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# *Serving It Safe*

## PART I

7 CREDIT HOURS



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National Food Service Management Institute  
under a Cooperative Agreement  
with  
United States Department of Agriculture,  
Food and Nutrition Service

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## **Instructions For Completing This Training Module**

1. After reviewing this material with your day home representative, please read and study the material carefully.
2. Complete the test for the material and return it to Child Food Program Of Texas at your convenience. There is no deadline to have this test back to us.
3. When we receive your completed test, we will evaluate it and then send you a certificate for 7 clock hours for completing this material.

## **Objectives**

1. To understand concept of food borne illness
2. To know what a food borne outbreak is.
3. To recognize how harmful microorganisms contaminate food
4. To learn how food borne illness can be prevented
5. To recognize food borne illnesses care caused by bacteria, viruses and fungi



# ***Food Safety Is Top Priority***

**In this chapter, find answers to the following questions:**

|  |             |
|--|-------------|
| <b>Why is food safety a top priority?</b> .....                  | (page 2)    |
| <b>What is a foodborne illness and foodborne outbreak?</b> ..... | (page 2)    |
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# Food Safety Is Top Priority

## Why is food safety a top priority?

Food safety is the responsibility of every person who is involved in foodservice. Serving safe food to children and adults who participate in Child Nutrition Programs is a top priority for every foodservice employee regardless of the job assignment. Every action in foodservice has the potential to impact the safety of the food, either during purchasing, storage, preparation, holding, service, or cleanup.

In 2001, the Centers for Disease Control and Prevention (CDC) estimated that 76 million cases of foodborne illness occurred each year in the United States. Foodborne illness is considered a major public health problem. For certain highly susceptible groups, such as seniors, young children, pregnant women, and the immune-compromised, foodborne illnesses can be fatal. In fact, the CDC estimates that there are 325,000 hospitalizations and 5,000 deaths related to foodborne illnesses each year. However, for most people, a foodborne illness results in discomfort lasting several days or longer.

Foodservice employees should know that a foodborne illness could occur in any operation. Just because a foodborne illness has not occurred in a foodservice operation does not mean it will never occur. To prevent a foodborne illness, all employees must practice good food safety habits on a routine basis. In addition to human suffering, an outbreak of foodborne illness can result in a damaged reputation and financial loss.

Foodservice employees have many opportunities throughout the day to ensure that the food served is safe to eat. In order to serve safe food, every foodservice employee must follow guidelines to maintain a safe foodservice environment.

## What is a foodborne illness and foodborne outbreak?

### Foodborne Illness

A foodborne illness, commonly referred to as food “poisoning,” is a disease carried to people by food or water. Although a person may become ill and show symptoms that go with a specific kind of foodborne illness, a foodborne illness can only be confirmed with a laboratory analysis that identifies the source of the illness.

### Foodborne Outbreak

A foodborne outbreak is an incident in which two or more people experience the same illness symptoms after eating a common food. A foodborne illness is confirmed when a laboratory analysis shows the source of illness to be a specific food. For example, it would be a foodborne outbreak if two or more students who ate undercooked hamburger patties in the school cafeteria became sick and their symptoms were confirmed by the State public health department to be caused by *E. coli* 0157:H7.

## What must be done to keep food safe?

Americans have a safe food supply. However, food can become contaminated at any stage in the foodservice process, from field or pasture to the customer's plate.

Foodborne illnesses are caused by eating a contaminated food or drinking a contaminated beverage. The first step in preventing a foodborne illness is to prevent the food or beverage from becoming contaminated and thus unsafe. Any food or beverage can be contaminated (made unsafe). There are three types of hazards (or contaminants) that can cause a food to be unsafe.

- Biological (microorganisms)
- Chemical
- Physical

### Know about Biological Hazards

#### *Understand What Causes Biological Contamination*

Bacteria or other microorganisms that have contaminated food cause most foodborne illnesses. These microorganisms are more likely to grow in the temperature danger zone. The temperature danger zone is between 41 °F to 135 °F and refers to the internal temperature of food. The harmful microorganisms, called **pathogens**, can come from a variety of sources.

- **People** spread organisms from their bodies to food by unclean hands, coughing, or sneezing. Food can be contaminated before or during processing, in the kitchen during preparation, or during service. In fact, most foodborne illnesses are caused by bacteria or other microorganisms spread by people who handle food.
- **Unsanitary facilities and equipment** may spread harmful organisms to people or food.
- **Disease-spreading pests**, such as cockroaches, flies, or mice, which are attracted to food preparation areas, may contaminate food, equipment, or service areas.

#### *Prevent Contamination from Microorganisms*

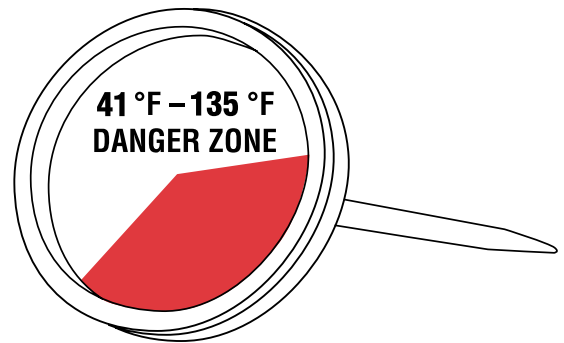
More information about the causes and prevention of foodborne illnesses from microorganisms is provided in Chapter 3: Basic Facts about Microorganisms.

### Know about Chemical Hazards

#### *Understand What Causes Chemical Contamination*

A foodborne illness can result from a harmful chemical getting into a food that is then eaten by a person. Foodservice establishments use a variety of chemicals to clean and sanitize and for pest control.

If handled inappropriately, the chemicals necessary to maintain a sanitary facility can contaminate food and make people sick. Employees who handle hazardous chemicals incorrectly also risk injury due to exposure.



Hazardous chemicals include

- sanitizers,
- pesticides,
- whitening agents,
- detergents,
- polishes,
- glass cleaners,
- caustics, and
- cleaning and drying agents.

***Prevent Chemical Contamination***

Chemical contamination of food and personal injury can be prevented if chemicals are handled and stored properly. Use the guidelines below to help prevent chemical contamination.

- Teach employees how to use chemicals.
- Store chemicals in original containers away from food to prevent accidental misuse as well as leakage into food.
- Make sure labels clearly identify chemical contents of containers.
- Use Materials Safety Data Sheets (MSDS) to ensure that all chemicals are stored and used correctly. MSDS should be readily accessible to all employees.
- Always measure chemicals in accordance with manufacturer’s recommendations.
- Allow only authorized personnel to have access to cleaning chemicals.
- Always test sanitizing solutions.
- Wash hands thoroughly after working with chemicals.
- Wash fresh produce that will be served whole, peeled, or cooked in cold, running water. Scrub thick-skinned produce with a brush designed for food preparation.
- Monitor procedures used by pest control operators to be sure pesticides do not contaminate food. Only professional operators should apply pesticides.

***Metals are another potential source of contamination. Highly acidic foods, such as tomatoes or lemons, can react with metals during cooking or storage, causing the metal to leach out into the food. To prevent this problem:***

- Use metal containers and metallic items only for their intended uses.
- Do not use galvanized containers to prepare or cook acidic foods like lemonade, tomato products, and salad dressing.
- Avoid enamelware, which can chip and expose underlying metal.
- Do not use metal mixing bowls for holding hot foods.
- Never store food in an open can; transfer to an appropriate, covered storage container and label.
- Use only commercial foodservice equipment. Look for the National Sanitation Foundation (NSF) International mark or the Underwriters Laboratories’ (UL) sanitation classification listings of commercial foodservice equipment that comply with those of NSF International.



## Know about Physical Hazards

### *Understand What Causes Physical Contamination*

A food can be contaminated by a foreign object getting into the food accidentally. Physical contaminants include dirt, hair, nail polish flakes, insects, broken glass and crockery, nails, staples, metal or plastic fragments, and bits of packaging materials. Bits of bone in ground beef would be considered a physical contaminant because it is a foreign object that should not be in the food. Some physical contaminants may get into the food during processing and some may accidentally get into the food during final preparation. Either way, physical contaminants can be harmful to the customer, and every effort should be made to avoid any foreign object in the food.

Because physical hazards are easily seen, customers commonly report them. Most physical food contamination can be prevented when foodservice personnel wear proper clothes and shoes, use hair restraints, avoid wearing nail polish and artificial nails, and use other commonsense precautions. Teach employees to be aware of potential physical contaminants.

### *Prevent Physical Contamination*

Use the guidelines below to help prevent physical contamination.

- Use a commercial scoop rather than a glass for portioning ice.
- Designate a source of ice for use in beverages and foods. Do not chill food items in the same ice that will be consumed.
- In a preparation area, store toothpicks and non-edible garnishes on lower shelves so they cannot fall into food.
- Place shields on lights.
- Clean can openers regularly and keep the blades sharp and in good repair.
- Remove staples, nails, etc. from boxes in the receiving area when food is received.
- Avoid repairing equipment temporarily with items that could potentially fall into food.
- Clean and sanitize equipment on a regular basis.
- For best practice, do not wear nail polish or artificial nails when working with food.
- Wear a hair restraint when working with food.
- Do not wear jewelry or medical information jewelry other than a plain ring, such as a wedding band, when preparing or serving food.
- Do not carry a pencil or pen behind the ear since it could fall into food.
- For best practice, avoid wearing earrings that could fall into food.
- Use only food containers or bags that are approved for food storage.
- Never reuse a single-use container.
- Have routine pest control maintenance administered by licensed personnel.

## Summary

CHAPTER 1: **"Food Safety is Top Priority,"** provides an explanation of three types of hazards that can contaminate food: biological (microorganisms), chemicals, and physical. The first line of defense against a foodborne illness is to prevent contamination of food. Bacteria or other microorganisms that have contaminated food cause most foodborne illnesses. These microorganisms are more likely to grow in the temperature danger zone. The temperature danger zone is between 41 °F to 135 °F and refers to the internal temperature of food. The harmful microorganisms, called **pathogens**, can come from a variety of sources. A foodborne illness can result from a harmful chemical getting into a food that is then eaten by a person. Foodservice establishments use a variety of chemicals to clean and sanitize and for pest control. Because physical hazards are easily seen, customers commonly report them. Most physical food contamination can be prevented when foodservice personnel wear proper clothes and shoes, use hair restraints, avoid wearing nail polish and artificial nails, and use other commonsense precautions. Teach employees to be aware of potential physical contaminants. Every foodservice employee is responsible for following all sanitation guidelines to prevent a foodborne illness.





# Prevent Foodborne Illness Understanding Microorganisms

**In this chapter, find answers to the following questions:**

**What happens in the body after a contaminated food has been eaten?** ..... (page 8)

**How do harmful microorganisms contaminate foods?** ..... (page 8)

**What are the main causes of a foodborne illness?** ..... (pages 9-10)

- Poor Personal Hygiene** ..... (page 9)
- Abuse of the Time-Temperature Relationship** ..... (page 9)
- Cross-contamination** ..... (page 10)

**How can foodborne illness caused by microorganisms be prevented?** ..... (pages 10-20 )

- Practice Good Personal Hygiene** ..... (page 11)
- Control Time and Temperature of Foods** ..... (pages 11-15)
- Prevent Cross-Contamination** ..... (pages 15-19)

**What are the responsibilities of the foodservice manager and employees?** ..... (page 20)

- Responsibilities of the Foodservice Manager** ..... (page 20)
- Responsibilities of Foodservice Employees** ..... (page 20)

**How should the foodservice manager respond if symptoms of foodborne illness are reported to the foodservice?** ..... (pages 21-22)

- General Guidelines for the Foodservice Manager**
  - When Foodborne Illness is Suspected** ..... (pages 21-22)

**Summary** ..... (page 23)

**Prevent Foodborne Illness Questionnaire** ..... (pages 24-25)

# Prevent Foodborne Illness— Understanding Microorganisms

In Chapter 1, the three main types of contaminants were described: harmful microorganisms in food, harmful chemicals in foods, and harmful physical objects in food. This chapter will provide a closer look at foodborne illness caused by harmful microorganisms.

Bacteria and other microorganisms are everywhere—in the soil, in saliva, under fingernails, on a doorknob, and on a towel. Some bacteria protect from infection, help digest food inside the body, and break down organic materials in the environment. Penicillin, a powerful antibiotic, was originally developed from mold. However, some microorganisms are dangerous to humans when consumed and are the primary causes of foodborne illness. Harmful bacteria and viruses cause most of the foodborne illness.

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## What happens in the body after a contaminated food has been eaten?

When a food with harmful microorganisms is ingested, there is a period of time before symptoms of the foodborne illness begin. The amount of time varies with the microorganism, how many were in the food, and the individual's physical condition. Many different harmful microorganisms produce the same symptoms including diarrhea, stomach cramping, nausea, and vomiting. Because symptoms are similar, a laboratory test and a trained health department official are necessary to identify the specific microorganism.

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## How do harmful microorganisms contaminate foods?

Harmful microorganisms may contaminate food

- During receiving
- During preparation and serving
- During preparation techniques such as cooking and cooling
- By cross-contamination of raw meat, poultry, seafood, or eggs with other foods
- From employees to food by unwashed hands, coughing, or sneezing
- From unsanitary facilities and equipment to people or food
- From disease-spreading pests, such as cockroaches, flies, and mice

How food is handled after it has been contaminated can make a big difference in whether the food will cause a foodborne illness. To control the growth of harmful microorganisms foodservice employees must control the conditions necessary for growth. All foodservice employees are responsible for handling every food according to guidelines

- To prevent contamination, and
- To prevent growth of microorganisms if the food should become contaminated.

## What are the main causes of a foodborne illness?

Knowing what can cause a foodborne illness is the first step in preventing it. Foodborne illnesses are caused by one or more of the factors described below.

- Poor personal hygiene
- Abuse of the time-temperature relationship
- Cross-contamination

### Poor Personal Hygiene

To prevent foodborne illness, foodservice personnel must follow procedures for good personal hygiene. Everyone has bacteria on skin, hair, eyes, nose, mouth, and hands. Some bacteria cause foodborne illness. Foodservice personnel can contaminate food and food-contact surfaces and cause foodborne illness.

Poor personal hygiene can result in food contamination when

- An employee does not wash hands after using the restroom. See more about handwashing on pages 16 and 17.

*Example:* Failure to wash hands properly after using the restroom presents a serious risk of fecal contamination.

- An employee coughs or sneezes on food.

*Example:* A cook is preparing chef salad and sneezes on the food.

- An employee prepares food with an open sore or cut, touches the wound, and then touches food.

*Example:* An employee burned her forearm and it became infected. While preparing sandwiches, she touches her open wound and then continues preparation of the sandwiches.

### Abuse of the Time-Temperature Relationship

To prevent foodborne illness, it is important to control the time that food is in the temperature danger zone. The temperature danger zone is between 41 °F to 140 °F and refers to the internal temperature of food. Check with State or local public health departments for additional information on time and temperature abuse.

Time-temperature relationship problems occur because

- Food is not stored, prepared, or held at required temperatures.

*Example:* The holding cabinet in a cafeteria is not set to hold hot foods at 135 °F or above.

- Food is not cooked or reheated to temperatures high enough to kill harmful microorganisms.

*Example:* Chili is not reheated to 165 °F or above for 15 seconds.

- Food is not cooled to low enough temperatures fast enough.

*Example:* Hot turkey gravy is stored in a deep, one-gallon storage container and is not cooled properly, so the internal temperature of the gravy remains in the temperature danger zone too long for food safety.

- Food is prepared in advance of service and proper temperature control is not maintained.

*Example:* Spaghetti sauce is prepared for the next day and when it is removed from the refrigerator to be heated for service, the internal temperature is 60 °F.

### Cross-Contamination

To prevent foodborne illness, avoid transferring harmful microorganisms from a surface to food or from one food to another food. This is known as cross-contamination.

Cross-contamination can occur when

- An undercooked food is added to another food that is not cooked further.

*Example:* Undercooked scrambled eggs are added to an existing pan of scrambled eggs on a steam table.

- A food-contact surface is not cleaned and sanitized as necessary for food safety.

*Example:* Before each use with a different type of raw animal food.

*Example:* Each time there is a change from working with raw foods to working with ready-to-eat (RTE) foods.

*Example:* Between uses with raw fruits and vegetables and with potentially hazardous foods.

- Raw meat touches or drips fluids onto a prepared food.

*Example:* Storing raw meats in a refrigerator on a shelf above cooked or ready-to-eat foods.

- A food employee's hands touch a food and then touch a prepared food that is ready-to-eat and will not be cooked.

*Example:* Washing potatoes and then immediately preparing lettuce salad without washing hands.

### How can foodborne illness caused by microorganisms be prevented?

The three primary ways of preventing foodborne illness are listed below.

- Practice good personal hygiene.
- Control time and temperature of foods.
- Prevent cross-contamination.

### Practice Good Personal Hygiene

Every person who works in or around food has the potential of contaminating a food with bacteria and viruses that are present on our bodies. Not only are bacteria on our bodies, they are present on common items that we handle regularly, such as money, pens, pencils, and doorknobs. These bacteria can easily spread to food. The personal hygiene, dress, and general good health habits of foodservice employees play a crucial role in keeping these bacteria away from the food they prepare and serve.

**It is the manager's responsibility to establish procedures for good personal hygiene and make sure that everyone follows them.**

### Good personal hygiene includes certain practices.

- Bathe daily.
- Shampoo hair frequently.
- Wear freshly laundered work clothes or uniforms daily and change aprons after they become soiled.
- Keep fingernails clean, trimmed, and unpolished. Best practice is not to wear fingernail polish or artificial fingernails.
- Treat and bandage wounds and sores. When hands are bandaged, clean single-use gloves should be worn at all times to protect the bandage and keep it from falling into food.
- Wash hands correctly and often.
- Wash hands before putting on gloves or changing into a new pair.
- Change gloves each time a new task is begun.

More detail about good personal hygiene can be found in Chapter 4, pages 51 to 53.

### Control Time and Temperature of Foods

#### *Know the rules of time-temperature control.*

The relationship between time and temperature is critical in the prevention of foodborne illness and the assurance of food quality. **Harmful microorganisms grow and multiply at temperatures between 41 °F and 135 °F, the temperature range referred to as the temperature danger zone.** Whenever a food is in the temperature danger zone too long, it can become unsafe. Many authorities suggest that food should remain in the temperature danger zone a minimum amount of time not to exceed four hours.

Best practice is to keep food at or below 41 °F or at 135 °F or above.

### Temperature Danger Zone

- The temperature danger zone is between 41 °F and 135 °F. Follow State and local public health department requirements.
- During any point of the food production process when food could be in the temperature danger zone, the internal temperature must be documented. Follow State and local public health department recommendations to control time and temperature at each stage of food production.

- The time period when the food could be in the temperature danger zone includes the receiving process, storage, cooking, preparation, holding, serving, reheating, and cooling.
- When heating or cooling foods, use procedures to pass them through the temperature danger zone as quickly as possible.

### ***Chilling Food***

For best practice, chill foods to take them through the temperature danger zone rapidly.

**Chill cooked hot food from 135 °F to 70 °F within 2 hours and from 70 °F to 41°F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds. For details on safe cooling, see page 83.**

Use the right tools to monitor and document the internal temperature of foods.

### **EXAMPLE 1:**

The following is an example of how a food could be exposed to temperatures in the temperature danger zone at several stages:

- A delivery truck arrives at 9:15 a.m. on Monday morning. The truck driver sees that the manager is on the phone and decides to unload the cases of food and supplies on the dock while he waits. A former employee stops in to visit and the truck driver, manager, and employee reminisce about the past.
- At 10:30 a.m. the manager checks in the order and notices the 100 pounds of ground beef does not feel cold. He accepts the delivery and tells the driver not to worry about it.
- The manager is on his way to get a cart to transport the ground beef to the refrigerator when a cook asks a question about the upcoming menu. The manager stops to talk.
- The cart with the ground beef is rolled into the refrigerator at 11:00 a.m.
- On Tuesday, the cook is making “Maggie’s Meatloaf” for lunch on Wednesday. She rolls the cart with the 100 pounds of ground beef to her work area. When she reads the recipe, she discovers she will only need 40 pounds. She decides she will put away the remaining 60 pounds of ground beef in the refrigerator when she is finished making the meatloaf. She decides this is more efficient since it will be one less trip to the refrigerator.
- She places the meatloaf in 6-inch steam table pans, then covers, labels, dates, and places the meatloaf and remaining ground beef in the refrigerator.
- On Wednesday, she cooks the meatloaf. After about 20 minutes of cooking, she opens the oven door and decides it needs about 5 more minutes. She feels it is not necessary to take the internal temperature since this is how she has always cooked it, and it is a favorite among students and staff.

**EXAMPLE II:**

Cold sandwiches are made and planned for service at a special Saturday meeting with parents and teachers. The sandwiches will be removed from cold temperature control at 11:30 a.m. and chilled on ice until all are consumed or until 1:30 p.m., whichever comes first. Temperatures are monitored and documented every 30 minutes. A foodservice employee will be on hand to serve the food and assure that the written procedures are followed.

It is easy for time in the temperature danger zone to add up quickly. For best practice, a foodservice operation should document temperatures and maintain written procedures. Follow State and local public health department recommendations to control time and temperature at each stage of food production.

**TOOL 1: Food Thermometers**

Accurate food thermometers are the only tools that can judge the internal temperature of a food product. The length of time a food has been cooked or the appearance of a food is not a good indicator of safety and doneness.

The two most common types of food thermometers used to determine the internal temperature of foods are

- **a bi-metallic stemmed thermometer with an instant-read dial that measures temperatures from 0 °F to 220 °F.**

This type of thermometer is most commonly used in foodservice operations and is referred to as a food thermometer in this document. It should have an adjustable calibration nut and an easy-to-read temperature marking. A dimple marks the end of the sensing area.

- **a digital thermometer that measures temperature with a metal probe and displays the temperature on a digital readout.**

This type of thermometer is available in various styles from a pocket-size up to a panel-mounted display. Many digital thermometers have interchangeable temperature probes used to measure temperature of different items.

**Every foodservice employee who is responsible for preparing or serving food should have easy access to a food thermometer and be taught to calibrate it and use it correctly.**

Determine the safe internal temperature when food is

- Received (milk, produce, frozen food, etc.)
- In hot-holding cabinets
- Being cooked
- On the service line

- Cooled for later cold storage
- Leftover
- Reheated

### How to use a food thermometer

- Clean and sanitize the stem of the thermometer after every use.
- After washing the stem, sanitize the stem with a sanitizing solution or a sanitizing wipe. Allow to air dry.
- Store in a clean and sanitized case.
- The clean case should be sanitized by immersing in a sanitizing solution.
- For digital thermometers, remember to check and change batteries on a routine basis.
- Measure the internal temperature of a food by inserting the stem of the thermometer into the center and thickest part of the food.
- Insert the thermometer into the center of the food enough to cover the sensor.
- Avoid pockets of fat in meat and touching bone.
- Wait for the dial or digital indicator to stop (about 15 seconds) and then read the temperature.
- Insert the thermometer again in a different part of the food for a second reading and a third time to confirm the internal temperature meets requirements.
- Clean and sanitize the thermometer before inserting it into the next food.
- Use the food thermometer to check the temperature of refrigerated foods during the receiving process. Refrigerated foods should be delivered at or below 41 °F, except as specified in laws governing milk, shell eggs, and molluscan shellfish.
- Packaged foods—Insert the thermometer in between two packages without puncturing the packages.
- Milk—Open a carton and insert the thermometer at least two inches into the milk. If the milk meets temperature requirements, the milk can be used for cooking if kept at proper temperature, or it may be discarded.
- Use a food thermometer to check the temperature of frozen foods if necessary. Insert the stem of the food thermometer between frozen packages. Frozen foods should be delivered frozen solid.
- Calibrate the food thermometer on a routine basis. Teach employees how to calibrate a food thermometer and establish a routine of having each thermometer calibrated at the beginning of the workday. If a food thermometer is dropped, calibrate prior to using it to be sure the temperature reading is accurate.

### How to calibrate a food thermometer

Use these methods to calibrate food thermometers.

#### *Ice-Point Method*

The ice-point method is used most often unless a thermometer cannot register a temperature of 32 °F (0 °C).

1. Fill a glass with crushed ice. Add water until the glass is full.
2. Place the thermometer in the center of the glass of ice water, not touching the bottom or sides of the glass.
3. Agitate the glass of ice water to assure even temperature distribution throughout. Wait until the indicator stops.



- The temperature should register 32 °F. If it does not, adjust the calibration nut by holding it with pliers or a wrench and turning the face of the thermometer to read 32 °F. If using a digital thermometer with a reset button, adjust the thermometer to read 32 °F while the metal probe is in the ice water, or replace the battery.

**Boiling-Point Method**

This method may be less reliable than the ice-point method because of variation due to high altitude.

Use this method to calibrate food thermometers with scales beginning at 32 °F.

- Using a deep pan, bring water to a boil.
- Place the thermometer in the center of the boiling water, not touching the bottom or sides of the pan. Wait until the indicator stops.
- The temperature should register 212 °F. If it does not, adjust the calibration nut by holding it with pliers or a wrench and turning the face of the thermometer to read 212 °F. If using a digital thermometer with a reset button, push it while the metal probe is in the boiling water, or replace the battery. Follow work safety procedures.
- The boiling point of water is lower at high altitudes. For each 550 feet above sea level, the boiling point of water is 1 °F lower than the standard of 212 °F. For example, a kitchen located at 5,500 feet above sea level water would boil at 202 °F. The pointer on a dial food thermometer inserted into boiling water would need to be adjusted to the temperature 202 °F at the higher altitude of 5,500 feet.

**TOOL 2: Daily Temperature Form – Internal Food Temperatures**

Before food is placed on the service line, it is recommended that the internal temperature be measured and documented to be sure that hot food is at or above the required internal temperature for the type of food product. Hot food placed in a holding cabinet or on the service line should be held at or above 135 °F and cold food should be held at or below 41 °F.

If food is held in a holding cabinet or on the service line more than 30 minutes, it is best practice to check and document the internal temperature every 30 minutes to be sure it is at the safe level. Some foodservice operations record the internal temperatures of food in holding cabinets or on the service lines on a temperature form that includes the name of food, time, and internal temperature. A sample Daily Temperature Form – Internal Food Temperatures is provided as Appendix 3, page 118.

| Daily Temperature Form — Internal Food Temperatures |           |                    |                    |                    |
|---|-----------|--------------------|--------------------|--------------------|
| Date  | Food Item | Time / Temperature | Time / Temperature | Time / Temperature |
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## Prevent Cross-Contamination

One of the most common causes of foodborne illness is cross-contamination, the transfer of bacteria from

- Hand to food,
- Food to food, or
- Equipment to food.

Microorganisms live throughout the kitchen and can easily move around by attaching themselves to people, food, and equipment. Cross-contamination can occur anywhere in a foodservice operation but can be prevented by physical barriers or by food safety procedures.

## Hand-to-Food Cross-Contamination

Hand-to-food cross-contamination occurs when contaminated hands handle cooked or ready-to-eat foods. Bacteria are found throughout the body – on hair, skin, and clothing; in the mouth, nose, and throat; in the intestinal tract; and on open wounds, sores or scabs or scars. These bacteria often end up on the hands where they can easily spread to food. People can also pick up bacteria by touching raw food and then handling cooked or ready-to-eat food.

### *How to Prevent Hand-to-Food Cross-contamination*

Follow these guidelines to prevent hand-to-food cross-contamination:

- Wash hands properly, frequently, and at appropriate times.
- Wash hands before putting on single-use gloves and change gloves frequently.
- Cover cuts, sores, and wounds.
- Keep fingernails short, unpolished and clean (no artificial nails).
- Avoid wearing jewelry except for a plain ring, such as a wedding band.
- Use prosthetic devices safely.

### *Wash hands properly, frequently, and at appropriate times.*

Handwashing is one of the most critical aspects of good personal hygiene in foodservice. Clean hands are necessary to prevent contamination of food during preparation and service.

## When to Wash Hands

Wash hands whenever hands are soiled and before

- beginning food preparation,
- putting on disposable gloves, and
- serving customers.

Wash hands after

- arriving at work and after breaks;
- using the restroom and then again at the kitchen handwashing sink;
- eating, drinking, smoking, or chewing tobacco or gum;
- using the telephone;

- using a handkerchief or a tissue;
- handling inventory;
- handling raw food;
- touching or scratching areas of the body, such as ears, mouth, nose, or hair;
- coughing or sneezing;
- clearing or cleaning tables;
- clearing, scraping, or washing dirty plates or utensils;
- handling garbage;
- handling money on the cafeteria line;
- after touching dirty aprons, clothing, or dirty surfaces; and
- using cleaning chemicals.

Remember to post appropriate handwashing signs as required by State and local public health departments.

### How to Wash Hands

- Use the handwashing sink with running water at approximately 100 °F and liquid soap.
- Lather hands and exposed arms.
- Rub hands together for at least 20 seconds.
- Wash hands thoroughly, paying close attention to fingernails.
- Rinse in clean, running water. Turn off the faucet with the paper towels in your hands.
- Dry hands using a paper towel or air dryer, not a cloth or apron.

An easy way to determine if hands are rubbed and lathered for 20 seconds is to sing one verse of “Old MacDonald.”

### *Wash hands before putting on single-use gloves and change gloves frequently.*

Increasing emphasis is being placed on the importance of avoiding bare-hand contact with ready-to-eat food. By using single-use gloves on clean hands, a barrier is placed between the food employee and the food. Gloves are only one kind of barrier; others include tongs and deli paper. Follow the regulations of the State and local public health department.

### How to use single-use gloves correctly

- Wash and dry hands.
- Put on clean gloves.
- Use the gloves as if they were a serving utensil.
- Change gloves if they become torn or soiled or if you begin working with a different food.
- Never wash and re-use gloves.

### *Cover cuts, sores, and wounds.*

Cuts, burns, or any kind of break in the skin could harbor harmful microorganisms that can contaminate food and cause a foodborne illness. Cover the wound with a clean impermeable bandage, and then place a clean single-use glove over the bandage. Some

foods services have a policy that anyone with an open wound cannot work with food until the injury completely heals.

***Avoid wearing nail polish and artificial nails.***

Fingernails should be kept short, unpolished, and clean. Both nail polish and artificial nails pose considerable danger around food and should not be worn by anyone handling food according to best practices for food safety. The nail polish can harbor microorganisms between the nail and the polish and can also flake off in food. Nail polish can also mask dirty fingernails. Food employees should not wear any type of nail polish or nail ornament. Best practice is that artificial fingernails (fake nails, acrylic nails, press-on nails) should not be worn by anyone handling food. The artificial nail harbors bacteria and other microorganisms between the real nail and artificial nail. Furthermore, the nail can break off in food.

***Avoid wearing jewelry except for a plain ring, such as a wedding band.***

Preparing and serving food is no place to wear jewelry. Follow State and local public health department or State Agency regulations for what jewelry can be worn when working with food. The *Food Code* states that food employees may not wear jewelry including medical information jewelry on their arms and hands. The only jewelry permitted is a plain ring, such as a wedding band. It is difficult to maintain clean hands when wearing rings because bacteria can hide on the finger underneath the ring and also in a ring setting. Foodservice is not the place to wear costume jewelry. Costume jewelry such as a ring, bracelet, or earrings can get caught in equipment and cause an injury to the wearer.

***Use prosthetic devices safely.***

A food employee who wears a prosthetic arm or other device should follow the guidance of State and local public health office regulations to ensure that the device is used in a safe and sanitary manner.

## **Food-to-Food Cross-Contamination**

Food-to-food cross-contamination happens when harmful microorganisms from one food, such as unwashed produce, contaminate other foods. Bacteria in raw meat and poultry can be spread to other foods, utensils, and surfaces. A common mistake is to leave thawing meat on a top shelf in the refrigerator where it can drip onto foods stored below.

### ***How to Prevent Food-to-Food Cross-Contamination***

- Store cooked foods and foods that will not be cooked in the refrigerator on a higher shelf than raw foods.  
**Example:** Store cooked spaghetti on a higher shelf than raw ground beef.
- While the FDA *Food Code* does not prohibit mixing leftover food with fresh food in controlled situations, it is strongly recommended and best practice not to mix leftover food and fresh food to protect the quality, appearance, and potential safety of a food.  
**Example:** Do not mix leftover tuna salad with a fresh batch of tuna salad.

- Wash fresh fruits and vegetables in cold running water before peeling.
  - Example:* Wash cantaloupes before removing the rind.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
  - Example:* Apples.
- Do not let raw meat and raw fruits or vegetables be prepared on the same surface at the same time. The two foods should not contact each other.
  - Example:* Do not clean or portion raw chicken on the same surface as lettuce.

### Equipment-to-Food Cross-Contamination

Bacteria may pass from equipment to food when the equipment that has touched food has not been properly cleaned and sanitized before being used to prepare another food. For example, cross-contamination can occur when a meat slicer used for slicing deli meats is then used for slicing fresh tomatoes.

#### *How to Prevent Equipment-to-Food Cross-contamination*

- Use separate cutting boards for different foods, such as meats and fresh fruits and vegetables. Cutting boards should be cleaned and sanitized after each use.
- If possible, prepare raw foods in a separate area from fresh foods that will not be cooked. For example, designate a special work surface for raw meat preparation away from the work surface used for salads and desserts.
- Clean and sanitize equipment, work surfaces, and utensils after preparing each food.
- Use specific containers for various types of food products. Clearly label the containers with contents and date. For example, designate specific containers for thawing raw chicken, meat salad, and grated cheese.
- If cleaning cloths are permitted for use by the State sanitation code, follow guidelines for use and maintenance in a sanitizing solution. Make sure cloths or towels used for wiping spills are not used for any other purpose. Cleaning cloths should be rinsed after each use and stored in a clean sanitizing solution.
- Wash and sanitize the can opener on a regular schedule every day.
- Clean and sanitize food preparation equipment such as the food slicer after each use. For example, clean and sanitize the slicer after slicing ham for sandwiches.
- Never re-use single-use containers, such as old mayonnaise jars or single-use plastic containers.
- Never re-use plastic wrap or aluminum foil; throw it away after one use.
- Touch dishes, trays, flatware, glasses, or serving utensils by contacting only the outside surface; never touch the surface where food will be placed or where a person's mouth will touch.
- When a new pan of food is added to the steam table, use a clean, sanitized utensil, not the utensil used in the previous pan.

**Sanitize wiping cloths** during and in-between use so they will not be a source of cross-contamination. A wiping cloth that has been used to clean a surface where raw food has been prepared can easily carry bacteria to other areas, including to cooked food. A good rule is to place wiping cloths in a clean, sanitizing solution when not in use. Remember to check sanitizing solution concentration at different intervals during the day. *Follow State and local public health department regulations for use and concentration levels of sanitizing solutions. Follow manufacturer's label directions for correct mixing procedures, storage, and specific first aid information.*

This section answered the question, “How can foodborne illness caused by microorganisms be prevented?” Prevent foodborne illness by

- practicing good personal hygiene,
- controlling time and temperature of foods, and
- preventing cross-contamination.

## What are the responsibilities of the foodservice manager and employees?

Everyone in the foodservice operation plays an important role in the prevention of foodborne illness. Like any other aspect of a job, more knowledge helps prevent problems.

### Responsibilities of the Foodservice Manager

The foodservice manager is responsible for

- knowing and implementing the State and local public health department regulations regarding food sanitation and safety;
- solving problems of noncompliance cited on sanitation inspections;
- maintaining up-to-date knowledge regarding food safety and sanitation;
- training and coaching employees regarding food safety; and
- holding employees responsible for following food safety requirements and guidelines.

The foodservice manager should use available resources to learn more about preventing foodborne illness. There are many excellent resources in addition to this book. Appendix 1 – Resources for Food Safety Information provides a list of printed resources and Internet addresses for Web sites; see pages 111 to 115.

### Responsibilities of Foodservice Employees

Foodservice employees are responsible for

- learning about food safety, and
- following food safety requirements and guidelines.

Food safety is everyone’s responsibility. A foodborne illness can occur in any foodservice facility when food safety requirements and guidelines are not followed.

## How should the foodservice manager respond if symptoms of foodborne illness are reported to the foodservice?

The manager is responsible for responding correctly and demonstrating leadership in this emergency situation. It is important to know and follow State and local public health department and school district guidelines. General guidelines are described below.

### General Guidelines for the Foodservice Manager When Foodborne Illness is Suspected

Follow school district guidelines and cooperate with State and local officials. The general guidelines described below will be helpful in handling any emergency.

1. **Keep your cool and cooperate with the health department.** Keep a level head; do not panic. There are many reasons that students may not be feeling well other than eating food from the foodservice operation. Remaining calm will help you respond rationally and systematically to the situation and may help keep everyone involved from overreacting.
2. **Talk with your supervisor immediately for additional guidance.** To avoid panic and “sympathy symptoms,” ask the principal and teachers not to discuss the problem with anyone except the school nurse.
3. **Stop serving the suspect food.** If you have an idea which food caused a foodborne illness, stop serving it or using it as an ingredient.
4. **Keep samples of suspect foods** in the original containers, in clean containers that have been boiled, or in unused plastic bags. Store the samples of suspect foods in the refrigerator until the health agency evaluates the epidemiological evidence and, if necessary, makes further arrangements to get samples. At least a half-pint or whatever food is remaining must be kept. Having samples of food could help determine the cause of a foodborne illness and could also help determine that the illness was not caused by food from your operation.

Securely wrap samples of the suspect foods in containers using a heavy plastic bag. Label the bag with contents and date, mark “DO NOT USE AND DO NOT DISCARD,” and, store where it will not be mistaken for edible food.

If possible, save the container, box or case, wrapping, and metal clips used on the original packaging. Save the food label and invoice to help locate the vendor who supplied the suspect foods.

Be familiar with State and local public health department requirements since some States require that schools routinely keep sample trays of all foods served.

5. **Cooperate with the health department to gather information.** Follow directions from the local health department. Health professionals may ask you to gather information about the foods that were served and how they were handled.

*Gather information from your own kitchen.*

Determine the foods on the menu and any other foods that were served but were not on the written menu. Have available the daily production record and the temperature forms.

*Determine how the foods were handled before and during preparation.*

Have available the Storage Temperature Forms from the freezer and refrigerator to document storage temperatures. See Appendix 4 for a sample form.

Ask employees how long the foods were in the preparation process. Have documentation available. Were the suspect foods prepared and then refrigerated or heated quickly as necessary to keep foods out of the temperature danger zone? How were internal temperatures monitored?

- 6. Report the information you were asked to assemble.** Report all the information you have gathered to your supervisor/district director and principal or other person in charge, regardless of whether or not it is a good report.

If you have found a particular area that could have caused a foodborne illness, alert your supervisor/district director and principal to the potential problem.

If a problem has been identified, you or your supervisor/district director should report this to the local health department. If more than two persons (non-related) who ate a common food report being ill at the same time, it should be reported to the health authorities (local health department).

- 7. Only health professionals should give medical advice.** If a foodborne outbreak is suspected, cooperate with the health department and health professionals. Take every report of possible foodborne illness seriously, and follow the appropriate steps. Be careful not to diagnose, interpret symptoms, or suggest treatments.
- 8. Direct all media inquiries to the appropriate designated school district representative.**
- 9. For those students who have reported symptoms of foodborne illness, parents should be contacted by personnel designated by the school or school district.**

What is the procedure in your school or school district when there is a report of a potential foodborne illness? Record names and phone numbers of people you should contact.



## Summary

CHAPTER 2, **“Prevent Foodborne Illness—Understanding Microorganisms,”** describes how consuming a food or beverage contaminated in harmful microorganisms causes foodborne illness. The main causes of foodborne illness include poor personal hygiene, allowing food to remain in the temperature danger zone too long, and cross-contamination. To prevent foodborne illness every foodservice operation should establish procedures to ensure safe food and make sure everyone follows them. Foodservice employees should wash hands properly, frequently, and at the appropriate times. Understanding the time and temperature relationship helps to implement procedures to reduce microorganism growth. Chill hot foods rapidly. Use a food thermometer to determine the internal temperature of food at every stage of the foodservice process: receiving, storage, preparation, cooking, holding, serving, reheating, and chilling. Document internal temperatures of cold and hot foods and calibrate thermometers often. Remember to check sanitizing solution concentration at different intervals during the day. Follow State and local public health department regulations for the concentration level and use of sanitizing solutions. Follow the manufacturer’s label directions for correct mixing procedures, storage, and specific first aid information. Guidelines are provided to prevent cross-contamination through hand-to-food, food-to-food, and equipment-to-food contact. Remember, preventing foodborne illness is the responsibility of the manager and all foodservice employees.

## Prevent Foodborne Illness Questionnaire

**Rate your foodservice facility using the Prevent Foodborne Illness Questionnaire.** Make plans to improve procedures to prevent foodborne illness. Check the box that best describes the current status of each item in your foodservice program.

**OK:** This is being done right now and no changes are needed.

**Improve:** This is not being done and improvement is needed. Write your plans for improving this food safety procedure on the back of this page.

|   | OK                       | Improve                  |
|---|--------------------------|--------------------------|
| <b><i>Practice good personal hygiene</i></b>  |                          |                          |
| Rules for good personal hygiene have been established; all foodservice employees have been informed of the rules, and follow the rules.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Employee personal hygiene practices are observed and follow-through for correction is made on a routine basis.  | <input type="checkbox"/> | <input type="checkbox"/> |
| <b><i>Control time and temperature of foods</i></b>   |                          |                          |
| Procedures are in place to minimize the time that a food is in the temperature danger zone during receiving, storage, preparation, cooking, holding, and service.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Every foodservice employee who is responsible for the receiving, storage, preparation, cooking, or service of food has access to a food thermometer and has been taught how to calibrate it and use it correctly. | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of certain foods during the receiving process.  | <input type="checkbox"/> | <input type="checkbox"/> |
| Internal temperatures for hot and cold foods are documented.  | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of foods in hot-holding cabinets on a regular basis.  | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of cooked foods to determine when cooking is complete.  | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of foods held on the service line on a regular basis.   | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of foods that are being chilled for later cold storage.   | <input type="checkbox"/> | <input type="checkbox"/> |
| A food thermometer is used to determine the internal temperatures of foods that are reheated.   | <input type="checkbox"/> | <input type="checkbox"/> |



|   | OK                       | Improve                  |
|---|--------------------------|--------------------------|
| Hot foods are chilled correctly. (Chill cooked hot food from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F or below in an additional 4 hours for a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.) | <input type="checkbox"/> | <input type="checkbox"/> |
| <b><i>Prevent cross-contamination</i></b>   |                          |                          |
| Best practice (includes WHEN and HOW TO) for handwashing is followed by everyone.)  | <input type="checkbox"/> | <input type="checkbox"/> |
| Single-use gloves are used correctly.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Cuts, sores, and wounds are cleaned and covered, and the employee wears a clean single-use glove.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Employees avoid wearing nail polish and artificial nails.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Employees avoid wearing jewelry except a plain ring, such as a wedding band.  | <input type="checkbox"/> | <input type="checkbox"/> |
| An employee who wears a prosthetic device follows the guidance of the State and local public health department to ensure food safety.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Employees who are ill do not work with food.  | <input type="checkbox"/> | <input type="checkbox"/> |
| Prepared foods or ready-to-eat foods are stored on higher shelves in the refrigerator than raw foods (meat, poultry).   | <input type="checkbox"/> | <input type="checkbox"/> |
| A leftover food is never mixed with a freshly prepared food.  | <input type="checkbox"/> | <input type="checkbox"/> |
| All fresh produce that will be served whole, peeled, or cooked is washed in cold, running water.  | <input type="checkbox"/> | <input type="checkbox"/> |
| Cutting boards are cleaned and sanitized after each use.  | <input type="checkbox"/> | <input type="checkbox"/> |
| A separate preparation area has been designated for the preparation of raw meats and other foods, such as fresh fruits and vegetables; or the preparation area is sanitized before being used.  | <input type="checkbox"/> | <input type="checkbox"/> |
| Equipment, work surfaces, and utensils are cleaned and sanitized after each use. State sanitation guidelines are followed for the use of wiping cloths.   | <input type="checkbox"/> | <input type="checkbox"/> |
| A regular schedule is set up for washing and sanitizing the can opener.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Single-use food containers are not re-used.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Plastic wrap and aluminum foil are used once.   | <input type="checkbox"/> | <input type="checkbox"/> |
| Employees touch dishes, trays, flatware, glasses, or handles of serving utensils by contacting only the outside surface.  | <input type="checkbox"/> | <input type="checkbox"/> |

### When to Wash Hands

Wash hands whenever hands are soiled and before

- beginning food preparation,
- putting on disposable gloves, and
- serving customers.

### How to Wash Hands

- Use the handwashing sink with running water at approximately 100 °F and liquid soap.
- Lather hands and arms up to the elbow.
- Rub hands together for at least 20 seconds.
- Clean between fingers.
- Rinse in clean, running water. Turn off the faucet with the paper towels in your hands.
- Dry hands using a paper towel or air dryer, not a cloth or apron.



# Basic Facts About Microorganisms

In this chapter, find answers to the following questions:

**What are the most common causes of foodborne illnesses?** ..... (page 29)

**What are the major foodborne illnesses caused by bacteria and how can they be prevented?** ..... (pages 29-35)

**Botulism** ..... (pages 30)

**Campylobacteriosis or campylobacter** ..... (page 30)

**E. coli infection** ..... (page 31)

**Listeriosis** ..... (page 32)

**Perfringens foodborne illness** ..... (page 32)

**Salmonellosis** ..... (page 33)

**Shigellosis (bacillary dysentery)** ..... (page 34)

**Staphylococcal foodborne illness** ..... (page 34)

**What are the major foodborne illnesses caused by viruses and how can they be prevented?** ..... (pages 35-36)

**Gastroenteritis from Norwalk and**

**Norwalk-like Viruses/calicivirus** ..... (page 35)

**Hepatitis A** ..... (page 36)

**What are the major foodborne illnesses caused by fungi and how can they be prevented?** ..... (page 36)

**Molds** ..... (page 37)

**Yeasts** ..... (page 37)

*Continued on next page*

**What are the major foodborne illnesses caused by parasites and how can they be prevented?** ..... (pages 38-40)

**Cyclosporiasis** ..... (page 38)

**Giardiasis** ..... (page 39)

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**How do microorganisms grow?** ..... (pages 40-46)

**Stages of Growth** ..... (pages 40-41)

**Control Conditions to Prevent the Growth of Foodborne Microorganisms** ..... (pages 41-46)

**Summary** ..... (page 46)

**Check Your Knowledge—Growth of Harmful Microorganisms** ..... (page 47)



# Basic Facts About Microorganisms

## What are the most common causes of foodborne illnesses?

Most foodborne illnesses are caused by harmful microorganisms—tiny, living organisms that are so small they can be seen only with a microscope. There are two groups of microorganisms.

**Pathogens** are harmful microorganisms that cause some form of illness. Consuming a food or beverage contaminated with pathogens is the main cause of foodborne illness.

- **Bacteria** are the group of pathogens of greatest concern in foodservice.
- **Viruses** represent another group of pathogens that can cause foodborne illness.

**Spoilage microorganisms** include two groups of fungi: molds and yeasts. These microorganisms spoil food and may cause illness. More detail about pathogens and spoilage microorganisms can be found in later sections of this chapter.

Foodborne illness can also be caused by **parasites**. These are small organisms that live in a host organism such as cattle, swine, or fish. Proper cooking can kill parasites. More detail about parasites can be found in later sections of this chapter.

## What are the major foodborne illnesses caused by bacteria and how can they be prevented?

Bacteria are responsible for most outbreaks of foodborne illness. The word “bacteria” is actually the plural of the Latin word “bacterium.”

- A bacterium is a living organism made up of a single cell that can grow and reproduce.
- Some bacteria actually cause disease while other bacteria produce poisons, called toxins, as they multiply.
- Some bacteria produce thick-walled spores that are resistant to boiling, freezing, and some sanitizing solutions.

Being familiar with the harmful microorganisms that cause most foodborne illness is important in learning how to prevent foodborne illness. Major foodborne illnesses and the harmful microorganisms that cause them have been described in alphabetical order.

## BACTERIA

### Botulism (BOT-u-li-zum)

#### **Bacteria:** *Clostridium botulinum*

Foodborne botulism is a life-threatening illness caused by consumption of food contaminated with preformed neurotoxin produced by *Clostridium botulinum*. The bacteria and its toxin can be destroyed with thorough cooking at high temperatures. Although cases of botulism are not often seen, when untreated it can cause death. Symptoms usually begin from 18 to 36 hours after eating the contaminated food. Symptoms may begin with diarrhea or constipation; weakness; dizziness; double vision or blurred vision; difficulty speaking, swallowing, and breathing; and paralysis. Death can occur if the illness is not treated immediately and properly.

**Foods involved in outbreaks:** Foods that have been the cause of botulism include home-canned foods, improperly processed foods, and foods not stored at the proper temperature. Some specific examples of foods that have caused botulism are sausages; meat products; canned low-acid foods such as certain vegetables; untreated garlic-and-oil products; leftover, unrefrigerated foil-wrapped baked potatoes; and sautéed onions in butter sauce.

#### **Prevention**

- Discard a bulging can, a container with a bulging jar lid, a can that spurts liquid when opened, dented cans, and cracked jars.
- Do not use home-canned foods in a foodservice establishment.
- Do not mix and then store oil and garlic; buy only treated oil and garlic products and keep them refrigerated.
- Follow rules for time and temperature control.
- Sauté onions as needed; do not sauté and then store unrefrigerated, for later use.
- Do not store leftover baked potatoes in foil wrapping. Unwrap and chill correctly.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.

### Campylobacteriosis or *Campylobacter* (CAM-py-lo-BAC-ter-i-osis)

#### **Bacteria:** *Campylobacter jejuni* (cam-py-lo-bac-ter je-jun-i)

After eating a food with these bacteria, symptoms are typically experienced in 2 to 5 days. Symptoms include diarrhea (watery or bloody), fever; nausea and vomiting, abdominal pain, headache, and muscle pain. It is the leading cause of bacterial diarrhea in the United States. The symptoms can last from 7 to 10 days and relapses are common.



**Foods involved in outbreaks:** Foods that can be contaminated with these bacteria include unpasteurized milk and dairy products, raw poultry, raw beef, and nonchlorinated or fecal-contaminated water. Birds and flies can also carry these bacteria and contaminate foods.

### Prevention

- Practice good personal hygiene.
- Follow handwashing guidelines.
- Follow procedures for avoiding cross-contamination.
- Cook all poultry, meat, and other foods to the required safe internal temperature and test with a food thermometer.
- Maintain good pest control.
- Use only pasteurized dairy products.
- Use water from approved sources.

### E. coli infection (e-CO-ly)

**Bacteria:** *Escherichia coli* O157:H7

*E. coli* O157:H7 is a bacterium that produces Shiga toxin, a poisonous substance that causes severe symptoms. *E. coli* infection is characterized by severe cramping and diarrhea, which begins as watery but may become bloody. Sometimes vomiting occurs. Some young children with this illness develop a Hemolytic Uremic Syndrome (HUS) that causes kidney failure and permanent loss of kidney function leading to death. The symptoms can be seen from 3 to 8 days after eating the contaminated food and last from 2 to 9 days.

**Foods involved in outbreaks:** These dangerous bacteria are found in the intestinal tract of animals, particularly cattle and humans. Foods that may be contaminated with these bacteria include raw or undercooked ground beef, raw milk or dairy products, unpasteurized apple cider or juice, imported cheeses, dry salami, and uncooked fruits and vegetables.

### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Cook all poultry, meat, and other foods to the required safe internal temperature and test with a food thermometer.
- Use only pasteurized milk, dairy products, or juices.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.


**Listeriosis (lis-TIR-ee-o-sis)**
**Bacteria:** *Listeria monocytogenes*

Listeriosis is a serious foodborne illness with early symptoms similar to flu, including the sudden onset of fever, muscle aches, and sometimes diarrhea or vomiting. The severity of the symptoms may vary. If the infection spreads to the nervous system, the symptoms may include headaches, stiff neck, confusion, loss of balance, or convulsions. The symptoms may be seen as early as 3 days or as late as 70 days, but usually appear about three weeks after eating contaminated food.

Listeriosis can be particularly dangerous for pregnant women and their unborn babies. Foodborne illness caused by *Listeria* in pregnant women can result in premature delivery, miscarriage, fetal death, and severe illness or death of a newborn from the infection.

Foods involved in outbreaks: *Listeria* bacteria can be found in soil and ground water, on plants, and the intestinal tracts of humans and animals. These bacteria can contaminate unpasteurized milk and cheeses, ice cream, raw vegetables, raw and cooked poultry, all raw meats, raw fish, prepared and chilled ready-to-eat foods, deli meats, luncheon meats, hot dogs, and certain soft cheeses such as feta, Brie, blue-veined cheese, and Mexican-style cheeses (example: “queso blanco fresco”). *Listeria* bacteria can grow at refrigerated temperatures as low as 37.4 °F, as well as in damp environments.

**Prevention**

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Cook all poultry, meat, and other foods to the required safe internal temperature and test with a food thermometer.
- Use only pasteurized milk, dairy products, or juices.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Clean and sanitize food contact surfaces.
- Keep equipment, food preparation surfaces, and facilities dry.


**Perfringens foodborne illness (per-FRING-ens)**
**Bacteria:** *Clostridium perfringens*

Severe abdominal cramping and diarrhea characterize *perfringens* foodborne illness. Usually there is no vomiting. The symptoms usually show up from 8 to 24 hours after eating the contaminated food, and they are usually over in 24 hours. The bacteria can be found in the intestinal tracts of humans and animals and can live in soil. These bacteria grow only in little or no oxygen.

**Foods involved in outbreaks:** *Clostridium perfringens* bacteria are called the “cafeteria germs” because many foodborne outbreaks result from food left for long periods on steam tables at improper temperatures or at room temperatures. Foods usually associated with this kind of foodborne illness are cooked meat and poultry, gravy, and beans. The bacteria grow when contaminated foods are not cooked to the right temperature or are not cooled properly. Cooking to required internal temperatures destroys bacteria, but some toxin-producing spores may survive.

### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Cook all poultry, meat, and other foods to the required safe internal temperature and test with a food thermometer.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.

### Salmonellosis (SAL-mon-el-osis)

**Bacteria:** *Salmonella* bacteria

Symptoms of this foodborne illness can occur as early as 6 hours after eating a contaminated food or up to 48 hours later. Symptoms include stomach cramps, headache, nausea, fever, diarrhea, and sometimes vomiting. For infants and seniors (older adults), severe dehydration may result. The illness usually lasts 1 to 2 days.

**Foods involved in outbreaks:** The bacteria is found in a variety of foods that have been contaminated by soil, insects, and the intestinal wastes from domestic or wild animals and from humans. Foods most often associated with *Salmonella* bacteria include raw meats, poultry; eggs, milk and dairy products; fish; shrimp; yeast; coconut; sauces and salad dressing; cake mixes; cream-filled desserts and toppings; dried gelatin; peanut butter; cocoa and chocolate; sliced fresh fruits and vegetables such as melons, strawberries, and tomatoes; raw sprouts; and other produce.

### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Cook all poultry, meat, eggs, and other foods to the required safe internal temperature and test with a food thermometer.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.


**Shigellosis (bacillary dysentery) (SHIG-a-losis)**
**Bacteria:** *Shigella* bacteria

These bacteria come from the human intestinal tract and are found in polluted water and are spread by flies and by food handlers with poor personal hygiene. Symptoms begin after 12 to 50 hours and last from a few days up to 2 weeks. Symptoms include abdominal pain, diarrhea containing blood and mucus, fever, nausea, vomiting, chills, fatigue, and dehydration.

**Foods involved in outbreaks:** The foods most often involved in outbreaks include meat salads, potato and pasta salads, lettuce and other raw vegetables, milk and dairy products, and moist and mixed foods.

**Prevention**

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Use water from approved sources.
- Control flies.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.


**Staphylococcal foodborne illness (STAFF-y-lo-COC-al)**
**Bacteria:** *Staphylococcus aureus*

Produces an enterotoxin (or toxin) that can cause foodborne illness. A toxin is a poisonous substance produced by a living organism such as bacteria. Symptoms of staphylococcal foodborne illness begin soon after eating the contaminated food and include nausea, vomiting, stomach cramping, and exhaustion. Victims usually recover in 2 or 3 days.

**Foods involved in outbreaks:** Humans and animals are the main carriers of these bacteria. In fact, it is estimated that half or more of all healthy people have “staph” bacteria present on their skin and hair and in their nose and throat. Food handlers are usually the main source of food contamination with these bacteria. Foods that are most often associated with outbreaks include leftovers, meat and poultry, eggs and products containing eggs, milk and dairy products, meat salads and potato salad, salad dressings, and sandwich fillings.

**Prevention:**

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Cover a burn, cut, or wound with a waterproof bandage and wear disposable gloves while preparing and serving food.
- Cook all poultry, meat, and other foods to the required safe internal temperature and test with a food thermometer.
- Refrigerate food at 41°F or below.
- Chill cooked hot foods from 135 °F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.

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**What are the major foodborne illnesses caused by viruses and how can they be prevented?**

Viruses are another type of pathogen that can contaminate food and beverages. Unlike bacteria, viruses cannot reproduce outside a living organism because they are not complete cells. Therefore, they do not multiply in food but rather may be transported on food, food surfaces, and utensils. Once inside a human host, they can reproduce and cause foodborne illness.

Viral outbreaks are most commonly associated with poor personal hygiene or a contaminated water supply. However, they can also be food-related.

For example, eating raw or undercooked shellfish such as oysters, mussels, and clams that have been harvested from polluted water may cause foodborne viral illnesses. As a result, seafood should always be purchased from vendors with approved health-inspected facilities.

Prevention of viral contamination should include good personal hygiene, correct handwashing, good employee health (no fever and no diarrhea), and no bare-hand contact with ready-to-eat food.

Some common viruses and the foodborne illnesses they cause are described on the following pages.

## VIRUSES

### Gastroenteritis from Norwalk and Norwalk-like viruses/calicivirus (ca-LEE-see-virus)

**Virus:** Norwalk and Norwalk-like viral agents

These viruses cause a foodborne illness with symptoms of nausea, vomiting, diarrhea, abdominal pain, headache, and mild fever. These viruses come from the human intestinal tract and are transmitted through water or food. Only the common cold is reported more frequently than viral stomach upset. The symptoms begin from 1 to 2 days after the contaminated food or water is eaten, and they last for 1 to 3 days.

**Foods involved in outbreaks:** Contaminated drinking water is a source of these viruses as is shellfish from contaminated water. Other foods that can be contaminated, often by dirty hands, include raw vegetables, fresh fruits, and salads.

#### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Use water from approved sources.
- Obtain shellfish from approved health-inspected sources and cook thoroughly.
- Cook all foods to required safe internal temperatures and test with a food thermometer.

### Hepatitis A (HEP-a-tie-tus)

**Virus:** *Heptovirus* or Hepatitis A virus

This virus is found in the human intestinal tract and urinary tract and also in contaminated water. The symptoms begin with a fever and also include fatigue, headache, nausea, loss of appetite, vomiting, stomach pain, and later jaundice (yellow skin and eyes). Symptoms may be seen 10 days to almost 2 months after the contaminated food or water is consumed.

**Foods involved in outbreaks:** Foods involved in Hepatitis A outbreaks have usually been contaminated by food handlers, either in processing plants or foodservice facilities. Water, ice, and most foods can be contaminated. Foods that are of particular concern are those that will not receive further cooking such as deli meats, sandwiches, fruit and fruit juices, milk and dairy products, raw fruits and vegetables, and salads.

### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Use water from approved sources.
- Cook all foods to the required safe internal temperature and test with a food thermometer.

### What are the major foodborne illnesses caused by fungi and how can they be prevented?

Yeasts, molds, mildew, and mushrooms are all types of fungi found naturally throughout the environment. The two kinds of fungi that typically cause spoilage in a foodservice operation are molds and yeasts.

Bacteria and viruses can cause foodborne illness before food spoilage is evident; molds and yeasts actually cause food spoilage.

#### Molds

Although individual mold cells are microscopic, they grow quickly and soon become visible to the naked eye. Molds spoil food, causing discoloration, and an unpleasant smell and taste. Most people have seen mold on bread and on cheese.

Molds can grow on almost any food in any condition – moist, dry, acidic, non-acidic, salty, sweet, cold, and warm. A few cheeses, such as Brie, are processed to have a natural and safe mold coating. Examples of foods that are susceptible to mold include fruits, vegetables, meats, cheeses, and breads.

**Toxins can be dangerous.** Contrary to popular belief, certain molds can be dangerous to humans. They produce toxins, some of which have been linked to cancer in animals and to rare, isolated incidents of foodborne illness. Other molds can cause serious infection and allergies. Aflatoxin, which is produced by two specific molds, can cause liver disease.

**Discard molded food.** Discard any food with visible mold unless the mold is a natural part of the food such as Brie, Camembert, Gorgonzola, and bleu cheese. Although the cells and spores of molds can be killed by heating foods to 140 °F for 10 minutes, the *toxins are heat stable* and are not destroyed.


**Yeasts**

Jellies, honey, syrup, and fruit juices often harbor sugar-loving yeasts. While there is no evidence that yeasts found in food cause illness, they do spoil food, as evidenced by bubbles and an alcoholic smell or taste. Any food that has an unnatural color or smell should be discarded.

### What are the major foodborne illnesses caused by parasites and how can they be prevented?

A parasite is a living organism that depends on nutrients from a living host to complete its life cycle. Ranging in size from tiny, single-celled organisms to worms visible to the naked eye, parasites are more and more frequently being identified as causes of foodborne illness in the United States. Parasites can live in many animals that are used for human food including pigs and hogs, cattle, poultry, and fish. Parasites can be transmitted from animals to humans, from humans to humans, or from humans to animals. The illnesses they can cause range from mild discomfort to debilitating illness and possibly death.

This section describes three foodborne illnesses caused by parasites. Information on other common parasites can be obtained from USDA's Meat and Poultry Hotline (800-535-4555).



## PARASITES


**Cyclosporiasis (CY-clo-spo-RYE-a-sis)**

**Parasite:** *Cyclospora cayetanensis*

This tiny parasite is responsible for an increasing number of foodborne illnesses. Symptoms include watery diarrhea, stomach cramps, nausea, vomiting, muscle aches, low-grade fever, and fatigue. Some cases are without symptoms. The symptoms appear about a week after the parasite has been ingested and can last from a week up to a month.

**Foods involved in outbreaks:** The parasite may be in contaminated water, or it may be in or on anything that has touched the stool of a person or animal with cyclosporiasis. In recent years, outbreaks have involved berries from outside the United States, mixed lettuce products, and fresh herbs.

#### Prevention

- Practice good personal hygiene.
- Follow procedures for avoiding cross-contamination.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Use water from approved sources.



 **Giardiasis (GEE-are-DYE-uh-sis)****Parasite:** *Giardia duodenalis*

This microscopic parasite is found all over the world and can live in the intestines of animals and people. It is most frequently associated with waterborne illness but can cause foodborne illness. Symptoms include diarrhea, stomach cramps, and nausea. The symptoms appear from about 1 to 2 weeks after the parasite has been ingested and can last from 4 to 6 weeks. Sometimes there are no symptoms.

**Foods involved in outbreaks:** The parasite may be in contaminated water, or it may be in or on anything that has touched the stool of a person or animal with giardiasis. Adults and children in daycare centers are at risk.

**Prevention**

- Practice good personal hygiene.
- Use only pasteurized milk, dairy products, and juices.
- Wash all fresh produce that will be served whole, peeled, or cooked in cold, running water.
- Use water from approved sources.

 **Trichinosis (TRICK-a-NO-sis)****Parasite:** *Trichinella spiralis*

This parasite looks like a small, hairy, round worm. People contract trichinosis by eating undercooked pork or game that is infested with *Trichinella* larvae. Fortunately, there has been much progress in reducing *Trichinella* in grain-fed hogs. As a result, human cases of trichinosis are now on the decline, but it is still important to take precautions. Symptoms of trichinosis include nausea, vomiting, and abdominal pain. The symptoms appear anywhere from 2 to 28 days after eating infected meat. Later symptoms may develop to include sore muscles, a fever, or a rash.

**Foods involved in outbreaks:** Foods that could contain *Trichinella* larvae include undercooked pork and pork sausages. Ground meats could be contaminated through meat grinders that have been used to grind contaminated pork.

**Prevention**

- Cook all meat to the required safe internal temperature to destroy any live *Trichinella* larvae and test with a food thermometer.
- Prevent cross-contamination by washing and sanitizing equipment used in preparation of raw pork products, such as meat grinders and slicers.

The harmful microorganisms discussed in this section include bacteria, viruses, fungi, and parasites. These microorganisms are the most common food contaminants and can result

in foodborne illness. Knowing more about these pathogens and understanding how they can contaminate food will serve as an important reminder for foodservice personnel to use preventive measures.

## How do microorganisms grow?

### Stages of Growth

Bacteria are considered *vegetative* because they can grow and reproduce. Under certain conditions, they will reproduce very rapidly. In fact, in an environment that is ideal for growth, a single bacterial cell can turn into *billions* in only 10 to 12 hours!

Certain vegetative bacteria protect themselves by producing a thick-walled spore within the bacterial cell. A spore can become dormant and survive unfavorable environmental conditions such as boiling water, freezing temperatures, and some sanitizing solutions.

Given warmth, moisture, and a little food, bacterial spores may become vegetative and reproduce very easily. The vegetative cell simply enlarges and splits in two; these “offspring” then divide to create two more bacteria, and so on. This type of reproduction results in extremely rapid population growth.

| Time   | 0 min    | 20 min     | 40 min       | 1 hour               | 1 hr 20 min               | 10 hr           |
|--------|----------|------------|--------------|----------------------|---------------------------|-----------------|
| #cells | 1 cell ● | 2 cells ●● | 4 cells ●●●● | 8 cells ●●●●<br>●●●● | 16 cells ●●●●●●<br>●●●●●● | 1 billion cells |

When bacteria multiply, growth happens in four phases.

**PHASE 1: Lag phase**—When a food is contaminated with bacteria, the bacteria take some time to adjust. They do not grow much but get ready to grow. When the bacteria’s requirements for growth are minimized, they remain in the lag phase and rapid growth is prevented.

**PHASE 2: Log phase**—When the bacteria’s growth requirements are met, they can multiply rapidly by splitting in two. Bacteria in the log phase can double their number every twenty minutes. During this phase, a contaminated food becomes unsafe to eat. Bacteria continue to grow until the conditions they need deteriorate.

For most harmful microorganisms, the number of bacteria needed to cause a foodborne illness is very small.

**PHASE 3: Stationary phase**—If bacteria continue to grow, they reach a phase where the conditions are no longer favorable, and they begin to die. When some bacteria are still growing but the same numbers are dying, the bacteria are in the stationary phase.

**PHASE 4: Death phase**—This last phase means that more bacteria are dying than are growing.



### Heat kills bacteria!

- Heating foods to recommended safe internal temperatures kills vegetative bacteria and parasites. However, some bacteria can change into a different form called a spore.
- The spore forms a thick wall around the bacteria for protection; then the bacteria can survive conditions such as high or low temperatures, low moisture, and high acidity.
- A spore cannot grow, but when conditions are right again, the spore returns to the vegetative state and begins to grow.
- This explains why it is so important to cook foods to the right temperatures, chill them rapidly to 41 °F or below, and then reheat them to safe temperatures.

### Control Conditions to Prevent the Growth of Foodborne Microorganisms

Certain conditions affect the growth and reproduction of microorganisms. Except for viruses, all foodborne microorganisms need food, the right amount of acidity, appropriate temperature, time to grow, and water. Some bacteria need oxygen and others thrive without oxygen. **Because food handlers never know when a food has been contaminated with harmful microorganisms, the safe way to handle food means controlling the conditions needed for the growth of microorganisms.**

The acronym, FAT-TOM, is one way to remember the six conditions that can be regulated to control the growth of most microorganisms.

#### Control Conditions = Prevent Growth

- F** Food
- A** Acidity
- T** Temperature
- T** Time
- O** Oxygen
- M** Moisture

**F - Food****Condition for Growth: Food****How Food contributes to growth of bacteria**

Bacteria feed on protein and carbohydrates. Food that contains these ingredients can support growth of foodborne bacteria.

The *Food Code* defines potentially hazardous food as one that is natural or synthetic and that requires temperature control because it is in a form capable of supporting

- the rapid and progressive growth of harmful microorganisms,
- the growth and toxin production of *Clostridium botulinum*, or
- the growth of *Salmonella enteritidis* in raw shell eggs.

Potentially hazardous foods include

- Animal foods that are raw or heat-treated,
- Plant foods that are heat-treated,
- Raw seed sprouts,
- Cut melons, and
- Garlic-in-oil mixtures that are not modified to prevent the growth of harmful microorganisms.

These groups of food have the potential for contamination because of the way they are produced or processed. They have certain characteristics in common that allow harmful microorganisms to grow. Potentially hazardous foods are usually moist, high in protein, and are chemically neutral or slightly acidic.

**Everyone should be aware of the potentially hazardous foods that are included on menus.**

- All animal products are potentially hazardous (meat, poultry, fish, shellfish, eggs and egg products, milk and milk products).
- Vegetables and plant products may also be hazardous once they are cooked. This is because cooking destroys protective barriers in plants and converts proteins and carbohydrates into a form more usable by microorganisms. This makes vegetables and plant products, such as potatoes, tofu, beans, winter squash, pasta, stuffed pasta, and rice, potentially hazardous once they are cooked.
- Shelf-stable foods are potentially hazardous once removed from their containers.
- If not washed, raw fruits and vegetables may be potentially hazardous (onions, melons, apples).
- It is best practice to avoid serving raw seed sprouts and garlic-in-oil mixtures in Child Nutrition Programs.

**Be aware that most any food can be contaminated with harmful microorganisms and has the potential for causing a foodborne illness. Use safe food handling practices for all foods, not just the foods listed as potentially hazardous.**

**How to control the growth of bacteria in food**

- Purchase certified, inspected foods from certified, inspected vendors.
- Avoid cross-contamination of a food.
- Cook food to the required safe internal temperature and test with a food thermometer.

**A - Acidity**

**Condition for Growth: Acidity**

The indicator known as “pH” indicates the level of acidity or alkalinity of a food or other substance. The pH scale ranges from 0.0 to 14.0, with 7.0 being neutral. A pH less than 7.0 is acidic and a pH of more than 7.0 is alkaline. Distilled water has a neutral pH of 7.0.

**How Acidity contributes to growth of bacteria**

Bacteria can grow best in foods that are neutral or slightly acidic, in the pH range of 4.6 to 7.5. The pH value of meats and many other foods is optimal for bacterial growth. The scale below shows some typical pH values for common foods, but the values are not exact for any one specific food.

| Acid |       |       |      | Neutral  |     |     | Alkaline |
|------|-------|-------|------|----------|-----|-----|----------|
| 0.0  | 2.2   | 3.5   | 4.3  | 5.9      | 7.0 | 7.5 | 14.0     |
|      | Lemon | Apple | Mayo | Grd.Beef | Egg |     |          |

**If the pH is:**

Below 4.6 ..... Bacteria will not grow well.

Between 4.6 and 7.0 ..... Bacteria will thrive.

Between 7.0 and 9.0 ..... Bacteria may survive.

Highly acidic foods, such as vinegar and the flesh of most fresh fruits, inhibit bacterial growth. However, *E.coli* O157:H7 can grow in unpasteurized apple juice that has a pH around 4.0.

Although commercially prepared mayonnaise has a pH below 4.6, adding it to a meat salad will not inhibit bacterial growth. The meat will increase the pH of the salad to a level where bacteria can multiply.

**How to control Acidity to control growth of bacteria**

Some food preparation techniques reduce the risk of bacterial growth by making the recipe more acidic. Examples of such techniques include using salad dressing made of oil, vinegar, and garlic or marinating meat or poultry in a mixture including fruit juice or vinegar.

## T - Temperature

### Condition for Growth: Temperature

#### How Temperature contributes to growth of bacteria

Given a little time and a nice warm environment, bacteria multiply rapidly. The temperature range between 41 °F and 135 °F is known as the *temperature danger zone*. Holding foods in the temperature danger zone is one of the primary causes of foodborne illness outbreaks.

A few bacteria, such as *Listeria*, can grow and multiply between 32 °F and 45 °F, and some can survive at temperatures as low as 19 °F. For this reason, it is important to monitor the length of time a product is kept in refrigeration. Bacterial spores can survive very hot or very cold temperatures, and when the conditions are right, they can begin to grow again.

#### How to control Temperature to control growth of bacteria

- Control the temperature of food during storage, preparation, holding, cooling, reheating, and service.
- Check the internal temperature of a food with a food thermometer.
- Store foods at the recommended safe temperatures for dry storage, refrigerator, or freezer storage.
- Cook food to required internal temperature and test with a food thermometer.
- Keep foods out of the temperature danger zone, at 41 °F or below or above 140 °F.

## T - Time

### Condition for growth: Time

#### How Time contributes to growth of bacteria

When a food has been contaminated with a microorganism, the bacteria need time to grow. The bacteria grow slowly at first, and then move into a very rapid growth period before the conditions become unfavorable and they begin to die. When a food is in the temperature danger zone, the clock is ticking because bacteria can grow. If allowed to thrive, one bacterium can become more than one million bacteria in just four hours.

#### How to control Time to control growth of bacteria

- Store received foods as quickly as possible to limit time in the temperature danger zone.
- Do not remove foods for preparation from refrigerator or freezer more than 20 minutes before they will be used.
- Prepare foods as close to the service time as possible.
- Check the temperature of holding cabinets to be sure they will maintain the internal temperature of hot foods at 135 °F or above.
- Cook food to the recommended safe internal temperature.

- Chill cooked hot food from 135 ° F to 70 °F within 2 hours and from 70 °F to 41 °F in an additional 4 hours for no more than a total cooling time of 6 hours. If the food has not reached 70 °F within 2 hours, it must be reheated immediately to 165 °F for 15 seconds.
- Mark the date for all foods stored in the refrigerator and freezer so the storage time can be monitored.
- Reheat leftover foods to an internal temperature of 165 °F for 15 seconds.

## O - Oxygen

### Condition for Growth: Oxygen

#### How Oxygen contributes to growth of bacteria

Various microorganisms have different oxygen requirements for growth. For example, aerobic microorganisms *require* oxygen to grow. Anaerobic microorganisms can grow only when oxygen is *not* present. For example, anaerobic microorganisms, *Clostridium perfringens* and *Clostridium botulinum*, grow without oxygen.

Facultative microorganisms are those that can grow *with or without* oxygen. Most bacteria that cause foodborne illness are in this group.

#### How to control Oxygen to control growth of bacteria

- Although the oxygen requirement is different for various microorganisms, there is no way to control this condition. Rather, it is important to control all the other conditions using the suggestions provided.
- Because *Clostridium perfringens* and *Clostridium botulinum* need an environment without oxygen, it emphasizes the importance of cooling foods quickly in shallow pans. In this instance, by using the time-temperature relationship principle, you can control the growth if the food has been contaminated.

## M - Moisture

### Condition for Growth: Moisture

#### How Moisture contributes to growth of bacteria

Bacteria need water for growth. Because they cannot take in solids, bacteria get their nutrients from water solutions. In other words, they can only use food when it is moist. Most fresh foods contain the ideal amount of water for bacterial growth.

Sugar products, cereal products, dried fruits, jams, and jellies have low moisture levels and are, therefore, resistant to bacteria.

### How to control Moisture to control growth of bacteria

- Lower the amount of moisture in food through freezing, dehydrating, adding sugar or salt, or cooking. Remember that even though bacteria cannot grow in foods low in moisture, they remain alive and can become potentially hazardous when moisture is added in cooking. For example, dry foods such as beans, pasta, and rice become vulnerable to bacteria when cooked.

By controlling the conditions necessary for growth, it is possible to prevent foodborne illness even when harmful microorganisms have contaminated a food.

## Summary

CHAPTER 3, **"Basic Facts About Microorganisms,"** describes the major foodborne illness caused by bacteria, viruses, fungi, and parasites. Because harmful microorganisms are responsible for most cases of foodborne illness, it is important for foodservice personnel to be familiar with how microorganisms contaminate food, grow, and reproduce. Bacteria are the microorganisms of greatest concern in a foodservice. Controlling the conditions they need to grow can control the growth of bacteria: food, acidity, time, temperature, oxygen, and moisture.



## CHECK YOUR KNOWLEDGE

### Growth of Harmful Microorganisms

**Directions:** This is a self-assessment for you to determine your own level of knowledge. Place the letter of the one best answer for each item in the box provided.

- |  |  |
|--|--|
| <p><input type="checkbox"/> 1. <b>A pathogen is</b><br/> a. A harmful microorganism<br/> b. Any microorganism<br/> c. Always a harmful bacteria<br/> d. All of the above</p> <p><input type="checkbox"/> 2. <b>The one way to be sure that bacteria are killed is to</b><br/> a. Cook at low temperature for a long period of time<br/> b. Keep the food out of the danger zone<br/> c. Freeze the food for four hours<br/> d. Heat to the required safe temperature for the required time</p> <p><input type="checkbox"/> 3. <b>The conditions that favor the growth of most foodborne microorganisms (excluding viruses) are</b><br/> a. Food, acidity, temperature, time, oxygen, moisture<br/> b. Food, time, and temperature<br/> c. Food and temperature<br/> d. Food, temperature, and moisture</p> <p><input type="checkbox"/> 4. <b>Which of the foods listed below would not be considered a potentially hazardous food?</b><br/> a. Lemon<br/> b. Sliced melon<br/> c. Baked potato<br/> d. Cooked rice</p> <p><input type="checkbox"/> 5. <b>Bacteria grow best at what pH level?</b><br/> a. Very alkaline<br/> b. Very acid<br/> c. Neutral to slightly acid<br/> d. Water</p> | <p><input type="checkbox"/> 6. <b>A food is in the temperature danger zone when the internal temperature is between</b><br/> a. 165 °F to 212 °F<br/> b. 41 °F to 135 °F<br/> c. 65 °F to 165 °F<br/> d. 0 °F to 40 °F</p> <p><input type="checkbox"/> 7. <b>When chilling a hot food from 140 °F down to 41 °F, it must be reheated immediately to 165 °F for 15 seconds if it has not reached 70 °F within</b><br/> a. 1 hour<br/> b. 2 hours<br/> c. 4 hours<br/> d. 6 hours</p> <p><input type="checkbox"/> 8. <b>Which of the following foods would be most likely to support bacterial growth if contaminated?</b><br/> a. Dry rice<br/> b. Cooked rice<br/> c. Fresh fruit<br/> d. Bread</p> <p><input type="checkbox"/> 9. <b>All of the following behaviors would help prevent foodborne illness except</b><br/> a. Washing hands.<br/> b. Avoiding jewelry except a plain ring, such as a wedding band<br/> c. Wearing closed toe shoes<br/> d. Using single-use gloves correctly</p> <p><input type="checkbox"/> 10. <b>Four types of pathogens that cause foodborne illness include</b><br/> a. Bacteria, viruses, fungi, and parasites.<br/> b. Viruses, fungi, bonechips, larvae.<br/> c. Bacteria, viruses, fungi, insecticide.<br/> d. All of the above.</p> |
|--|--|

Answers: 1-a; 2-d; 3-a; 4-a; 5-c; 6-b; 7-b; 8-b; 9-c; 10-a

## Food Safety Checklist

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- What are the major foodborne illnesses caused by bacteria and how can they be prevented?
- What are the major foodborne illnesses caused by viruses and how can they be prevented?
- What are the major foodborne illnesses caused by fungi and how can they be prevented?
- What are the major foodborne illnesses caused by parasites and how can they be prevented?
- How do microorganisms grow?