavour profile close to the freshly ground spice, which make them an acceptable form of natural flavouring ingredient in a wide spectrum of food applications. In comparison to the ground spices, they are hygienic and can be standardized for acceptable flavour levels by blending. Unlike the essential oils, oleoresins contain natural antioxidants of the corresponding spices, which make them more stable. Oleoresins are quite concentrated and have good replacement value. They provide a better distribution in the finished products and require less storage space than the corresponding spices. However, spice oleoresins exhibit sensitivity to light, heat and oxygen, and have short storage lives if not stored properly. Some chemical and organoleptic changes can also occur in the oleoresin during prolonged storage. Destruction of several pigments occurs under exposure to oxygen wherein the hydroxylic groups are converted into unstable ketones. These in turn decompose into colourless compounds with a shorter carbon skeleton (Gilbertson, 1971)." [19]

Excerpt from Organic Spices, Inc. Products Page

Source type: Spice, Herb, and Organic Extract and Oleoresins Vendor

"Oleoresins are the concentrated liquid form of the spice. They are obtained from organic spices by extraction with a non-aqueous solvent followed by removal of the solvent by evaporation and by super critical fluid extraction. This spice derivative has the same character and property of the spice it is obtained from. They reproduce the character of the respective organic spice and organic spice oil fully. Organic spice oleoresins represent the complete flavor profile of the organic spice. It contains the volatile as well as non-volatile constituents of spices. Oleoresins can replace whole/ground spices without impairing any flavor and aroma characteristic. Spice oleoresins guarantee superior quality of flavor and aroma. They are complete and balanced, consistent and standardized.

Advantages of oleoresins

- Easy to store and transport
- More stable when heated
- More economical to use
- Easier to control for quality and cleaner than the equivalent ground spices
- Free from contamination
- Concentrated form reduces storage space and bulk handling and transport requirements
- Concentrated and virtually moisture-free form of oleoresins ensures longer shelf life due to minimal oxidative degradation or loss of flavor" [20]

Excerpt from Microbiological Control of Spices and Herbs

Source type: Sigma-Aldrich, a company that sells chemicals and biomedical supplies

"Cultures around the world rely on herbs and spices to add flavour and zest to food. Many spices, however, contain very high numbers of bacteria, making them a potent source for food spoilage and pathogens.

To study the microbiological status of herbs and spices, E. de Boer et al.[1] tested 150 samples collected from 54 different spices, spice mixtures and herbs. They reported at least 1,000 organisms per gram, withmost spices containing 105-106 cells per gram. A high number of

psychotropic bacteria, yeasts and Enterobacteriaceae was detected mainly on herbal spices originating in moderate climate areas. The study also reported highmould counts, identifying *Aspergillus niger, A. flavus, A. tamarii, Penicillium citrinium, P. chrysogenum, and Absidia corymbifera* as the most frequent isolated species. Since A. flavus may produce aflatoxins, one of the most potent naturally occurring toxins, its presence should be a matter of concern and monitored closely by the spice industry. Another serious potential public health risk may involve the presence of pathogenic bacteria; frequently reported species are *Clostridium perfringens, Bacillus cereus and Salmonella*.

Several issues present a challenge in the microbiological study of dried herbs and spices. Dryness, inhibiting substances, high osmotic pressure, and other adverse conditions heavily stress the cells. Long stress periods can eventually lead the cells to a "viable but not culturable" (VNC) state. In a VNC state, the microbes cannot grow on conventional laboratory plating media but may revive in vivo and cause disease. However, with the addition of certain growth factors, traditional media can be upgraded and VNC organisms can be resuscitated."

[21, 22]

Except from The Microbiology of Herbs and Spices

Source type: ThermoFisher Scientific, a company that sells biological materials and laboratory equipment

Imported herbs and spices are widely used to enhance the flavor of foods. As Dr. Roy Betts explains, some herbs and spices are contaminated with potentially harmful microbes, such as bacteria and fungi.[1] While this isn't a widespread problem among herbs and spices derived from developed nations, you might not be aware that your favorite herbs and spices could be adding more than just flavor to foods.

Contamination by microorganisms can occur when fruits, roots, or bark are dried in the sun. While drying, plants are accessible to insects, reptiles and other animals. Once dried, these plant parts are then ground into spices. Similarly, the leafy parts of plants that make up herbs will become contaminated if they are grown in unclean water or soil. This is why washing of herbs and other leafy greens must be undertaken to ensure that foods sold as ready-to-eat items do not harbor microorganisms. Another strategy, heating foods, will kill bacteria, but isn't always foolproof; spore forming microbes representing the Genera *Bacillus* and *Clostridium*, can be resistant to heat and still survive during cooking.

Dr. Betts also describes some of the difficulties involved with applying microbiology testing to herbs and spices. Because they are typically dehydrated, or in powdered form, samples are concentrated and problematic for labs to process. Some contaminants may also be underrepresented because of natural antimicrobial agents within herbs and spices.

In 2013, Van Doran *et al.* examined foodborne illness outbreaks resulting from herbs and spices occurring between 1973 and 2010.[2] The authors identified 14 outbreaks reported by countries including Canada, Denmark, England and Wales, France, Germany, New Zealand, Norway, Serbia, and the United States.

From those outbreaks, 1,946 people became sick, 128 were hospitalized and two individuals died. The authors noted that 70% of illnesses occurred from foods in which spices had been added to the food after the final microbial reduction step had been applied, indicating herb and

spice contamination resulted in illness. The authors reported that salmonella was identified as the causative agent in 71% (10/14) of outbreaks, accounting for 87% of reported illnesses. *Bacillus* spp. were identified as the causative agent in 29% (4/14) of outbreaks, accounting for 13% of illnesses.

While this study and others like it highlight a possible risk of contamination, Dr. Betts also states that the likelihood of this is fairly low, and that microbial contamination is much more common with imported and smaller-scale growing operations. He posits that large-scale herb and spice producers have established handling and processing methods that ensure that their products have low levels of contamination.

[23-25]

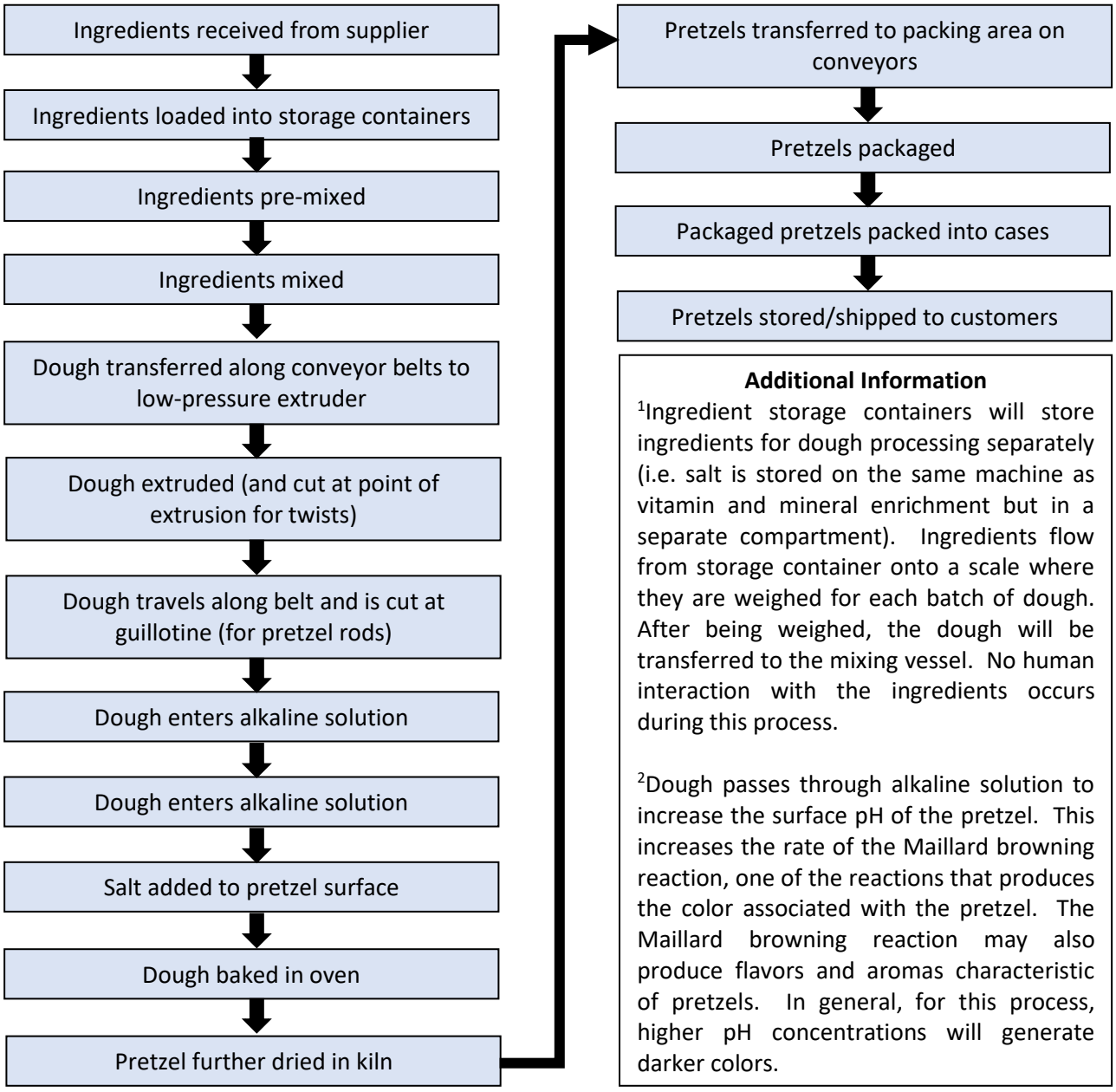
Table 1. Spice recalls within the last three years [26]

Item Recalled	Date Recalled	Recall Voluntary (Y/N)	Reason Recalled	Illnesses Reported (to Date)
Organic Tarragon	10/16/2017	N	*Salmonella*	0
Black Pepper Powder	8/31/2016	N	*Salmonella*	0
Organic Ginger	4/29/2016	Y	*Salmonella (may be contaminated)*	0
Cardamom Pods Green (Whole)	3/9/2018	Y	*Salmonella*	0
Ginger Powder Product	4/27/2017	Y	*Salmonella*	0
Ground turmeric	9/26/2016	N	*Elevated levels of lead*	0
Turmeric powder	8/5/2016	N	*Elevated levels of lead*	0
Ground turmeric	8/5/2016	N	*Elevated levels of lead*	0
Turmeric powder	7/28/2018	N	*Elevated levels of lead*	0

[In-Class Activity: Pete's Perfect Pretzels]
[Hazard Analysis Critical Control Point (HACCP)]

As a member of Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP) team, you have been asked to review the process for making pretzel twists and pretzel rods, outline potential hazards, and to outline how to control the hazards. You first made a process flow diagram to identify key steps in the pretzel production process.

Pretzel Twist/Rod Process Flow Diagram



Additional Information

[1]Ingredient storage containers will store ingredients for dough processing separately (i.e. salt is stored on the same machine as vitamin and mineral enrichment but in a separate compartment). Ingredients flow from storage container onto a scale where they are weighed for each batch of dough. After being weighed, the dough will be transferred to the mixing vessel. No human interaction with the ingredients occurs during this process.

[2]Dough passes through alkaline solution to increase the surface pH of the pretzel. This increases the rate of the Maillard browning reaction, one of the reactions that produces the color associated with the pretzel. The Maillard browning reaction may also produce flavors and aromas characteristic of pretzels. In general, for this process, higher pH concentrations will generate darker colors.

To complete Table 1. Hazard Analysis, review the process flow diagram for steps where there are potential associated hazards.

1. Place the processing step under the "Processing Step" column.
2. List the hazard(s) associated with that step.
3. Provide a reason, backed by evidence, you believe the hazard exists at this processing step under the "Justification" column.
4. Indicate whether the identified hazards will be addressed in the HACCP plan. Enter a "Y" to indicate, "Yes, the hazard will becovered." Enter an "N" to indicate, "No, the hazard will not be covered."
5. List what measures you would take to limit the hazards you identified under the "Control Measures."
6. Based on the definition of critical control point, indicate whether the identified processing step is a critical control point. "Y" indicates the step is a critical control point. "N" indicates the step is not a critical control point.
7. For each critical control point identified, list the critical limit(s) that should be met to ensure the product is safe for consumers. This could be time, temperature, pH value, relative humidity, water activity, etc.

It is not necessary to list every processing step in the Table 1; you may just list the steps for which you have identified a potential hazard. You can look back over the pretzel processing video shown at the start of this activity to review the process as needed.

Table 1. Hazard Analysis

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)

Hazard Analysis Critical Control Point (HACCP) Video Notes

Seven Steps of HACCP

1. Conduct a Hazard Analysis

2. Determine the Critical Control Point

3. Establish Critical Control Limits

4. Establish Monitoring Procedures

5. Establish Corrective Actionstyu

6. Establish Verification Procedures

7. Establish Record Keeping and Documentation Procedure[17]

Hazard Analysis Critical Control Point (HACCP) Video Notes

Food Safety Hazards

	Biological	Chemical	Physical	Radiological
Example of Hazards				Radioactive minerals in ground water Cadmium or other radioactive compounds in sandy areas Fields contaminated with radiation from nuclear disasters (less common than other sources mentioned)[18]
Method to Control Hazards				

Hazard Analysis Worksheet Example 1

List each ingredient and step in processing	Identify potential hazards for each ingredient and step	Indicate the hazards controlled for each ingredient and step	Does the potential hazard need to be controlled in the HACCP plan	Justification for answer	If answered "yes" what measures can be applied to reduce, prevent, or eliminate hazard	Is this a CCP? If "yes" identify hazard and assign a number
Ingredient	Biological: Vegetative and spore forming pathogens Chemical: None Physical: None	B: None C: None P: None	No	Low likelihood; GMP and vendor certification programs are function and in place	Regular inspections of storage areas performed. Only approved vendors are used. QA inspects all ingredient shipments.	No CCP:
Pasteurization	Biological: None Chemical: None Physical: None	B: Vegetative pathogens C: None P: None	Yes	Medium likelihood, severity is high SQF 2, B-5	Pasteurization Cooking time and temperature chart and CCP log.	Yes CCP: 1 (B) SQF 5- CCP
Blending	Biological: None Chemical: None Physical: Foreign material that can cause injury	B: None C: None P: Foreign material large enough to cause injury	Yes	Medium likelihood, severity high SQF 2, A-3	A sifter screen is located at the bottom of the blender. Blender CCP Log	Yes CCP: 2(P) SQF 3-CCP

*Table from RemCo Products [19]

Hazard Analysis Worksheet Example 2

Hazard Identification/Preventive Measures

Cooked Sausages (Fully Cooked - Not Shelf Stable I)

Process Step	Potential Hazard		What Control Measures Can Be Applied To Prevent The Hazard	Is Hazard Significant And Reasonably, Likely To Occur?		CCP #
1. Receive meat (from lab slaughter)	B	Pathogens* in meat	Controlled at CCP-1B (step 11).	B	Yes	
	P	None	No history of problems.	P	No	
	C	None	No history of problems.	C	No	
2. Receive meat and natural casings from outside sources	B	Pathogens present	Receiving program checks meat for temperature and condition; controlled at CCP-1B (step 11).	B	Yes	
	P	Foreign material	Letter of guarantee (casings); meat visually checked during processing.	P	No	
	C	Harmful chemicals	Letter of guarantee (casings).	C	No	
3. Store meat and natural casings	B	Growth of pathogens	Cooler and freezer temperatures monitored regularly. Controlled at CCP-1B (step 11).	B	Yes	
	P	None	Proper storage procedures prevent contamination.	P	No	
	C	None	Proper storage procedures prevent contamination.	C	No	
4. Receive non-meat ingredients	B	Pathogens may be present in spices	Letters of guarantee from suppliers. Controlled at CCP-1B (step 11).	B	No	
	P	Foreign material in ingredients	Letters of guarantee from supplier.	P	No	
	C	Harmful chemicals present in ingredients	Letters of guarantee from supplier.	C	No	

Hazards: B=Biological, C=Chemical, P=Physical

"Cooked Sausage", HACCP #1, 12-3-03

*Pathogens of concern include *Salmonella, E. coli* O157:H7, and *Campylobacter*.

**Table from "Bare-Bones" Overview of HACCP [1]

Hazard Identification/Preventive Measures **Cooked Sausages (Fully Cooked - Not Shelf Stable I)**

Process Step	Potential Hazard		What Control Measures Can Be Applied To Prevent The Hazard	Is Hazard Significant And Reasonably, Likely To Occur?		CCP #
5. Store non-meat ingredients	B	None	Proper storage conditions prevent contamination.	B	No	
	P	None	Proper storage conditions prevent contamination.	P	No	
	C	None	Proper storage conditions prevent contamination.	C	No	
6. Receive dry casings and packaging materials	B	None	No history of problems.	B	No	
	P	None	No history of problems.	P	No	
	C	Harmful chemicals in casings or vacuum bags.	Letters of guarantee from suppliers.	C	No	
7. Store dry casings and packaging materials	B	None	Proper storage conditions prevent contamination - SSOP.	B	No	
	P	None	Proper storage conditions prevent contamination - SSOP.	P	No	
	C	None	Proper storage conditions prevent contamination - SSOP.	C	No	
8. Grind meat	B	Pathogens in meat, and cross contamination of pathogens from environment and people	SSOP directs effective pre-op. and operational sanitation; controlled at CCP-1B (cooking).	B	Yes	
	P	Bone, metal or employee personal items	Visual inspection for foreign materials as meat is ground. SSOP outlines employee dress code to prevent personal items from getting into product.	P	No	
	C	None	SSOP, no history of problems.	C	No	

Hazards: B=Biological, C=Chemical, P=Physical

**Table from "Bare-Bones" Overview of HACCP

Hazard Identification/Preventive Measures **Cooked Sausages (Fully Cooked - Not Shelf Stable I)**

Process Step	Potential Hazard		What Control Measures Can Be Applied To Prevent The Hazard	Is Hazard Significant And Reasonably, Likely To Occur?		CCP #
9. Mixing meat, non-meat ingredients and water	B	Pathogens in meat, and cross contamination of pathogens from environment and people	SSOP directs effective pre-op. and operational sanitation. Controlled at CCP-1B (cooking).	B	Yes	
	P	None	No history of problems.	P	No	
	C	None	No history of problems - SSOP.	C	No	
10. Stuff and hang sausages	B	Pathogens in meat, and cross contamination of pathogens from environment and people	SSOP directs effective pre-op. and operational sanitation. Controlled at CCP-1B (cooking).	B	Yes	
	P	None	No history of problems.	P	No	
	C	None	No history of problems.	C	No	
11. Smoke and cook	B	Survival of pathogens	Cook to appropriate temperature/time to destroy pathogens.	B	Yes	CCP-1B
	P	None	No history of problems.	P	No	
	C	None	No history of problems - SSOP.	C	No	
12. Cold shower	B	None	No history of problems (potable water).	B	No	
	P	None	No history of problems.	P	No	
	C	None	No history of problems (potable water).	C	No	

Hazards: B=Biological, C=Chemical, P=Physical

**Table from "Bare-Bones" Overview of HACCP [1]

**Table from "Bare-Bones" Overview of HACCP [1]

Hazard Identification/Preventive Measures

Cooked Sausages (Fully Cooked - Not Shelf Stable I)

Process Step	Potential Hazard		What Control Measures Can Be Applied To Prevent The Hazard	Is Hazard Significant And Reasonably, Likely To Occur?		CCP #
13. Chill	B	Growth of spore-forming pathogens (*clostridium perfringens*) due to improper cooling	Product is placed into cooler within 60 minutes after cold shower. Product temperature is monitored to insure compliance with stabilization guidelines.	B	Yes	CCP-2B
	B	Cross contamination with pathogens (*Listeria monocytogenes*)	Safe food handling practiced by employees. Strict separation of raw and cooked products, equipment, and clothing (SSOP).	B	No	
	P	None	No history of problems.	P	No	
	C	None	No history of problems.	C	No	
14. Package and label	B	Cross contamination of pathogens (including *Listeria monocytogenes*) to cooked product during packaging	Proper cleaning and sanitizing per SSOP. Safe food handling practiced by employees. Strict separation of raw and cooked products, equipment, and clothing.	B	No	
	P	None	No history of problems.	P		
	C	Allergens in product	Proper label is placed on product.	C		
15. Store finished product in cooler or freezer	B	None	Proper storage procedures prevent contamination. Temperature control in coolers/freezers.	B	No	
	P	None	Proper storage conditions prevent contamination.	P	No	
	C	None	Proper storage conditions prevent contamination.	C	No	

Hazards: B=Biological, C=Chemical, P=Physical

**Table from "Bare-Bones" Overview of HACCP [1]

Final Project Rubric

Presentation Component	Does Not Meet Requirements (1)	Meets Requirements (2)	Exceeds Requirements (3)	Score
Quality of images and description of relationship of images to CLEAN concepts	Images are not distinguishable AND do not relate to topic	Images are not distinguishable OR do not relate to topic	Images are clear AND relate to topic	
Quality of images and description of relationship of images to COOK/CHILL concepts	Images are not distinguishable AND do not relate to topic	Images are not distinguishable OR do not relate to topic	Images are clear AND relate to topic	
Quality of images and description of relationship of images to CROSS-CONTAMINATION concepts	Images are not distinguishable AND do not relate to topic	Images are not distinguishable OR do not relate to topic	Images are clear AND relate to topic	
Quality of images and description of relationship of images to CHOOSE concepts	Images are not distinguishable AND do not relate to topic	Images are not distinguishable OR do not relate to topic	Images are clear AND relate to topic	
Quality of images and description of relationship of images to HACCP concepts	Images are not distinguishable AND do not relate to topic	Images are not distinguishable OR do not relate to topic	Images are clear AND relate to topic	
Presentation quality: presentation organization, slide aesthetics, spelling and grammar	The presentation is not organized logically, the slides are challenging to read/pictures are cluttered, AND/OR contains several spelling/grammatical errors	The presentation is generally organized, the slides are readable/pictures are organized, AND contains few spelling/ grammatical errors	The presentation is well-organized, the slides are readable/pictures are organized, AND contains minimal spelling/ grammatical errors	
Presentation delivery: Presenters/voiceovers are audible, paced appropriately, and understandable	Presenters/voiceovers are inaudible, pace is too fast/slow, AND/OR not understandable	Presenters/voiceovers are generally audible, paced appropriately, AND understandable	Presenters/voiceovers are audible, paced appropriately, AND understandable	
			Presentation Total	

Comments	

Take-Home Activities

Take-Home Activity: Clean

In class, you learned some ways to prevent the spread of microorganisms in a food processing facility. Using the information you learned, try applying the concepts to your home kitchen. Think about the GMP and SSOP you and your classmates designed in class, and try developing a GMP and SSOP for your home kitchen.

Quick Answer Questions

What are some similarities between cleaning in a food processing facility and home kitchen?

What are some differences between cleaning in a food processing facility and home kitchen?

Good Kitchen Practices (GKP)

To get started, think about what practices everyone who enters the kitchen should follow. Are the practices the same or different for cooking vs. getting a ready-to-eat snack like a pack of peanut butter crackers or a package of pre-cut apple slices with caramel? You may use the below template or create your own.

GKP Title
Goals: statement:
GKP Polices 1. 2. 3. 4. 5.

Kitchen Sanitation Standard Operating Procedure: Clean

Category (e.g. ingredient storage, processing equipment, area adjacent to equipment)	**Cleaning Method** (e.g. name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying)	**Cleaning Frequency** (e.g. daily, weekly, monthly, after running a certain product)	**Potential Cleaning Challenges** (e.g. equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried)	**Method to Verify Area is Clean** (e.g. visual inspection)	**Frequency of Cleaning Verification** (e.g. daily, weekly, monthly, after running a certain product)	**Record** (Y/N. If yes, specify)	**Corrective Action if Cleaning is not Properly Completed** (Y/N. If yes, specify.)

Take-Home Task: Chill, Cook, and Food Preparation

Now that you have discussed proper refrigeration techniques, take a look around your kitchen at home to see how food is stored. Complete the below questions and chart.

1. What are some similarities between the refrigeration practices within a processing facility and within your home?

2. What are some differences between the refrigeration practices within a processing facility and within your home?

3. What microorganisms do you think would be found in your refrigerator or freezer (and why)? How can you decrease the number of unwanted microorganisms in your refrigerator/freezer?

4. What are some similarities between testing that can be completed at home and in industry to measure food safety?

5. What are some differences between testing that can be completed at home and in industry to measure food safety?

6. Thinking about foods you or your family might prepare at home, what are some foods for which it is hard to take the internal temperature? How can you increase your confidence that the food is safe to eat? For example, think about flour tortillas. Flour can be contaminated with *Salmonella*, but it is hard to measure the internal temperature of a tortilla due to its thickness. How could you justify the safety of this product at home?

Technique Checked	Observation	Rating	Ideas to Improve (if applicable)
Storage temperature			
Time perishable food remained at room temperature before being put away			
Storage containers used to put away leftovers			
Placement of containers within the refrigerator			
Raw food items separated from cooked food items			
All leftovers covered with lids, foil, or plastic wrap			
Refrigerator/freezer is clean and free of spills			
Internal temperatures are being used to make sure meat and reheated leftovers are at the recommended temperature			

*✓= practicing technique, — = needs improvement, X = not practicing technique

Take-Home Task: Cross-Contamination

1. Update your cleaning SSOP to incorporate the information you have learned about cross-contamination. For example, you might want to add a statement like, "Wash cutting boards with hot, soapy water. Sanitize the washed cutting board, and let the cutting board air dry before storing."

2. Observe a family member cooking, and record the cross-contamination events that you notice.

Observation of Cross-contamination/ Cross-contact event	When Event Occurred	Frequency of Occurrence

Take-Home Task: Choose Scavenger Hunt

Look at the foods you have at home. Fill in the table below with foods that you find that fit the category described.

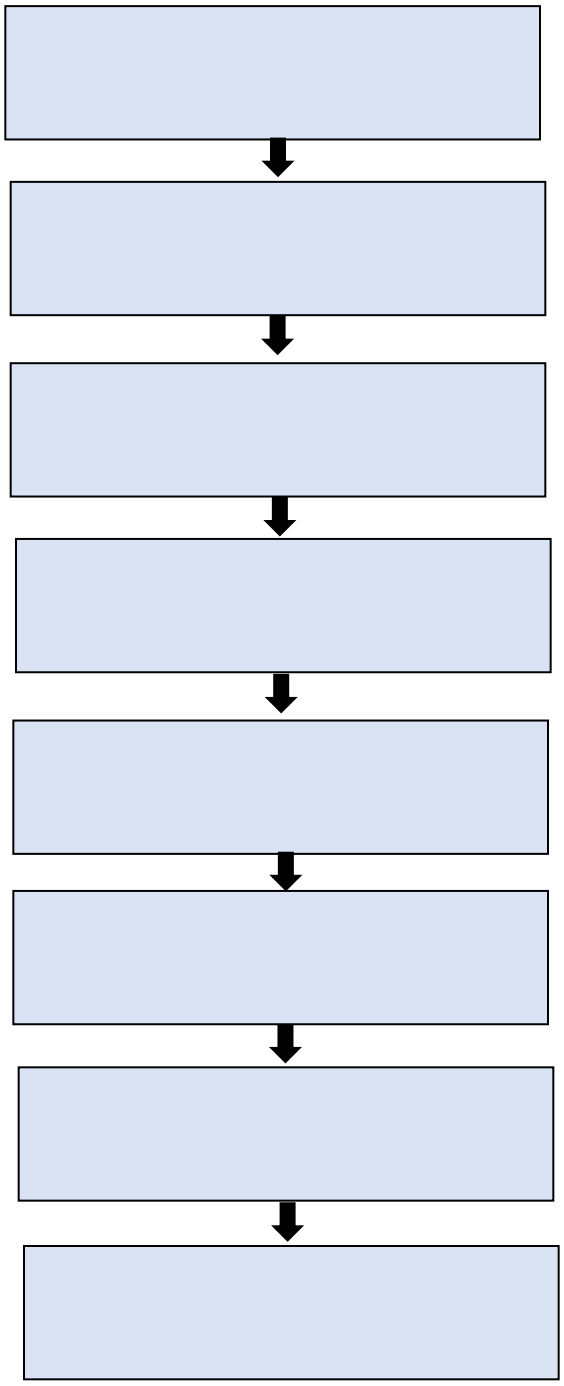
Scavenger Hunt Item	Item(s) Found
Fruit or vegetable without bruises or blemishes	
Food or beverage that has been pasteurized or contains a pasteurized ingredient	
Food that has been irradiated	
Food that has been thermally processed	
Fruits or vegetables that have been washed (at point of purchase or before preparing for consumption)	
Food or beverage that has been treated with UHT (ultra high temperature)	
Food or beverage that has been treated by a method other than one listed (specify food and method)	
Food or beverage not treated by any method	

Take-Home Task: HAACP

Observe someone prepare food. In the process flow diagram below, identify the processing steps required to make the food from start to finish. You may add additional boxes to the process flow diagram as needed.
After completing, the process flow diagram, complete the HACCP table to identify if there are any critical control points (CCPs) in the process and what should be done to control the associated hazards. If no CCPs are identified for the process you observed, what might be some CCPs involved in processing the ingredients used to make the dish you watched being prepared?

Process Flow Diagram for Making

_____



Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)

Guided Answers to In-Class Activities

In-Class Activity: Clean (Guided Answers)
GMP Development

As Pete's Perfect Pretzels' Quality Assurance team, your group has been tasked with developing guidelines for the GMP policy that will promote proper personal hygiene practices among employees. When developing the GMP guidelines, a few topics to consider are proper hand-washing techniques, hand-washing frequencies, when gloves should be worn, and employee hand conditions (fingernail length, open wounds, etc.). You may use the provided GMP example from the Small Scale Food Processor Association as a guide.

You will have 5 minutes to develop your list as a group. At the end of 5 minutes, each group will share their lists to create a class list. The class should try to reach a consensus on which components should be included on the class GMP list.

Pete's Perfect Pretzels GMP Policy

Pete's Perfect Pretzels is committed to producing safe, quality products for our consumers. To maintain quality and safety standards of Pete's Perfect Pretzels, it is important for all employees to abide by the Good Manufacturing Practices (GMP) established in this document.
To produce a safe, quality product, Pete's Perfect Pretzels employees must

1.

Follow the format of the provided example from the Small Scale Food Processor Association. Students may decide not to include all parts of the GMP from the example or may decide to include additional components in their GMPs that were not covered in the example.

Students should include the topics discussed in this lesson. Cross-contamination information will be covered in a later section and should be excluded at this time.

1. Hand washing before beginning or returning to work, including having clean nails.
2. Hand washing after hands become contaminated from activities, including picking up product or debris from the floor, touching one's hair and/or face, and handling cleaning chemicals.
3. Glove wearing to handle product/changing gloves when they become contaminated, soiled, or torn.
4. Hand drying using approved materials (i.e., disposable hand towels rather than clothing).

In-Class Activity (10 minutes): Clean (Guided Answers)
Pete's Perfect Pretzels SSOP Development

As Pete's Perfect Pretzels' Quality Assurance team, you have been tasked with developing a Sanitation Standard Operating Procedure (SSOP) for the pretzel-processing area. The pretzel-processing area includes dry ingredient storage containers as well as all the equipment shown in the video clip. As a group, your task is to determine the points in the process that require cleaning, which pathogen or microorganism will be targeted, the cleaning method, cleaning frequency, potential cleaning challenges, methods to verify the area is clean, and frequency of verification.
You may use any resources you choose to create your SSOP.

Provided Resources

- References have been provided that outline potential pathogens, cleaning agents, and cleaning verification methods to consider. To establish cleaning and cleaning-verification frequencies, you might want to consider the risk of foodborne illness, time to clean/verify, and cost.
- You may use the FSIS USDA SSOP example as a guide.
- A planning table has been provided to help you think through different areas of the facility that must be cleaned.

After 10 minutes, all groups will discuss their SSOP's to generate a class SSOP. Try to reach a consensus when making the class SSOP.

Follow the format of the provided example from FSIS USDA. Students may decide not to include all parts of the SSOP from the example, or students may decide to include additional components their SSOPs not covered in the example.

Because many SSOPs are company-specific, they are subject to what company management deems acceptable. Companies are required to comply with certain regulations, but as long as they follow their procedures and justify their product as safe, cleaning and monitoring practices are essentially the responsibility of the company's management. Therefore, many SSOPs are acceptable as long as students can justify their procedures with sound reasoning (since they will not be able to collect actual cleaning-verification data to prove their cleaning procedures are effective).

Students should include the following topics discussed in this lesson:

1. Cleaning food-contact and food-contact-adjacent surfaces.
2. Cleaning the environment around the equipment.
3. Considerations as to what types of cleaning agents can be used on surfaces (i.e., chemicals used on food-contact and food-contact-adjacent surfaces should be non-toxic to prevent illness or injury if cleaning residues persist).
4. Cleaning frequencies (should lines be cleaned at a certain shift each day, on changeovers from one product to another, or only when allergens are a concern for changeovers)
5. Methods used to verify cleaning. Answers may include:
    a. Zones 1 and 2: Visual inspection for cleanliness (i.e., no visible product debris, chemical residue, or cleaning utensil debris like towel fuzz) coupled with ATP swabbing for organic material.
        i. Frequencies may include:
            1. After every cleaning prior to being released for production OR
            2. Daily on the third shift.
    b. Zones 1 and 2: Environmental swabbing for aerobic plate count and coliforms to further verify cleaning.
        i. Frequencies may include:
            1. Various pieces of equipment swabbed weekly on a schedule to ensure all locations identified are swabbed twice to four times per year. For example, the

pretzel facility may have 12 pretzel lines, and locations on each line are swabbed 4 times per year. Line 1 could be swabbed in weeks 1, 14, 27, and 40, while Line 2 could be swabbed in weeks 4, 17, 30, and 43. *Students do not need to be specific about their weekly swabbing schedule; they can simply state they will be doing environmental swabbing weekly on identified sites.*

2. Various pieces of equipment are swabbed monthly on a schedule to ensure all locations identified are swabbed twice to four times per year.

c. Zones 3 and 4: Environmental swabbing for pathogens such as *Salmonella spp.*, *Listeria spp.*, or *E. coli*.
    i. Frequencies as in 5.c. above apply.
d. Students may also include pathogen swabbing in Zones 1 and 2. If they choose this, they should consider what could happen if the test results indicate pathogens are present. If the results indicate a pathogen is present, the company will need to discard products produced on the line. This discard will include the product produced during the timeframe between where they can prove the line was free of pathogens prior to and post discovering the contaminated sample. If the timeframe for discard is long enough, this could result in recalls. The company could experience financial losses due to product losses, and a damaged reputation from public recalls. In some instances, bankruptcy could occur.

6. Records to ensure cleaning is completed on time and/or thoroughly.
    a. Pre-operational checklist:
        i. Used after cleaning and before the equipment is released to use in production.
        ii. Might include:
            1. Visual check of certain pieces of the equipment and
            2. Test results verifying the line is clean (usually ATP swabbing due to rapid indication methods).
            3. Column to indicate if recleaning occurred.
            4. Column to indicate corrective action taken to address test failures.
    b. Cleaning log:
        i. Sanitation employees (or other qualified employees) who complete the cleaning task complete the log indicating which pieces of equipment they have cleaned on a certain date and shift.
    c. Results from in-house testing or third-party lab for environmental swabs.
        i. Documents which locations were swabbed on which day.
        ii. Documents results, indicating if the area swabbed passes or fails.
        iii. Documents any areas that failed and were reswabbed and reswab results.
        iv. Any corrective action taken can be saved with these results.
7. Corrective actions if cleaning is not properly completed may include:
    a. Retraining employees. Identify who did not complete the cleaning correctly based on the information in the cleaning log. Retrain the employee(s) on the process and have them demonstrate understanding by taking a quiz or performing the task while being observed by an individual qualified to complete the task.
    b. Review the chemicals used for cleaning.
        i. *Additional discussion points, if time permits.*
            1. Were the chemicals used at the correct concentration levels?
                a. If the issue originated from the supplier, contact the supplier to resolve.
                b. If the issue originated with employees diluting the chemicals or not creating the correct dilution if concentrations were used, the employee could be retrained.
            2. Were the correct chemicals used?

a. Retrain employees.

c. Maintenance or Engineering can look at the equipment design and make alterations that would make the equipment easier to clean.

d. Reexamine and adjust cleaning procedure to better address cleaning challenges.

Planning Sheet for Sanitation Standard Operating Procedure (Guided Answers)

Student answers may include the information listed in the below table. However, other answers are acceptable if they are logical and adequate justification is made for students' choices. Some provided answers have additional details for the teacher/leader to discuss further if time allows. Student answers do not need to include these additional details; student answers should reflect information covered in the unit.

Category	Cleaning Method	Cleaning Frequency	Potential Cleaning Challenges	Method to Verify Area is Clean	Frequency of Cleaning Verification	Record	Corrective Action if Cleaning is not Properly Completed
Ingredient storage	This area would potentially not be cleaned with chemicals frequently. Ideally, ingredients would be packaged and not leaking to reduce the risk of microorganism contamination. Keeping areas swept and free of debris may be sufficient. If spills occur, the product may need to be relocated to a clean area or discarded (if damaged by spill), and the spill contained. Cleaning and disinfecting agents may be used at the spill site. Let the area air dry.	Regular upkeep like sweeping could occur on a daily or weekly basis. Cleaning to address spills can occur as needed.	Spill difficult to access (if the spill is between pallets or ingredient containers).	Routine cleaning: Visual inspection. For spills: Visual inspection. Environmental swabbing may also be used based on spill type.	Routine cleaning: Visual inspection daily or weekly. For spills: After the spill has been cleaned.	Routine cleaning: Cleaning log. For spills: May have a special document depending on the spill type. Uncontrolled water events are commonly documented on a specific form developed by each company. Otherwise, cleaning logs can be used.	Routine cleaning: Retrain employees if cleaning is completed as scheduled or correctly. For spills: Retrain employees (if the employee caused spill). Contact supplier if spill resulted due to supplier issues like improperly sealed containers or bags that were damaged during loading onto the truck at the supplier facility.
Equipment (Zones 1 and 2)	Spray equipment from top to bottom with water to remove debris. Add cleaner/degreaser (one of the non-toxic options)	May occur daily on a particular shift (e.g., second or third shift).	Some equipment may be challenging to clean. For example, salt dispensers would need to be emptied to clean,	Visual inspection coupled with ATP swabbing. Cleanliness can	Visual inspection coupled with ATP swabbing conducted	Pre-Operation Checklist for visual and ATP swabbing.	Retrain employees. Check chemical used.

Category	Cleaning Method	Cleaning Frequency	Potential Cleaning Challenges	Method to Verify Area is Clean	Frequency of Cleaning Verification	Record	Corrective Action if Cleaning is not Properly Completed
	from top to bottom. Follow cleaning instructions for each chemical used. Rinse equipment from top to bottom using water to remove the cleaner/degreaser. Apply disinfectant/sanitizer (one of the non-toxic options) to equipment from top to bottom. If disinfectant/sanitizer needs to be rinsed off, rinse the equipment from top to bottom. Allow equipment to air dry to minimize microbial recontamination from drying equipment (towels) and to reduce physical contamination (e.g., towel lint).	May occur after the changeover from one product to another. May occur after allergens have been used.	and excess water in the salt dispenser could cause clumping of salt, which could clog the system and prevent salt from being dispensed during processing. The salt dispenser could arguably go longer than other pieces of equipment since salt is generally not contaminated with microorganisms.	further be verified by conducting environmental swabbing Environmental swabbing may include aerobic plate count, coliform, and/or pathogens like *Salmonella spp.*, *Listeria spp.*, *or E. coli*.	after every cleaning and before releasing equipment to be used in food processing. Environmental swabbing conducted weekly or monthly.	Cleaning log for employees to sign after cleaning. Environmental swabbing locations and results.	Maintenance/ Engineering redesigns equipment. Re-evaluate cleaning procedures and potentially revise.
Processing Environment (Zone 3)	Clean walls and floor as described for Zones 1 and 2. Harsher chemicals may be used on Zone 3 surfaces.	Same as listed for Zones 1 and 2.	Areas difficult to reach due to equipment placement. Drains may be hard to keep clean as product and cleaning residue may build up.	Visual inspection. Environmental swabbing as described above. ATP swabbing typically not used as higher levels of	Visual inspection after each cleaning. Environmental swabbing weekly or monthly.	Cleaning log. Environmental swabbing locations and results.	Same as listed for Zones 1 and 2.

Category	Cleaning Method	Cleaning Frequency	Potential Cleaning Challenges	Method to Verify Area is Clean	Frequency of Cleaning Verification	Record	Corrective Action if Cleaning is not Properly Completed
				microorganisms would be acceptable on floors and walls than on equipment where food is prepared. The primary concern about these surfaces is pathogens.			
Processing facility (Zone 4 – like cafeteria, breakrooms, etc.)	Typically, janitorial staff would clean with cleaners (degreasers would not usually be necessary) and sanitizers.	Daily	Employees using the area could result in some areas not being cleaned thoroughly. Leftover food in refrigerators could cause unsanitary conditions.	Visual inspection. Environmental swabbing as described above.	Visual inspection after each cleaning. Environmental swabbing weekly or monthly.	Environmental swabbing locations and results.	Same as listed for Zones 1 and 2.

In-Class Activity: Chill (Guided Answers)
Dessert Pretzels

Pete's Perfect Pretzels would like to work with Decadent Dipped Desserts to produce a line of dessert pretzels. The two companies are working on three different dessert pretzel recipes (below). As a member of the Pete's Perfect Pretzels' Quality Assurance team, you have been asked to inspect the Decadent Dipped Desserts facility to ensure the facility's products will meet quality and safety standards. You have been tasked with completing an evaluation of ingredient storage.

The table below includes a description of each product and a simplified ingredient list. Your task is to complete the ingredient storage conditions column with the proper storage location for each ingredient, concerns that would drive storage location like microbial growth or shelf-life associated with the ingredient, and the justification for your choice of storage conditions.

Name	Description	Ingredients List	Ingredient Storage Conditions (Ambient, Refrigerator, or Freezer)	Concern (Potential Microorganism, shelf-life, bloom, etc.)	Justification
Pete's Dark Chocolate Peanut Butter Pretzel Bites	Lightly salted pretzel rods coated in dark chocolate	Peanut-butter-filled pretzels 3. Pretzel 4. Peanut butter Dark chocolate 4. Unsweetened chocolate 5. Cocoa butter 6. Sugar	Peanut-butter-filled pretzel 1. Ambient 2. Ambient Dark chocolate 1. Ambient or refrigerator 2. Ambient or refrigerator 3. Ambient	Peanut-butter-filled pretzel 1. *Salmonella spp.* 2. *Salmonella spp.* Dark Chocolate 1. N/A 2. N/A 3. N/A	Peanut-butter-filled pretzel 1. Stable at room temperature. Risk controlled by baking (increased temperature) and low water activity in the final product. 2. Stable at room temperature. *Salmonella spp.* controlled by roasting step in peanut processing. Dark chocolate 1. Stable at room temperature, but if warehouse temperatures are high, refrigeration could prevent bloom and end of shelf-life. Low water activity. 2. Stable at room temperature, but if warehouse temperatures are high, refrigeration could prevent melting and recrystallization of the cocoa butter into a less stable form. 3. Stable at room temperature. Low water activity.
Milk chocolate caramel dipped pretzel rods	Lightly salted pretzel rods dipped in caramel and covered in milk chocolate	Pretzel rods Caramel 6. Brown sugar 7. Sweetened condensed milk 8. Unsalted butter 9. Salt	Pretzels rods: ambient Caramel 1. Ambient 2. Ambient 3. Refrigerator 4. Ambient 5. Ambient	Pretzel rods: *Salmonella spp.* Caramel 1. N/A 2. *Campylobacter jejuni* *E. coli 0157:H7*	Pretzel rods: Stable at room temperature. Risk controlled by baking (increased temperature) and low water activity in the final product. Caramel 1. Low water activity. 2. Stable at room temperature.

		10. Vanilla Milk chocolate 4. Sugar 5. Cocoa butter 6. Unsweetened chocolate	Milk Chocolate 1. Ambient 2. Ambient or refrigerator 3. Ambient or refrigerator	*Listeria monocytogenes* *Staphylococcus aureus* *Yersinia enterocolitica* 3. Same as listed for sweetened condensed milk 4. N/A 5. N/A Milk Chocolate 1. N/A 2. N/A 3. N/A	Listed pathogens are commonly found in unpasteurized milk. Processing steps heat the product and reduce/eliminate pathogens. [20] 3. Butter subject to melting. Water activity of water high enough to support bacterial growth. Growth could increase at room temperature. Listed pathogens are commonly found in unpasteurized milk. [20] Pasteurization of milk controls the pathogens. 4. Low water activity. 5. Stable at room temperature. Alcohol content of vanilla extract is at least 35%. [21] The alcohol content helps control growth microorganisms. Milk Chocolate: same as above for each ingredient.
Dessert trail mix	Lightly salted mini pretzel twists, dried blueberries, and strawberry-chocolate bites (small squares of milk chocolate with strawberry filling)	Mini pretzel twists Dried blueberries Milk chocolate (same as above) Strawberry filling 4. Strawberry puree 5. High fructose corn syrup 6. Citric acid	Mini pretzel twists: ambient Dried blueberries: ambient Milk chocolate (same as above) Strawberry filling 1. Refrigerator or freezer 2. Ambient 3. Ambient	Mini pretzel twists: *Salmonella spp*. Dried blueberries: N/A Milk chocolate (same as above) Strawberry filling 1. Yeast/mold 2. N/A 3. N/A	Mini pretzel twists: Stable at room temperature. Risk controlled by baking (increased temperature) and low water activity in the final product. Dried blueberries: Stable at room temperature. Risk controlled by low water activity. Milk chocolate: same as above. Strawberry filling 1. High sugar content leads to lower water activity. Yeast and mold could potentially grow, but pathogens are not likely to grow. Refrigerating/freezing will help slow yeast and mold growth. pH is likely acidic enough to reduce pathogenic growth as well. 2. Stable at room temperature. Low water activity due to high sugar content. 3. Stable at room temperature. Low water activity.

In-Class Activity: Dessert Pretzels (cont.) (Guided Answers)

While walking around the warehouse at Decadent Dipped Desserts, you make the following observations:

4. Employees responsible for receiving temperature-sensitive ingredients are checking the temperature of the delivery vehicles to make sure the temperature with the vehicle is within the acceptable range for the received product.
5. Full pallets of butter (stacked in cases) have just been delivered and have been placed in the refrigerator until an employee can move them to their new location in the warehouse. The cases of butter are touching one another, both on the pallet and across pallets. All warehouse employees are currently busy or at lunch and will not move or relocate the butter within the next hour.
6. Employees entering and leaving the refrigerator section of the warehouse sometimes forget to close the doors. It is summer, and the warehouse may become hot. You check the temperature data logger in the refrigerated room and see that the temperature has climbed to the acceptable upper-temperature limit twice in the last week.

What feedback would you provide the Quality/Management team at Decadent Dipped Desserts to ensure the products they make for Pete's Perfect Pretzels will be safe and high-quality? Feedback can include what Decadent Dipped Desserts is doing well and areas for improvement.

For identified improvement areas, what are some possible solutions?

1. Employees are following the correct procedure. They should be checking the receiving temperatures to ensure the product is within the acceptable temperature range when it arrives.
2. Storing the butter in the refrigerator is correct; however, the butter pallets should be spaced far enough apart so air can circulate around each pallet, thereby maintaining the butter within the specified temperature range. Possible solutions may include:
    a. Employees on break cannot be called back to work, but busy employees could potentially reprioritize their work to decrease the food-safety risk posed by butter stored at incorrect temperatures.
    b. More space could be left between the pallets while being temporarily stored. If there is not enough room at the current location to spread out the pallets, some of the pallets could be potentially located to another area of the refrigerator to create additional space.
3. Employees need to remember to shut the doors because open doors will allow warm air from the warehouse to enter the refrigerator and will heat the ingredients. If the temperature exceeds the upper acceptable temperature range and remains above the acceptable temperature range for an extended period of time, microorganisms may be able to grow more rapidly and cause spoilage or increase the risk for foodborne illness. Possible solutions include:
    a. Employees could be retrained to emphasize the importance of closing refrigerator doors.
    b. Signs could be posted near and on the doors to remind employees to close the refrigerator doors.
    c. Automatic doors could be installed so the doors will close after a certain period of time if left open.

In-Class Activity: Cook (Guided Answers)
Is it safe to eat?

You have been asked to evaluate the safety of your finished product with respect to pathogens such as *Salmonella*, which has been known to contaminate flour. To determine if your product is safe, you review the current tests conducted on pretzels. Identify which tests are beneficial in determining product safety and justify your answer. Propose additional testing or procedures you would use to make sure your pretzels are safe to consume.

Questions to Consider: Can the internal temperature of the final product be determined? If no, what are some ways you can use to justify the safety of your product?

The internal temperature of the final pretzel cannot be easily measured. Inserting a thermometer into the hard pretzel will likely cause breakage. This could expose the thermometer to the air, in addition to the pretzel, resulting in inaccurate readings. Additionally, the exposure of the pretzel interior to air can cause more rapid cooling of the pretzel and produce inaccurate readings.

Current Tests Performed	Beneficial to Food Safety	Justification
Moisture analysis on finished pretzel	No	Low-moisture foods could have low water activities as well. However, measuring water activity is the best way to determine if and which microorganisms will be able to grow.
Color analysis on finished pretzel	No	Color can be affected by several factors, including temperature and pH. Higher pH values will generate darker pretzels. This is at the surface of the pretzel and may not indicate if the interior is properly baked. Dark color can occur on pretzel surfaces, but the interior might not have reached the appropriate temperature to reduce/eliminate microorganisms. Dark color can develop on the surface if the temperature is too high, and the heat does not have enough time to transfer to the interior.
Salt content on finished pretzel	No	While salt can reduce the water activity and inhibit bacterial growth in foods, salt is primarily used for seasoning on pretzels and is largely concentrated on the exterior. The interior dough experiences little decrease in water activity due to salt content.
pH of finished pretzel (pH results are usually basic due to dipping pretzel in an alkaline solution)	Somewhat	It is important to maintain a pH below a certain level to prevent adverse effects on consumers. Foods with a high pH could cause injury to consumers. However, it might be difficult to justify pH ranges with respect to microbial growth because the alkaline solution is predominately concentrated on the pretzel surface. There would likely be a pH gradient through the product.

% Breakage	No	Breakage measures the physical defects of the pretzels.
Dimensions (diameter, length, width)	No	Dimensions measure pretzel size. The variation in size will likely have little impact on factors that affect microbial growth.

Proposed New Tests	How Test Benefits Understanding of Product Safety	Justification
Water activity	Measures water activity	Water activity is a better determiner of microorganism growth than moisture content. Water activity can be correlated to which microorganisms are likely to grow.
Final product testing	Measures selected pathogens	Could be used to determine if pathogens such as *Salmonella spp*. are present in the finished product.
Ingredient testing	Measures selected pathogens	Ingredients that pose a larger risk, like flour, could be sent for pathogen testing. If results came back negative, there could be some increased confidence pathogens are not prevalent in the ingredient.

In-Class Activity: Cross-Contamination (Guided Answers)
Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)

Pete's Perfect Pretzels' customer service department has recently received customer complaints about consumers feeling ill after eating some of Pete's Perfect Pretzels products. Customers' symptoms have included fever, nausea, vomiting, and stomach cramps. The products consumers have eaten include Pete's Salt and Black Pepper Nuggets, Pete's Sour Cream and Onion Nuggets, and Pete's Dark Chocolate Peanut Butter Pretzel Bites. The table below can be used to organize information from your investigation. Note that the three products all have the same base ingredients (flour, salt, corn oil, yeast, etc.), and are stored in the same area. You may interview employees in the following departments: sanitation, quality, processing, packaging, warehouse, and record retention.

The black pepper was contaminated. When an employee opened black pepper bags near the peanut butter processing line, black pepper residue contaminated the peanut butter processing equipment, even though the black pepper is invisible to the naked eye. Black pepper also contaminated sour cream and onion seasoning bags during storage in the warehouse. The employee handling the sour cream and onion seasoning bags cross-contaminated the sour cream and onion seasoning by wiping the black pepper off the sour cream and onion seasoning bags with his hands and then adding the sour cream and onion seasoning to the processing line without washing his hands. Even if the cross-contamination did not happen by hand, black pepper was on the sour cream and onion seasoning bags and could have contaminated the processing line as the sour cream and onion seasoning bags were moved closer to the salt and black pepper pretzel line.

Product Name	Production Date and Time	Ingredient Storage	Processing Equipment/Area	Other Relevant Information
Pete's Salt and Black Pepper Nuggets	5/31/2018 at 9:30 am	Black pepper bags torn open and spilled black pepper onto the sour cream and onion seasoning stored below the black pepper pallets.	Black pepper powder released into the air when the bags were opened. Bags opened near peanut butter pretzel line.	N/A (Students might note some information they learned)
Pete's Sour Cream and Onion Nuggets	5/31/2018 at 8:15 am	Partial pallet of sour cream and onion seasoning stored below the black pepper bags. Black pepper on the outside of the sour cream and onion seasoning bags.	Employee wiped black pepper powder from the outside of the sour cream and onion seasoning bags and did not wash hands before dumping/scooping the sour cream and onion seasoning onto the line.	N/A (Students might note some information they learned)
Pete's Dark Chocolate Peanut Butter Pretzel Bites	5/31/2018 at 7:00 am	Stored in the proper location. No leaks/spills. Product was sealed.	Extruder die had to be recleaned due to peanut butter residue. Passed on second inspection.	Peanut butter sent for ingredient testing. Test results indicated no *Salmonella* was present in the sample.

In-Class Activity: Choose (Guided Answers)
You Decide: Are Spices Safe?

Considering customer complaints about Pete's Perfect Pretzels and the black pepper recall by the FDA, Pete's Perfect Pretzels Management team has decided to revise training procedures and investigate other ingredient options that pose less risk of being contaminated with pathogens. Management has provided the following information on oleoresins and wants your team to determine if using oleoresins is a viable option to replace all or some of the seasonings used in Pete's Perfect Pretzels products. Research and Development will also be working to determine how the change from powder seasoning to oleoresins will impact the product attributes, including flavor, texture, and shelf-life. You will also need to discuss these potential changes with Research and Development before presenting to management.

You have been provided with excerpts from different sources related to spices and/or oleoresins. You may use these sources or sources you find to gather information. If other sources are used, cite your sources and briefly explain the source type (e.g., spice vendor's website, scientific equipment vendor, etc.).

1. Use the space below to list the goals of the new formulation including oleoresin, why the identified attribute is important, and which team(s) would be responsible for this aspect of the product. An example has been provided for you.

Goal	Justification	Team Responsible
New formulation should be the same or lower in price compared to original formulation	Higher prices may result in increased product cost to consumers and could decrease profits.	Procurement: Responsible for finding suppliers and working with suppliers on ingredient pricing. Research and Development: Responsible for formulation and product design. Product design will drive resource needs.

2. Experiment with the pretzels you have been provided. DO NOT EAT the oleoresin or the pretzel containing the oleoresin. Use the space below to calculate the ratio of oleoresin to black pepper needed for the formulation. Then, calculate the cost ratio of oleoresin to black pepper used in the formulation.

Calculate ratio of oleoresin to black pepper needed for the formulation.

Example procedure:

1. Students determine how much oleoresin (mass of oleoresin used per pretzel) is needed to achieve the desired product properties.
2. Students determine how much black pepper (mass of black pepper used per pretzel) is needed to achieve the desired product properties.
3. Students divide the answer from step one by the answer from step two to find the ratio of oleoresin to black pepper. *The mass unit used for oleoresin and black pepper should be the same (e.g. both are measured in mg).

Calculate cost ratio of oleoresin to black pepper used in your formulation.

Example procedure:

1. Students look up (or teacher provides) the cost of oleoresin and black pepper.
2. Students convert the cost per unit from step one to match the units they used. For example, if students have units of mg of black pepper per pretzel from their experiment, and the cost was provided in dollars per pound of black pepper, students can convert the cost to dollars per mg of black pepper.
3. Students multiply the ratio of oleoresin to black pepper by the ratio of cost/unit oleoresin to cost/unit black pepper. The result is the cost ratio of oleoresin to black pepper.
   **It is important to note that these calculations can give students an idea of the cost comparison between oleoresin and black pepper. To more accurately calculate the cost ratio of oleoresin to black pepper, data should be taken from the scaled-up process for production of both products.*

3. *W*hat are some of the limitations with the experiments you were able to perform with the materials you have been provided? For each limitation, describe how you would change the procedure you used if you were able to run the experiment in a factory or research lab.

   The table below includes possible student answers. Any logical answer provided by students is acceptable.

Description of limitation	How would you change the experiment in industry?
The process is not scaled up. Only a few pretzels are being used to determine the mass of oleoresin and black pepper used in the process.	The process could be scaled up to more accurately calculate the ingredient cost for oleoresin and black pepper.
The ingredients can only be added to the exterior of the pretzel.	The oleoresin could be added to the pretzel dough to determine how the sensorial properties would be affected.
The effects of baking on oleoresin properties cannot be determined in the in-class experiment.	The effects of baking on oleoresin properties can be evaluated using a sensory panel.
A limited variety of oleoresins are available for experimentation.	Procurement could acquire a more diverse selection of oleoresins for experimentation.
The pricing provided to students might not align with the industry price. For example, a minimum quantity of oleoresin might have to be ordered. If production will not use the minimum quantity of oleoresin, this could generate ingredient waste.	Procurement could provide information on minimum order quantities for oleoresin. This information can be used to more accurately calculate production costs.

4. Based on your calculations, experiments, and article review, complete the below table.

The table below contains possible answers. Any logical or evidenced-based answer is acceptable.

	Spices	**Oleoresin**
Advantages	• Spices would add to the visual aesthetics of the pretzels. • Provides "gritty" feel characteristic of a product flavored with herbs and spices. • Oleoresins might not be available for all spices.	• Easy to store and transport. • More stable when heated. • More economical to use. • Easier to control for quality and cleaner than the equivalent ground spices. • Free from contamination. • Concentrated form reduces storage space and bulk handling and transport requirements. • Concentrated and virtually moisture-free form of oleoresins ensure longer shelf-life due to minimal oxidative degradation or loss of flavor.
Disadvantages	• Can have heavy microbial loads.	• Depending on consumer preferences, oleoresins may be aesthetically inferior because they lack particulates, which the consumer may want to see to indicate seasoning. • Depending on consumer preferences, oleoresins may be texturally inferior due to lack of particles. • Sensitive to light, heat, and oxygen, which could shorten shelf-life.
Potential Pathogens	• *Clostridium perfringens* • *Bacillus cereus* • *Salmonella spp.*	• Minimal microbial loads

Similarities	• If processed by a reputable producer, microbial loads are less likely to be high. • Imparts flavor and color to products.	
Choice	**Justification for Choice**	
	Students may choose either option as long as they provide a justification for their choice.	

How credible were the sources you used? Explain your reasoning.
Information presented by spice/oleoresin vendors could be biased since they are trying to sell products.
Information presented by scientific companies may be less biased, but there could be some bias since they are selling supplies and services.
Information presented by scientific journals may be least biased because they present factual information and have research that should not be biased. Scientific journals have reviewers, which can help reduce bias.

In-Class Activity: Pete's Perfect Pretzels (Guided Answers)
Hazard Analysis Critical Control Point (HACCP)

As a member of Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP) team, you have been asked to review the process for making pretzel twists and pretzel rods, outline potential hazards, and to outline how to control the hazards. You first made a process flow diagram to identify key steps in the pretzel production process.

Follow the examples provided. As a note, the structure of HACCP worksheets may vary between companies. Identification of hazards, controls, and critical limits should be completed. Below are key hazards in the process. Students may identify and justify additional hazards.

Table 1. Hazard Analysis

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)
Ingredient Receipt	Biological: microbial contamination (*Salmonella* in flour, pathogens in spices/seasoning).	B: N	B: Supplier should control hazard (Certificate of Analysis).	B: See processing; controlled at CCP-2.	B: None at this step.	B: None at this step.
	Chemical: chemical contamination (e.g., pesticides).	C: N	C: Supplier should control hazard (Certificate of Analysis).	C: None.	C: None.	C: None.
	Physical: insects, metal.	P: Y	P: Supplier should control hazard, but metal contamination could cause serious injury.	P: See ingredient storage step; controlled at CCP-1.	P: None at this step.	P: None at this step.
	Radiological: Soil and water used for growing products (wheat) could contain contaminants.	R: N	R: Should be controlled by supplier. Pete's Perfect Pretzel suppliers are reputable with no history of radiological contamination of soil or water where products are grown.	R: None.	R: None.	R: None.

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)
Ingredient storage/ automated transport of dry ingredients to processing line	Biological: microbial growth.	B: Y	B: Some ingredients may contain spores (spices). *Salmonella* could survive/grow on stored flour.	B: Proper storage (most ingredients used have low water activity and will be stored at ambient temperatures in a dry location to limit moisture needed for pathogen growth); controlled by CCP-2 (baking).	B: None at this step.	B: None at this step.
	Chemical: Cross-contact (allergens).	C: N	C: Segregation of allergen products in storage should control risk.	C: None.	C: None.	C: None.
	Physical: metal.	P: N	P: Supplier should control; however, metal could be present in ingredients from supplier process that went undetected. Metal contamination is high-risk and could cause injury.	P: Magnets in dry storage compartments used to collect metal fragments.	P: CCP-1	P: 0 pieces of metal 7mm – 25mm in length/diameter [22].
	Radiological: None.	R: N	R: Should be controlled by supplier, and few ingredients contain water.	R: None.	R: None.	R: None.
Product Processing	Biological: microbial growth.	B: Y	B: Some ingredients may contain spores (spices). *Salmonella* could survive/grow on stored flour.	B: Baking (sustaining high temperature long enough to eliminate pathogens).	B: CCP-2	B: 0 pathogenic organisms.
	Chemical: Cross-contact (allergens).	C: N	C: Allergens only processed on certain lines. Lines cleaned and allergen swabbing performed.	C: None.	C: None.	C: None.
				P: Metal detectors (CCP-3)		

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)
	Physical: Potential metal or *other hard/sharp material from processing. Radiological: Radiological contaminants could be in the water added to the pretzel dough. *Some processes might not include an X-ray. However, metal detectors should always be included before packing product.	P: Y R: N	P: Metal or hard/sharp materials on or around the processing lines could contaminate product. R: Water could potentially contaminate the final product with radiological material, but no history of problem. Water tested annually, at a minimum, to ensure the water is safe for use.	and *X-ray detectors (CCP-4) on packaging lines before product is package and/or sealed. R: None.	P: CCP-3 and *CCP-4 R: None.	P: None. R: None.
Product Packaging	Biological: Pathogens could be reintroduced via cross-contamination. Chemical: Cross-contact (allergens). Physical: None.	B: N C: N P: N	B: Equipment is cleaned, and employees practice safe food-handling techniques. C: Allergens are segregated to certain processing lines. Lines are cleaned and swabbed for allergens. Employees practice safe food-handling techniques. P: Product packed immediately	B: None. C: None. P: None.	B: None. C: None. P: None.	B: None. C: None. P: None.

Processing Step	Potential Hazard(s)	Hazard to be addressed in the plan? (Y/N)	Justification	Control Measures	Critical Control Point (Y/N)	Critical Limit(s)
			or soon after passing through metal detector. No incidents recorded.			
	Radiological: Water used for cleaning could be contaminated.	R: N	R: Water tested annually. Low-risk area.	R: None.	R: None.	R: None.
Product Storage and Shipment	Biological: None.	B: N	B: Product properly sealed and stored to prevent contamination.	B: None.	B: None.	B: None.
	Chemical: None.	C: N	C: Product properly sealed and stored to prevent contamination.	C: None.	C: None.	C: None.
	Physical: None.	P: N	P: Product properly sealed and stored to prevent contamination.	P: None.	P: None.	P: None.
	Radiological: None.	R: N	R: Product properly sealed and stored to prevent contamination.	R: None.	R: None.	R: None.

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