

LESSON 3

What Are Some Important Foodborne Pathogens?

GOAL

To understand five of the important foodborne pathogens and their characteristics.

OBJECTIVES

- To identify five important foodborne pathogens and describe the illnesses they cause.
- To describe how pathogens get into our food supply and how to control them.
- To name the five pathogens that are cause for exclusion from working in food service.

TEACHER BACKGROUND INFORMATION

Lesson 3 covers

1. How foodborne illness occurs.
2. The number of pathogenic cells it takes to cause illness.
3. Important foodborne pathogens.
4. Five pathogens for further study.
5. Pathogens that are cause for exclusion from work in food service.

Approximate time to teach lesson: 20–75 min.

Definitions

cross contamination—The transfer of pathogens between items such as food, hands, countertops, utensils, etc.

pasteurization—Heating a food product to destroy all vegetative pathogenic bacteria. Various spoilage and harmless bacteria do survive the pasteurization process, particularly spore formers, but some vegetative cells survive as well.

pathogen—Any microorganism that causes disease.

spore form—The inactive or dormant state that some bacteria enter when environmental conditions are adverse.

vegetative cell—The active growing state of bacterial cells.

More than thirty different pathogens are identified as causing foodborne disease in the United States. Bacteria, in particular, are known by their scientific names, even in the popular press. These names can be intimidating for high school students to learn, but it is important that students know about how microorganisms get into food and how to control them. Thus, we have chosen to concentrate on just five foodborne pathogens. If students want to know more, a number of sources contain more detail. Two recommended ones are

1. **You Can Prevent Foodborne Illness** (PNW 250). This twenty-page extension bulletin was written for consumers who are motivated to know a lot about food safety. It gives excellent information about the important foodborne pathogens to know, which is useful for food service audiences. Download it from <http://cru.cahe.wsu.edu/CEPublications/PNW0250/PNW0250.pdf>.

2. An excellent web resource is FDA's 292-page *Bad Bug Book*: <https://www.fda.gov/media/83271/download>. This resource provides basic facts regarding foodborne pathogenic microorganisms and natural toxins. It brings together information from the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), the USDA Food Safety Inspection Service (FSIS), and the National Institutes of Health (NIH). (Pages from this resource are included as part of the student activity envelopes in the "Pathogens for Study" activity.)

Foodborne Pathogens Cause Illness in Three Ways

- **Infection** is caused by eating food that contains living disease-causing organisms. After ingestion, the organism burrows into the lining of the victims' digestive tract and begins to grow in number. This leads to symptoms of gastrointestinal (GI) tract upset, like diarrhea.
- **Intoxication**, different from alcohol intoxication, can occur when ingested food is contaminated with toxins or toxin-producing bacteria. Some toxins produced by bacteria are very heat stable and are not destroyed by cooking.
- **Toxin-mediated infection** develops when a person eats food that contains harmful bacteria. When the bacterial organism enters the GI tract, it produces a toxin.

Number of Pathogenic Cells Required to Cause Disease

The data on the number of pathogenic cells required to cause illness is sketchy, because experiments that involve feeding pathogens to people are rarely done, for obvious ethical considerations. Most data are thus estimates based on actual outbreaks. It is known that the number of cells required varies by

- **Specific microorganisms.** For some bacteria (e.g., *Bacillus cereus*), probably about 1 million bacterial cells are needed to cause illness; for other pathogens, far fewer cells are needed. For example, for *Listeria*, about 500 cells need to be consumed for infection to take place; for *E. coli* 0157:H7, as few as 10 cells are thought to be infective.
- **Health of the person ingesting the cells.** Whether illness results from ingesting pathogens depends on a number of personal factors such as age, health, nutritional status, and so forth.
- **Condition of the gastrointestinal tract.** When stomach acid is diluted by large volumes of food or neutralized with antacids, this condition enables the microorganism to survive more easily and reach the small intestine.

Pathogens That Cause the Most Foodborne Illnesses in the United States

This table (Jones and Gerber, 2001) shows which pathogens cause the most illnesses. However, in 68% of reported foodborne outbreaks in the United States, the pathogenic cause is not identified.

Pathogen	Pathogen classification	Estimated percentage of foodborne illness in the USA caused by this pathogen
Norovirus	Virus	67
<i>Campylobacter jejuni</i>	Bacteria	14
<i>Salmonella species</i>	Bacteria	10
<i>Clostridium perfringens</i>	Bacteria	2
<i>Giardia lamblia</i>	Parasite	2
<i>Escherichia coli</i>	Bacteria	1
<i>Staphylococcus aureus</i>	Bacteria	1
<i>Shigella</i>	Bacteria	1
<i>Streptococcus</i>	Bacteria	0.4
<i>Listeria monocytogenes</i>	Bacteria	<0.1
Hepatitis A virus	Virus	<0.1

Information on Five Specific Pathogens

The following five pathogens were chosen for in-depth study because they represent a variety of important characteristics. Later in this lesson, the five pathogens that are the cause for excluding food employees from food-service establishments are briefly discussed.

Norovirus—previously called Norwalk-like Virus (virus)

Characteristics. Viruses are smaller than bacteria. Norovirus is the most common cause of foodborne illness in the United States today, but because diagnosis is difficult and symptoms are mild, it is under reported. Norovirus has been in the newspaper headlines over the past few years as a cause of illness on cruise ships. Viruses do not multiply in food; they begin to multiply when they have invaded a person’s body, causing infection. Even though they do not grow in food, they are not destroyed until the food is cooked. Viruses are more resistant to sanitizers than bacteria.

Source. Most outbreaks are associated with contaminated water supplies; shellfish, raw vegetables, fresh fruits, and salads are the most frequently implicated foods. Food handlers who did not wash their hands properly are another source of contamination.

Symptoms. Nausea, vomiting, diarrhea, abdominal pain, and sometimes headache and low-grade fever. Only a few norovirus particles are required to cause illness. Fortunately, symptoms are self-limiting and mild, and sufferers usually recover within two or three days without serious or long-term health effects.

Control. Obtain shellfish from approved sources; ensure food handlers practice good personal hygiene; thoroughly cook foods to minimum safe internal temperatures; use potable water. Proper cooking and reheating inactivate the virus.

Campylobacter jejuni (bacteria) (pronounced Kamp’-e-lo-back’-ter je’joon-i)

Characteristics. This bacteria only forms vegetative cells; it is not a spore former. It is the most common bacterial source of foodborne illness.

Source. This bacteria commonly inhabits the gastrointestinal tract of animals. Slaughter and further processing may result in contamination to meat products. Various studies have shown that 20% to 100% of all fresh poultry in supermarkets carries *Campylobacter* bacteria. Always assume that raw meat is contaminated with foodborne pathogens and treat it accordingly. The foods most commonly associated with *Campylobacter* outbreaks are unpasteurized milk and dairy products, raw poultry, and contaminated water.

Symptoms. Consuming *Campylobacter* bacteria causes a foodborne infection. The symptoms are slight to severe bloody diarrhea, fever, abdominal pain, headache, and muscle pain. The illness will develop in 2 to 5 days after eating contaminated food and will last about 2 to 5 days.

Control. Avoid cross contamination, especially of meats (particularly poultry), with other foods. Cook food to a proper minimum internal temperature. *Campylobacter* is destroyed by cooking.

Salmonella species (bacteria) (There are over 2,200 species of *Salmonella* bacteria, many of which are pathogenic)

Characteristics. *Salmonella* only forms vegetative cells; it is not a spore former.

Source. Similar to *Campylobacter*, it is found in the GI tract of animals. It is also commonly found on fresh poultry and meat (about 20% of fresh chickens carry *Salmonella* organisms).

Salmonella is found inside approximately 1 in every 20,000 fresh eggs, deposited there by the hen during egg production. Always assume raw eggs are contaminated and handle appropriately.

Symptoms. Consuming *Salmonella* causes an infection. The symptoms, which include abdominal cramps, headache, nausea, fever, and sometimes vomiting, generally develop 12 to 36 hours after ingesting food containing the bacteria. As few as 15 to 20 cells are required for infection. It may (rarely) cause arthritic symptoms 3 to 4 weeks later.

Control. Avoid cross contamination, especially of meats (particularly poultry), with other foods. Cook food to proper minimal internal temperature. *Salmonella* is destroyed by cooking. Cook egg dishes thoroughly; do not use recipes in which eggs are not cooked (e.g., eggnog, Caesar salad, etc.).

***Escherichia coli* 0157:H7** (*E. coli* 0157:H7) (bacteria) (pronounced Esh'-sher-ree'- kee-ah kole'-i)

Characteristics. This organism causes less than 1% of foodborne illness in the United States, yet its effects are very serious, and sometimes lead to death. *E. coli* 0157:H7 is not a spore former. However, its vegetative cells are tough. It survives high acidity (pH below 4) and grows slowly at refrigeration temperatures.

Source. As with *Campylobacter* and *Salmonella*, this bacteria is found in the intestinal tract of animals, particularly ruminants. Foods associated with outbreaks of *E. coli* 0157:H7 include raw

and undercooked ground beef (this is what caused the outbreak at the Jack in the Box restaurants in Seattle in 1993 that caused the deaths of four children), imported cheese, unpasteurized milk and apple cider/juice, lettuce, and water (seven individuals died in 1999 in Walkerton, Ontario, Canada, from *E. coli*-contaminated well water).

Symptoms. These bacteria produce a toxin-mediated infection, meaning they grow in the intestine and begin producing their toxin inside the body. The symptoms are watery diarrhea that may become bloody, severe abdominal cramps and pain, vomiting, and mild or no fever.

Control. Avoid cross contamination of raw meat with other foods. Cook ground beef to 155°F for 15 sec. Practice good personal hygiene.

***Clostridium botulinum* (*C. botulinum*)** (bacteria) (pronounced Klost-rid'-ee-um bot'-u-lie'-num)

Characteristics. *C. botulinum* produces one of the most deadly toxins known to man. (The toxin is so deadly that authorities fear bioterrorists may try to use it as a weapon.) One millionth of a gram or less is lethal to an adult. *C. botulinum* is also very common in U.S. soils. Fortunately, botulism poisoning is very rare.

- *C. botulinum* forms both vegetative cells and spores. If *C. botulinum* spores are present in food, normal cooking procedures will not destroy them. In fact, normal cooking will kill off all the competing bacteria, paving the way for *C. botulinum* spores to germinate and to grow unimpeded. Spores require temperatures above the boiling point of water for destruction, which is why pressure canning must be used with some foods.
- *C. botulinum* also requires an environment without oxygen (anaerobic) for growth. If spores are not destroyed during canning, a can of food would be the perfect place for the spores to germinate and grow. *C. botulinum* will not grow if the pH is below 4.6.

Source. *C. botulinum* can be present on almost all foods of either animal or vegetable origin because it is a common soil inhabitant. Fortunately, this microorganism is fairly fastidious and rarely grows in food. Foods involved include leftover baked potatoes (remember the audiotape from Lesson 1), improperly processed low-acid canned food, untreated garlic-in-oil mixtures, sautéed onions in butter sauce, stews, and improperly prepared pickled eggs.

Symptoms. Vomiting and constipation or diarrhea may be present initially, which progresses to fatigue, weakness, vertigo, blurred or double vision, difficulty in speaking and swallowing, dry mouth, possibly leading to paralysis and death. Symptoms generally present themselves 12 to 36 hrs after consumption of contaminated food.

MATERIALS NEEDED

- **Control.** Home-canned products may not be used in food service. Rapidly cool leftovers (baked potatoes, stews, meat loaves). Purchase only acidified garlic-in-oil mixtures.
- Make handouts for students from master copies at the back of this lesson: “Common Foodborne Pathogens,” “Fill-in the Pathogen,” and “Pathogen Worksheet.”
- For the “Pathogens for Study” activity, make activity envelopes for each of the five pathogens (each envelope contains copies of an article and copies of pages from FDA’s *Bad Bug Book* for that pathogen).*

*Item included on the *Ready, Set, Food Safe* website.

(Slide 1) **Lesson 3** **What Are Some Important Foodborne Pathogens?**

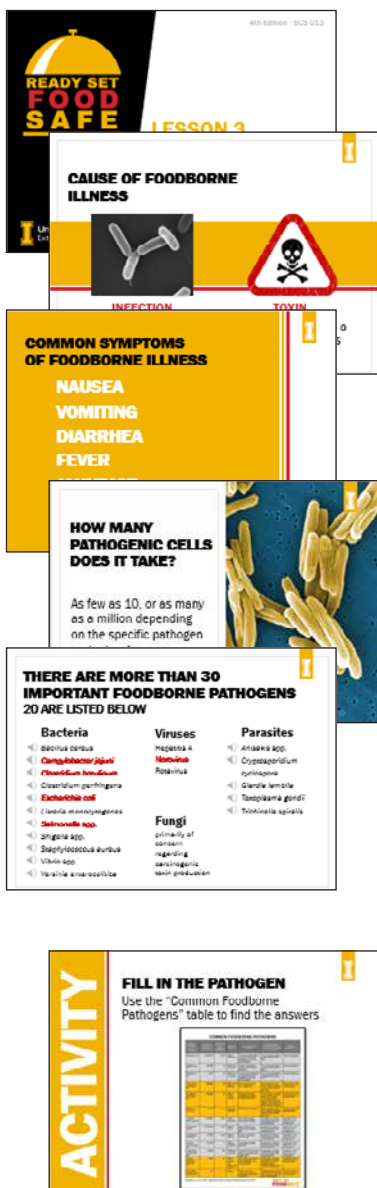
1. (Slide 2) **Cause of Foodborne Illness.** Foodborne illness occurs when the food or water we ingest contains a pathogen that can grow in our gastrointestinal tract and cause infection or when either contains a toxin produced by a pathogen.

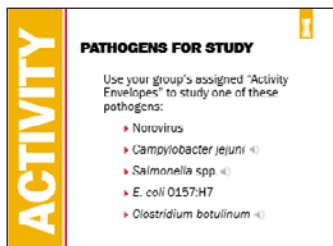
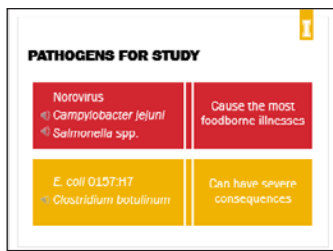
(Slide 3) The common symptoms of foodborne illness include nausea, vomiting, diarrhea, fever, jaundice, abdominal cramps, and headache. Other symptoms, specific to the cause of illness, may include fever, fatigue, muscle cramps, and a variety of others.

2. (Slide 4) **Number of Pathogenic Cells It Takes to Cause Illness.** More research on this topic is needed. Current information suggests that for some pathogens as few as ten cells are enough to cause illness, while other pathogens require a million or more.
3. (Slide 5) **Important Foodborne Pathogens.** There are more than thirty foodborne pathogens. Twenty of them, shown in this slide, are important in food-service food safety. (This slide is hard to read with so many pathogen names, but it gives the students an idea of their extent.) You can play an audio file that provides the pronunciation of many of the pathogens’ names by clicking on the speaker icons located near the names on the slides.

(Slide 6) **Fill-in the Pathogen**

This activity helps students become more familiar with foodborne pathogens. Have them use the “Common Foodborne Pathogens” handout to find the answers for the “Fill-in the Pathogen” activity sheet found at the end of the lesson. Discuss the handout and how it should be used to find the answers for the worksheet. (This activity could be assigned as homework the day before the lesson.)





4. (Slide 7) **Five Pathogens Selected for Further Study.** In this lesson we will concentrate on five pathogens for further study. The five were chosen either because of the amount of illness they cause or because of the seriousness of the illness they cause. They also provide some diversity of characteristics. The five pathogens that will be covered in depth are

1. *Norovirus* Causes the most foodborne illnesses
2. *Campylobacter jejuni*
3. *Salmonella* species
4. *E. coli* O157:H7
5. *Clostridium botulinum* Can have severe consequences

(Slide 8) **Pathogens for Study**

Divide students into five groups and assign each group one of the five pathogens. Give each group the Activity Envelope labeled with that pathogen name and a Pathogen Worksheet found at the end of the lesson. Give the students 15 min to study the resource materials in the envelope and the Common Foodborne Pathogens handout from the previous activity. The Activity Envelopes contain 2 pages from the FDA’s *Bad Bug Book* for that pathogen and either a newspaper article, a webpage article, or a summary of a journal article about the illness caused by the pathogen. Have students complete the Pathogen Worksheet. Use PowerPoint slides 10, 12, 15, and 17–19 to display the relevant food sources and control measures.

Summary of Articles in Activity Envelopes

Pathogen	Story Source	Summary
Norovirus (formerly called Norwalk-like Virus)	“Football Virus,” Associated Press, October 25, 2000.	Describes how the Duke University football team transmitted Norwalk-like virus to the Florida State University football team during a game.
Campylobacter	“ <i>Campylobacter</i> Outbreak Expands,” <i>Food-SafetyNews.com</i> , September 18, 2009.	Describes an outbreak of <i>Campylobacter</i> due to raw milk consumption. Raw milk is increasingly popular, but carries risks, especially to at-risk groups. In food service, foods must be sourced from approved suppliers. The <i>Idaho Food Code</i> (section 3-201.13) requires milk to meet Grade A standards.

Salmonella	“I Scream from Ice Cream,” <i>Lewiston Morning Tribune</i> , March 22, 1998.	Describes experience of Jennifer Thompson who contracted a <i>Salmonella</i> infection by eating contaminated ice cream when she was in eighth grade.
E. coli 0157:H7	“Dear Journal, I Survived Summer Break,” <i>The Spokesman-Review</i> , August 10, 2002; “Agreement Puts An End to Ordeal,” <i>The Spokesman-Review</i> , September 2, 2006.	Describes the experience of a high school student from Spokane, WA, who contracted <i>E. coli</i> O157:H7 from salad at a cheer-leader camp. A follow-up article describes her situation four years later.
Clostridium botulinum	“Botulism from Mishandled Frozen Chili Sold at a Salvage Store,” <i>Clinical Infectious Diseases</i> 37:1490, 2003.	Commercially prepared frozen chili caused an outbreak of botulism at a church supper. The frozen chili had been held at improper temperatures at a salvage store. The relevant information has been summarized.

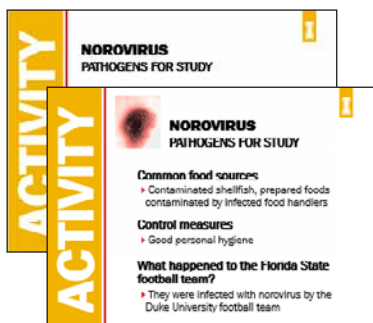
(Slide 9) **Norovirus** (virus)

(Slide 10) **Source.** Viruses get into food mostly through contaminated water or from food handlers who did not wash their hands properly. This is referred to as the “fecal-oral” route of infection. Most outbreaks are associated with contaminated water supplies; shellfish, raw vegetables, fresh fruits, and salads are the most frequently implicated foods.

Control.

- Ensure that food handlers practice good personal hygiene.
- Obtain shellfish from approved sources.
- Inactivate the virus with proper cooking and reheating of foods to minimum safe internal temperatures.
- Use potable water.

Activity report. What happened to the Florida State football team? They were infected with norovirus by the Duke University football team.



ACTIVITY

CAMPYLOBACTER JEJUNI
PATHOGENS FOR STUDY

ACTIVITY

CAMPYLOBACTER JEJUNI
PATHOGENS FOR STUDY

Common food sources

- Raw milk, poultry, beef, pork, shellfish

Control measures

- Avoid cross-contamination, cook thoroughly

What food caused an outbreak of *Campylobacter* in the article?

- Raw milk

Can raw milk be served in food service establishments?

- No

(Slide 11) *Campylobacter jejuni* (bacteria)

(Slide 12) **Source.** This bacteria commonly inhabits the gastrointestinal tract of animals. This means that during slaughter and further processing it may contaminate the meat products. Always assume that raw meat is contaminated with foodborne pathogens and treat it accordingly. Foods most commonly associated with *Campylobacter* outbreaks are unpasteurized milk and dairy products, raw poultry, and contaminated water.

Control. It is very important to avoid cross contamination, especially of meats—specifically poultry—with other foods, and those that will not be cooked before eating. Because *Campylobacter* is destroyed by cooking, cook food to its proper minimum internal temperature.

Activity report. What food caused an outbreak of *Campylobacter* in the article? Raw milk. Can raw milk be served in food-service establishments? No.

(Slide 13) In food service, the *Idaho Food Code* requires that only pasteurized milk be served. Pasteurization is the heating of milk to destroy any vegetative pathogenic bacteria present (other bacteria may survive pasteurization).

(Slide 14) *Salmonella species* (bacteria)

(Slide 15) **Source.** Similar to *Campylobacter* and found in the GI tract of animals. It also is commonly found in fresh poultry and meat. *Salmonella* is found inside approximately 1 in every 20,000 fresh eggs, deposited there by the hen during egg production. Always assume raw eggs are contaminated; handle them appropriately.

Control. It is very important to avoid cross contamination, especially of meats (specifically poultry), with other foods, particularly those that will not be cooked before eating. Cook egg dishes thoroughly. Do not use recipes in which eggs are not cooked (e.g., eggnog, Caesar salad, etc.). *Salmonella* is destroyed by cooking.

Activity report. What long-term problems continued to plague Jennifer Thompson as a result of the *Salmonella* infection she developed after eating contaminated ice cream? Arthritis and gastrointestinal tract problems.

(Slide 16) *Escherichia coli* 0157:H7 (*E. coli* 0157:H7) (bacteria)

(Slide 17) **Source.** As with *Campylobacter* and *Salmonella*, this bacterium is found in the intestinal tract of animals, particularly ruminants. Foods associated with outbreaks of *E. coli* 0157:H7

ACTIVITY

CAMPYLOBACTER JEJUNI
PATHOGENS FOR STUDY

ACTIVITY

CAMPYLOBACTER JEJUNI
PATHOGENS FOR STUDY

- In food service, only pasteurized milk can be served
- Pasteurization is the heating of milk to destroy bacteria

ACTIVITY

SALMONELLA SPECIES
PATHOGENS FOR STUDY

ACTIVITY

SALMONELLA SPECIES
PATHOGENS FOR STUDY

Common food sources

- Poultry, eggs, meat, raw milk, fresh produce

Control measures

- Avoid cross-contamination, cook thoroughly

What long-term problems continue to plague Jennifer Thompson as a result of *Salmonella* infection from ice cream?

- Arthritis and gastrointestinal tract problems

ACTIVITY

ESCHERICHIA COLI (E. COLI) 0157:H7
PATHOGENS FOR STUDY

ACTIVITY

E. COLI 0157:H7
PATHOGENS FOR STUDY

Some food sources

- Raw and undercooked ground beef, lettuce, unpasteurized apple juice

Control measures

- Avoid cross-contamination, cook thoroughly (ground beef to 155° F for 15 seconds)

How did 16-year-old Angela contract *E. coli*?

include raw and undercooked ground beef (this is what caused the outbreak at the Jack in the Box restaurants in Seattle in 1993 that caused the deaths of four children), imported cheese, unpasteurized milk and apple cider/juice, lettuce, and water (seven individuals died in 1999 in Walkerton, Ontario, Canada, from *E. coli*-contaminated well water).

Control. Avoid cross contamination of raw meat with other foods. Cook ground beef to 155°F for 15 sec. (*E. coli* 0157:H7 dies when cooked at 155°F for 15 sec.) Practice good personal hygiene.

Activity report. How did 16-year-old Angela contract *E. coli*? Caesar salad served at summer drill-team camp. How long was she in the hospital? 27 days.



(Slide 18) *Clostridium botulinum* (*C. botulinum*) (bacteria)

C. botulinum produces one of the most deadly toxins known to man. One millionth of a gram or less is lethal to an adult. *C. botulinum* is also very common in U.S. soils, but fortunately botulism is very rare.

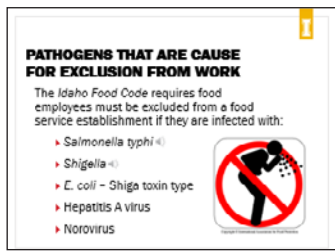
- *C. botulinum* forms both vegetative cells and spores. If *C. botulinum* spores are present in food, normal cooking procedures will not destroy them. In fact, normal cooking will kill off all the competing bacteria, paving the way for *C. botulinum* spores to germinate and grow unimpeded. Spores require temperatures above the boiling point of water for destruction, which is why we must use pressure canning with some foods.
- *C. botulinum* also requires an environment without oxygen (anaerobic) for growth. If spores are not destroyed during canning, a can of food would be the perfect place for the spores to germinate and grow.



(Slide 19) **Source.** Since it is common in soil, *C. botulinum* can be present on almost all foods of either animal or vegetable origin. Foods involved have included leftover baked potatoes (remember the audiotape from Lesson 1), improperly processed low-acid canned food, untreated garlic-in-oil mixtures, sautéed onions in butter sauce, stews, improperly prepared pickled eggs, and frozen chili that was held in the Danger Zone too long and not adequately heated.

Control. Do not use home-canned products in food service. Rapidly cool leftovers (baked potatoes, stews, meat loaves). Purchase only acidified garlic-in-oil mixtures.

Activity report. What was the source of botulism contracted by church supper attendees? Frozen chili that had been held at warm temperatures during storage by a food salvage store.



5. (Slide 20) **Pathogens That Are Cause for Exclusion from Work in Food Service.** Five pathogens are considered so infectious and serious that food employees must be excluded from a food-service establishment if they have been diagnosed with an infection from
1. *Salmonella typhi*
 2. *Shigella* (any species of *Shigella*)
 3. *Escherichia coli* of a type that produces the Shiga toxin (includes *E. coli* 0157:H7)
 4. Hepatitis A virus
 5. Norovirus

Salmonella typhi is a type of *Salmonella*. There are over 2,200 species of *Salmonella*, many but not all of which cause foodborne illness. *Salmonella typhi* is responsible for typhoid fever, a serious disease that is fortunately rare in the United States.

Shigella species cause shigellosis, also known as bacillary dysentery. It is a highly infectious disease and can be severe.

***E. coli* 0157:H7** is one type of *E. coli* that produces the Shiga toxin, which can cause life-threatening symptoms. There are other *E. coli* types that produce the Shiga toxin, but their existence is more common in Europe.

Hepatitis A is a very infectious virus. Hepatitis A infections are usually mild but can be severe.

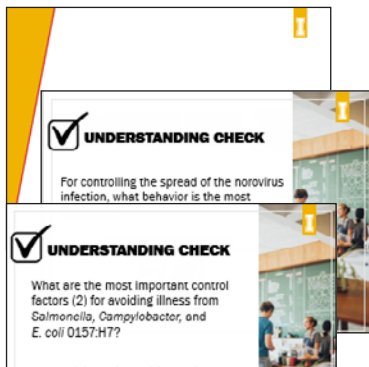
Norovirus is the most common cause of foodborne illness in the United States today. It was added as a pathogen for exclusion in the *Idaho Food Code* in 2008. Viruses do not multiply in food; they begin to multiply when they have invaded a person's body, causing infection. Viruses get into food mostly through contaminated water or from food handlers who did not wash their hands properly.

The fecal-oral route of disease transmission is common for these pathogens. Students should be able to name these five pathogens. Some additional information on these pathogens can be found on the Common Foodborne Pathogens chart.

(Slide 21) **UNDERSTANDING CHECK**

(Slide 22) **Question:** For controlling the spread of norovirus infection, what behavior is most important?
Answer: Good personal hygiene.


(Slide 23) **Question:** What are the most important control factors (2) for avoiding illness from *Salmonella*, *Campylobacter*, and *E. coli* 0157:H7?
Answer: Adequate cooking and avoiding cross contamination.



✓ UNDERSTANDING CHECK

If a food worker is infected with one of these five pathogens, he/she must not work in a food establishment:

Salmonella typhi
Shigella
E. coli - Shiga toxin
Hepatitis A
Norovirus



(Slide 24) **Question:** If a food worker is infected with one of these five pathogens, he/she must not work in a food establishment.

Answer: *Salmonella typhi*, *Shigella*, *E. coli*-shiga toxin-producing, Hepatitis A, Norovirus.

(Slides 25–27) **A Case of Norwalk (2:43)**

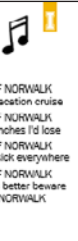
This song discusses norovirus, which is one of the microorganisms this lesson focuses on. The song includes the symptoms and sources of this virus. Note that the name of this pathogen has recently changed to norovirus, although many references to it as Norwalk-virus still exist.

ACTIVITY

A CASE OF NORWALK

On when the weather got cool
 I thought I'd treat myself to a cruise
 But then the Norwalk Virus showed up and had me singing the blues
 A case of Norwalk
 Out on the sea
 In the bathroom of my cabin
 Is where I'll be

A CASE OF NORWALK
 On my vacation cruise
 A CASE OF NORWALK
 Many lunches I'd lose
 A CASE OF NORWALK
 People sick everywhere
 A CASE OF NORWALK
 Cruisers better beware OF THE NORWALK VIRUS



A CASE OF NORWALK (“Under the Boardwalk” by the Drifters)

Oh when the weather got cool I thought I'd treat myself to a cruise
 But then the Norwalk Virus showed up and had me singing the blues

A case of Norwalk
 Out on the sea
 In the bathroom of my cabin
 Is where I'll be

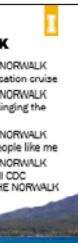
A CASE OF NORWALK
 On my vacation cruise
 A CASE OF NORWALK
 Many lunches I'd lose
 A CASE OF NORWALK
 People sick everywhere
 A CASE OF NORWALK
 Cruisers better beware
 OF THE NORWALK VIRUS

ACTIVITY

A CASE OF NORWALK

Don't know if it came from the passengers or from the food
 But I'll tell you this, it can really affect your mood
 A case of Norwalk
 Out on the sea
 In the bathroom of my cabin
 Is where I'll be

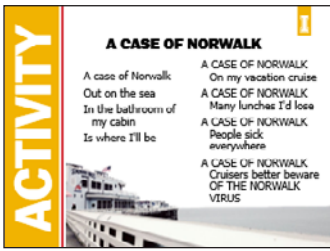
A CASE OF NORWALK
 On my vacation cruise
 A CASE OF NORWALK
 Now I'm singing the blues
 A CASE OF NORWALK
 Lots of people like me
 A CASE OF NORWALK
 Better call CDC
 ABOUT THE NORWALK VIRUS



Don't know if it came from the passengers or from the food
 But I'll tell you this, it can really affect your mood

A case of Norwalk
 Out on the sea
 In the bathroom of my cabin
 Is where I'll be

A CASE OF NORWALK
 On my vacation cruise
 A CASE OF NORWALK
 Now I'm singing the blues
 A CASE OF NORWALK
 Lots of people like me
 A CASE OF NORWALK
 Better call CDC
 ABOUT THE NORWALK VIRUS



A case of Norwalk
Out on the sea
In the bathroom of my cabin
Is where I'll be

A CASE OF NORWALK
On my vacation cruise
A CASE OF NORWALK
Many lunches I'd lose
A CASE OF NORWALK
People sick everywhere
A CASE OF NORWALK
Cruisers better beware
OF THE NORWALK VIRUS

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