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SAFE FOOD-HANDLING PRACTICES:

# Food Safety Curriculum for High School Students

## Acknowledgments

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- **Dr. Hui-Hui Wang**, assistant professor, Purdue University Department of Agricultural Sciences Education and Communication
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# Content

# INTRODUCTION

## Rationale

### *Background*

Foodborne illness is an economic burden to public health in the United States. It is caused by eating or drinking food or beverages that are contaminated with microbes or pathogens. Each year in the United States, foodborne pathogens cause an estimated 48 million illnesses, including approximately 128,000 hospitalizations and approximately 3,000 deaths. In other words, one in six Americans becomes ill annually from consuming contaminated foods or beverages.

### *Need for Food Safety Education*

Three main factors strongly support the need to focus on student food safety education:

**1.** An increasing number of teenagers are involved in food handling (e.g., cooking or grocery shopping). Larson et al., reported that teenagers are involved with shopping for groceries and preparing dinner (Larson, Story, and Neumark-Sztainer 2006).

**2.** Students might be current and future food-service employees. Consequently, students receiving food-safety education in their high-school curricula will have a potentially positive impact on the food-service industry.

**3.** Multiple previous studies reported that middle- and high-school students can lack food-safety knowledge, which has the potential to put themselves and others at risk to develop an 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 food-safety education for students, who are consumers and potential food-service employees.

### *Need for Teacher Involvement*

Teachers can foster excitement for learning about the science related to food. They are positioned to deliver key safe food-handling messages to students, provide compelling examples of the challenges of foodborne illness, and encourage participation in a learning module designed to help students 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 lifetime.

## Unit Design and Pedagogical Theories

*Safe Food-Handling Practices* is a food-safety curriculum for high-school students in which safe food-handling recommendations are delivered through a structured discussion led by a trained teacher. Its objective is to provide high-school teachers with food-safety information and resources to promote safe food-handling practices among all students, including those that are or care for individuals who are at high risk for contracting foodborne illness.

The curriculum content is based on the Partnership for Food Safety Education's Fight BAC!® Campaign, which is a food-safety initiative designed to educate consumers about four food-safety principles: clean, separate, cook, and chill. A fifth principle—choose safe food—is also included to address the myths related to food choices with greater safety risks.

This curriculum uses a positive deviance approach, which relies on positive deviants, or those within the group who practice the recommended behavior, to act as role models to encourage others in the group to practice that behavior as well. People are more willing to try advice from peers who are like themselves. Research has shown that using a positive deviance approach to present this curriculum encouraged participants to learn more about safe food handling and practice recommended behaviors more as compared to relying solely on conventional reading materials (Feng and Bruhn 2016; Feng, Bruhn, and Marx 2016).

## Unit Information

**Grade Levels:** Recommended for grades 9–12

**Prerequisites:** Students should have foundational knowledge of microbiology (pathogen identification and bacterial growth requirements), chemistry (water activity and pH), and mathematics (surface area, volume, and ratio calculations). Students will need basic laboratory skills, including the ability to safely heat and mix substances, and basic plating techniques.

**Duration:** This curriculum requires a minimum of eight 60-minute class periods. Additional time may be required based on student experience and engagement. The units can also be completed in a larger number of shorter sessions. Be sure to plan adequate time to complete the food preparation experiments.

**Required Materials**

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 1:**<br>Cooking Lab 1 (Pre) | ***Activity 1: Pre-Survey Administration***<br>▪ Pre-survey<br><br>***Activity 2: Cooking Activity***<br>▪ Student Cooking Observation Checklist<br>▪ Cheeseburgers recipe<br>▪ *Optional*: video recording devices<br>▪ Ingredients for Cheeseburgers recipe (per group):<br>◆ 1 pound ground beef<br>◆ 1 teaspoon salt<br>◆ 1 teaspoon black pepper<br>◆ 8 slices American cheese<br>◆ 4 hamburger buns<br>◆ ketchup<br>◆ mustard<br>◆ mayonnaise<br>◆ sliced tomatoes<br>◆ sliced pickles<br>◆ fresh lettuce<br>▪ Ingredients for Zucchini Crisps recipe (per group):<br>◆ 2 medium zucchinis, sliced into $^{1}/_{8}$-inch rounds<br>◆ ½ teaspoon salt<br>◆ ½ teaspoon pepper<br>◆ 1½ cups Parmesan cheese, grated<br>▪ Cooking equipment and supplies (per group unless noted otherwise):<br>◆ 1 cooking thermometer<br>◆ 1 skillet<br>◆ 2 spatulas<br>◆ 1 mixing bowl<br>◆ 1 baking sheet<br>◆ 1 knife<br>◆ 1 cutting board<br>◆ food handler's gloves (enough for class)<br>◆ 1 can of cooking spray (enough for class)<br>◆ aluminum foil (enough for class)<br>◆ parchment paper (enough for class)<br>◆ plates (enough for class)<br>◆ eating utensils (enough for class)<br>◆ paper towels (enough for class) | |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 2:**<br>Clean | ***Activity 1: Building Concepts Related to Safe Food-Handling Practices: Cleaning***<br>▪ Final Project Rubric<br>▪ Video: Recommendations for Washing Hands and Produce, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/<br><br>***Activity 2: Applying Cleaning Concepts***<br>▪ Video: Benzel Pretzels: Where's Charlie?, https://www.youtube.com/watch?v=TQjZjF-Tcao<br>▪ Video: Zones in a Food Processing Facility, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/<br>▪ In-Class Activity—Clean: Good Manufacturing Practices (GMP) Development<br>▪ GMP student reference *(print and distribute if students can't access electronically during class)*:<br>◆ Employee Health, Hygiene, and Hand Washing, https://dairyextension.foodscience.cornell.edu/resources/food-safety/good-manufacturing-procedures/employee-health-hygiene-and-hand-washing/<br>◆ In-Class Activity—Clean: Pete's Perfect Pretzels SSOP (Sanitation Standard Operating Procedures) Development<br>◆ SSOP student reference *(print and distribute if students can't access electronically during class):*<br>◆ Sanitation Standard Operating Procedure (SSOP) Example, https://meatsci.osu.edu/node/116<br>▪ Pathogen References for Students<br>▪ Chemical and Testing Reference Sheet<br><br>***Activity 3: Take-Home Activity to Assess Student Comprehension***<br>▪ Take-Home Activity—Clean: Good Kitchen Practices (GKPs) worksheet<br>▪ Take-Home Activity—Clean: Kitchen Sanitation Standard Operating Procedures (SSOPs) worksheet<br><br>*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned. | |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 3:**<br>**Cook and Chill** | ***Activity 1: Introduction of Concepts Related to Safe Food-Handling Practices: Chilling, Cooking, and Food Preparation***<br>▪ For Cabbage Juice Activity (per 3–4 students):<br>◆ three 5-ounce containers of red cabbage juice<br>◆ 0.5 ounce (15 ml) distilled white vinegar<br>◆ 1 teaspoon (3.5 g) baking soda<br>◆ 2 stirring rods<br>◆ 3 pH test strips<br>▪ Video: Bacterial Growth, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/<br><br>***Activity 2: Building Concepts—Heat Transfer***<br>▪ Dough for Heat Transfer Activity (Make color-changing dough in advance; one batch yields enough dough for approximately three groups of four students each.)<br>◆ 4 cups flour<br>◆ 1½ cups salt<br>◆ 2 tablespoons oil<br>◆ 1 cup water<br>◆ 5–10 grams color-changing powder (add until the desired color is reached)<br>▪ 1 hot plate (per 3–4 students)<br>▪ aluminum foil<br>▪ spatula (one per 3–4 students)<br>▪ *Optional:* plastic knives for dividing dough<br>▪ Video: Temperature Control, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/<br><br>***Activity 3: Ingredient Storage and Product Testing***<br>▪ In-Class Activity—Chill: Dessert Pretzels<br>▪ In-Class Activity—Cook: Is It Safe to Eat?<br><br>***Activity 4: Take-Home Activity to Assess Student Comprehension***<br>▪ Take-Home Activity—Chill, Cook, and Food Preparation: How Does Your Home Kitchen Compare to a Processing Facility?<br><br>*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned. | Instructions for making red cabbage juice are found at Red Cabbage Chemistry, Steve Spangler Science, https://www.stevespanglerscience.com/lab/experiments/red-cabbage-chemistry/<br><br>Color-changing powder may be purchased from Atlanta Chemical Engineering®, https://www.atlantachemical.com/.<br><br>Color-changing powder is classified as Thermochromic (Powder) Pigments. The powder comes in various colors and temperature-change thresholds. |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 4:**<br>Cross-Contamination | ***Activity 1: Building of Concepts Related to Safe Food-Handling Practices: Wrap-Up of* In-Class Activity-Chill: Dessert Pretzels *and* In-Class Activity—Cook: Is It Safe to Eat?**<br>▪ None<br><br>***Activity 2: Building of Concepts Related to Safe Food-Handling Practices: Cross-Contamination***<br>▪ Video: Don't Wash Your Chicken! Germ-Vision Animation, https://www.youtube.com/watch?v=JZXDotD4p9c<br><br>***Activity 3: Cross-Contamination Investigation***<br>▪ In-Class Activity—Cross-Contamination: Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)<br>▪ Teacher's Notes for In-Class Activity—Cross-Contamination: Pete's Perfect Pretzels P.I.'s (Pretzel Investigators) (1 copy per group, cut apart into slips by departments and placed into envelopes marked by group number)<br>▪ envelopes to hold paper slips (1 per group)<br><br>***Activity 4: Take-Home Activity to Assess Student Comprehension***<br>▪ Take-Home Activity—Cross-Contamination: Spot and Stop the Pathogen Spread!<br><br>*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned. | |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 5:**<br>Choose Safe Food | ***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Cross-Contamination***<br>▪ None<br><br>***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Choose Safe Foods***<br>▪ Three to seven food products processed with UHT, such as:<br>◆ fruit jam<br>◆ guacamole<br>◆ pasteurized juice<br>◆ salad dressing<br>◆ soup<br>◆ yogurt<br>▪ Video: What Is UHT Milk?, https://www.youtube.com/watch?v=wFkVefQJpfg<br>▪ Video: Julie Riggs (raw milk), https://www.youtube.com/watch?v=tpV9CHSVuJM&feature=youtu.be<br>▪ Video: Food Safety in the Produce Aisle, https://www.youtube.com/watch?v=Zy_QuxLkr7c<br>▪ Video: Using Nuclear Science in Food Irradiation, https://www.youtube.com/watch?v=pe6AKh_tLys (start at 0:55 seconds)<br>▪ In-Class Activity—Choose: Experiment Design<br>▪ For Experiment Design Activity (per group unless noted otherwise):<br>◆ nutrient agar (to use in petri dishes):<br>◆ How to Make Nutrient Agar, https://www.youtube.com/watch?v=YX_b02KYN9g<br>◆ Sterilizing without an Autoclave, https://www.youtube.com/watch?v=OUjsqyZJTag<br>◆ Source for purchasing premade plates: https://www.flinnsci.com/search-results/?type=All&query=nutrient+agar+plates<br>◆ pasteurized apple juice (2–3 fl. oz. for the class)<br>◆ unpasteurized apple juice (2–3 fl. oz. for the class)<br>◆ 2 beakers<br>◆ 5 sterile swabs<br>◆ 2 stirring rods<br>◆ parafilm<br>◆ nitrile gloves<br>◆ 5 sterile petri dishes containing nutrient agar<br><br>***Activity 3: Using Collected and Experimental Data to Decide If Spices Should Be Used in Pretzel Production***<br>▪ In-Class Activity—Choose: Are Spices Safe?<br>▪ For the Are Spices Safe? Activity (per group):<br>◆ 5 salt pretzels<br>◆ 5 salt-and-pepper pretzels<br>◆ one ⅓-fl. oz. (10 mL) food-/ pharmaceutical-grade black pepper oleoresin (or substitute black pepper essential oil) (enough for class)<br>◆ 2–6 droppers to dispense the oleoresin (enough for class)<br>◆ *Optional:* 1 scale to weigh oleoresin for more accurate calculations (enough for class)<br><br>***Activity 4: Take-Home Activity to Assess Student Comprehension***<br>▪ Take-Home Activity—Choose: Scavenger Hunt<br><br>*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned. | Food- or pharmaceutical-grade black pepper oleoresin and food- or pharmaceutical black pepper essential oil can both be purchased at retail stores or online. The black pepper essential oil can be used in place of black pepper oleoresin.<br><br>Oleoresin: https://www.lalaessentialoils.com/black-pepper-oleoresin.html<br><br>Essential Oil: https://www.lalaessentialoils.com/black-pepper-oil-certified-organic.html |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 6:**<br>Hazard Analysis Critical Control Point (HACCP) | ***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Choose Safe Foods*** *(10 minutes)*<br>▪ None<br><br>***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Begin HACCP***<br>▪ Handout: In-Class Activity—Hazard Analysis Critical Control Point (HACCP) Video Notes<br>▪ Video: Hazard Analysis & Critical Control Points (HACCP)–Fulton County [Georgia], https://www.youtube.com/watch?v=X2kw40KyVnY<br>▪ Video: HACCP Food Safety Hazards, https://www.youtube.com/watch?v=lEZbSaikBTw<br>▪ HACCP student reference *(print and distribute if students can't access electronically during class)*:<br>◆ Fully Cooked, Not Shelf Stable Meat and Poultry—HACCP Plan, https://www.aamp.com/fc-not-ss-haccp-plan/ *(After following the link, click on "Hazard Analysis.")*<br><br>*Note:* If this document cannot be shared electronically during class, print at least the first eight pages to help students understand the different types of information they should include. Be sure to print at least one page that contains a potential safety hazard that is significantly likely to occur (column 3 = Yes). The first example of this is on page 8 for the "Cook" process step.<br><br>***Activity 3: HACCP In-Class Activity***<br>▪ Handout: In-Class Activity—Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP)<br><br>***Activity 4: Take-Home Activity to Assess Student Comprehension***<br>▪ Handout: Take-Home Activity—Hazard Analysis Critical Control Point (HAACP): Make It Safe!<br>▪ Links to share with students:<br>◆ *Food Safety for Fruit and Vegetable Farms,* Purdue Extension/University of Illinois Extension, https://www.extension.purdue.edu/extmedia/GP/GP-1-W.pdf<br>◆ Integrated Pest Management, G.A.P (Good Agricultural Practices) in Action, GLOBALG.A.P., https://www.youtube.com/watch?v=7qQCLMFjRew<br>◆ Good Agricultural Practices on the Farm and in Your Home Garden, College of Tropical Agriculture and Human Resources, University of Hawai'i–Mānoa, https://www.youtube.com/watch?v=wO5miD90wMQ<br><br>*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned. | |

| Lesson | Materials List<br>*(Note: Where "per group" is indicated, the group size is expected to be 3–4 students.)* | Additional Information |
|---|---|---|
| **Day 7:**<br>**Presentations** | ***Activity 1: Discussion of Concepts Related to Food-Handling Practices: Evaluate Petri Dishes from Choose Experiment Design***<br>▪ streaked petri dishes from In-Class Activity—Choose: Experiment Design<br>▪ Handout: In-Class Activity—Choose: Experiment Design *(partially completed by students during Day 5, Activity 2)*<br><br>***Activity 2: Final Project Presentations***<br>▪ Final Project Rubric<br>▪ projection equipment for electronic presentations<br><br>*Note:* Provide alternative presentation methods as needed for those students who will not be making a digital presentation. | |
| **Day 8:**<br>**Cooking Lab 2 (Post)** | ***Activity 1: Post-Survey Administration***<br>▪ Post-survey<br><br>***Activity 2: Cooking Activity***<br>▪ Student Cooking Observation Checklist<br>▪ *Optional:* video recording devices<br>▪ Ingredients for Cheeseburgers recipe (per group):<br>◆ 1 pound ground beef<br>◆ ¼ cup mild or spicy nacho cheese sauce<br>◆ ½ teaspoon salt<br>◆ ½ teaspoon pepper<br>◆ 4 hamburger buns, split and toasted<br>◆ shredded lettuce<br>◆ 4 green onions, sliced<br>▪ Ingredients for Salsa recipe (per group):<br>◆ 2 large plum tomatoes, diced (yields 1 cup)<br>◆ ⅛ cup white onion, chopped<br>◆ 1½ tablespoons fresh cilantro, chopped<br>◆ 1 teaspoon jalapeño, minced (remove seeds for lower heat)<br>◆ ¾ teaspoon fresh lime juice<br>◆ ¼ teaspoon kosher salt (or to taste)<br>◆ tortilla chips (for serving salsa)<br>▪ Cooking equipment and supplies (per group unless noted otherwise):<br>◆ 1 cooking thermometer<br>◆ 1 skillet<br>◆ 1 spatula<br>◆ 2 mixing bowls<br>◆ 1 spoon<br>◆ 1 knife<br>◆ 1 cutting board<br>◆ food handler's gloves (enough for class)<br>◆ plates (enough for class)<br>◆ eating utensils (enough for class)<br>◆ paper towels (enough for class) | |

# Glossary

| Term | Description |
|---|---|
| **ATP (adenosine triphosphate)** | "[E]nergy-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)."[1] |
| **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"[2] |
| **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"[3] |
| **Cross-Contact** | "Cross-contact happens when one food comes into contact with another food and their proteins mix."[4] |
| **Cross-Contamination** | "Inadvertent transfer of bacteria or other contaminants from one surface, substance, etc., to another especially because of unsanitary handling procedures"[5] |
| **Food and Drug Administration (FDA)** | The FDA is the U.S. federal agency responsible for regulating the production of certain food items. The FDA publishes guidance documents to disseminate information to producers and manufacturers related to safe food processing, transporting, and storage. |
| **Good Manufacturing Practice (GMP)** | A GMP is established to ensure that products are safely produced. GMPs include components that address items such as employee hygiene, plant design, facility maintenance, and pest control. |
| **Gram-negative** | "Refers to the inability of a type of bacterium to resist decolorization with alcohol after being treated with crystal violet. However, following decolorization, these bacteria can be readily counterstained with safranin, imparting a pink or red color to them when viewed by light microscopy. This reaction is usually an indication that the outer structure of the bacterium consists of a cytoplasmic (inner) membrane surrounded by a relatively thin peptidoglycan layer, which in turn is surrounded by an outer membrane." |
| **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."[7] |
| **Microorganism** | "An organism (such as a bacterium or protozoan) of microscopic or ultramicroscopic size"[8] |
| **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"[9] |
| **Pathogen** | "A specific causative agent (such as a bacterium or virus) of disease"[10] |
| **Peptidoglycan** | A polymer found in the cell walls of prokaryotes that consists of polysaccharide and peptide chains in a strong molecular network. |
| **Process Flow Diagram** | An organizational chart that outlines how steps in a system are interrelated |
| **Radiological Hazard** | "The uncontrolled release of radioactive material that can harm people or damage the environment"[11] |
| **Sanitation Standard Operating Procedure (SSOP)** | SSOPs are written instructions detailing methods for maintaining equipment and processing environments in a sanitary manner.[12] |
| **Spore** | "A dormant or resting stage of certain bacteria and other organisms, capable of surviving for long periods in hostile environments and of reactivating under suitable conditions." |
| **Spore-former** | "An organism that forms spores." Citation: Merriam-Webster Dictionary. 2020. Available from: www.merriam-webster.com/dictionary. |
| **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 food-contact surfaces. |
| **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 break rooms. |

1. Britannica 2018
2. Merriam-Webster, www.merriam-webster.com/dictionary
3. U.S. Food and Drug Administration 2017
4. Food Allergy Research & Education, www.foodallergy.org/resources/avoiding-cross-contact
5. Merriam-Webster, www.merriam-webster.com/dictionary
6. Medical Dictionary. 2020. Available from: https://medical-dictionary.thefreedictionary.com.
7. U.S. Food and Drug Administration 2017
8. Bright Hub Engineering 2008
9. Merriam-Webster, www.merriam-webster.com/dictionary
10. Merriam-Webster, www.merriam-webster.com/dictionary
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12. Medical Dictionary. 2020. Available from: https://medical-dictionary.thefreedictionary.com.
13. Washington State Military Department 2018
14. Kaylegian 2018
15. Medical Dictionary. 2020. Available from: https://medical-dictionary.thefreedictionary.com.
16. Medical Dictionary. 2020. Available from: https://medical-dictionary.thefreedictionary.com.

# 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 behaviors prior to receiving food-safety education. Teach students food safety using five days of food-safety lessons, then during an additional class session, have students give presentations on what they have learned. At the end of the five-day unit and one-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 behaviors after receiving food-safety education.

## Day 1

### Principle(s)

Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. 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 illnesses among consumers.

### Unit Objective(s)

- Collect data to establish a baseline for student food-safety knowledge, attitudes, and behaviors.

### Materials List

***Activity 1: Pre-Survey Administration***

- Pre-survey

***Activity 2: Cooking Activity***

- Student Cooking Observation Checklist
- Cheeseburgers recipe
- Optional: video recording devices
- Ingredients for Cheeseburgers recipe (per group):
  - 1 pound ground beef
  - 1 teaspoon salt
  - 1 teaspoon black pepper
  - 8 slices American cheese
  - 4 hamburger buns
  - ketchup
  - mustard
  - mayonnaise
  - sliced tomatoes
  - sliced pickles
  - fresh lettuce
- Ingredients for Zucchini Crisps recipe (per group):
  - 2 medium zucchinis, sliced into ⅛ -inch rounds
  - ½ teaspoon salt
  - ½ teaspoon pepper
  - 1½ cups Parmesan cheese, grated
- Cooking equipment and supplies (per group unless noted otherwise):
  - 1 cooking thermometer
  - 1 skillet
  - 2 spatulas
  - 1 mixing bowl
  - 1 baking sheet
  - 1 knife
  - 1 cutting board
  - food handler's gloves (enough for class)
  - 1 can of cooking spray (enough for class)
  - aluminum foil (enough for class)
  - parchment paper (enough for class)
  - plates (enough for class)
  - eating utensils (enough for class)
  - paper towels (enough for class)

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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 behaviors prior to receiving food-safety education. Teach students food safety using five days of food-safety lessons, then during an additional class session, have students give presentations on what they have learned. At the end of the five-day unit and one-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 behaviors after receiving food-safety education.

## Day 1

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br><br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses among consumers. | ▪ Collect data to establish a baseline for student food-safety knowledge, attitudes, and behaviors. |

### Materials List

***Activity 1: Pre-Survey Administration***

- Pre-survey

***Activity 2: Cooking Activity***

- Student Cooking Observation Checklist
- Cheeseburgers recipe
- *Optional*: video recording devices
- Ingredients for Cheeseburgers recipe (per group):
  - 1 pound ground beef
  - 1 teaspoon salt
  - 1 teaspoon black pepper
  - 8 slices American cheese
  - 4 hamburger buns
  - ketchup
  - mustard
  - mayonnaise
  - sliced tomatoes
  - sliced pickles
  - fresh lettuce
- Ingredients for Zucchini Crisps recipe (per group):
  - 2 medium zucchinis, sliced into $^{1}/_{8}$-inch rounds
  - ½ teaspoon salt
  - ½ teaspoon pepper
  - 1½ cups Parmesan cheese, grated
- Cooking equipment and supplies (per group unless noted otherwise):
  - 1 cooking thermometer
  - 1 skillet
  - 2 spatulas
  - 1 mixing bowl
  - 1 baking sheet
  - 1 knife
  - 1 cutting board
  - food handler's gloves (enough for class)
  - 1 can of cooking spray (enough for class)
  - aluminum foil (enough for class)
  - parchment paper (enough for class)
  - plates (enough for class)
  - eating utensils (enough for class)
  - paper towels (enough for class)

| Day 1 | Learning Activities |
|---|---|

1. ***Activity 1: Pre-Survey Administration*** *(15 minutes)*
   - 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. Distribute the **pre-survey.** (The post-survey administered at the end of the unit will contain the same questions.) Monitor the students as they complete it to deter them from sharing information with one another. Collect the completed pre-surveys.
2. ***Activity 2: Cooking Activity*** *(45 minutes)*
   - 2.1. Cooking station setup:
     - Label the cooking stations from 1 to 6.
     - Store the temperature-sensitive ingredients (meat, cheese, vegetables, etc.) in the refrigerator. Non-temperature-sensitive ingredients may be stored on a common table or at the stations.
     - Place one copy of each recipe (**Cheeseburgers** and **Zucchini Crisps**) at each station.
     - Ensure that students have the necessary equipment as outlined in the materials list.
   - 2.2. Before going to the cooking lab:
     - Assign students to (or allow students to pick) their lab groups and their lab stations (1 to 6). There should be no more than four students per group. Teacher/Leader says, "We are going to do a cooking activity in which you will make cheeseburgers."
     - Lead students to the cooking 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 cooking lab:
     - Once in the lab, assign groups of students to cooking stations labeled 1 to 6. Group 1 should be assigned to station 1; group 2, to station 2; etc.
     - When 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."
       - Monitor students to ensure that they are using the kitchen equipment safely.
       - Use video recordings or the included **Student Cooking Observation Checklist** to record students' food-handling behaviors.
       - Intervene only when students or property are in danger (e.g., students are handling food in a way that could result in illness, misusing knives, or operating the stove in a way that could result in a fire, etc.). Record all instances of improper food handling and all interventions on the observation checklist.
       - Have students indicate when they are finished cooking, then measure the internal temperature of the burger patties. If the internal temperature measures below 160°F, have students continue cooking the burgers until the internal temperature is at least 160°F. When students are finished cooking, eating, and cleaning up the kitchen for the next class, dismiss the students.

   *Note:* The information in the videos or 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 on 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 recorded on 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 each cooking session, with each group cooking for one class period and observing during the other class period.

## Day 2

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br><br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses among consumers. | ▪ Students are able to apply cleaning methods to reduce or eliminate unwanted microorganisms and pathogens on hands, surfaces, and foods.<br>▪ Students are able to define and identify examples of Zones 1–4 in a food-processing environment.<br>▪ 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.<br>▪ Students are able to develop a basic Good Manufacturing Practices (GMP) document for a food-processing company.<br>▪ Students are able to compare and contrast cleaning and verification methods utilized in processing facilities and home kitchens. |

**Suggested Pre-Knowledge**

Basic knowledge of microbiology

**State Standards Addressed**

Indiana Department of Education, Advanced Life Science: Foods

**Domain—Safety, Sanitation, and Quality of Food**

**Core Standard 1** Students analyze and manage operational and safety procedures in food product and processing facilities.

**Standards**

ALSF-1.1 Construct plans that ensure implementation of safety programs for food products, processing facilities, and the environment.

ALSF-1.3 Describe the importance of performing quality-assurance tests on food products and applying corrective procedures as needed.

ALSF-1.5 Develop and implement operating procedures aligned with current industry regulations.

**Core Standard 2** Students apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

**Standards**

ALSF-2.1 Identify sources of contamination in food products and/or processing facilities and develop ways to eliminate contamination.

ALSF-2.5 Characterize, identify, and research the physical, chemical, and biological properties of microbes as they pertain to food spoilage and foodborne illness.

| Day 2 | Materials List |
|---|---|

***Activity 1: Building Concepts Related to Safe Food-Handling Practices: Cleaning***

- Final Project Rubric
- Video: Recommendations for Washing Hands and Produce, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/

***Activity 2: Applying Cleaning Concepts***

- Video: Benzel Pretzels: Where's Charlie?, https://www.youtube.com/watch?v=TQjZjF-Tcao
- Video: Zones in a Food Processing Facility, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/
- In-Class Activity—Clean: Good Manufacturing Practices (GMP) Development
- GMP student reference *(print and distribute if students can't access electronically during class)*:
  - Employee Health, Hygiene, and Hand Washing, https://dairyextension.foodscience.cornell.edu/resources/food-safety/good-manufacturing-procedures/employee-health-hygiene-and-hand-washing/
- In-Class Activity—Clean: Pete's Perfect Pretzels SSOP (Sanitation Standard Operating Procedures) Development
- SSOP student reference *(print and distribute if students can't access electronically during class):*
  - Sanitation Standard Operating Procedure (SSOP) Example, https://meatsci.osu.edu/node/116
- Pathogen References for Students
- Chemical and Testing Reference Sheet

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

- Take-Home Activity—Clean: Good Kitchen Practices (GKPs) worksheet
- Take-Home Activity—Clean: Kitchen Sanitation Standard Operating Procedures (SSOPs) worksheet

*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned.

| Day 2 | Learning Activities |
|---|---|

***1. Activity 1: Building Concepts Related to Safe Food-Handling Practices: Cleaning*** *(15 minutes)*

1.1. Distribute the **Final Project Rubric** to students, and introduce the final project that students will present in their groups. Tell students they will take photos to represent ideas they learn from each unit of study, then 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. To open the discussion of cleaning concepts, teacher/leader asks students, "What do you think is the most common cause of foodborne illness in the United States?" **Answer:**

- Virus and bacteria

1.3. Ask students to share thoughts on ways to prevent foodborne illnesses at home. **Potential answers:**

- Washing hands
- Drying hands on single-use towels
- Wearing clean clothing
- Thoroughly cooking meat
- Washing produce with clean water

1.4. After students answer, ask them, "What about in a manufacturing facility? Are the ways to prevent foodborne illnesses the same as or different than in home kitchens?" **Answers may include:**

- Washing hands (same)
- Drying hands on single-use towels (same, but paper towels are more likely used in manufacturing facilities than cloth towels)
- Wearing clean clothing (same, but some employees are required to change their clothing or wear special clothing when handling allergens)
- Thoroughly cooking meat (same)
- Washing produce with clean water (same, but some manufacturing facilities use approved chemicals such as peracetic acid to prevent pathogenic growth)

1.5. Ask students, "Where are microorganisms and pathogens located in your homes or at a manufacturing facility?" **Potential answers:**

- On food handlers' hands and gloves
- On reusable towels
- On equipment surfaces
- In ingredients
- In environment

1.6. Ask students to identify how to eliminate or reduce pathogens on hands and gloves. **Potential answers:**

- Wash hands for 20 seconds using soap and warm water.
- Follow other recommended hand-washing techniques (e.g., wash the backs of hands, under fingernails, between fingers, fingertips, thumbs, etc.)
- Change gloves when they are contaminated or lose elasticity.
- Wash hands between glove changes.

1.7. Ask students to identify ways to dry hands. **Potential answers:**

- Disposable paper towels—This is the best method because there is limited opportunity for microorganisms to grow (as with multiuse towels) or circulate (as with electric hand dryers).
- Multiuse towels
- Air hand dryers

After students provide responses, ask them to identify the best way to dry hands and to justify their answers.

**Day 2**

**Learning Activities** *(continued)*

1.8. Show students **Recommendations for Washing Hands and Produce** (https://ag.purdue.edu/foodsci/Fenglab/extension-articles/).

1.9. Ask students to identify ingredients that could contain pathogens and what pathogens they think could be associated. **Potential answers:**

- Meat—*Campylobacter jejuni, E. coli* O157:H7, *Listeria monocytogenes, Salmonella* spp., *Staphylococcus aureus,* and *Yersinia enterocolitica*
- Poultry—*Campylobacter jejuni, Clostridium botulinum* (canned chicken), *Clostridium perfringens, Listeria monocytogenes, Staphylococcus aureus,* and *Yersinia enterocolitica*
- Seafood—*Campylobacter jejuni, Listeria monocytogenes,* and *Yersinia enterocolitica*
- Eggs—*Salmonella* spp. *and Staphylococcus aureus*
- Milk—*E. coli* O157:H7, *Staphylococcus aureus,* and *Yersinia enterocolitica*
- Flour—*Salmonella* spp.
- Produce—*Campylobacter jejuni, Clostridium botulinum* (canned produce), *Clostridium perfringens, E. coli* O157:H7 (unpasteurized juice), *Listeria monocytogenes,* and *Salmonella* spp.
- Spices—*Clostridium perfringens* and *Salmonella* spp.
- Water—*Shigella* spp.

***2. Activity 2: Applying Cleaning Concepts*** *(45 minutes)*

2.1. Have students get into groups of four. Teacher/Leader says, "Now that you know some basics about cleaning, we have an activity to apply these concepts. You are going to assume the role of a Quality Assurance Team member in a pretzel production 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 of a pretzel production facility so you will have a better understanding of what the facility and equipment look like."

2.2. Show students **Benzel Pretzels: Where's Charlie?** (https://www.youtube.com/watch?v=TQjZjF-Tcao). Ask them to record parts of the process that could be affected by pathogens and why they think there is a risk at that point in the processing.

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

- Equipment used for handling raw ingredients (e.g., belts/compartments carrying raw or uncooked ingredients/products, ingredient storage tank interior, mixers, pumps, etc.)
- Areas adjacent to processing (e.g., surfaces next to conveyor belts; control panels; handles to storage tanks and ingredient buckets; tools such as thermometers, scoops, and scrapers; etc.)

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

- Floors
- Drains
- Common areas, such as cafeterias
- Areas with water leaks, such as from ceilings or around pipes

2.5. Show students the **Zones in a Food Processing Facility** video (https://ag.purdue.edu/foodsci/Fenglab/extension-articles/).

## Day 2

**Learning Activities** *(continued)*

2.6. Tell students that they are going to become members of the Quality Assurance Team for a pretzel company called Pete's Perfect Pretzels. Their first job as a member of this team is to develop good manufacturing practices, or GMPs, for the pretzel production facility. Distribute the **In-Class Activity—Clean: Good Manufacturing Practices (GMP) Development** handout. Also, have students access the following link or distribute this resource as a printout:

- GMP student reference: **Employee Health, Hygiene, and Hand Washing,** https://dairyextension.foodscience.cornell.edu/resources/food-safety/good-manufacturing-procedures/employee-health-hygiene-and-hand-washing/.

Read aloud the worksheet instructions, and give the students 5–10 minutes to complete the worksheet. When the time is up, ask each group to contribute ideas to the class GMP policy for Pete's Perfect Pretzels.

2.7. Tell students that their second job as members of the Quality Assurance Team is to develop sanitation standard operating procedures, or SSOPs, for the pretzel production facility. Distribute the following handouts to students:

- **In-Class Activity—Clean: Pete's Perfect Pretzels SSOP (Sanitation Standard Operating Procedures) Development;**
- **Pathogen Reference Sheets for Students,** which list microorganisms and pathogens commonly associated with food processing; and
- **Chemical and Testing Reference Sheet**

Also, have the students access the following link or distribute this resource as a printout:

- SSOP student reference: **Sanitation Standard Operating Procedure (SSOP) Example,** https://meatsci.osu.edu/node/116

With students still in their groups, read aloud the worksheet instructions, and give students 15–20 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. When the time is up, ask each group to contribute ideas to the class SSOP for Pete's Perfect Pretzels.

*Note:* Times for completing these two worksheets will vary, depending on student experience. If students are less familiar with the material, the GMP and SSOP worksheets can be divided into sections, with each group working on a different section. The sections can then be combined into one GMP or SSOP.

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

- Tell students they are going to continue their exploration of clean food-handling practices at home. Distribute the **Take-Home Activity—Clean: Good Kitchen Practices (GKPs)** and **Take-Home Activity—Clean: Kitchen Sanitation Standard Operating Procedures (SSOPs)** worksheets, and ask students to complete the information based on what they learned in class today. Explain that students will be asked to answer two questions comparing and contrasting food-processing facilities and home kitchens. Also, explain that they need to develop a Good Kitchen Practices policy and Kitchen Sanitation Standard Operating Procedures (SSOP). Instruct students to turn in the assignments at the next class period, and remind students to take a photo to represent something they learned during this unit and to work on their final project.

## Day 3

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br><br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses among consumers. | ▪ 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.<br>▪ Students are able to identify the temperature at which chicken, beef, pork, and leftovers should be cooked in order to kill pathogens as well as the temperature at which refrigerators and freezers should be kept.<br>▪ Students are able to explain heat transfer through a product and can explain how surface-area-to-volume ratios and heat-transfer rates relate to cooking and cooling foods.<br>▪ Students are able to identify where foods should be stored.<br>▪ 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.<br>▪ 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—Safety, Sanitation, and Quality of Food**

**Core Standard 1** Students analyze and manage operational and safety procedures in food product and processing facilities.

**Standards**

ALSF-1.3 Describe the importance of performing quality-assurance tests on food products and applying corrective procedures as needed.

ALSF-1.4 Demonstrate procedures for safe handling of food products.

**Core Standard 2** Students apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

**Standard**

ALSF-2.5 Characterize, identify, and research the physical, chemical, and biological properties of microbes as they pertain to food spoilage and foodborne illness.

| Day 3 | Materials List |
|---|---|

***Activity 1: Introduction of Concepts Related to Safe Food-Handling Practices: Chilling, Cooking, and Food Preparation***

- For Cabbage Juice Activity (per 3–4 students):
  - three 5-ounce containers of red cabbage juice
  - 0.5 ounce (15 ml) distilled white vinegar
  - 1 teaspoon (3.5 g) baking soda
  - 2 stirring rods
  - 3 pH test strips
- Video: Bacterial Growth, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/

***Activity 2: Building Concepts—Heat Transfer***

- Dough for Heat Transfer Activity (Make color-changing dough in advance; one batch yields enough dough for approximately three groups of four students each.)
  - 4 cups flour
  - 1½ cups salt
  - 2 tablespoons oil
  - 1 cup water
  - 5–10 grams color-changing powder (add until the desired color is reached)
- 1 hot plate (per 3–4 students)
- aluminum foil
- spatula (one per 3–4 students)
- *Optional:* plastic knives for dividing dough
- Video: Temperature Control, https://ag.purdue.edu/foodsci/Fenglab/extension-articles/

***Activity 3: Ingredient Storage and Product Testing***

- In-Class Activity—Chill: Dessert Pretzels
- In-Class Activity—Cook: Is It Safe to Eat?

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

- Take-Home Activity—Chill, Cook, and Food Preparation: How Does Your Home Kitchen Compare to a Processing Facility?

*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned.

## Day 3

**Learning Activities**

1. ***Activity 1: Introduction of Concepts Related to Safe Food-Handling Practices: Chilling, Cooking, and Food Preparation*** *(15 minutes)*

   1.1. Teacher/Leader introduces the unit with the cabbage juice activity. Setup for **Cabbage Juice Activity:**

   - At each station, set out (or have available) the following items:
     - three 5-ounce containers of red cabbage juice
     - 0.5 ounce (15 ml) distilled white vinegar
     - 1 teaspoon (3.5 g) baking soda
     - 2 stirring rods
     - 3 pH test strips

   1.2. Instruct students to assemble in their groups of four. Have students add 0.5 ounce of vinegar to one of the 5-ounce containers of red cabbage juice and 1 teaspoon of baking soda to another one of the 5-ounce containers of red cabbage juice. 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. **Answer:** Caused by pH changes. When students mention pH, respond that the color change did happen due to changes in pH. Ask students what each color represents. **Answer:** Vinegar added to the cabbage turned pink and is acidic, and baking soda added to cabbage turned green and is basic. When students respond that the solutions represent acidic and basic solutions, distribute the pH strips. Ask students to verify their answers by measuring the pH using the pH strips. Cabbage juice is the pH indicator in this experiment and should have a pH of around 7.

   1.4. Ask students what role pH plays in food safety. **Answer:** It prevents bacteria growth. Ask students which solution(s) would prevent bacterial growth. **Answer:** 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

   Allow students to guess and justify their responses. Tell students that temperature/time (cooling and cooking), moisture, and nutrients also affect bacterial growth rates.

   1.5. Ask students how they know if their food is being cooled to the correct temperature in the refrigerator or freezer. **Answers may include:**

   - Thermometer indicates temperature inside the refrigerator or freezer *(correct)*.
   - Contents in the refrigerator are cold *(incorrect)*.
   - Air in the refrigerator feels cold *(incorrect)*.

   1.6. Ask 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:**

   - By cooking the food at the correct temperature for the recommended time *(incorrect)*
   - By cooking until juices run clear *(incorrect)*
   - By checking the color *(incorrect)*
   - By checking the texture *(incorrect)*
   - By using a cooking thermometer *(correct)*

   1.7. Show students the **Bacterial Growth** video (https://ag.purdue.edu/foodsci/Fenglab/extension-articles/).

   1.8. Ask students about methods for checking pH, moisture, and nutrients. Teacher/Leader says, "Why are these methods not used frequently?" **Answers may include:**

   - These things are difficult to measure at home.
   - People do not have correct equipment at home.

## Day 3

**Learning Activities**

2. ***Activity 2: Building Concepts—Heat Transfer*** *(15 minutes)*

2.1. Teacher/Leader distributes the **color-changing dough**. *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. 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 its 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.

*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.*

2.3. 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.

2.4. Show students the **Temperature Control** video (https://ag.purdue.edu/foodsci/Fenglab/extension-articles/). 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.

3. ***Activity 3: Ingredient Storage and Product Testing*** *(30 minutes)*

3.1. 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?** worksheets. Tell students they will have the remaining class time to complete the activity, and the class will discuss the answers to this activity at the start of the next class. Have groups 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.

| Activity | Groups 1 and 2 | Groups 3 and 4 | Groups 5 and 6 |
|---|---|---|---|
| Ingredient Identification | Pete's Dark Chocolate Peanut Butter Pretzel Bites | Milk chocolate caramel-dipped pretzel rods | Dessert trail mix |
| Warehouse Inspection | All questions | | |
| Quality Measurements | | | |

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

Teacher/Leader explains to students they will continue their exploration of food-handling practices related to following chilling and cooking practices at home. Distribute the **Take-Home Activity—Chill, Cook, and Food Preparation: How Does Your Home Kitchen Compare to a Processing Facility?** worksheet and instruct students to answer the questions on it based on what they learned in class today. Instruct students to turn in the homework at the next class period. Remind students to take a photo to represent something they learned during this unit and to work on their final project.

| Day 3 | Resources |
|---|---|
| | ▪ Red Cabbage Chemistry, Steve Spangler Science, https://www.stevespanglerscience.com/lab/experiments/red-cabbage-chemistry/<br>▪ Fight BAC!® by Chilling Out, U.S. Department of Agriculture, 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<br>▪ Go 40 or Below, Fight BAC!®, Partnership for Food Safety Education, http://www.fightbac.org/food-safety-education/40-or-below/<br>▪ Color of Cooked Ground Beef as It Relates to Doneness, USDA Food Safety Inspection Service, 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<br>▪ Your Gateway to Food Safety Information, U.S. Department of Health and Human Services, www.foodsafety.gov<br>▪ Food Safety, Teens Health, Nemours Foundation, http://kidshealth.org/teen/food_fitness/nutrition/food_safety.html<br>▪ Food Safety for Your Family, Kids Health, Nemours Foundation, http://kidshealth.org/parent/firstaid_safe/home/food_safety.html<br>▪ National Cattlemen's Beef Association, www.beef.org<br>▪ Free Resources, Fight BAC!®, Partnership for Food Safety Education, www.fightbac.org<br>▪ Thermy™ Campaign, USDA Food Safety and Inspection Service, https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/teach-others/fsis-educational-campaigns/thermy |

## Day 4

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br><br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses among consumers. | ▪ Students define and distinguish between cross-contamination and cross-contact.<br>▪ Students explain ways to prevent cross-contamination and/or cross-contact.<br>▪ 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.<br>▪ 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—Safety, Sanitation, and Quality of Food**

**Core Standard 1** Students analyze and manage operational and safety procedures in food product and processing facilities.

**Standard**
ALSF-1.4 Demonstrate procedures for safe handling of food products.

**Core Standard 2** Students apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

**Standards**
ALSF-2.1 Identify sources of contamination in food products and/or processing facilities and develop ways to eliminate contamination.
ALSF-2.5 Characterize, identify, and research the physical, chemical, and biological properties of microbes as they pertain to food spoilage and foodborne illness.

**Domain—History and Current Developments of the Food Industry**

**Core Standard 9** Students examine the scope of the food industry by evaluating local and global policies, trends, and customs for food production.

**Standard**
ALSF-9.7 Demonstrate an ability to critically evaluate the validity of information that commonly appears in newspapers, magazines, radio, and television (e.g., food recalls).

## Day 4

### Materials List

***Activity 1: Building of Concepts Related to Safe Food-Handling Practices: Wrap-Up of* In-Class Activity-Chill: Dessert Pretzels *and* In-Class Activity—Cook: Is It Safe to Eat?**

- None

***Activity 2: Building of Concepts Related to Safe Food-Handling Practices: Cross-Contamination***

- Video: Don't Wash Your Chicken! Germ-Vision Animation, https://www.youtube.com/watch?v=JZXDotD4p9c

***Activity 3: Cross-Contamination Investigation***

- In-Class Activity—Cross-Contamination: Pete's Perfect Pretzels P.I.'s (Pretzel Investigators)
- Teacher's Notes for In-Class Activity—Cross-Contamination: Pete's Perfect Pretzels P.I.'s (Pretzel Investigators) (1 copy per group, cut apart into slips by departments and placed into envelopes marked by group number)
- envelopes to hold paper slips (1 per group)

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

- Take-Home Activity—Cross-Contamination: Spot and Stop the Pathogen Spread!

*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned.

### Learning Activities

1. ***Activity 1: Building of Concepts Related to Safe Food-Handling Practices: Wrap-Up of* In-Class Activity—Chill: Dessert Pretzels *and* In-Class Activity—Cook: Is It Safe to Eat?** *(15 minutes)*

   1.1. Teacher/Leader asks students to take out their **In-Class Activity—Chill: Dessert Pretzels** and **In-Class Activity—Cook: Is It Safe to Eat?** worksheet from the previous class period. Have Groups 1 and 2 share their ideas for ingredient storage conditions, concerns, and justification of their choices. Then have Groups 3 and 4 share their ideas, followed by Groups 5 and 6. Work to generate consensus among students.

   1.2. After sufficient discussion or students reach an agreement, have each group share feedback for Decadent Dipped Desserts and suggestions related to the warehouse observations. Work to generate consensus among students.

   1.3. Ask students to share their quality-control answers. Work to generate consensus among students.

2. ***Activity 2: Building of Concepts Related to Safe Food-Handling Practices: Cross-Contamination*** *(10 minutes)*

   2.1. Teacher/Leader tells students they will now learn about cross-contamination. Ask students to define cross-contamination based on their current understanding of the term.

   2.2. Ask if cross-contamination is the same as cross-contact. **Answer:** Cross-contact involves unintentionally spreading allergens from one surface to another, whereas cross-contamination involves spreading bacteria from one surface to another.

   2.3. Ask students to identify items in their kitchen that could cause cross-contamination or cross-contact. **Possible answers may include:**

   - Cutting boards
   - Knives
   - Dish towels
   - Dishcloths
   - Counter

   2.4. Ask students how they prevent cross-contamination. **Possible answers may include:**

   - Washing the surface with soap and water
   - Using a disinfectant

   2.5. Ask students if they wash salt and pepper shakers, refrigerator handles, oven-door handles, sink faucets, or raw meat. Facilitate a discussion and promote correct cleaning and food-handling practices.

   2.6. Show students the **Don't Wash Your Chicken! Germ-Vision Animation** video (https://www.youtube.com/watch?v=JZXDotD4p9c).

| Day 4 | **Learning Activities** *(continued)* |
|---|---|

***3. Activity 3: Cross-Contamination Investigation*** *(35 minutes)*

3.1. Teacher/Leader 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 will need to learn information from different Pete's Perfect Pretzel employees. I have information from employees in the following departments: Sanitation, Quality Assurance, Processing, Packaging, Warehouse, and Record Retention. One person from each group may come to my desk and ask me for information from one of the departments. I will provide you with a slip of paper containing information from the department you requested. Please share this information with your group members and record the information you receive on your worksheet. After you finish recording and discussing the information you gathered, send one person from your group to ask for information from another department. Continue this process until you have gathered information from all the departments or until you have identified the contamination source. Remember, it might not be necessary to get information from all of the departments in order to determine the contamination source."
*(Note:* Use the prepared envelopes to distribute information to groups as requested and track the information still available for each group.)

3.2. Allow students to work for the remaining class time on identifying the source of contamination. Toward the end of the class period, inform the students that the FDA has issued a recall for black pepper. If students are not familiar with this acronym, explain that "FDA" stands for the U.S. Food and Drug Administration. The FDA is responsible for regulating the production of certain food items. The FDA publishes guidance documents to disseminate information to producers and manufacturers related to safe food processing, transporting, and storage. When food is suspected to be unsafe, the FDA issues recalls to notify the public of the potential hazard and conducts an investigation to determine the source of the problem.

3.3. Tell students you will discuss their investigation results at the start of the next class period. If students have trouble determining the source, remind students about the different sources of contamination, including an object in the facility, a person, or an ingredient.

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

4.1. Teacher/Leader explains to students that they are going to continue their exploration of food-handling practices related to cross-contamination at home. Distribute the **Take-Home Activity—Cross-Contamination: Spot and Stop the Pathogen Spread!** worksheet and ask students to answer the questions based on what they learned in class today. Instruct students to turn in this worksheet at the next class period. Remind students to take a photo to represent something they learned during this unit and to work on their final project.

## Day 5

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

**Core Standard 1** Students analyze and manage operational and safety procedures in food product and processing facilities.

**Standard**

ALSF-1.3 Describe the importance of performing quality-assurance tests on food products and applying corrective procedures as needed.

**Core Standard 2** Students apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

**Standards**

ALSF-2.1 Identify sources of contamination in food products and/or processing facilities and develop ways to eliminate contamination.

ALSF-2.5 Characterize, identify, and research the physical, chemical, and biological properties of microbes as they pertain to food spoilage and foodborne illness.

## Day 5

**Materials List**

***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Cross-Contamination***

- None

***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Choose Safe Foods***

- Three to seven food products processed with UHT, such as:
  - fruit jam
  - guacamole
  - pasteurized juice
  - salad dressing
  - soup
  - yogurt
- Video: What Is UHT Milk?, https://www.youtube.com/watch?v=wFkVefQJpfg
- Video: Julie Riggs (raw milk), https://www.youtube.com/watch?v=tpV9CHSVuJM&feature=youtu.be
- Video: Food Safety in the Produce Aisle, https://www.youtube.com/watch?v=Zy_QuxLkr7c
- Video: Using Nuclear Science in Food Irradiation, https://www.youtube.com/watch?v=pe6AKh_tLys (start at 0:55 seconds)
- In-Class Activity—Choose: Experiment Design
- For Experiment Design Activity (per group unless noted otherwise):
  - nutrient agar (to use in petri dishes):
    - How to Make Nutrient Agar, https://www.youtube.com/watch?v=YX_b02KYN9g
    - Sterilizing without an Autoclave, https://www.youtube.com/watch?v=OUjsqyZJTag
    - Source for purchasing premade plates: https://www.flinnsci.com/search-results/?type=All&query=nutrient+agar+plates
  - pasteurized apple juice (2–3 fl. oz. for the class)
  - unpasteurized apple juice (2–3 fl. oz. for the class)
  - 2 beakers
  - 5 sterile swabs
  - 2 stirring rods
  - parafilm
  - nitrile gloves
  - 5 sterile petri dishes containing nutrient agar

***Activity 3: Using Collected and Experimental Data to Decide If Spices Should Be Used in Pretzel Production***

- In-Class Activity—Choose: Are Spices Safe?
- For the Are Spices Safe? Activity (per group):
  - 5 salt pretzels
  - 5 salt-and-pepper pretzels
  - one 1/3-fl. oz. (10 mL) food-/ pharmaceutical-grade black pepper oleoresin (or substitute black pepper essential oil) (enough for class)
  - 2–6 droppers to dispense the oleoresin (enough for class)
  - *Optional:* 1 scale to weigh oleoresin for more accurate calculations (enough for class)

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

- Take-Home Activity—Choose: Scavenger Hunt

*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned.

## Day 5

**Learning Activities**

1. ***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Cross-Contamination*** *(5 minutes)*

   1.1. Teacher/Leader asks students to take out their In-Class Activity—Cross-Contamination: Pete's Perfect Pretzels P.I.'s (Pretzel Investigators) worksheets and has each group to share with the class the source of contamination they identified and their justification. If groups reached different conclusions, try to reach a consensus.

2. ***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Choose Safe Foods*** *(30 minutes)*

   2.1. Show students three to seven food products processed by ultra-high temperature (UHT), such as fruit jam, guacamole, pasteurized juice, salad dressing, soup, and yogurt. Ask students what these items have in common. If students do not guess that the similarity is in processing methods, tell the students these foods are commonly processed using ultra-high temperature (UHT).

   2.2. Show students the **What Is UHT Milk?** video (https://www.youtube.com/watch?v=wFkVefQJpfg), which describes ultra-high temperature processing for milk.

   2.3. Ask students what other ways they think food can be handled or treated to reduce or limit bacterial growth. **Potential answers:**

   - Canning food
   - Dehydrating food
   - Choosing foods without blemishes or defects

   2.4. After students contribute answers, ask them why they think those methods make foods safer for consumption. **Potential answers:**

   - Reduced water activity
   - Heat treatment to kill bacteria
   - pH below 4.6
   - Modified oxygen content inside the product package

   2.5. Show students videos covering various foods and making choices that decrease their risk of foodborne illness:

   - **Julie Riggs (raw milk)** (https://www.youtube.com/watch?v=tpV9CHSVuJM&feature=youtu.be)
   - **Food Safety in the Produce Aisle** (https://www.youtube.com/watch?v=Zy_QuxLkr7c)
   - **Using Nuclear Science in Food Irradiation** (https://www.youtube.com/watch?v=pe6AKh_tLys; start at 0:55 seconds)

   2.6. 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: Experiment Design**. Provide each group with the following items:

   - pasteurized apple juice (2–3 fl. oz. for the class)
   - unpasteurized apple juice (2–3 fl. oz. for the class)
   - 2 beakers *(Note:* Students will need approximately 0.5 ounce of juice per group. They can pour the juice they need from larger containers into beakers and carry the beakers back to their lab stations.)
   - 5 sterile swabs
   - 2 stirring rods
   - parafilm
   - nitrile gloves
   - 5 sterile petri dishes containing nutrient agar

   Have students develop a hypothesis about which juice(s) is 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 one to two days, depending on their experimental procedure. Students will make observations about what they see on their petri dishes when they remove them from the incubator.

**Day 5**

**Learning Activities** *(continued)*

2.7. 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. **Answers may include:**

- Using ingredients that are properly treated to mitigate associated with pathogens
- Choosing reputable suppliers
- Testing incoming ingredients for pathogens or to ensure the product meets the standard of identity

***3. Activity 3: Using Collected and Experimental Data to Decide If Spices Should Be Used in Pretzel Production*** *(25 minutes)*

3.1. Relate the discussion back to the cross-contamination investigation activity. Remind students that the pretzel seasoning was the source of pathogens. Ask students to work in their lab groups to determine what a safe seasoning choice would be for Pete's Perfect Pretzels by completing the **In-Class Activity—Choose: Are Spices Safe?** worksheet.

3.2. Distribute the following materials to each group of students unless noted otherwise:

- 5 salt-and-pepper pretzels (e.g., Snack Factory® Pretzel Crisps Sea Salt and Cracked Pepper)

  *(Note:* These will represent the product produced by Pete's Perfect Pretzels and will serve as the control for the experiment.)

- 5 salt pretzels (e.g., Snack Factory® Pretzel Crisps Original)
- one 1/3-fl. oz. (10 mL) bottle of oleoresin or essential oil (enough for the class)

  *(Note:* Instruct the students **NOT TO EAT** the oleoresin or essential oil.)

3.3. Allow students to experiment with the pretzels and oleoresin or essential oil to determine their formulation and to answer questions on the corresponding worksheet. Ask students to be prepared to discuss their answers at the beginning of the next class period.

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

4.1. Teacher/Leader explains to students that they will continue their exploration of food-handling practices related to Choose Safe Foods at home. Distribute the **Take-Home Activity—Choose: Scavenger Hunt** worksheet and ask students to answer the questions based on what they learned in class today. Instruct students to turn in this worksheet at the next class period. Remind students to take a photo to represent something they learned during this unit and to work on their final project.

## Day 6

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses among consumers. | ▪ Students define HACCP and can identify the seven principles of HACCP.<br>▪ 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.<br>▪ Students are able to develop a basic process flow diagram to describe a process from initiation to completion.<br>▪ 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

**Domain—Safety, Sanitation, and Quality of Food**

**Core Standard 1** Students analyze and manage operational and safety procedures in food product and processing facilities.

**Standard**

ALSF-1.1 Construct plans that ensure implementation of safety programs for food products, processing facilities, and the environment.

**Materials List**

***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Choose Safe Foods*** *(10 minutes)*

- None

***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Begin HACCP***

- Handout: In-Class Activity—Hazard Analysis Critical Control Point (HACCP) Video Notes
- Video: Hazard Analysis & Critical Control Points (HACCP)–Fulton County [Georgia], https://www.youtube.com/watch?v=X2kw40KyVnY
- Video: HACCP Food Safety Hazards, https://www.youtube.com/watch?v=lEZbSaikBTw
- HACCP student reference *(print and distribute if students can't access electronically during class):*
  - Fully Cooked, Not Shelf Stable Meat and Poultry—HACCP Plan, https://www.aamp.com/fc-not-ss-haccp-plan/ *(After following the link, click on "Hazard Analysis.")*

*Note:* If this document cannot be shared electronically during class, print at least the first eight pages to help students understand the different types of information they should include. Be sure to print at least one page that contains a potential safety hazard that is significantly likely to occur (column 3 = Yes). The first example of this is on page 8 for the "Cook" process step.

***Activity 3: HACCP In-Class Activity***

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

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

- Handout: Take-Home Activity—Hazard Analysis Critical Control Point (HAACP): Make It Safe!
- Links to share with students:
  - *Food Safety for Fruit and Vegetable Farms,* Purdue Extension/University of Illinois Extension, https://www.extension.purdue.edu/extmedia/GP/GP-1-W.pdf
  - Integrated Pest Management, G.A.P (Good Agricultural Practices) in Action, GLOBALG.A.P., https://www.youtube.com/watch?v=7qQCLMFjRew
  - Good Agricultural Practices on the Farm and in Your Home Garden, College of Tropical Agriculture and Human Resources, University of Hawai'i–Mānoa, https://www.youtube.com/watch?v=wO5miD90wMQ

*Note:* Students will need a camera or other technology to take pictures for their final presentation. If students have a camera on their cell phones, they could use their personal camera. If no classroom or multimedia department technology is available for students who do not have a cell phone, students can make posters using markers or computer-generated pictures to illustrate pictures of what they have learned.

## Day 6

**Learning Activities**

1. ***Activity 1: Discussion of Concepts Related to Safe Food-Handling Practices: Wrap-Up of Choose Safe Foods*** *(10 minutes)*

   1.1. Teacher/Leader leads students in a discussion of answers to the In-Class Activity—Choose: Are Spices Safe? worksheet from the previous class period. Have students share whether they would use spices or oleoresins, and ask them to provide justification for their choice(s).

2. ***Activity 2: Discussion of Concepts Related to Safe Food-Handling Practices: Begin HACCP*** *(20 minutes)*

   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. Tell students they will watch two videos to learn about the seven principles of HACCP and about different hazards related to foods. Distribute the **In-Class Activity—Hazard Analysis Critical Control Point (HACCP) Video Notes**, and instruct students to use it to take notes on the details of the HACCP principles and hazards. These notes can be used later during their own HACCP analysis. Show students the following videos:

   - **Hazard Analysis & Critical Control Points (HACCP)—Fulton County [Georgia]** (https://www.youtube.com/watch?v=X2kw40KyVnY)
   - **HACCP Food Safety Hazards** (https://www.youtube.com/watch?v=lEZbSaikBTw)

   2.2. After the videos, have students brainstorm methods to prevent the hazards listed in each category (i.e., biological, chemical, physical, and radiological). **Answers may include:**

   - Using metal detectors
   - Using X-ray machines
   - Checking for chemical residue(s)
   - Having policies that prohibit employees from bringing medication into production areas
   - Choosing ingredient sources to minimize exposure to radiological hazards

   2.3. Have students refer to the HACCP Student Reference titled **Fully Cooked, Not Shelf Stable Meat and Poultry—HACCP Plan** (https://www.aamp.com/fc-not-ss-haccp-plan/). Review this HACCP plan with the students, and highlight the types of information included in the plan with an emphasis on documentation of potential food safety hazards.

3. ***Activity 3: HACCP In-Class Activity*** *(30 minutes)*

   3.1. Distribute the **In-Class Activity—Pete's Perfect Pretzels Hazard Analysis Critical Control Point (HACCP)** worksheet. Review the simplified process flow diagram of Pete's Perfect Pretzels with students. Begin walking students through the HACCP examples on the **In-Class Activity—Hazard Analysis Critical Control Point (HACCP) Video Notes**. After talking through the examples, ask students to work as a class to begin filling in Table 1, Hazard Analysis, on the in-class worksheet for Pete's Perfect Pretzels using the examples as guides. Facilitate movement through processing steps, identification of critical control points (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. Distribute the **Take-Home Activity—Hazard Analysis Critical Control Point (HAACP): Make It Safe!** worksheet and ask students to answer the questions based on what they learned in class today. Instruct students to turn in the worksheet at the next class period. 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:

   - *Food Safety for Fruit and Vegetable Farms,* Purdue Extension/University of Illinois Extension, https://www.extension.purdue.edu/extmedia/GP/GP-1-W.pdf
   - Integrated Pest Management, G.A.P (Good Agricultural Practices) in Action, GLOBALG.A.P., https://www.youtube.com/watch?v=7qQCLMFjRew
   - Good Agricultural Practices on the Farm and in Your Home Garden, College of Tropical Agriculture and Human Resources, University of Hawai'I-Mānoa, https://www.youtube.com/watch?v=wO5miD90wMQ

## Day 7

| Principle(s) | Unit Objective(s) |
|---|---|
| Each year in the United States, an estimated 48 million people are affected by foodborne illnesses. Of those affected, approximately 128,000 will be hospitalized and approximately 3,000 will die.<br>Practicing safe food-handling techniques can help reduce the risk of foodborne illnesses 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

**Domain—Leadership**

**Core Standard 12** 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.

**Standard**

ALSF-12.1 Communicate clearly, effectively, and with reason through speaking, writing, visuals, and active listening in formal and informal settings.

**Materials List**

***Activity 1: Discussion of Concepts Related to Food-Handling Practices: Evaluate Petri Dishes from Choose Experiment Design***

- streaked petri dishes from In-Class Activity—Choose: Experiment Design
- Handout: In-Class Activity—Choose Experiment Design *(partially completed by students during Day 5, Activity 2)*

***Activity 2: Final Project Presentations***

- Final Project Rubric
- projection equipment for electronic presentations

*Note:* Provide alternative presentation methods as needed for those students who will not be making a digital presentation.

**Learning Activities**

1. ***Activity 1: Discussion of Concepts Related to Food-Handling Practices: Evaluate Petri Dishes from Choose Experiment Design*** *(25 minutes)*

   1.1. Teacher/Leader instructs students to check the petri dishes from the experiment they designed in the Choose unit (Day 5, Activity 2). Have students record their results on their **In-Class Activity—Choose: Experiment 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 them to share their experiment design, their results, and their conclusions. Discuss strengths of their designs and what could be improved. Allow 10–15 minutes for class discussion.

2. ***Activity 2: Final Project Presentations*** *(35 minutes)*

   2.1. Teacher/Leader tells students to begin presentations. Each group presentation should be 5 to 6 minutes long, depending on the number of groups and the length of the class period. Have each group present their projects. Allow time for the class to ask questions of each group. Use the **Final Project Rubric** included with this curriculum to grade the students' presentations.

## Day 8

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

**Materials List**

***Activity 1: Post-Survey Administration***

- Post-survey

***Activity 2: Cooking Activity***

- Student Cooking Observation Checklist
- *Optional:* video recording devices
- Ingredients for Cheeseburgers recipe (per group):
  - 1 pound ground beef
  - ¼ cup mild or spicy nacho cheese sauce
  - ½ teaspoon salt
  - ½ teaspoon pepper
  - 4 hamburger buns, split and toasted
  - shredded lettuce
  - 4 green onions, sliced
- Ingredients for Salsa recipe (per group):
  - 2 large plum tomatoes, diced (yields 1 cup)
  - ⅛ cup white onion, chopped
  - 1½ tablespoons fresh cilantro, chopped
  - 1 teaspoon jalapeño, minced (remove seeds for lower heat)
  - ¾ teaspoon fresh lime juice
  - ¼ teaspoon kosher salt (or to taste)
  - tortilla chips (for serving salsa)
- Cooking equipment and supplies (per group unless noted otherwise):
  - 1 cooking thermometer
  - 1 skillet
  - 1 spatula
  - 2 mixing bowls
  - 1 spoon
  - 1 knife
  - 1 cutting board
  - food handler's gloves (enough for class)
  - plates (enough for class)
  - eating utensils (enough for class)
  - paper towels (enough for class)

| Day 8 | Learning Activities |
|---|---|

1. ***Activity 1: Post-Survey Administration*** *(15 minutes)*
   - 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 for you to complete 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. Distribute the **post-survey**. Monitor students as they complete it to deter them from sharing information with one another. Collect the completed post-surveys.
2. ***Activity 2: Cooking Activity*** *(45 minutes)*
   - 2.1. Set up cooking stations the same as noted in Day 1, Activity 2. Tell students they will be preparing the cheeseburger recipe using different seasonings and topping ingredients.
   - 2.2. Lead students to the cooking 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. In the lab, students should be assigned to the same groups and cooking stations as before. Group 1 should be assigned to station 1; Group 2, to station 2, etc.
   - 2.3. When 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."
     - Monitor students to ensure that they are using the kitchen equipment safely.
     - Use video recordings or the included **Student Cooking Observation Checklist** to record students' food-handling behaviors.
     - Intervene only when students or property are in danger (e.g., students are handling food in a way that could result in illness, misusing knives, or operating the stove in a way that could result in a fire, etc.). Record all instances of improper food handling and all interventions on the observation checklist.
     - Have students indicate when they are finished cooking, then measure the internal temperature of the burger patties. If the internal temperature measures below 160°F, have students continue cooking the burgers until the internal temperature is at least 160°F. When students are finished cooking, eating, and cleaning up the kitchen for the next class, dismiss the students.

# Lab Cooking Materials

# Student Cooking Observation Checklist

Date:_____

Name:_____

| Food-Safety Behavior | Observed Behavior | | | | | | |
|---|---|---|---|---|---|---|---|
| Washed hands (how) | Never | With water only | With water and soap | For less than 5 seconds | For 5–10 seconds | For 10–20 seconds | For more than 20 seconds |
| Count: | | | | | | | |
| Dried hands (how) | Did not dry | Dried by shaking | Dried on clothes | Dried on fresh cloth | Dried on used cloth | Dried on paper towel | |
| Count: | | | | | | | |
| Washed hands (when) | Never | Before preparing meal | After handling raw meat | After touching surfaces | After touching body and/or clothing | After sneezing and/ or wiping nose, eyes | After handling garbage |
| Count: | | | | | | | |
| Washed items that contacted raw food (e.g., knife, cutting board, skillet, spatula, etc.) | Yes | No | Threw away | | | | |
| Count: | | | | | | | |
| Plate for cooked item | Plate not washed after holding raw meat | Plate rinsed or wiped after holding raw meat | Plate washed with soap and water after holding raw meat | A new, clean plate was used | | | |
| Count: | | | | | | | |
| Used thermometer | Did not use a ther-mometer | Used thermometer incorrectly | Used thermometer correctly | | | | |
| Count: | | | | | | | |
| Glove use | 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 and/or clothing | After sneezing and/ or wiping nose, eyes | After handling garbage |

## Student Cooking Observation Checklist (continued)

| Food-Safety Behavior | Observed Behavior | | | | | | |
|---|---|---|---|---|---|---|---|
| Count: | | | | | | | |
| Cleaning and sanitizing (how) | Never | Wiped off work surfaces with paper towel or towel | Wiped work surfaces with water | Cleaned work surfaces with soap & water, no sanitizing | Cleaned work 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: | | | | | | | |
| Left the station while cooking | No | Yes | | | | | |
| Count: | | | | | | | |
| Washed vegetables | Vegetable 1: _____ (entered by observer) | Vegetable 2: _____ (entered by observer) | Vegetable 3: _____ (entered by observer) | Vegetable 4: _____ (entered by observer) | Vegetable 5: _____ (entered by observer) | Vegetable 6: _____ (entered by observer) | Vegetable 7: _____ (entered by observer) |
| Count: | | | | | | | |

# Recipes for Cooking Lab 1

**Reminder for students:**

*Wash your hands with soap and water and change gloves after touching raw meat and before touching ready-to-eat ingredients.*

*Use food thermometer to check the doneness of meat.*

## Cheeseburgers (per group)

### *Ingredients*

1 pound ground beef
1 teaspoon salt
1 teaspoon black pepper
8 slices American cheese
4 hamburger buns

### *Garnishes*

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 overmix or burgers will be tough.
2. Divide mixture into four equal portions, and form into hamburger patties without pressing too hard. The patties should be uniform in thickness. Smooth out any cracks using your fingers. Make the patties right before you cook them so they stay at room temperature for the least amount of time possible.
3. Preheat pan to medium heat, and add the patties.
4. Cook the patties until the crust that forms on the bottom releases the patties from the pan or grate, approximately 3 to 5 minutes. Gently test, but don't flip the patties until they get to this point. When patties lift up easily, flip them and cook for an additional 3 to 5 minutes to form a crust on the other side. Continue cooking the patties, flipping them every minute, until the internal temperature reaches 160°F, approximately 5 more minutes. Top each patty with two slices of cheese. Continue cooking just until cheese melts.
5. Remove burger patties from heat with a sturdy metal spatula, and transfer to a plate. Allow the burger patties to rest for several minutes, then transfer them onto hamburger buns.
6. Garnish as desired, and serve immediately.

## Zucchini Crisps (per group)

### *Ingredients*

2 medium zucchinis, sliced into ⅛-inch rounds
½ teaspoon salt
½ teaspoon pepper
1½ cups Parmesan cheese, grated

**Reminder for students:**

*Wash your hands with soap and water and change gloves after touching raw meat and before touching ready-to-eat ingredients.*

*Use food thermometer to check the doneness of meat.*

### *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 zucchinis into ⅛-inch rounds.
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 teaspoon of grated Parmesan cheese on top of each slice.
6. Bake for 15 minutes or until golden brown on top.
7. Cool for a few minutes before transferring to a plate. Serve immediately.

# Recipes for Cooking Lab 2

**Reminder for students:**

*Wash your hands with soap and water and change gloves after touching raw meat and before touching ready-to-eat ingredients.*

*Use food thermometer to check the doneness of meat.*

## Cheeseburgers (per group)

### *Ingredients*

1 pound ground beef
¼ cup mild or spicy nacho cheese sauce
½ teaspoon salt
½ teaspoon pepper
4 hamburger buns

### *Garnishes*

shredded lettuce
4 green onions, sliced

### *Directions*

1. Divide ground beef into four equal portions, and form into hamburger patties without pressing too hard. The patties should be uniform in thickness. Smooth out any cracks using your fingers. Make the 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 patty with salt and pepper.
3. Preheat your pan to medium heat, and add the patties with the salt-and-pepper side facing up.
4. Cook the patties until the crust that forms on the bottom releases the patties from the pan or grate, approximately 3 to 5 minutes. Gently test, but don't flip the patties until they get to this point. When patties lift up easily, flip them and cook for an additional 3 to 5 minutes to form a crust on the other side. Continue cooking the patties, flipping them every minute, until the internal temperature reaches 160°F, approximately 5 more minutes. Top each patty with two slices of cheese. Continue cooking just until cheese melts.
5. During the last minute of cooking, spoon 1 tablespoon of cheese sauce onto each patty; spread slightly. Allow the cheese to start melting.
6. Remove burger patties from heat with a sturdy metal spatula, and transfer to a plate. Allow the patties to rest for several minutes, then transfer them onto hamburger buns.
7. Garnish as desired, and serve immediately.

## Salsa

*Ingredients*

2 large plum tomatoes, diced (yields 1 cup)
⅛ cup white onion, chopped
1½ tablespoon fresh cilantro, chopped
1 teaspoon jalapeño, minced (remove seeds for lower heat)
¾ teaspoon fresh lime juice
¼ teaspoon kosher salt (or to taste)

*Directions*

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

**Reminder for students:**

*Wash your hands with soap and water and change gloves after touching raw meat and before touching ready-to-eat ingredients.*

*Use food thermometer to check the doneness of meat.*

# Surveys

**Validated surveys were developed and are available on request.**
**Please contact co-author Dr. Yaohua Feng, at yhfeng@purdue.edu.**

# In-Class Activities

# In-Class Activity

## Clean: Good Manufacturing Practices (GMP) Development

As the Quality Assurance Team for Pete's Perfect Pretzels, your group has been asked to develop guidelines for the Good Manufacturing Practices (GMP) that will promote proper personal hygiene practices among employees. When developing the GMP guidelines, a few topics to consider are proper handwashing techniques, handwashing frequency, when gloves should be worn, and employee hand conditions (for example, fingernail length, open wounds, etc.).

Develop your list as a group, and then each group will share their list 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 the 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.

2.

3.

4.

5.

6.

7.

8.

# In-Class Activity

## Clean: Pete's Perfect Pretzels SSOP (Sanitation Standard Operating Procedures) 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 of the equipment shown in the video. 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 outlining 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 illnesses, time to clean/verify, and cost.
- Planning Sheet for Sanitation Standard Operating Procedure—
  This has been provided to help you think through different areas of the facility that must be cleaned.

All groups will discuss their SSOPs to generate the class SSOP. Try to reach a consensus when making the class SSOP.

# 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
- Flagellum and motility in many strains
- Microaerophilic; 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 such as cheese, contaminated water
- Found in other sources including seafood, vegetables, and other meats

**Symptoms**
- Duration usually 2-10 days
- Major symptoms: Fever, diarrhea, abdominal cramps, and vomiting
- Other symptoms: Abdominal and muscle pain, nausea, and headache

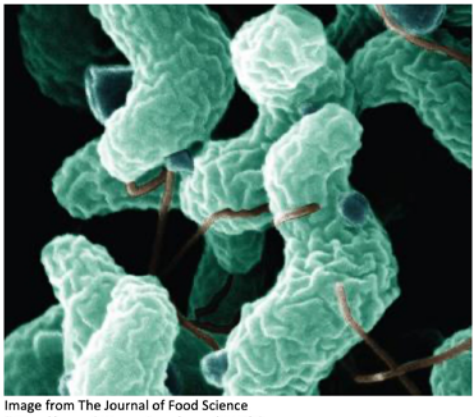

Image from The Journal of Food Science (https://www.fstjournal.org/news/28-1/3)

**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
- Illness documented from ng of toxin
- Single toxin produced (many strains); two toxins produced (some strains)

**Sources**
- Growth and toxin production supported by 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/botulism/general.html)

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

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)
- Enterotoxin production
- Heat resistant and relatively cold resistant
- Infective dose >$10^6$ vegetative cells or spores
- High multiplication rate (much faster than most other bacteria)

**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; potential for high doses of *Clostridium perfringens* on unrefrigerated food that has been contaminated

**Symptoms (gastroenteritis form)**
- Milder form: Duration usually 12-14 hours
- In infants or the elderly: May last 1-2 weeks
- Major symptoms: Watery diarrhea and mild abdominal cramps

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

**Susceptible to**
Heating (spore survival possible) and refrigeration

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

# Enterohemorrhagic *Escherichia coli* (EHEC) O157:H7

*Accounts for approximately 75% of EHEC infections in the world*
*Disease: Hemorrhagic colitis*
*Entry Route: Oral*

**Organism**
- Gram-negative rod
- Shiga-toxin production
- Infective dose 10-100 cells (approximately)
- Acid tolerance possible to develop

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

**Symptoms**
- Duration usually 2-9 days with an average of 8 days in uncomplicated cases
- Major symptoms: Low-grade fever, severe cramping (abdominal pain), nausea or vomiting, and diarrhea that initially is watery but becomes bloody
- Severe cases: Hemolytic uremic syndrome (HUS) and kidney failure
- May be transmitted from person to person

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

**Susceptible to**
Heating, proper washing of food surfaces

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

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

**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 from 3 days to 3 months
- Host-dependent infections with variable symptoms
  - Minor symptoms: Mild or no symptoms possible
  - Major symptoms: Fever, muscle aches, nausea, vomiting, and diarrhea
  - Severe symptoms: Nervous system affected, headaches, confusion, loss of balance, and convulsions
- Pregnant women highly susceptible; if infected, potential to lose the fetus

**Susceptible to**
Heating, proper washing of food surfaces

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* most significant to public health of the *Salmonella* spp.
- Infective dose, nontyphoidal salmonellosis: one cell (depending on strain and host's age/health)
- Infective dose, typhoid fever: fewer than 1,000 cells

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

**Sources**
- Nontyphoidal salmonellosis: Meat, eggs, fruits, vegetables, spices, tree nuts, cocoa
- Typhoidal salmonellosis: Usually associated with sewage-contaminated water
- *Salmonella* potentially carried by pets such as reptiles and chicks

**Symptoms**
Nontyphoidal salmonellosis
- Onset usually 6-72 hours, duration usually 4-7 days
- Major symptoms: Nausea, vomiting, abdominal cramps, diarrhea, fever, headache

Typhoid fever
- Onset usually 1-3 weeks (up to 2 months) after exposure, duration usually 2-4 weeks
- Major symptoms: High fever (103°F-104°F), gastrointestinal symptoms, loss of appetite, achiness, and sometimes rash development

**Susceptible to**
Heating and refrigeration

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; rapid death
- Survival (sometimes growth) in low-pH foods
- Enterotoxin and Shiga toxin production by some strains
- Infective dose 10-200 cells: depending on host's age/health

**Sources**
- Spreads from contaminated feces and unclean water
- Possible to spread *Shigella* to food and consumers from food handlers with fecal matter contaminated with *Shigella* on their hands

**Symptoms**
- Onset usually 8-50 hours; duration usually 5-7 days
- Major symptoms: Abdominal pain, cramps, diarrhea, fever, vomiting, and pus/mucus in stools
- Illness usually mild
- Severe illness: Most likely to develop in young children, elderly, people with weakened immune systems

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

**Susceptible to**
Heating, 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) that appear in pairs, short chains, or bunches under the microscope
- Extended periods of survival in a dry state
- Heat-resistant enterotoxins possible

**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**
- Duration usually only a few hours to one day
- Major symptoms: Nausea, abdominal cramping, vomiting, and diarrhea
- Severe symptoms: Dehydration, headache, muscle cramping, changes in blood pressure and pulse rate

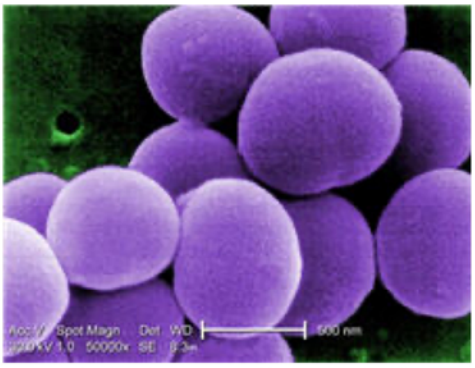

Image from CDC (https://www.cdc.gov/hai/organisms/staph.html)

**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)
- Survival in frozen foods for extended periods
- Persists longer in cooked foods than in raw foods
- Can grow at pH range of 4-10

**Sources**

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

**Symptoms**

- Onset usually 1 day to 2 weeks; duration 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

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

**Susceptible to**

Heating, refrigeration, and proper washing of hands, raw fruits, and raw 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

## Cleaners/Degreasers

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

# Chemical and Testing Reference Sheet (cont.)

## Disinfectants/Sanitizers

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

# Chemical and Testing Reference Sheet (cont.)

## 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<br>▪ Provides a near-instant measurement<br>▪ Reports a numeric value<br>▪ 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<br>▪ Color change in protein swabs to indicate presence of proteins<br>▪ Testing completed in-house |
| ATP Swabs for Allergens | ▪ Can detect the target allergen in ingredients, liquids, finished foods, and on environmental surfaces<br>▪ Kits available for different allergens (dairy, egg, soy, various nuts, etc.) |
| Environmental Swabs (Aerobic plate count, coliforms, *Salmonella*, *Listeria*) | ▪ Sponge containing nutrient broth<br>▪ Qualified employee swabs designated areas<br>▪ Plate in-house for aerobic plate count (one day of incubation) and coliforms (two days of incubation)<br>▪ Pathogenic swab analysis completed at third-party lab (outside of plant) |
| Pathogen testing of ingredients and final | ▪ Samples of final product and/or ingredients collected and sent to third-party products lab (outside of plant) for analysis<br>▪ Samples taken by qualified employee |

3M. 2018. *3M™ Quat Disinfectant Cleaner Concentrates 5A, 5H and 5L*. Available from: https://multimedia.3m.com/mws/media/60040O/5a-5h-5l-quat-disinfectant-cleaner-concentrate-tech-data-sheet.pdf .

Pfuntner, A. 2011. Sanitizers and Disinfectants: The Chemicals of Prevention. *Food Safety Magazine*. August/September 2011. Available from: https://www.foodsafetymagazine.com/magazine-archive1/augustseptember-2011/sanitizers-and-disinfectants-the-chemicals-of-prevention/ .

Velocity Chemicals. 2015. *The 5 Most Effective Sanitizing Chemicals for Food Processing Operations*. Available from: http://velocitychemicals.com/the-5-most-effective-sanitizing-chemicals-for-food-processing-operations/ .

# Planning Sheet for Sanitation Standard Operating Procedure (SSOP)

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

This table includes a description of each product and a simplified ingredient list. Your task is to identify the proper ingredient storage conditions, concerns that would affect storage location (such as microbial growth or shelf life of the ingredient), and the justification for your choice of storage conditions.

| **Name** | **Description** | **Ingredient List** | **Ingredient Storage Conditions** (ambient, refrigerator, or freezer) | **Concerns** (potential microorganism, shelf life, bloom, etc.) | **Justification** |
|---|---|---|---|---|---|
| Pete's Dark Chocolate, Peanut Butter Pretzel Bites | Lightly salted, peanut-butter-filled pretzels coated in dark chocolate | Peanut-butter-filled pretzels:<br>1. Pretzel<br>2. Peanut butter<br>Dark chocolate<br>1. Unsweetened chocolate<br>2. Cocoa butter<br>3. Sugar | | | |
| Milk Chocolate, Caramel-Dipped Pretzel Rods | Lightly salted pretzel rods dipped in caramel and covered in milk chocolate | Pretzel rods:<br>Caramel:<br>1. Brown sugar<br>2. Sweetened condensed milk<br>3. Unsalted butter<br>4. Salt<br>5. Vanilla<br>Milk chocolate:<br>1. Sugar<br>2. Cocoa butter<br>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<br>Dried blueberries<br>Milk chocolate (same as above)<br>Strawberry filling:<br>1. Strawberry puree<br>2. High fructose corn syrup<br>3. Citric acid | | | |

## Chill: 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 inside the cargo area of 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 of 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) | | |
| Percent (%) 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)

The Customer Service Department at Pete's Perfect Pretzels 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. Use the table below 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 gather information provided by employees in the following departments: Sanitation, Quality Assurance, 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 | | | | |

# Teacher's Notes for In-Class Activity

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

***Pre-Class Preparation:***

- Photocopy this worksheet. Students will work in small groups to complete the activity, so you'll need to make one copy for each small group in your class.
- Cut apart one complete worksheet so each department appears on a separate slip, and place one full set of the department slips into an envelope. Repeat until you have one envelope for each group in your class.
- Label each envelope with a different group number.

***To Conduct the Activity:***

- Assign a number to each group of students, and tell students they will need to provide you with their group number to receive information slips.
- Have one student from each group come to your desk, tell you their group number, and tell you which department they would like to gather information from.
- Hand the student the corresponding slip of paper for the department from the envelope for that group number. Once students receive the information, they should return to their seats to discuss the information with their group members, make notes on their worksheets, and decide what additional information they need.
- Instruct students to continue coming to your desk to gather information as desired until they have collected information from all of the departments or have reached a conclusion about the source of cross-contamination.

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**Sanitation—**Information provided by employees:

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 Assurance—**Information provided by employees:

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 5 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—**Information provided by employees:

1. The employee working on the peanut-butter pretzel line noticed that the employee from the salt-and-black-pepper pretzel line was opening bags of black pepper near the peanut-butter pretzel line. Black pepper was released into the air as that employee opened the bags to add more seasoning to the other 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 was training a new employee. The primary employee noticed the new employee was opening the bags of black pepper near the peanut-butter pretzel line. Black pepper was seen in the air where the bags of black pepper were opened. The primary employee helped the new employee relocate the bags of black pepper closer to the salt-and-black-pepper pretzel line and showed the new employee how to reduce the release of black pepper 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—**Information provided by employees:

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

**Warehouse—**Information provided by employees:

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 bags of black pepper 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 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—**Information provided by customer service indicates a starting production date of 5/31/2020 for each of the three products. Information provided by employees following a review of cleaning paperwork, including cleaning logs and preoperational checklists:

1. Peanut-butter pretzel bites were run on Line 5 (next to processing Line 6). Line 5 was cleaned 5/31/2020 during the night shift. When Quality did a visual inspection and ATP swab, part of the line failed the inspection initially but later passed. Line 5 started production at 7:00 A.M. on 5/31/2020.
2. Salt-and-black-pepper pretzels were run on Line 6 (next to Lines 5 and 7). Line 6 was cleaned 5/31/2020 during the night shift. When Quality did a visual inspection and ATP swab, the line passed inspection. Line 6 started production at 9:30 A.M. on 5/31/2020.
3. Sour-cream-and-onion pretzels were run on Line 7 (next to Line 6). Line 7 was cleaned 5/29/2020 during the night shift. When Quality did a visual inspection and ATP swab, the line passed inspection. Line 7 started production at 8:15 A.M. on 5/31/2020.

# In-Class Activity

## Choose: Experiment Design

To answer the question below, develop a hypothesis, then design an experiment to test your hypothesis. You may use the materials provided to design your experiment. Use the outline below to document your hypothesis, experiment procedures, results, and conclusion. Use written descriptions to document your results. You can also use pictures if you would like. 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:**

**Experiment Procedures:**

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

# In-Class Activity

## Choose: Experiment Design (cont.)

**Results:**

**Conclusion:**

**What went well in your experiment?**

**What would you improve if you ran the experiment again?**

# In-Class Activity

## Choose: Are Spices Safe?

Considering customer complaints about Pete's Perfect Pretzels and the black pepper recall by the U.S. Food and Drug Administration, the 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 (Quality Assurance) 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 powdered seasoning to oleoresins will impact the product attributes, including flavor, texture, and shelf life. You will need to discuss the potential changes with Research and Development before presenting to Management.

Use information on the Excerpts Related to Spices and Oleoresins handout 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: This team is responsible for finding suppliers and working with suppliers on ingredient pricing.<br>Research and Development: This team is responsible for formulation and product design. Product design will drive resource needs. |
| | | |
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| | | |

2. Use the pretzels you have been provided for your experiment. In this experiment, essential oils are representative of oleoresin and can be used in place of oleoresin for calculation purposes. **DO NOT EAT the oleoresin, the essential oil, or the pretzel containing the oleoresin or essential oil.** 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 the 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? |
|---|---|
| | |
| | |
| | |
| | |
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| | |

4. Based on your calculations, experiments, and literature review, complete the following table:

| | Spices | Oleoresin/Essential Oil |
|---|---|---|
| **Advantages** | | |
| **Disadvantages** | | |
| **Potential Pathogens** | | |
| **Similarities** | | |
| **Choice** | Justification for Choice | |
| | | |

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

## Literature Review to Provide Justification for Choice Between Using Spices and Oleoresins

Research spices and oleoresins to identify advantages, disadvantages, and potential pathogens associated with each. Use the literature you find to justify your final decision to use spices or oleoresins in question 4 of the Choose: Are Spices Safe? worksheet. You may use the following excerpts and sources to begin your literature search.

**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.

Reprinted from G. Gilbertson (1971), Oleoresin as flavour ingredients. *Flavour industry* 43, 403–5.

*Table 1. Spice recalls, 2016-2018*

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

*Source:* U.S. Food and Drug Administration. 2020. Recalls, Market Withdrawals, & Safety Alerts. Available from: https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts .

**Other Suggested Sources:**

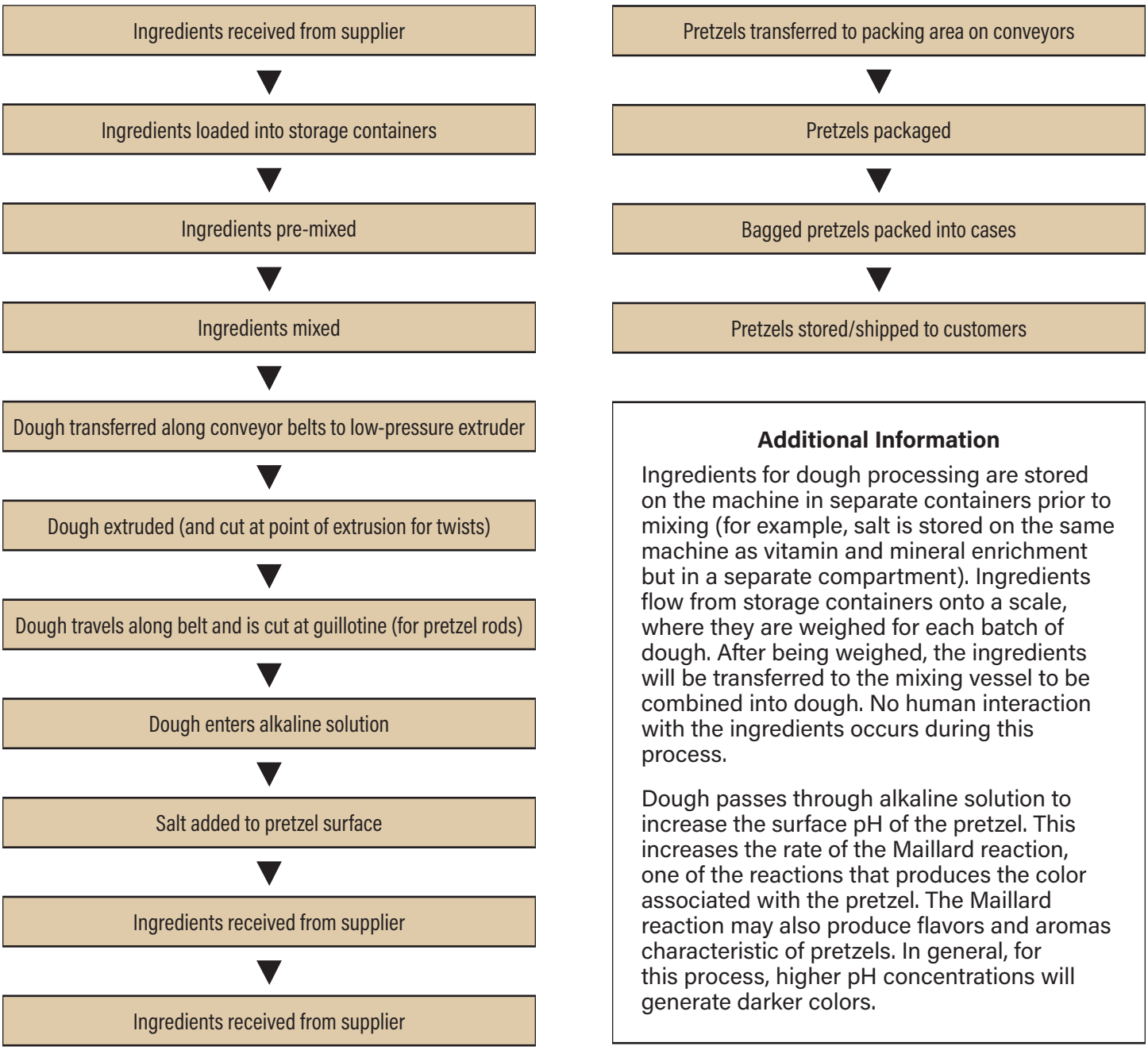
- The Microbiology of Herbs and Spices, https://www.thermofisher.com/blog/food/the-microbiology-of-herbs-and-spices/
- What Are Oleoresins?, http://www.organicspices.com/blog/2014/4/2/oleoresins-whats-the-buzz
- Spice Oleoresins, https://www.fb101.com/2012/06/spice-oleoresins/
- Microbiological Control of Spices and Herbs, https://www.sigmaaldrich.com/technical-documents/articles/analytix/microbiological-control.html

# 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, then outline potential hazards and how to control them. You will use the process flow diagram below, which identifies key steps in the pretzel production process.

**Pretzel Twists/Pretzel Rods**




**Additional Information**

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

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

1. To complete Table 1., Hazard Analysis, review the process flow diagram for steps where there are potential associated hazards.In column 1, identify a processing step.
2. In column 2, list the potential hazard(s) associated with that step.
3. In column 3, indicate whether the identified hazards will be covered in the HACCP plan. Enter a "Y" to indicate "Yes, the hazard will be covered." Enter an "N" to indicate "No, the hazard will not be covered."
4. In column 4, provide a reason backed by evidence to support your decision to include the hazard identified in column 3 in the HACCP plan or to exclude it.
5. In column 5, list the control measures you would take to limit the hazards you identified.

   In column 6, based on the definition of critical control point, indicate whether the identified processing step is a critical control point. "Y" indicates the
6. step is a critical control point. "N" indicates the step is not a critical control point.
7. In column 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) |
|---|---|---|---|---|---|---|
| | | | | | | |
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| 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) |
|---|---|---|---|---|---|---|
| | | | | | | |
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# In-Class Activity

## Hazard Analysis Critical Control Point (HACCP) Video Notes

*Seven Steps of HACCP*

1. Conduct a Hazard Analysis.

2. Determine the Critical Control Points.

3. Establish Critical Limits.

4. Establish Monitoring Procedures.

5. Establish Corrective Actions.

6. Establish Verification Procedures.

7. Establish Record-Keeping and Documentation Procedure.

# In-Class Activity

## Hazard Analysis Critical Control Point (HACCP) Video Notes (cont.)

Complete the table by listing examples of each hazard and methods to control the hazards. Follow the example provided under the Radiological column heading.

| Food Safety Hazards | Biological | Chemical | Physical | Radiological |
|---|---|---|---|---|
| **Example of Hazards** | | | | Radioactive minerals in groundwater<br><br>Cadmium or other radioactive compounds in sandy areas<br><br>Fields contaminated with radiation from nuclear disasters (less common than other sources mentioned)[1] |
| **Method to Control Hazards** | | | | |

[1] Appels, K., and R. Kooijmans. 2016. *Become a Recognized Food Safety Expert!* Available from: https://www.foodsafety-experts.com/algemeen/radiological-hazards/ .

## 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 contain several spelling/grammatical errors AND/OR are challenging to read; pictures are cluttered. | The presentation is generally organized; the slides contain few spelling/ grammatical errors AND are readable; pictures are organized. | The presentation is well organized; the slides contain minimal spelling/ grammatical errors AND are readable; pictures are organized. | |
| Presentation delivery: Audible, paced appropriately, and understandable | Presenters/voiceovers are inaudible, paced 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

These activities are intended to provide students with the opportunity to connect what they have learned about food-handling in a manufacturing environment to food-handling in their own homes. As such, student answers will vary, depending on their home kitchen setup and the foods prepared in their homes. To evaluate student answers on take-home activities, use the information provided in the guided answers to the in-class activities for each section.

# Take-Home Activity

## Clean: Good Kitchen Practices (GKPs)

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 a home kitchen?

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

To get started, think about which practices everyone who enters the kitchen should follow. Are the practices the same or different for cooking vs. getting a ready-to-eat snack such as a package of peanut butter crackers or a package of pre-cut apple slices with caramel sauce? Use the template below or create your own. In the space under "GKP Title," record a title of your choice. For example, you could title your GKP "Smith Home GKP." Then create a goals statement to outline what your GKP will help you achieve. Create a list of practices everyone entering the kitchen should follow.

| |
|---|
| **GKP Title:** |
| **Goals Statement:** |
| **GKP Policies:**<br>1.<br>2.<br>3.<br>4.<br>5. |

## Take-Home Activity

### Clean: Kitchen Sanitation Standard Operating Procedures (SSOPs)

| **Category** (Examples: ingredient storage, processing equipment, area adjacent to equipment, etc.) | **Cleaning Method** (Examples: name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying, etc.) | **Cleaning Frequency** (Examples: daily, weekly, monthly, after preparing a certain recipe, etc.) | **Potential Cleaning Challenges** (Examples: equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried, etc.) | **Method to Verify Area Is Clean** (Example: visual inspection, etc.) | **Frequency of Cleaning Verification** (Examples: daily, weekly, monthly, after preparing a certain recipe, etc.) | **Record** Y/N. If yes, specify. | **Corrective Action If Cleaning Is Not Properly Completed** Y/N. If yes, specify. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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# Take-Home Activity

## Chill, Cook, and Food Preparation: How Does Your Home Kitchen Compare to a Processing Facility?

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

# Take-Home Activity

## Chill, Cook, and Food Preparation: How Does Your Home Kitchen Compare to a Processing Facility? (cont.)

| 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 clean and free of spills | | | |
| Internal temperatures being used to make sure meat and reheated leftovers are at the recommended temperature | | | |

✓ = practicing technique correctly
NI = practicing technique incorrectly; needs improvement
X = practicing technique incorrectly

# Take-Home Activity

## Cross-Contamination: Spot and Stop the Pathogen Spread!

1. 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 |
|---|---|---|
| | | |
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2. Locate your cleaning SSOP from the Take-Home Activity—Clean: **Kitchen Sanitation Standard Operating Procedures (SSOPs)** worksheet. Update the SSOP to incorporate the information you have learned about cross-contamination. For example, you might want to add a statement such as, "Wash cutting boards with hot, soapy water. Sanitize the washed cutting board, and let the cutting board air dry before storing."

# Take-Home Activity

## Choose: Scavenger Hunt

Look at the foods you have at home. Fill in the table below with foods you found 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 | |

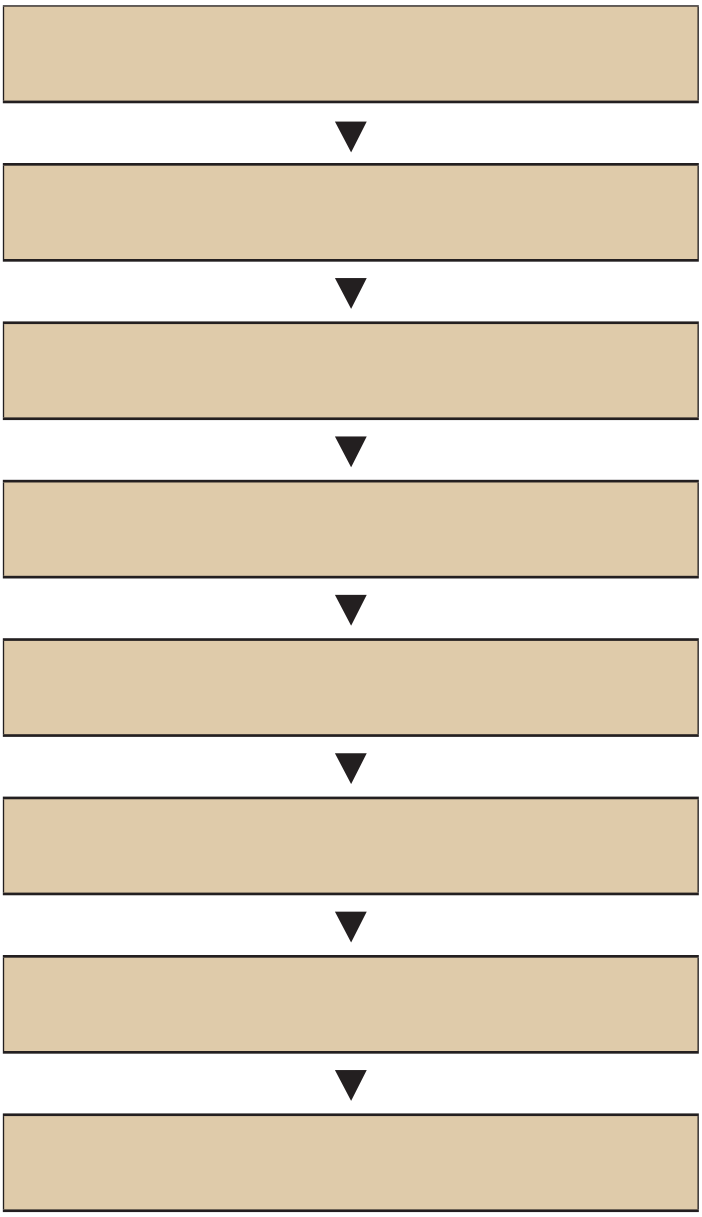
# Take-Home Activity

## Hazard Analysis Critical Control Point (HAACP): Make It Safe!

Observe someone preparing food. In the process flow diagram below, write the name of the food being prepared on the line below "Process Flow Diagram for Making." Then identify the processing steps required to make the food from start to finish. You may add boxes as needed.

After completing, the process flow diagram, complete the Hazard Analysis Critical Control Point (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**



*Hazard Analysis Critical Control Point (HACCP) Table*

| 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) |
|---|---|---|---|---|---|---|
| | | | | | | |
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# Guided Answers to In-Class Activities

# Guided Answers

## In-Class Activity

### Clean: Good Manufacturing Practices (GMP) Development

As the Quality Assurance Team for Pete's Perfect Pretzels, your group has been asked to develop guidelines for the Good Manufacturing Practices (GMP) that will promote proper personal hygiene practices among employees. When developing the GMP guidelines, a few topics to consider are proper handwashing techniques, handwashing frequency, when gloves should be worn, and employee hand conditions (for example, fingernail length, open wounds, etc.).

Develop your list as a group, and then each group will share their list 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 the 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:

*Note:* Follow the format of the provided example "Employee Health, Hygiene, and Hand Washing." Students may decide not to include all parts of the GMP from the example or may decide to include additional components 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 (e.g., disposable hand towels rather than clothing)

# Guided Answers

## In-Class Activity

### Clean: Pete's Perfect Pretzels SSOP (Sanitation Standard Operating Procedures) 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 of the equipment shown in the video. 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 outlining 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 illnesses, time to clean/verify, and cost.
- Planning Sheet for Sanitation Standard Operating Procedure—
  This has been provided to help you think through different areas of the facility that must be cleaned.

All groups will discuss their SSOPs to generate the class SSOP. Try to reach a consensus when making the class SSOP.

Follow the format of the provided example from the USDA Food Safety and Inspection Service (FSIS). Students may decide not to include all parts of the SSOP from the example or may decide to include additional components that were 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 nontoxic 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 should include:
    a. Zones 1 and 2: Visual inspection for cleanliness (i.e., no visible product debris, chemical residue, or cleaning utensil debris such as towel fuzz) coupled with ATP swabbing for organic material
        i. Examples of frequencies that could be used include:
            1. after every cleaning and 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. Examples of frequencies that could be used include that:
            1. various pieces of equipment are swabbed weekly on a schedule to ensure that all identified locations are swabbed two 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 that all identified locations are swabbed two to four times per year

*Note:* 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 time frame between where they can prove the line was free of pathogens prior to and after discovering the contaminated sample. If the time frame for the 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.

c. Zones 3 and 4: Environmental swabbing for pathogens such as *Salmonella* spp., *Listeria* spp., or *E. coli*
    i. Frequencies as in 5a and 5b above apply.

6. Records to ensure cleaning is completed on time and/or thoroughly
    a. Preoperational 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
            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. Documentation of which locations were swabbed on which day
        ii. Documentation of results, indicating if the area swabbed passes or fails
        iii. Documentation of any areas that failed and were reswabbed and reswab results
        iv. Documentation of any corrective actions taken (which 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. Reviewing 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.

# Guided Answers

## Planning Sheet for Sanitation Standard Operating Procedure (SSOP)

Student answers could 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** (Examples: ingredient storage, processing equipment, area adjacent to equipment, etc.) | **Cleaning Method** (Examples: name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying, etc.) | **Cleaning Frequency** (Examples: daily, weekly, monthly, after running a certain product, etc.) | **Potential Cleaning Challenges** (Examples: equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried, etc.) | **Method to Verify Area Is Clean** (Examples: ATP swabs, environmental swabbing, visual inspection, etc.) | **Frequency of Cleaning Verification** (Examples: daily, weekly, monthly, after running a certain product, etc.) | **Record** (Examples: cleaning log, pre-operation checklist, etc.) | **Corrective Action If Cleaning Is Not Properly Completed** (Examples: retrain employees, review chemicals used, have engineering team redesign/adjust equipment, etc.) |
|---|---|---|---|---|---|---|---|
| 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, such as sweeping, could occur on a daily or weekly basis. Cleaning to address spills can occur as needed. | Spill is difficult to access (if the spill is between pallets or ingredient containers). | *Routine cleaning:* Visual inspection<br><br>*For spills:* Visual inspection<br><br>Environmental swabbing may also be used, based on spill type. | *Routine cleaning:* Visual inspection daily or weekly<br><br>*For spills:* After the spill has been cleaned | *Routine cleaning:* Cleaning log<br><br>*For spills:* Use cleaning logs unless the spill type requires a special document. (For example, uncontrolled water events are commonly documented on a specific form developed by each company.) | *Routine cleaning:* Retrain employees if cleaning is not completed as scheduled or is completed incorrectly.<br><br>*For spills:* Retrain employees (if the employee caused spill). Contact supplier if spill resulted due to supplier issues, such as 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 nontoxic options) 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 nontoxic 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 (e.g., towels) and to reduce physical contamination (e.g., towel lint). | May occur daily on a particular shift (e.g., second or third shift)<br><br>May occur after the changeover from one product to another<br><br>May occur after allergens have been used | Some equipment may be challenging to clean. For example, salt dispensers would need to be emptied to clean, 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. | Visual inspection coupled with ATP swabbing (Cleanliness can be further verified by conducting environmental swabbing, which may include aerobic plate count, coliform, and/ or pathogens such as *Salmonella* spp., *Listeria* spp., or *E. coli.)* | Visual inspection coupled with ATP swabbing conducted after every cleaning and before releasing equipment to be used in food processing<br><br>Environmental swabbing conducted weekly or monthly | Preoperation Checklist for visual and ATP swabbing<br><br>Cleaning log for employees to sign after cleaning<br><br>Locations of environmental swabbing and results | Retrain employees.<br><br>Check chemical used.<br><br>Maintenance/ Engineering redesigns equipment.<br><br>Re-evaluate cleaning procedures and potentially revise. |

| **Category** (Examples: ingredient storage, processing equipment, area adjacent to equipment, etc.) | **Cleaning Method** (Examples: name of cleaning agent, time to leave cleaning agent on surface, method for rinsing, method for drying, etc.) | **Cleaning Frequency** (Examples: daily, weekly, monthly, after running a certain product, etc.) | **Potential Cleaning Challenges** (Examples: equipment difficult to access, water could cause ingredient clumping if equipment not sufficiently dried, etc.) | **Method to Verify Area Is Clean** (Examples: ATP swabs, environmental swabbing, visual inspection, etc.) | **Frequency of Cleaning Verification** (Examples: daily, weekly, monthly, after running a certain product, etc.) | **Record** (Examples: cleaning log, pre-operation checklist, etc.) | **Corrective Action If Cleaning Is Not Properly Completed** (Examples: retrain employees, review chemicals used, have engineering team redesign/adjust equipment, etc.) |
|---|---|---|---|---|---|---|---|
| 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 are difficult to reach due to equipment placement.<br><br>Drains may be hard to keep clean as product and cleaning residue may build up. | Visual inspection<br><br>Environmental swabbing as described above<br><br>ATP swabbing is not typically used as higher levels of microorganisms would be acceptable on floors and walls than on equipment where food is prepared. The primary concern about these surfaces is pathogens. | Visual inspection after each cleaning<br><br>Environmental swabbing weekly or monthly | Cleaning log<br><br>Locations of environmental swabbing and results | Same as listed for Zones 1 and 2. |
| Processing facility (Zone 4 – such as cafeteria, break rooms, 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.<br><br>Leftover food in refrigerators could cause unsanitary conditions. | Visual inspection<br><br>Environmental swabbing as described above | Visual inspection after each cleaning<br><br>Environmental swabbing weekly or monthly | Locations of environmental swabbing and results | Same as listed for Zones 1 and 2. |

# Guided Answers

## 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 (see 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 asked to evaluate ingredient storage.

This table includes a description of each product and a simplified ingredient list. Your task is to identify the proper ingredient storage conditions, concerns that would affect storage location (such as microbial growth or shelf life of the ingredient), and the justification for your choice of storage conditions.

| **Name** | **Description** | **Ingredient List** | **Ingredient Storage Conditions** (ambient, refrigerator, or freezer) | **Concerns** (potential microorganism, shelf life, bloom, etc.) | **Justification** |
|---|---|---|---|---|---|
| Pete's Dark Chocolate, Peanut Butter Pretzel Bites | Lightly salted, peanut-butter-filled pretzels coated in dark chocolate | Peanut-butter-filled pretzels:<br>1. Pretzel<br>2. Peanut butter<br>Dark chocolate<br>1. Unsweetened chocolate<br>2. Cocoa butter<br>1. Sugar | Peanut-butter-filled pretzels:<br>1. Ambient<br>2. Ambient<br>Dark chocolate:<br>1. Ambient or refrigerator<br>2. Ambient or refrigerator<br>3. Ambient | Peanut-butter-filled pretzels:<br>1. *Salmonella* spp.<br>2. *Salmonella* spp.<br>Dark chocolate:<br>1. N/A<br>2. N/A<br>3. N/A | Peanut-butter-filled pretzels:<br>1. Pretzels are stable at room temperature; risk is controlled by baking (increased temperature) and low water activity in the final product.<br>2. Peanut butter is stable at room temperature; *Salmonella* spp. is controlled by roasting step in peanut processing.<br>Dark chocolate:<br>1. Unsweetened chocolate is stable at room temperature, but if warehouse temperatures are high, refrigeration could prevent bloom and end of shelf-life. This ingredient has a low water activity.<br>2. Cocoa butter is 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.<br>3. Sugar is stable at room temperature. This ingredient has a low water activity. |

## Chill: Dessert Pretzels (cont.)

| Name | Description | Ingredient List | Ingredient Storage Conditions (ambient, refrigerator, or freezer) | Concerns (potential microorganism, shelf life, bloom, etc.) | Justification |
|---|---|---|---|---|---|
| Milk Chocolate, Caramel-Dipped Pretzel Rods | Lightly salted pretzel rods dipped in caramel and covered in milk chocolate | Pretzel rods:<br>Caramel:<br>1. Brown sugar<br>2. Sweetened condensed milk<br>3. Unsalted butter<br>4. Salt<br>5. Vanilla<br>Milk chocolate:<br>1. Sugar<br>2. Cocoa butter<br>1. Unsweetened chocolate | Pretzels rods: Ambient<br>Caramel:<br>1. Ambient<br>2. Ambient<br>3. Refrigerator<br>4. Ambient<br>5. Ambient<br>Milk chocolate:<br>1. Ambient<br>2. Ambient or refrigerator<br>3. Ambient or refrigerator | Pretzel rods: *Salmonella* spp., *E. coli* 0157:H7<br>Caramel:<br>1. N/A<br>2. *Campylobacter jejuni, E. coli* 0157:H7, *Listeria monocytogenes, Staphylococcus aureus, Yersinia enterocolitica*<br>3. Same as listed for sweetened condensed milk<br>4. N/A<br>5. N/A<br>Milk chocolate:<br>1. N/A<br>2. N/A<br>3. N/A | Pretzel rods are stable at room temperature; risk is controlled by baking (increased temperature) and low water activity in the final product.<br>Caramel:<br>1. Brown sugar has a low water activity.<br>2. Sweetened condensed milk is stable at room temperature. The listed pathogens are commonly found in unpasteurized milk. Processing steps heat the product and reduce/eliminate pathogens.[1]<br>3. Butter is subject to melting. Water activity of butter is high enough to support bacterial growth. Growth could increase at room temperature. The listed pathogens are commonly found in unpasteurized milk.[1] Pasteurization of milk controls the pathogens.<br>4. Salt has a low water activity.<br>5. Vanilla is stable at room temperature. Alcohol content of vanilla extract is at least 35%.[2] The alcohol content helps control growth microorganisms.<br>Milk chocolate is the same as above. |
| 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<br>Dried blueberries<br>Milk chocolate (same as above)<br>Strawberry filling:<br>1. Strawberry puree<br>2. High fructose corn syrup<br>3. Citric acid | Mini pretzel twists: Ambient<br>Dried blueberries: Ambient<br>Milk chocolate: Same as above<br>Strawberry filling:<br>1. Refrigerator or freezer<br>2. Ambient<br>3. Ambient | Mini pretzel twists: *Salmonella* spp.<br>Dried blueberries: N/A<br>Milk chocolate: Same as above<br>Strawberry filling:<br>1. Yeast/mold<br>2. N/A<br>3. N/A | Mini pretzel twists are stable at room temperature; risk is controlled by baking (increased temperature) and low water activity in the final product.<br>Dried blueberries are stable at room temperature; risk is controlled by low water activity.<br>Milk chocolate: Same as above<br>Strawberry filling:<br>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. The pH is likely acidic enough to reduce pathogenic growth as well.<br>2. High fructose corn syrup is stable at room temperature and has a low water activity due to its high sugar content.<br>3. Citric acid is stable at room temperature and has a low water activity. |

[1] U.S. Food and Drug Administration, 2012. *Bad Bug Book, Handbook of Foodborne Pathogenic Microorganisms and Natural Toxins,* 2nd ed. Available from: https://www.fda.gov/media/83271/download .

[2] U.S. Food and Drug Administration, 2019. Vanilla extract. 21 C.F.R. §169.175 (2019). Available from: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=169.175 .

# Guided Answers

## 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 inside the cargo area of 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 of 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 stored temporarily. If there is not enough room at the current location to spread out the pallets, some of the pallets could potentially be 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 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.

# Guided Answers

## 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?

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, 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 microorganisms will be able to grow and, if so, which ones. |
| 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. |
| Percent (%) 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 | Final product testing 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, such as flour, could be sent for pathogen testing. If results came back negative, there could be some increased confidence that pathogens are not prevalent in the ingredient. |

# Guided Answers

## In-Class Activity

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

The Customer Service Department at Pete's Perfect Pretzels 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. Use the table below 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 gather information provided by employees in the following departments: Sanitation, Quality Assurance, Processing, Packaging, Warehouse, and Record Retention.

The black pepper was contaminated. When an employee opened bags of black pepper near the peanut-butter pretzel processing line, black pepper residue contaminated the peanut-butter pretzel processing equipment, even though the black pepper is invisible to the naked eye. Black pepper also contaminated the 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** | 5/31/2020 at 9:30 A.M. | Bags of black pepper were torn open and spilled black pepper onto the sour-cream-and-onion seasoning stored below the pallets of black pepper. | Black-pepper powder was released into the air when the bags were opened. These bags were opened near peanut-butter pretzel line. | N/A (Students might note some information they learned.) |
| **Pete's Sour Cream and Onion Nuggets** | 5/31/2020 at 8:15 A.M. | A partial pallet of sour-cream-and-onion seasoning was being stored below the bags of black pepper. Black pepper was on the outside of the sour-cream-and-onion-seasoning bags. | An employee wiped black-pepper powder from the outside of the sour-cream-and-onion seasoning bags and did not wash his 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** | 5/31/2020 at 7:00 A.M. | Product was stored in the proper location and was sealed. There were no leaks or spills. | The extruder die had to be recleaned due to peanut butter residue. The extruder die passed the second inspection. | Peanut butter was sent for ingredient testing. Test results indicated no *Salmonella* was present in the sample. |

# Guided Answers

## In-Class Activity

### Choose: Are Spices Safe?

Considering customer complaints about Pete's Perfect Pretzels and the black pepper recall by the U.S. Food and Drug Administration, the 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 (Quality Assurance) 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 powdered seasoning to oleoresins will impact the product attributes, including flavor, texture, and shelf life. You will need to discuss the potential changes with Research and Development before presenting to Management.

Use information on the Excerpts Related to Spices and Oleoresins handout 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.

**Note to Teacher:** Students have been provided with an example of how to record the information in the following table. Students should consider different stakeholders, including Marketing, Procurement, Processing, Research and Development, and Quality Assurance. Goals could include maintaining sensory properties, reducing cost, avoiding the use of ingredients that the public may consider objectionable, and reducing microbial loads of ingredients to improve the product's safety. Justification and teams responsible should be logical.

| 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: This team is responsible for finding suppliers and working with suppliers on ingredient pricing.<br><br>Research and Development: This team is responsible for formulation and product design. Product design will drive resource needs. |
| | | |
| | | |

2. Use the pretzels you have been provided for your experiment. In this experiment, essential oils are representative of oleoresin and can be used in place of oleoresin for calculation purposes. **DO NOT EAT the oleoresin, the essential oil, or the pretzel containing the oleoresin or essential oil.** 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 1 by the answer from step 2 to find the ratio of oleoresin to black pepper. .

*Note: Regardless of the procedure used to calculate the ratio of oleoresin to black pepper needed for the formulation, the mass units used for oleoresin and black pepper should be the same (e.g., both are measured in grams or milligrams).*

**Calculate cost ratio of oleoresin to black pepper used in the 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 1 to match the units they used. For example, if students have units of milligrams 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 milligrams of black pepper.
3. Students multiply the ratio of oleoresin to black pepper by the ratio of cost per unit of oleoresin to cost per unit of 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. 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.

   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 literature review, complete the following table:

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

| | Spices | Oleoresin/Essential Oil |
|---|---|---|
| **Advantages** | ▪ Spices would add to the visual aesthetics of the pretzels.<br>▪ Spices provide "gritty" feel characteristic of a product flavored with herbs and spices.<br>▪ Oleoresins might not be available for all spices. | ▪ Easy to store and transport<br>▪ More stable when heated<br>▪ More economical to use<br>▪ Easier to control for quality and cleaner than the equivalent ground spices<br>▪ Free from contamination<br>▪ Concentrated form reduces storage space, bulk handling, and transport requirements<br>▪ Concentrated and virtually moisture-free form of oleoresins ensures 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.<br>▪ Depending on consumer preferences, oleoresins may be texturally inferior due to lack of particles.<br>▪ Oleoresins are sensitive to light, heat, and oxygen, which could shorten shelf life. |
| **Potential Pathogens** | ▪ *Clostridium perfringens*<br>▪ *Bacillus cereus*<br>▪ *Salmonella spp.* | ▪ Minimal microbial loads |
| **Similarities** | ▪ If processed by a reputable producer, microbial loads are less likely to be high.<br>▪ Both impart 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.

# Guided Answers

## 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, then outline potential hazards and how to control them. You will use the process flow diagram below, which identifies key steps in the pretzel production process. [*Note:* Process flow diagram and Table 1 directions not included here.]

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) |
|---|---|---|---|---|---|---|
| Receipt of ingredient | 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: Supplier should control hazard. 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: Spores may be present in some ingredients (e.g. 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[1] |
| | Radiological: None | R: N | R: Supplier should control this risk, 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 are only processed on certain lines. Lines were cleaned and allergen swabbing was performed. | C: None | C: None | C: None |
| | Physical: Potential metal or other hard/sharp material from processing* | P: Y | P: Metal or hard/sharp materials on or around the processing lines could contaminate product. | P: Metal detectors (CCP-3) and X-ray detectors (CCP-4) on packaging lines before product is packaged and/or sealed* | P: CCP-3 and CCP-4* | P: None |
| | Radiological: Potential radiological contaminants in water added to the pretzel dough | R: N | R: Water could potentially contaminate the final product with radiological material, but there is no history of this problem. Water is tested annually, at a minimum, to ensure the water is safe for use. | 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) |
|---|---|---|---|---|---|---|
| Product packaging | Biological: Pathogens could be reintroduced via cross-contamination. | B: N | B: Equipment is cleaned, and employees practice safe food-handling techniques. | B: None | B: None | B: None |
| | Chemical: Cross-contact (allergens) | C: N | C: Allergens are segregated to certain processing lines. Lines are cleaned and swabbed for allergens. Employees practice safe food-handling techniques. | C: None | C: None | C: None |
| | Physical: None | P: N | P: Product is packed immediately or soon after passing through metal detector. No incidents recorded. | P: None | P: None | P: None |
| | Radiological: Water used for cleaning could be contaminated. | R: N | R: Water used for cleaning is tested annually. The water source is a low-risk area for radiological hazards. | 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 |

*Some processes might not include an X-ray. However, metal detectors should always be included before packing product.

[1] U.S. Food and Drug Administration, 2005. Foods, Adulteration Involving Hard or Sharp Foreign Objects. CPG Sec. 555.425, p. 3. Available from: https://www.fda.gov/media/71953/download .

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