Microbiological Warfare

Microbiology and Food Safety

Grade Level
9-12

Lesson Length
3 periods x 55 Minutes

STEM Careers
- Microbiologist, Food Scientist, and Nutritionist

Nebraska Science Standards
- SC12.3.1 (Structure and Function of Living Systems)

Next Generation Science Standards
- LS1.B (Growth and Development of Organisms)

Food Science
- 3. (Evaluate factors that affect food safety from production through consumption)

These lessons aim to bring the science, skills of inquiry, critical thinking, and problem solving to life through an agricultural context.

Learning Objectives

By the end of the unit, students should be able to:
- Discuss the relative incidence of food-borne illness.
- Name and describe microorganisms of food safety concern.
- Describe the effect of temperature on microbial growth.
- Design and implement a food safety experiment to test how different methods of thawing food affect microbiological counts.
- Determine differences in bacterial growth associated with different thaw techniques.
- Develop a simple HACCP outline for “in-home” food service (i.e., “Grillin’ Burgers).

Materials List – (per student team)

- One 1-lb frozen ground beef chub (whole class control)
- Two 1-lb frozen ground beef chubs
- 1 food thermometer
- Spray bottle containing 70% ethanol solution
- 1 scalpel handle & blade
- 1 roll of plastic wrap
- Scale (school provided) – to weigh ~ 1 g samples
- Sterilized de-ionized water (school provided)
- 10-25 ml graduated cylinder
- 40 sterile test tubes
- 40 graduated pipettes
- 40 prepared nutrient agar petri plates

Preparation

- Print Power Point slides
- Print lab reports and Microbiological Warfare Guidelines

	• Collect, organize, and prepare materials to be used for the creation of an experiment to test microbial growth relative to different thaw techniques.

Do

Introduction (Interest Approach)

Anonymously poll the class …

1) Have you ever experienced food poisoning? Yes or No

2) Are you concerned about the safety of your food? Yes or No

The following introduction may be conducted through usage of teams and small group discussion, as a whole class discussion, or through individual assignments or any combination thereof, per the instructor's discretion. Perhaps a "competition" (team or individual) could be established. For example, "You've got 2 minutes, jot down every possible way you can protect yourself from food-borne illnesses."

Essential Questions

- *How can you personally protect yourself from food-borne illness?*
- *How might the industry protect consumers from food-borne illness?*
- *Who is responsible for ensuring the safety of the food we consume?*

Learning Activity 1: News Reports

As a class, view the following YouTube videos.

- CDC Released New Report on Food-borne Illness, 2:29.
  https://www.youtube.com/watch?v=hf6yH3D7skI
- Chasing Outbreaks: How Safe is Our Food (Retro Report), 11:24.
  https://www.youtube.com/watch?v=yfGOJKbqrWk

After reviewing the YouTube videos of actual news reports, discuss the following questions (and be sure to let students know that there are no right or wrong answers):

1) Did these news reports scare you? If so, how? If not, why not?
2) Did these news reports provide a true reflection of the situation? Explain.
3) Do these news reports initiate a "call for action"? If so, by whom?
4) What more, if anything, should these news reports have included?

Learning Activity 2: Thawing

Distribute the "Ground Beef Thaw Experiment" guidelines to each student. Students may work in teams of 2-5 depending on class size.

To preserve foods for an extended period of time prior to consumption, many foods (particularly meats) are frozen prior to consumption. However, those foods must then be thawed prior to preparation for consumption, and there are a multitude of different methods by which consumers may thaw such products.

Teams of students will each be given two 1-lb chubs of frozen ground beef. Their task is to develop a comparative experiment to quantify the bacterial growth in ground beef associated with two different methods of thawing compared to a frozen control (whole class). Thaw processes that student teams may wish to test include …

1) Refrigerator
2) Microwave
3) Countertop – place product on the countertop @ room temperature.
4) Cold water bath – still water
5) Cold running water
6) Hot water bath – still water
7) Hot running water
8) OTHER – can you think of any other ways you might thaw the ground beef?

Prior to conducting the thaw process experiment, students must create a written plan of action that includes a research problem, hypothesis, materials list, procedure, and data tables. The written plan of action must be approved by the instructor prior to students conducting the experiment.

Students will conduct their experiment, and each student in the group will use the provided lab report to document their findings.

Learning Activity 3:

What is the true prevalence of food-borne illness & how do we protect ourselves? Distribute and discuss slides related to "Microbiology and Food Safety". The presentation provides information on the 5 "Cs" of food safety, information and prevalence of 5 key bacterial pathogenic organisms, and a quick overview of HACCP (Hazard Analysis of Critical Control Points).

One may also wish to view and discuss the YouTube video "6 Simple Steps to Avoid Food Poisoning" from the Finnish Safety Council (https://www.youtube.com/watch?v=lf_-DqzTcic, 2:13).

Reflection

As you watch this YouTube video (https://www.youtube.com/watch?v=IA8IW5abQTg, 5:38), each student should list as many food safety violations as they can find. Upon conclusion of the video, share the lists and discuss the violations. Note – This video provides no voice overlay or official explanations. You are the "Food Safety Officer"!

Apply

Given what you have learned from Learning Activities 1-3, working in small teams, develop a HACCP plan for "Grillin' Cheeseburgers!"

You've got frozen ground beef chubs. List all the steps from freezer to serving. Then, you must identify 3 critical control points and associated critical control limits (safe vs. unsafe) within the process.

Why did you select those 3 critical control points?
What information did you use to specify your critical control limits?

References:

- Zahid, S., Fleming, T., Randall, G. K. Microbial Growth in Ground Beef During Different Methods of Thawing. Undergraduate Research Journal for the Human Sciences, Vol. 9, [Online]. 2010. http://www.kon.org/urc/urc_research_journal9.html.

Ground Beef Thaw Experiment Guidelines

Objective: Determine differences in bacterial growth associated with different thaw techniques.

Guidelines:

1. Develop a comparative experiment to quantify the bacterial growth in ground beef associated with two different methods of thawing compared to a frozen control.
2. A written plan of action must be submitted before experimentation may begin. This experimentation plan should include a research problem, hypothesis, materials list, procedures, data tables, and a safety plan.
3. Each student in the group will use the provided lab report to document their findings.

Procedures:

1. A "whole class" control will be used with this experiment. In other words, each team will compare the results or bacterial growth associated with their thaw treatments to the frozen control.
2. Each student team must identify two different thaw procedures to test.
3. Whenever working with the product, students should wear gloves to minimize opportunity for microbial contamination.
4. The outside of each frozen beef chub to be thawed will be sterilized with a 70% ethanol solution (i.e., spray the outside of each frozen beef chub with your ethanol solution, before proceeding).
5. Throughout the thaw process, beef chubs shall be evaluated every 2 hours for a total of 6 hours. Thus, you will have four points of measurement at times 0, 2, 4, and 6 hrs.
6. Upon start of the experiment, using your scalpel, four 1-inch incisions will be made through the original plastic packaging of each ground beef chub, spaced approximately 1 inch apart along the length of the chub.
7. Cover incisions with plastic wrap.
8. At time 0, 2, 4, and 6 hrs, do the following for each of your comparable thaw treatments:
    a. Remove plastic wrap from the incision mark to be tested.
    b. From that incision, extract a 1 g sample of product (be sure to tare weigh paper on scale).
    c. Place sample into sterile test tube and dilute with 9 ml of sterilized de-ionized water; shake.
    d. With pipette, extract 0.25 ml of solution.
    e. Plate diluted samples onto a prepared Nutrient Agar plate and swirl to cover whole plate.
        i. You are attempting to spread any bacteria across the entire surface area of nutrient agar.
    f. Label plate with your team name/number, treatment, and time.
    g. Allow plates to "incubate" at room temperature for approximately 2-3 days.
9. Count the colonies present on each plate; then calculate the total # of colonies present per g of product.
    a. = (# of colonies * Dilution Factor)/volume of cell culture plated
    b. = (# of colonies counted * 10) / 0.25

Name:

Lab Report

Please complete the following report during the design and implementation of your experiment.

Research Problem
- Describe what you are investigating and justify why you are investigating the problem.

Hypothesis
- Formulate one or more hypotheses for your experiment.

Procedures
- Create the steps you will follow for your experiment.

Data Collection
- Describe the data that you will collect during your experiment.
- Provide graphs, tables, charts, and raw data as necessary.

Results
- Explain your results.

Conclusion
- Based on your data:
  - What can you conclude?
  - Were your hypotheses supported?
  - Were their limitations to your experiment?
  - What are new research questions that derived from this study?