Chapter 2: Food Safety

SAFE PRACTICES

Did you know good food safety habits are important in our every day lives?

From farmer to consumer, it is important to ensure food is safe. Foodborne microbes are one of the leading causes of illness in the United States. It has been estimated that 15% of US citizens each year are affected by **foodborne illness**.

The key is to prevent foodborne illness, not to treat. The United States government promotes food safety to its citizens. The Federal Drug Administration (FDA) and the United States Department of Agriculture (USDA) regulate and inspect foodservice facilities to ensure safety. Along with the FDA and USDA, the Environmental Protection Agency (EPA) and the Centers for Disease Control (CDC) require safe handling of raw and partially cooked meats. Raw and partially cooked meats are the most common causes of foodborne illness.

One of the top causes of foodborne illness is meat that has not been cooked to the proper temperature. Higher temperatures kill the microorganisms that can cause foodborne illness. When preparing meat, we should use thermometers to make sure the center of the

meat has been cooked to its proper temperature. Each type of meat requires a different cooking temperature. To properly determine the temperature, the thermometer must first be calibrated.

Calibration ensures the thermometer reads the correct temperatures. This can be done by placing it in ice-cold water (32° Fahrenheit) or

boiling water (212° Fahrenheit). Water molecules increase in motion as they move through these states (solid, liquid, gas). When energy changes state, it undergoes a phase change such as ***melting***, ***freezing***, ***evaporation***, or ***vaporization***. You will observe these types of state changes in *Food Explorations Lab I* of this chapter.

Melting occurs when a solid becomes a liquid by absorbing heat. In this phase change, molecular bonds are broken to allow melting to occur. Freezing is the opposite of melting. It is when a liquid becomes a solid. During freezing, heat leaves the liquid to allow tight molecular bonds to form. Evaporation and vaporization are when a liquid becomes a gas because heat moves into the liquid and allows the molecules to move more freely.

There are also other reasons foodborne illness may occur. For example, food can be contaminated with harmful bacteria during food preparation. Washing your hands for 20 seconds, or as long as it takes to sing Happy Birthday to yourself twice, at the proper temperature and using cleansing agents are essential in preventing illness. Washing our hands before eating can help keep us safe. The bacteria on our hands can easily transfer to the food we're eating. You will observe why hand washing is an important practice in *Food Explorations Lab II* of this chapter.

Preventing microbial growth in food can be a little harder. Many factors affect microbial growth on food (e.g. pH, moisture). It is important to keep foods at the right temperature to prevent growth (less than 40°F or greater than 140°F). Food can't be kept for too long at room temperature before it is considered unsafe for consumption. Storing raw foods (meat and dairy products) properly and washing foods, like fruits and vegetables, are also methods that keep food safe.

Given enough time, mold can grow in cold or hot temperatures.

Even when proper prevention techniques are in place, age effects occur. When foods age, they produce certain microorganisms like mold, yeast, and bacteria.

Molds are multicellular organisms with a cotton-like appearance. They grow on the surface of dry foods, like bread, at room temperature. If given enough time, they can grow in cold or hot temperatures. You will learn more about mold growth on food in *Food Explorations Lab III* of this chapter.

Yeast is a single celled microorganism. It can grow on foods like citrus fruits because they provide the best environment for yeast to reproduce. The conditions for this environment include sugar, acidity (pH 4.0 to 4.5), and oxygen.

Bacteria are tiny single cellular microorganisms smaller than molds and yeasts. They reproduce in high moisture and neutral pH conditions (pH 7), where sugar and salt are not present. Depending on the bacteria, different environmental conditions are needed. Some bacteria love the cold, some love the heat, and some love room temperature. It is important to remember, however, that not all bacteria are bad for your health!

From the farm to the kitchen, everyone should be aware of the methods to prevent foodborne illness. Let's find out what we can do to keep our food safe!

Think About It

Food Explorations Lab I

1. Thermometers should be calibrated to ensure that food is cooked to the correct _____temperature_____.

2. The state change from a liquid to a gas is called _____evaporation_____.

3. The water molecules in the _____frozen_____ state of matter move the slowest.

Food Explorations Lab II

1. Which part of our body is most likely to contaminate food during preparation? _____hands_____

2. The correct storage _____temperature_____ can prevent microbial growth on food.

3. Washing hands before _____eating_____ can help keep you safe.

Food Explorations Lab III

1. Multi-cellular organisms that grow on dry food are called _____mold_____.

2. A single cellular microorganism that grows on citrus fruit is called _____yeast_____.

3. The smallest microorganisms that grow on food are _____bacteria_____.

Food Explorations Lab I:
Changing States

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this lesson, you will learn how to calibrate a bimetallic stemmed thermometer. Your teacher will first demonstrate using the boiling water method. Then, you will calibrate a bimetallic stemmed thermometer using the ice water method. During both parts of the lab, you will record temperatures and then construct graphs using this data.

Lab Objectives

In this lab, you will learn how to…

1. Observe and graph the temperature changes that occur during the changes of state for water.

2. Calibrate a bimetallic stemmed thermometer.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

How can changes of state be used to calibrate a bimetallic stemmed thermometer?

Because changes of state are related to temperature change, you can use extremes (e.g. freezing, boiling) to calibrate a thermometer with the appropriate temperature.

Observation of State Changes

MATERIALS

Safety goggles
Aprons (optional)
1 thermometer
1 cup filled with ice chips
1 cup filled halfway with water
1 kitchen timer or stopwatch

PROCEDURE

Before you begin your part of the lab investigation, your teacher will heat a pot of water to demonstrate:

a. How to calibrate a thermometer with the Boiling Water Method.

b. Temperature and state changes that occur when heat is applied to water.

1. Record the temperature of the water as it warms every 2 minutes for 10-minutes in Table B.

2. Record any observed state changes in Table A.

3. Create a line graph in Line Graph B on page 37 with your data from Table B. First, label the y-axis in Line Graph B with the appropriate unit of measure. If your thermometer measures °F, create a y-axis ranging from 20° to 250°F. If your thermometer measures °C, create a y-axis ranging from -6° to 126°C. Be sure to use 10° increments.

4. Record each data point on the graph by matching degree of temperature with the minutes the temperature was measured. Connect the temperatures on your graph with a line (left to right) once all five points have been recorded.

5. If the final temperature reached for the boiling water was 212°F or 100°C, the thermometer is calibrated correctly and ready for use. If the final temperature is not correct, you will need to calibrate the thermometer. To calibrate, you should twist the nut below the thermometer head until the dial reaches 212 °F or 100 °C.

6. Next, your group will calibrate a thermometer using the Ice Water Method.

7. Combine the water with the ice chips. Place the thermometer into a cup of ice water. Measure and record the temperature of the water every 20 seconds for 180 seconds in Table C.

   NOTE: Do NOT let the thermometer stem touch the sides or bottom of the cup. When measuring the ice water, the thermometer should stay in the mixture for at least 30 seconds or until the dial stops moving.

8. Record any observed state changes in Table A.

9. Create a line graph in Line Graph C on page 37 with your data from Table C. First, label the y-axis in Line Graph C with the appropriate unit of measure. If your thermometer measures °F, create a y-axis ranging from 20° to 250°F. If your thermometer measures °C, create a y-axis ranging from -6° to 126°C. Be sure to use 10° increments.

10. Record each data point on the graph by matching degree of temperature with the seconds the temperature was measured. Connect the temperatures on your graph with a line (left to right) once all 9 points have been recorded.

11. If the final temperature reached for the ice water was 32°F or 0°C, the thermometer is calibrated correctly and ready for use. If the final temperature is not correct, you will need to calibrate the thermometer. To calibrate, you should twist the nut below the thermometer head until the dial reaches 32 °F or 0 °C.

Table A. Observed State Changes

State	Observed State Changes
Ice Water	Less ice and more water at the end of 10 minutes than at the beginning.
Boiling Water	Steam coming off water, less water at the end of 10 minutes than at the beginning

Table B. Boiling Water Time Table

State	MINUTES				
	2	4	6	8	10
Boiling Water					

Line Graph B. Boiling Water

	Boiling Water				
(°)					
	2	4	6	8	10
	Minutes				

Table C. Ice Water Time Table

State	SECONDS								
	20	40	60	80	100	120	140	160	180
Ice Water									

Line Graph C. Ice Water

	Ice Water								
(°)									
	20	40	60	80	100	120	140	160	180
	Minutes								

Conclusion:

1. Based on the reading and lab observations, were the thermometers used to measure the boiling water and the ice water calibrated? Support the answer using evidence from the investigation.

   Student responses will vary based on their individual experiment. Example responses may include:

   Yes, because the thermometer read 212°F when I measured the boiling water and/or 32°F when I measured the ice water.

   No, because the thermometer did not read 212°F when I measured the boiling water and/or 32°F when I measured the ice water.

2. Using the graphs, determine the boiling point and melting point of water. Describe the appearance of the graphs that allowed you to make this determination.

   Boiling water → The water began to slowly rise at the end of ten minutes instead of rapidly. Once it reached 212°F, it did not increase anymore. The change in state occurred at 212°F.

   Ice water → The water began to slowly decrease around 160 seconds. Once it reached 32°F, it did not decrease anymore. The change in state occurred at 32°F.

3. Describe how the water molecules' speed will change as the temperature increases and water changes from a solid to a liquid and from a liquid to a gas?

   When the water molecules are converted to gas, they begin to speed up. When they are concerted to solid, they slow down. Heat affects molecular speed. The higher the temperature, the more movement occurs.

4. Explain why it is important that thermometers be calibrated before being used for cooking.

Food can be over- or under-cooked, causing foodborne illness.

5. Describe how the changes of state were used to calibrate the thermometer.

In the Ice Water Method, the change from ice to water allowed the water to absorb the cold temperature until it reached a freezing temperature. This temperature was known (standard) - (32°F). If the temperature on my thermometer did not read 32°F, then I knew that the thermometer was not calibrated properly and needed to be adjusted. The thermometer could not be calibrated with only ice because the ice cannot fully submerge the probe. A similar outcome was observed for the Boiling Water Method. The change of liquid to gas represented another change in state. The known boiling temperature of water (212°F) was compared to the temperature read by the thermometer. Again, if the temperature was anything other than the standard 212°F, I knew the thermometer was not calibrated properly and needed to be adjusted.

Food Explorations Lab II:

Invisible Creatures

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, you will work in groups to determine where bacteria can be located on your hands and the effect of hand washing on cleanliness.

Lab Objectives

In this lab, you will learn how to…

1. Identify the areas of the hand where bacteria are the most concentrated.

2. Properly wash your hands for general health and disease prevention.

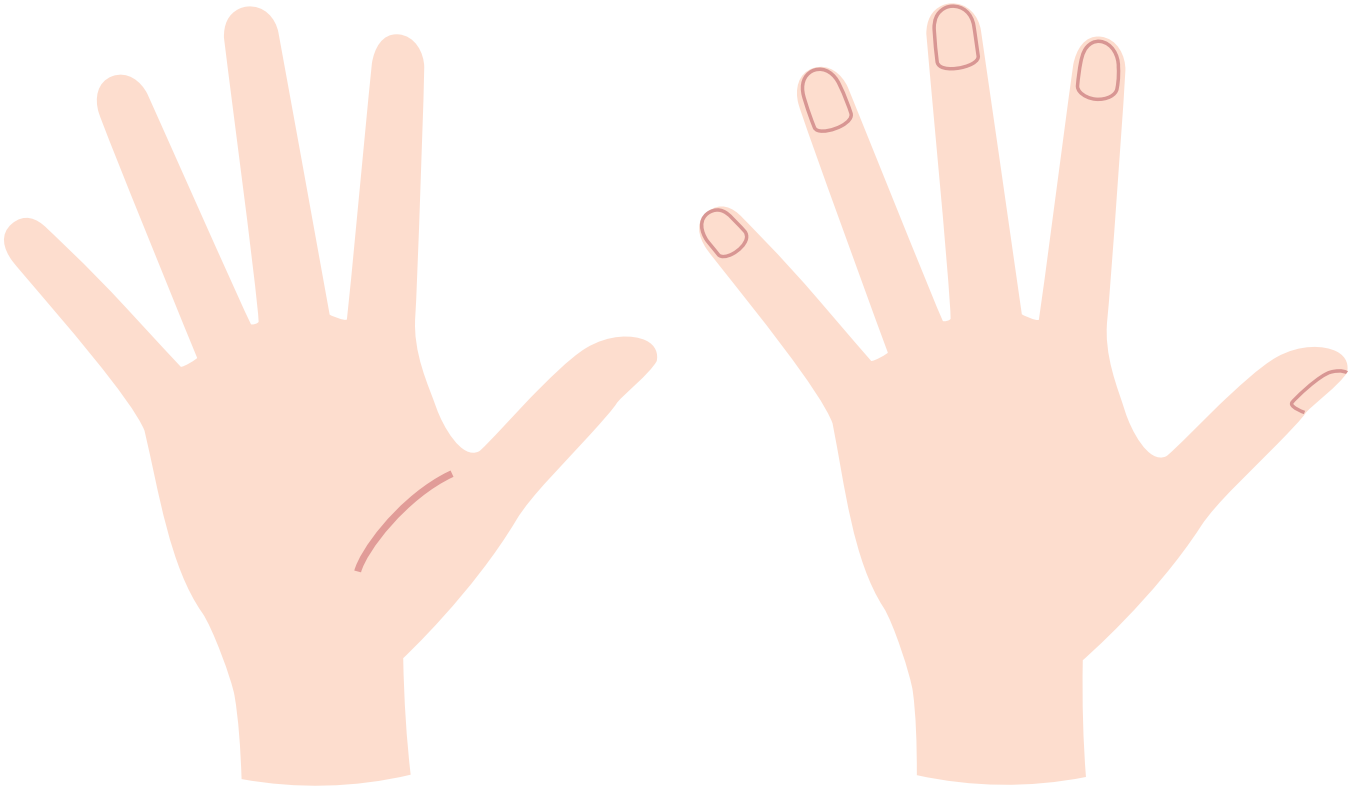
Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

Which of the following areas on the hand contain the most bacteria?

Palm Finger Nails Wrist Fingers Thumb Back of Hand

Prediction: Using the drawing below, shade in locations on each hand where you predict bacteria are the most concentrated.



Provide an explanation for your prediction:

Observation of Bacteria

MATERIALS

Safety goggles
Glo Germ™
Warm water
Colored pencils or markers
Aprons (optional)
UV light
Soap

PROCEDURE

You will use Glo Germ™ and a UV light to determine where bacteria concentrate on your hands. **Do not point the UV light in the direction of anyone's eyes and only turn it on when it is time to use.**

1. Gently shake the bottle of Glo Germ™. Place a small amount (about the size of a quarter) into your palm and spread over both of your hands. Make sure to cover the area under and around your nails, between your fingers and a small portion of your wrists.

2. Place your hands under the UV light to view the bacteria present. This part of the procedure works best in a darkened room.

3. Draw your *visual* observations of where the bacteria are located on your hands on the next page using a light colored pencil or marker.

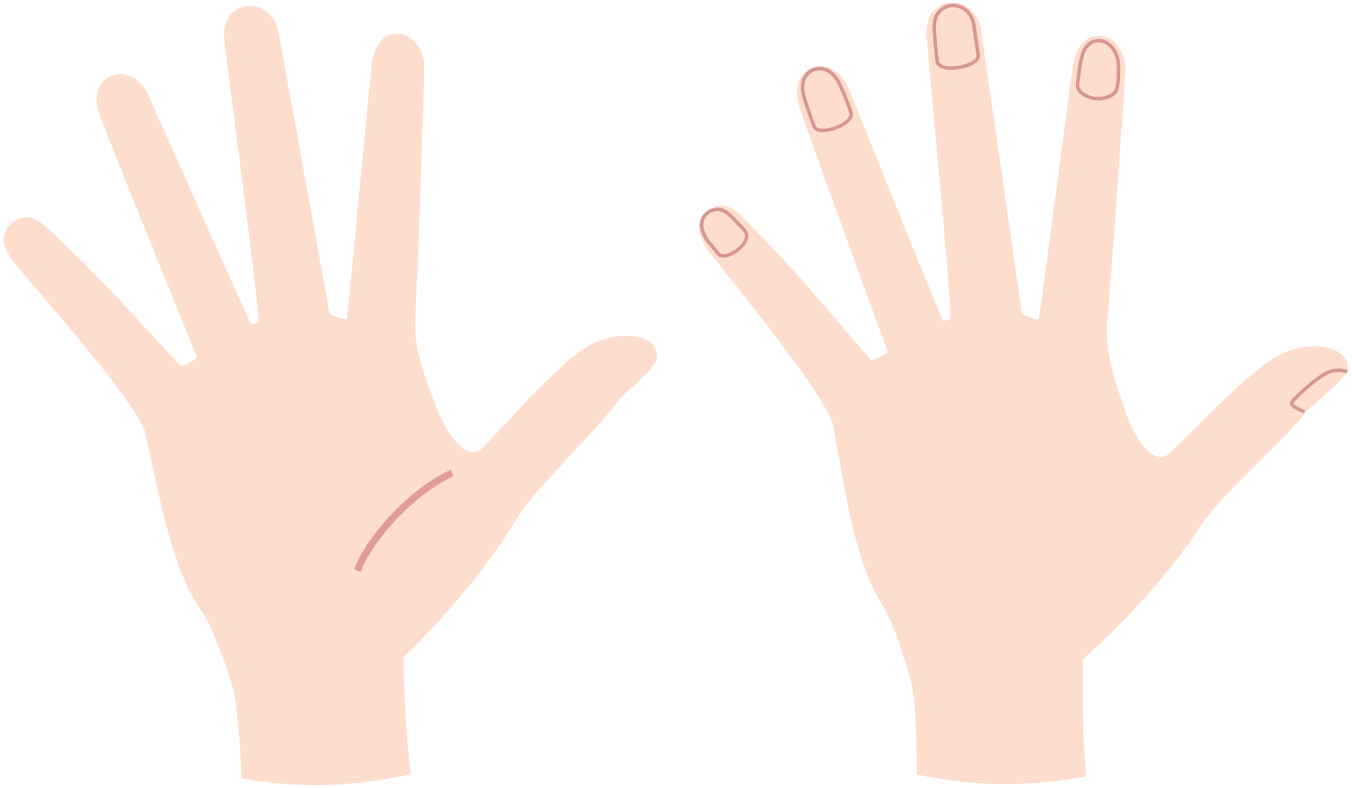
4. Wash your hands with warm water and soap for at least 20 seconds.

5. Place your hands under the UV light to view the bacteria present again. Draw your *visual* observations of where the bacteria are located on your hands on the next page (same hand drawing as before), but this time use a dark colored pencil or marker. The contrasting colors will highlight any areas that still had bacteria on them.

6. Wash your hands with warm water and soap for at least 20 seconds. Pay special attention to the areas that you were not able to clean properly the first time.

7. Draw your *visual* observations of where the bacteria are located on your hands on the next page, but this time circle the areas that still have bacteria on them.

DATA



Conclusion:

1. Explain how the amount and location of bacteria on your hand changed from no hand washing to the first and second hand washings?

   The bacteria decreased each time I washed my hands. For example, before washing my hands, there were bacteria all over my hands. The first hand washing decreased the bacteria everywhere except my fingernails and between my fingers. The second hand washing helped to decrease the bacteria in my fingernails and between my fingers.

2. Use supporting evidence from the investigation to explain if your original response to the lab question was correct or incorrect.

Student responses will vary

3. List the areas of your hands that had the most bacteria and explain why bacteria are often concentrated in these areas.

The areas on my hands that had the most bacteria were my fingernails and between my fingers. Bacteria are more concentrated in these areas because they are harder to clean. When washing my hands, I need to make sure to use soap, warm water, and pay extra attention to these areas.

4. Infer and describe how bracelets, jewelry, or watches may interfere with hand washing.

They could prevent certain parts of my hand or arms from being cleaning properly because they are blocking those locations.

5. Referring to the "Safe Practices" reading and your observations during the investigation, describe the most effective way to wash your hands to prevent foodborne illness.

I should turn on the faucet so that the water is warm, and then wet my hands with running water. Apply soap and rub my hands together for 20 seconds or as long as it takes to sing "Happy Birthday to You" twice. Then I should scrub under my fingernails and between my fingers. Rinse off all soap under running water. Use a clean paper towel to turn off the water. Dry my hands with another clean paper towel.

6. Explain three (3) ways people can spread the bacteria that is on their hands.

1. By shaking hands with other people
2. By touching food
3. By touching other surfaces (i.e. door knobs, light switches)

7. Identify 2 situations throughout your day in which hand washing is very important.

After going to the bathroom and before eating.

Food Explorations Lab III:
Multiplying Organisms

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, three types of food will each be placed in two different environments to determine which food and environment is best for the growth of mold.

Lab Objectives

In this lab, you will learn how to…

1. Identify factors that increase the growth of mold.

2. Identify ways to reduce the growth of mold on food.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Questions

1. Which of the following food items will produce the MOST mold growth? (Circle your answer.)

Apple Slices Cheese Bread

Prediction: I predict _____ will produce the most mold because…

2. Which environment will produce the most mold growth? (Circle your answer.)

Aerobic (air present) Anaerobic (air not present)

Prediction: I predict the _____ environment will produce the most mold because…

Observation of Mold Growth

MATERIALS

Safety goggles
Aprons (optional)
1 slice of white bread
2 slices of apple
2 pieces of cheese
1 paper plate
1 plastic sandwich bag
1 plastic knife
1 black permanent marker
1 microscope (optional)
2-3 microscope slides (optional)

PROCEDURE

1. Obtain your food samples. Draw your *visual* observations of each food in the Food Sample Drawings table under Day 1.

2. Prepare your food samples. Place one piece of each food type (half a slice of bread, 1 slice of apple, and 1 piece of cheese) in the plastic sandwich bag. The foods in the plastic bag should be considered an anaerobic environment (no air). Be sure to squeeze out any air from the plastic bag prior to closing it to ensure you are creating an anaerobic environment. Be sure to label your plastic bags with your group name.

3. Using the black marker, divide the paper plate into thirds. Place the remaining food samples (half a slice of bread, 1 slice of apple, and 1 piece of cheese) on the divided paper plate (aerobic environment, which has air). Be sure to label your paper plate with your group name.

4. Place all six food items to the side for later observation.

5. One to two times a week for up to 3 weeks, observe the food samples for visible mold growth. When mold is visible on at least 2 samples of the available food types, use a plastic knife to remove a small sample from each and proceed with the remainder of the lab investigation.

6. Record your *visual* observations after 3 weeks in the Food Sample Drawings table under Final Day. Be sure to identify if your sample was stored in an anaerobic or aerobic environment.

   NOTE: Not all foods will produce mold.

7. (Optional) Observe each mold type under a microscope.

Table A. Food Sample Drawings

Apple		Cheese		Bread	
Day 1					
Final Day					
AEROBIC	**ANAEROBIC**	**AEROBIC**	**ANAEROBIC**	**AEROBIC**	**ANAEROBIC**
Brown and mushy; edges of skin are curled and brown	Brown and mushy	Some gray and black mold, dry, cracked	Lots of gray and black mold	Hard like toast; may have green mold on one side	A little moist, blue-gray mold all over

TEACHER'S NOTE: Mock observations may differ slightly in appearance

Conclusion:

1. Which food type had the most mold growth? Why?

   Cheese grew the most mold because it provides the most nutrients (e.g. protein, water) mold needs for growth.

2. Describe how the mold types differ for each food sample? Consider appearance, color, and odor.

   Each food and environment produced a different color mold. Each color represents a different type of mold.

3. For each type of food, which environment produced the most mold? Is oxygen necessary for the mold to grow?

   Anaerobic produced the most mold because this environment retains more moisture. Oxygen is not necessary for mold to grow.

4. Brainstorm or research a few examples in which mold growth (fermentation) is used to produce food products. Describe your findings below.

   Beer, Bread, Sourdough, Kimchi, Sauerkraut, Wine, Vinegar, Cider, Cheese, Yogurt, Chorizo, Salami, Pepperoni

5. Based on the reading and your observations, what conditions are ideal for microbial growth? Describe how food can be kept safe from molds.

   The conditions ideal for microbial growth are food, low acidity, moderate temperatures (40-140°F), oxygen, and high moisture.

Investigating Your Health:

Fearless Food Safety

Name: _____

Objective: Investigate food safety by describing ways to prevent foodborne illness, describing the correct hand washing procedure, and tracking how many times you wash your hands in one day.

Food safety is handling, storing, and preparing food in ways to keep food safe. ***Cross-contamination*** is the spreading of bacteria to clean surfaces that can cause foodborne illness. To prevent cross-contamination, keep raw meat, fish, and poultry away from ready-to-eat foods, like fresh fruits and vegetables. Don't use a plate or knife that touched raw meat. Always wash your hands after you touch raw meat. Washing countertops and using clean dishes and silverware can also prevent cross-contamination. Washing your hands correctly, and before touching food, may also prevent bacteria from spreading to food. Cooking foods to their proper temperatures will prevent foodborne illness from occurring. Salmonella is the most common foodborne causing pathogen. It can be found in raw meat, fish, poultry, and eggs. E. coli is another pathogen that can be found in raw or undercooked meat, fish, and poultry. Both salmonella and E. coli are bacteria that can cause foodborne illness. ***Foodborne illness*** happens when you get sick from eating a food contaminated with a harmful substance. If food safety measures are not followed, you or the people you're cooking for could get sick. For more interesting food safety tips, see the *Try This at Home* recipe!

Hand Washing Practices

1. During the course of one day, track how many times you washed your hands. Describe the circumstances for why you washed your hands each time in the table below.

	Why did you wash your hands?
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

2. Investigate and describe the correct way to wash your hands as recommended by the Food and Drug Administration (FDA). Be sure to explain the importance of soap/water, how long to wash your hands for, and how to turn off the faucet.)

Turn on the faucet so that the water is warm. Wet your hands with running water. Apply soap. Rub your hands together for 20 seconds or as long as it takes to sing "Happy Birthday to You" twice. Scrub under your fingernails and between your fingers. Rinse off all soap under running water. Use a clean paper towel to turn off the water. Dry your hands with another clean paper towel.

3. List 3 instances when you should wash your hands.

Before eating; After using the bathroom; After blowing your nose, coughing, or sneezing; After touching an animal; After touching garbage; Before and after treating a cut; Before, during, and after preparing food.

4. Investigate and describe below 2 other ways can you prevent foodborne illness.

There are many possible responses. A few common methods include: refrigerating or freezing meat, poultry, eggs, and other perishables as soon as you get them home from the store; not thawing meat on the counter, but rather in the refrigerator; separating raw meats from other foods in your grocery-shopping cart, grocery bags, and in your refrigerator; using different cutting boards for fresh fruits & vegetables and raw meats; and heating leftovers properly.

5. Complete the table below to identify 3 ways foodborne illness can occur and what bacteria caused the illness. There are many possible responses. Common responses may include:

Situation	Cause	Bacteria
Example: **Improper Storing**	**Raw meat was stored next to fresh vegetables in the refrigerator**	**E. Coli Salmonella**
Cross-Contamination	Using the same fork to eat salad after it was used to whisk raw eggs	Salmonella
Improper Handling	Raw chicken was not cooked to the proper temperature	E. Coli Salmonella
Improper Storing	Raw meat was stored next to fresh vegetables in the refrigerator	E. Coli Salmonella

6. Ask a family member if they have had any bad experiences with mold, bacteria, or foodborne illness. Describe their experience below.

There are many possible responses.

TRY THIS AT HOME:
Wash Away Germs

You will need:

2-3 teaspoons of cooking oil
1 teaspoon cinnamon

How clean are your hands?

1. With your hands over the sink, pour 2-3 teaspoons of cooking oil into your hands.
2. Then sprinkle the cinnamon onto your hands. Pretend that the cinnamon is bacteria.
3. Rub your hands together.
4. Wash your hands without using soap. Sing "Happy Birthday to You," while you wash your hands.
5. Look at your hands. Can you still see bacteria (cinnamon)?
6. Wash your hands again using the directions below.

Proper Hand Washing Instructions

1. Wet your hands with warm running water.
2. Add soap.
3. Rub hands together while singing "Happy Birthday to You" twice.
4. Scrub under your fingernails and between every finger.
5. Rinse soap off with running water.
6. Use a clean paper towel to turn off the water.
7. Dry your hands with a clean paper towel.