Dozens of people became sick with botulism recently at a small café. Customers who ate the restaurant’s famous Baked Potato Salad began calling to complain of nausea and vomiting within two days after eating the dish. They eventually also experienced double vision and difficulty in speaking and swallowing.

Health department officials found that the baked potatoes used in the salad were the source of the outbreak. The potatoes had been wrapped in aluminum foil when they were baked. Then they were left on a prep table overnight to cool. Ultimately, the potatoes were left at room temperature for almost 18 hours before they were used in the salad. The bacteria *Clostridium botulinum*, which causes botulism, had the right conditions for growth—time, temperature, and a lack of oxygen provided by the potatoes’ foil wrapping.

Working with the inspector, the café changed its procedures for making the salad. Now the employees unwrap and chop the potatoes as soon as they come out of the oven. Then the potatoes are placed on sheet pans in the cooler. Employees monitor and record the potatoes’ temperature to make sure they cool in a safe amount of time.

**You Can Prevent This**

Illnesses from pathogens such as bacteria can be prevented if you understand how pathogens grow and contaminate food. In this chapter, you will learn about the following topics.

- The types of pathogens that cause illness
- What pathogens need to grow
- Food most likely to become unsafe
- The major foodborne illnesses and their characteristics

**Concepts from Earlier Chapters**

Before reading this chapter, remember these concepts and facts.

**Pathogens**  Certain viruses, bacteria, parasites, and fungi that can cause illness.

**Time-temperature abuse**  Food has been time-temperature abused when it stays too long at temperatures that are good for pathogen growth.

**Foodborne illness**  Disease transmitted to people by food.
2.2 ServSafe Essentials

Pathogens

Microorganisms are small, living organisms that can be seen only through a microscope. Many microorganisms are harmless, but some can cause illness. Harmful microorganisms are called pathogens. Some pathogens can make you sick when you eat them. Others produce poisons—or toxins—that make you sick. Understanding pathogens is the first step to preventing foodborne-illness outbreaks.

Types of Pathogens

There are four types of pathogens that can contaminate food and cause foodborne illness.

<table>
<thead>
<tr>
<th>Viruses</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasites</td>
<td>Fungi</td>
</tr>
</tbody>
</table>

Photos courtesy of the Centers for Disease Control and Prevention

Many viruses, bacteria, and parasites make people sick, but they cannot be seen, smelled, or tasted. On the other hand, some fungi, like mold, change the appearance, smell, or taste of food, but they may not cause illness.
# What Pathogens Need to Grow

Understanding how pathogens grow can help you prevent foodborne-illness outbreaks. Pathogens need six conditions to grow. You can remember these conditions by thinking of the words FAT TOM.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food</strong></td>
<td>To grow, pathogens need an energy source, such as carbohydrates or proteins.</td>
</tr>
<tr>
<td><strong>Acidity</strong></td>
<td>Pathogens grow best in food that contains little or no acid.</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Pathogens grow well in food held between the temperatures of 41°F and 135°F (5°C and 57°C). This range is known as the temperature danger zone.</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>Pathogens need time to grow. When food is in the temperature danger zone, pathogens grow. After four hours, they will grow to a level high enough to make someone sick.</td>
</tr>
<tr>
<td><strong>Oxygen</strong></td>
<td>Some pathogens need oxygen to grow. Others grow when oxygen is not there.</td>
</tr>
<tr>
<td><strong>Moisture</strong></td>
<td>Pathogens need moisture in food to grow.</td>
</tr>
</tbody>
</table>
### Food Most Likely to Become Unsafe

Any type of food can be contaminated. But some types are better for the growth of pathogens.

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk and dairy products</td>
<td></td>
</tr>
<tr>
<td>Eggs (except those treated to eliminate <em>Salmonella</em> spp.)</td>
<td></td>
</tr>
<tr>
<td>Meat: beef, pork, and lamb</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td>Fish</td>
<td></td>
</tr>
<tr>
<td>Shellfish and crustaceans</td>
<td></td>
</tr>
<tr>
<td>Baked potatoes</td>
<td></td>
</tr>
<tr>
<td>Heat-treated plant food, such as cooked rice, beans, and vegetables</td>
<td></td>
</tr>
<tr>
<td>Tofu or other soy protein</td>
<td></td>
</tr>
<tr>
<td>Synthetic ingredients, such as textured soy protein in meat alternatives</td>
<td></td>
</tr>
<tr>
<td>Sprouts and sprout seeds</td>
<td></td>
</tr>
<tr>
<td>Sliced melons</td>
<td></td>
</tr>
<tr>
<td>Cut tomatoes</td>
<td></td>
</tr>
<tr>
<td>Untreated garlic-and-oil mixtures</td>
<td></td>
</tr>
</tbody>
</table>

All these types of food have the right FAT TOM conditions that pathogens need to grow. They have a natural potential for contamination because of the way they are grown, produced, or processed. They are also commonly involved in foodborne-illness outbreaks.
Controlling the Growth of Pathogens

You can help keep food safe by controlling FAT TOM. In your operation, however, you will most likely be able to control only time and temperature. These two conditions are so important that the food listed on the previous page is known as food that needs time and temperature control for safety, or TCS food for short.

To control temperature, you must do your best to keep TCS food out of the temperature danger zone. To control time, you must limit how long the TCS food spends in the temperature danger zone. The prep chef in the photo at left is doing this by refrigerating pasta salad right after prepping it.

Like TCS food, ready-to-eat food also needs careful handling to prevent contamination. Ready-to-eat food is exactly what it sounds like: food that can be eaten without further preparation, washing, or cooking. Here are some examples.

- Washed fruit and vegetables, both whole and cut
- Deli meat
- Bakery items
- Sugar, spices, and seasonings
- Cooked food

Apply Your Knowledge

What I Need to Grow
Write an X next to each condition that supports the growth of pathogens in food.

1. High fat content
2. Protein
3. High acidity
4. Temperature of 155°F (68°C) or higher
5. Dry environment

TCS or Not?
Write an X next to each food item that supports the growth of pathogens.

1. Raw carrots
2. Sliced melons
3. Flour
4. Soda crackers
5. Limes
6. Milk

For answers, please turn to page 2.36.
Viruses

Viruses are the leading cause of foodborne illness. As a manager, you must understand what viruses are. You should also know the major foodborne illnesses they can cause. Most important, you must learn how to keep them from making your customers sick.

General Information about Viruses

Viruses share some basic characteristics.

Temperature  Viruses can survive cooler and freezer temperatures.

Growth  Viruses can’t grow in food. But once eaten, they grow inside a person's intestines.

Contamination  Viruses can contaminate both food and water.

Transfer  Viruses can be transferred from person to person, from people to food, and from people to food-contact surfaces.

When customers get sick from food contaminated with viruses, it's usually because their food was handled by an employee who has a virus. This might be the operation's employee, an employee of the manufacturer, or anyone who has the virus and then handles the food.

People carry viruses in their feces and can transfer them to their hands after using the restroom. Ready-to-eat food can then become contaminated if hands are not washed the right way. Here are the best ways to prevent the spread of viruses in your operation.

- Keep foodhandlers who are vomiting or have diarrhea or jaundice from working.
- Make sure foodhandlers wash their hands.
- Minimize bare-hand contact with ready-to-eat food.
**Major Foodborne Illnesses Caused by Viruses**

Hepatitis A and Norovirus gastroenteritis are two major foodborne illnesses caused by viruses. For each illness, you must understand the following characteristics.

- Common source
- Food commonly linked with it
- Most common symptoms
- Most important prevention measures

The table on page 2.8 is an overview of all the illnesses in this section. It will help you see similarities and differences that make it easier to remember each illness.

Throughout this chapter, you will also see that the illnesses have been grouped according to their most important prevention measure. Each illness will be grouped by one of the following measures.

- Controlling time and temperature
- Preventing cross-contamination
- Practicing personal hygiene
- Purchasing from approved, reputable suppliers

Note that this measure is not the only way to prevent each illness. Other measures are listed in the tables for each illness.

**Practicing Personal Hygiene**

These illnesses can be prevented by practicing personal hygiene.

- Hepatitis A  page 2.9
- Norovirus gastroenteritis  page 2.9
## Major Foodborne Illnesses Caused by Viruses

<table>
<thead>
<tr>
<th>Most Important Prevention Measure</th>
<th>Controlling time and temperature</th>
<th>Preventing cross-contamination</th>
<th>Practicing personal hygiene</th>
<th>Purchasing from approved, reputable suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virus Characteristics</td>
<td>Commonly Linked Food</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonly Linked Food</td>
<td>Poultry</td>
<td></td>
<td></td>
<td>Hepatitis A</td>
</tr>
<tr>
<td></td>
<td>Eggs</td>
<td></td>
<td></td>
<td>Norovirus</td>
</tr>
<tr>
<td></td>
<td>Meat</td>
<td></td>
<td></td>
<td>gastroenteritis</td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shellfish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ready-to-eat food</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Produce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rice/grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milk/dairy products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contaminated water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most Common Symptoms</td>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abdominal pain/cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vomiting</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Fever</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevention Measures</td>
<td>Handwashing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Holding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reheating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Approved suppliers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Excluding foodhandlers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preventing cross-contamination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Chapter 2  The Microworld

#### 2.9 Most Important Prevention Measure: Practicing personal hygiene

<table>
<thead>
<tr>
<th>Illness</th>
<th>Hepatitis A (HEP-a-TI-tiss)</th>
<th>Hepatitis A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus</td>
<td>Hepatitis A</td>
<td></td>
</tr>
</tbody>
</table>

Hepatitis A is mainly found in the feces of people infected with it. The virus can contaminate water and many types of food. It is commonly linked with ready-to-eat food. However, it has also been linked with shellfish contaminated by sewage.

The virus is often transferred to food when infected foodhandlers touch food or equipment with fingers that have feces on them. Eating only a small amount of the virus can make a person sick. An infected person may not show symptoms for weeks but can be very infectious. Cooking does not destroy hepatitis A.

#### Food Commonly Linked with the Virus
- Ready-to-eat food
- Shellfish from contaminated water

#### Most Common Symptoms
- Fever (mild)
- General weakness
- Nausea
- Abdominal pain
- Jaundice (appears later)

#### Other Prevention Measures
- Keep employees who have jaundice out of the operation.
- Keep employees who have been diagnosed with hepatitis A out of the operation.
- Wash hands.
- Minimize bare-hand contact with ready-to-eat food.
- Purchase shellfish from approved, reputable suppliers.

---

<table>
<thead>
<tr>
<th>Illness</th>
<th>Norovirus gastroenteritis (NOR-o-VI-rus GAS-tro-EN-ter-I-tiss)</th>
<th>Norovirus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus</td>
<td>Norovirus</td>
<td></td>
</tr>
</tbody>
</table>

Like hepatitis A, Norovirus is commonly linked with ready-to-eat food. It has also been linked with contaminated water. Norovirus is often transferred to food when infected foodhandlers touch food or equipment with fingers that have feces on them.

Eating only a small amount of Norovirus can make a person sick. It is also very contagious. People become contagious within a few hours after eating it. The virus is often in a person’s feces for days after symptoms have ended.

#### Food Commonly Linked with the Virus
- Ready-to-eat food
- Shellfish from contaminated water

#### Most Common Symptoms
- Vomiting
- Diarrhea
- Nausea
- Abdominal cramps

#### Other Prevention Measures
- Keep employees with diarrhea and vomiting out of the operation.
- Keep employees who have been diagnosed with Norovirus out of the operation.
- Wash hands.
- Minimize bare-hand contact with ready-to-eat food.
- Purchase shellfish from approved, reputable suppliers.
Apply Your Knowledge

Who Am I?
Identify the virus from the description given and write its name in the space provided.

1. ____________________________
   - I am commonly linked with ready-to-eat food.
   - I am found in the feces of infected people.
   - I can produce a mild fever and general weakness.
   - Purchasing shellfish from an approved, reputable supplier is one way to prevent me.

2. ____________________________
   - I am commonly linked with ready-to-eat food.
   - I am found in the feces of infected people.
   - Handwashing can prevent me.
   - Keeping foodhandlers with vomiting or diarrhea out of the operation is one way to control me.

For answers, please turn to page 2.36.
Bacteria

Most foodborne illnesses are caused by viruses. But bacteria can also make people sick. Knowing what bacteria are and how they grow can help you control them.

**Characteristics of Bacteria That Cause Foodborne Illness**

Bacteria that cause foodborne illness have some basic characteristics.

**Temperature**
Most bacteria are controlled by keeping food out of the temperature danger zone.

**Growth**
If FAT TOM conditions are right, bacteria will grow rapidly, as shown at left.

**Form**
Some bacteria change into a different form, called spores, to keep from dying when they don’t have enough food. They can change back and grow again when the food they are on has been time-temperature abused.

**Toxin production**
Some bacteria make toxins in food as they grow and die. People who eat the toxins can become sick. Cooking may not destroy these toxins.

**Major Foodborne Illnesses Caused by Bacteria**

For each major foodborne illness caused by bacteria, you must understand these characteristics.

- Common source
- Food commonly linked with it
- Most common symptoms
- Most important prevention measures

The table on page 2.13 is an overview of all the illnesses in this section. It will help you see similarities and differences that make it easier to remember each illness.

<table>
<thead>
<tr>
<th>Number of Cells</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cell</td>
<td>0 min.</td>
</tr>
<tr>
<td>2 cells</td>
<td>20 min.</td>
</tr>
<tr>
<td>4 cells</td>
<td>40 min.</td>
</tr>
<tr>
<td>8 cells</td>
<td>1 hr.</td>
</tr>
<tr>
<td>16 cells</td>
<td>1 hr. 20 min.</td>
</tr>
<tr>
<td>&gt; 1 billion</td>
<td>10 hrs.</td>
</tr>
</tbody>
</table>
Controlling Time and Temperature
These illnesses can be prevented through time and temperature control.

- *Bacillus cereus* gastroenteritis  page 2.14
- Listeriosis  page 2.14
- Hemorrhagic colitis  page 2.15
- *Clostridium perfringens* gastroenteritis  page 2.15
- Botulism  page 2.16

Preventing Cross-Contamination
These illnesses can be prevented by preventing cross-contamination.

- Salmonellosis  page 2.16

Practicing Personal Hygiene
These illnesses can be prevented by practicing personal hygiene.

- Shigellosis  page 2.17
- Staphylococcal gastroenteritis  page 2.17

Purchasing from Approved, Reputable Suppliers
These illnesses can be prevented by purchasing products from approved, reputable suppliers.

- *Vibrio vulnificus* primary septicemia/gastroenteritis  page 2.18
## Major Foodborne Illnesses Caused by Bacteria

<table>
<thead>
<tr>
<th>Bacteria Characteristics</th>
<th>Commonly Linked Food</th>
<th>Illness</th>
<th>Controlling time and temperature</th>
<th>Preventing cross-contamination</th>
<th>Practicing personal hygiene</th>
<th>Purchasing from approved, reputable suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td><strong>Characteristics</strong></td>
<td><strong>Most Important Prevention Measure</strong></td>
<td>Bacillus cereus gastroenteritis</td>
<td>Listeria monocytogenes</td>
<td>Staphylococcus aureus gastroenteritis</td>
<td>Botulism</td>
</tr>
<tr>
<td><strong>Most CommonSymptoms</strong></td>
<td></td>
<td></td>
<td>Diarrhea</td>
<td>Abdominal pain/cramps</td>
<td>Nausea</td>
<td>Vomiting</td>
</tr>
<tr>
<td><strong>Prevention Measures</strong></td>
<td></td>
<td></td>
<td>Handwashing</td>
<td>Cooking</td>
<td>Holding</td>
<td>Cooling</td>
</tr>
</tbody>
</table>
### Bacillus cereus gastroenteritis (ba-SIL-us SEER-ee-us GAS-tro-EN-ter-i-tiss)

*Bacillus cereus* is a spore-forming bacteria found in soil. The bacteria can produce two different toxins when allowed to grow to high levels. The toxins cause different illnesses.

**Food Commonly Linked with the Bacteria**
- **Diarrhea illness**
  - Cooked vegetables
  - Meat products
  - Milk

**Vomiting illness**
- Cooked rice dishes, including fried rice and rice pudding

**Most Common Symptoms**
- **Diarrhea illness**
  - Watery diarrhea
  - No vomiting

- **Vomiting illness**
  - Nausea
  - Vomiting

**Other Prevention Measures**
- Cook food to minimum internal temperatures.
- Hold food at the right temperatures.
- Cool food correctly.

### Listeriosis (liss-TEER-ee-O-sis)

*Listeria monocytogenes* is found in soil, water, and plants. Unlike other bacteria, it grows in cool, moist environments. The illness is uncommon in healthy people, but high-risk populations are especially vulnerable—particularly pregnant women.

**Food Commonly Linked with the Bacteria**
- Raw meat
- Unpasteurized dairy products
- Ready-to-eat food, such as deli meat, hot dogs, and soft cheeses

**Most Common Symptoms**
- Pregnant women
  - Miscarriage

- Newborns
  - Sepsis
  - Pneumonia
  - Meningitis

**Other Prevention Measures**
- Throw out any product that has passed its use-by or expiration date.
- Cook raw meat to minimum internal temperatures.
- Prevent cross-contamination between raw or undercooked food and ready-to-eat food.
- Avoid using unpasteurized dairy products
Most Important Prevention Measure: Controlling time and temperature

### Hemorrhagic colitis (hem-or-RA-jik ko-LI-tiss)
- **Bacteria**: Shiga toxin-producing *Escherichia coli* (ess-chur-EE-kee-UH KO-LI), including O157:H7, O26:H11, O111:H8, and O158:NM

Shiga toxin-producing *E. coli* can be found in the intestines of cattle. It can contaminate meat during slaughtering. Eating only a small amount of shiga toxin-producing *E. coli* can make a person sick. Once eaten, it produces toxins in the intestines, which cause the illness. The bacteria are often in a person’s feces for weeks after symptoms have ended.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Bacteria</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ground beef (raw and undercooked)</td>
<td>- Diarrhea (eventually becomes bloody)</td>
<td>- Cook food, especially ground beef, to minimum internal temperatures.</td>
</tr>
<tr>
<td>- Contaminated produce</td>
<td>- Abdominal cramps</td>
<td>- Purchase produce from approved, reputable suppliers.</td>
</tr>
<tr>
<td></td>
<td>- Kidney failure (in severe cases)</td>
<td>- Prevent cross-contamination between raw meat and ready-to-eat food.</td>
</tr>
</tbody>
</table>

### Clostridium perfringens gastroenteritis (klos-TRID-ee-um per-FRIN-jins GAS-tro-EN-ter-l-tiss)
- **Bacteria**: *Clostridium perfringens*

*Clostridium perfringens* is found in soil, where it forms spores that allow it to survive. It is also carried in the intestines of both animals and humans. *Clostridium perfringens* does not grow at refrigeration temperatures, but it grows very rapidly in food in the temperature danger zone. Commercially prepared food is not often involved in outbreaks. People who get sick usually do not have nausea, fever, or vomiting.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Bacteria</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Meat</td>
<td>- Diarrhea</td>
<td>- Cool and reheat food correctly.</td>
</tr>
<tr>
<td>- Poultry</td>
<td>- Severe abdominal pain</td>
<td>- Hold food at the right temperatures.</td>
</tr>
<tr>
<td>- Dishes made with meat and poultry, such as stews and gravies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.16 ServSafe Essentials

**Most Important Prevention Measure: Controlling time and temperature**

**Illness**  
Botulism (BOT-chew-liz-um)

**Bacteria**  
Clostridium botulinum (klos-TRID-ee-um BOT-chew-LINE-um)

*Clostridium botulinum* forms spores that are commonly found in water and soil. These spores can contaminate almost any food. The bacteria do not grow well in refrigerated or highly acidic food or in food with low moisture. However, *Clostridium botulinum* grows without oxygen and can produce a deadly toxin when food is time-temperature abused. Without medical treatment, death is likely.

**Food Commonly Linked with the Bacteria**
- Incorrectly canned food
- Reduced oxygen packaged (ROP) food
- Temperature-abused vegetables, such as baked potatoes
- Untreated garlic-and-oil mixtures

**Most Common Symptoms**
- **Initially**
  - Nausea and vomiting

- **Later**
  - Weakness
  - Double vision
  - Difficulty in speaking and swallowing

**Other Prevention Measures**
- Hold, cool, and reheat food correctly.
- Inspect canned food for damage.

**Most Important Prevention Measure: Preventing cross-contamination**

**Illness**  
Salmonellosis (SAL-men-uh-LO-sis)

**Bacteria**  
Salmonella spp. (SAL-me-NEL-uh)

Many farm animals carry *Salmonella* spp. naturally. Eating only a small amount of these bacteria can make a person sick. How severe symptoms are depends on the health of the person and the amount of bacteria eaten. The bacteria are often in a person's feces for weeks after symptoms have ended.

**Food Commonly Linked with the Bacteria**
- Poultry and eggs
- Dairy products
- Produce

**Most Common Symptoms**
- Diarrhea
- Abdominal cramps
- Vomiting
- Fever

**Other Prevention Measures**
- Cook poultry and eggs to minimum internal temperatures.
- Prevent cross-contamination between poultry and ready-to-eat food.
- Keep foodhandlers who have been diagnosed with salmonellosis out of the operation.
Most Important Prevention Measure: Practicing personal hygiene

<table>
<thead>
<tr>
<th>Illness</th>
<th>Shigellosis (SHIG-uh-LO-sis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>Shigella spp. (shi-GE-luh)</td>
</tr>
</tbody>
</table>

Shigella spp. is found in the feces of humans with shigellosis. Most illnesses occur when people eat contaminated food or water. Flies can also transfer the bacteria from feces to food. Eating only a small amount of these bacteria can make a person sick. High levels of the bacteria are often in a person’s feces for weeks after symptoms have ended.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Bacteria</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
</table>
| • Food that is easily contaminated by hands, such as salads containing TCS food (potato, tuna, shrimp, macaroni, and chicken) | • Bloody diarrhea  
• Abdominal pain and cramps  
• Fever (occasionally) | • Keep foodhandlers who have diarrhea out of the operation.  
• Keep foodhandlers who have been diagnosed with shigellosis out of the operation.  
• Wash hands.  
• Control flies inside and outside the operation. |
| • Food that has made contact with contaminated water, such as produce | | |

Most Important Prevention Measure: Practicing personal hygiene

<table>
<thead>
<tr>
<th>Illness</th>
<th>Staphylococcal gastroenteritis (STAF-ul-lo-KOK-al GAS-tro-EN-ter-I-tiss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>Staphylococcus aureus (STAF-uh-lo-KOK-us OR-ee-us)</td>
</tr>
</tbody>
</table>

Staphylococcus aureus can be found in humans—particularly in the hair, nose, throat, and infected cuts. It is often transferred to food when people carrying it touch these areas on their bodies and then handle food without washing their hands. If allowed to grow to large numbers in food, the bacteria can produce toxins that cause the illness when eaten. Because cooking cannot destroy these toxins, preventing bacterial growth is critical.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Bacteria</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food that requires handling during preparation, including:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| • Salads containing TCS food (egg, tuna, chicken, and macaroni) | • Nausea  
• Vomiting and retching  
• Abdominal cramps | • Wash hands, particularly after touching the hair, face, or body.  
• Cover wounds on hands and arms.  
• Hold, cool, and reheat food correctly. |
| • Deli meat | | |
2.18 ServSafe Essentials

Most Important Prevention Measure: Purchasing from approved, reputable suppliers

**Illnesses**
- **Vibrio gastroenteritis** (*VIB-ree-o GAS-tro-EN-ter-i-tiss*)
- **Vibrio vulnificus primary septicemia** (*VIB-ree-o vul-NIF-ih-kus SEP-ti-SEE-mee-uh*)

**Bacteria**
- **Vibrio vulnificus** and **Vibrio parahaemolyticus** (*VIB-ree-o PAIR-uh-HEE-mo-lit-ih-kus*)

These bacteria are found in the waters where shellfish are harvested. They can grow very rapidly at temperatures in the middle of the temperature danger zone. People with chronic illnesses (such as diabetes or cirrhosis) who become sick from these bacteria may get primary septicemia, a severe illness that can lead to death.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Bacteria</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oysters from contaminated water</td>
<td>Diarrhea</td>
<td>Cook oysters to minimum internal temperatures.</td>
</tr>
</tbody>
</table>

**Apply Your Knowledge**

**Who Am I?**
Identify the bacteria from the description given and write its name in the space provided.

1. Many farm animals carry me naturally.
   - I have been found in eggs, produce, and poultry.
   - I can produce diarrhea and vomiting.
   - Preventing cross-contamination is one way to prevent me.

2. I can produce toxins if I grow to large numbers.
   - I have been linked with salads containing TCS food.
   - I can produce retching and abdominal cramps.
   - Washing hands can prevent me.

3. I am found in soil.
   - I have been linked with cooked rice dishes.
   - I can produce watery diarrhea.
   - Cooking, holding, and cooling food correctly can prevent me.

4. I form spores.
   - I have been linked with meat and poultry.
   - I do not typically produce fever or vomiting.
   - Holding, cooling, and reheating food correctly can prevent me.

5. I do not need oxygen to grow.
   - I have been linked with canned and ROP food.
   - I can produce double vision.
   - Inspecting canned food for damage can prevent me.

6. I am found in the feces of the people I make sick.
   - I can cause bloody diarrhea and fever.
   - I can be in feces for weeks after symptoms have ended.
   - Washing hands can prevent me.

For answers, please turn to page 2.36.
Illnesses from parasites are not as common as those caused by bacteria or viruses. But it is still important to understand this group of pathogens so you can prevent the illnesses they cause.

**Characteristics of Parasites**

Parasites share some common characteristics.

**Growth**  Parasites cannot grow in food. They need to be in the meat of another animal to survive.

**Transfer**  Eating food contaminated with parasites will cause illness. Many animals can be hosts. Examples include cows, chickens, pigs, and fish. Parasites can also be found in the feces of animals and people.

**Contamination**  Parasites can contaminate both food and water—particularly water used to irrigate produce.

**Major Foodborne Illnesses Caused by Parasites**

For each major foodborne illness caused by parasites, you must understand these characteristics.

- Common source
- Food commonly linked with it
- Most common symptoms
- Most important prevention measures

The table on page 2.20 is an overview of all the illnesses in this section. It will help you see similarities and differences that make it easier to remember each illness.

**Purchasing from Approved, Reputable Suppliers**

These illnesses can be prevented by purchasing products from approved, reputable suppliers.

- Anisakiasis  page 2.21
- Cryptosporidiosis  page 2.21
- Giardiasis  page 2.22
### Major Foodborne Illnesses Caused by Parasites

<table>
<thead>
<tr>
<th>Most Important Prevention Measure</th>
<th>Controlling time and temperature</th>
<th>Preventing cross-contamination</th>
<th>Practicing personal hygiene</th>
<th>Purchasing from approved, reputable suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Illness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parasite Characteristics</strong></td>
<td><strong>Commonly Linked Food</strong></td>
<td><strong>Prevention Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anisakiasis</td>
<td>Chickens, fish</td>
<td>Handwashing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidiosis</td>
<td>Eggs</td>
<td>Cooking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giardiasis</td>
<td>Meat</td>
<td>Holding</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td>Cooling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shellfish</td>
<td>Reheating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ready-to-eat food</td>
<td>Approved suppliers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Produce</td>
<td>Excluding foodhandlers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rice/grains</td>
<td>Preventing cross-contamination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milk/dairy products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contaminated water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abdominal pain/cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vomiting</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Fever</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Headache</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illness</td>
<td>Anisakiasis (ANN-ih-SAHK-KYE-ah-sis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parasite</td>
<td>Anisakis simplex (ANN-ih-SAHK-iss SIM-plex)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

People can get sick when they eat raw or undercooked fish containing this parasite.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Parasite</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw and undercooked fish, including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Herring</td>
<td>• Tingling in throat</td>
<td>• Cook fish to minimum internal temperatures.</td>
</tr>
<tr>
<td>• Cod</td>
<td>• Coughing up worms</td>
<td>• If serving raw or undercooked fish, purchase sushi-grade fish that has been frozen to the right time-temperature requirements.</td>
</tr>
<tr>
<td>• Halibut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mackerel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pacific salmon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Illness</th>
<th>Cryptosporidiosis (KRP-TOH-spor-id-ee-O-sis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasite</td>
<td>Cryptosporidium parvum (KRP-TOH-spor-ID-ee-um PAR-vum)</td>
</tr>
</tbody>
</table>

*Cryptosporidium parvum* can be found in the feces of people infected with it. Foodhandlers can transfer it to food when they touch food with fingers that have feces on them. Day-care and medical communities have been frequent locations of person-to-person spread of this parasite. Symptoms will be more severe in people with weakened immune systems.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Parasite</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Contaminated water</td>
<td>• Watery diarrhea</td>
<td>• Use properly treated water.</td>
</tr>
<tr>
<td>• Produce</td>
<td>• Abdominal cramps</td>
<td>• Keep foodhandlers with diarrhea out of the operation.</td>
</tr>
<tr>
<td></td>
<td>• Nausea</td>
<td>• Wash hands.</td>
</tr>
<tr>
<td></td>
<td>• Weight loss</td>
<td></td>
</tr>
</tbody>
</table>
Most Important Prevention Measure: Purchasing from approved, reputable suppliers

Illness  Giardiasis (*JEE-are-DYE-uh-sis*)
Parasite  *Giardia duodenalis* (*jee-ARE-dee-uh do-WAH-den-AL-is*), also known as *G. lamblia* or *G. intestinalis*

*Giardia duodenalis* can be found in the feces of infected people. Foodhandlers can transfer the parasite to food when they touch food with fingers that have feces on them.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Parasite</th>
<th>Most Common Symptoms</th>
<th>Other Prevention Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improperly treated water</td>
<td>Initially</td>
<td>Fever</td>
</tr>
<tr>
<td>Produce</td>
<td>Later</td>
<td>Diarrhea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abdominal cramps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nausea</td>
</tr>
</tbody>
</table>

Apply Your Knowledge

Who Am I?

Identify the parasite from the description given and write its name in the space provided.

1. I have been found in produce.
   - I have been found in contaminated water.
   - I can produce a fever and diarrhea.
   - Excluding foodhandlers with diarrhea from the operation is one way to prevent me.

2. Cooking fish can destroy me.
   - I have been found in mackerel.
   - People infected with me cough up worms.
   - Purchasing fish from approved, reputable suppliers is one way to prevent me.

3. I can be spread by fingers with feces on them.
   - I have been found in contaminated produce.
   - I can produce watery diarrhea and weight loss.
   - Purchasing produce from approved, reputable suppliers is one way to prevent me.

*For answers, please turn to page 2.36.*
So far, you have learned about pathogens that cause foodborne illness. Fungi are pathogens that only sometimes make people sick. Mostly they spoil food. They are found in air, soil, plants, water, and some food. Mold (as shown in the photo of green beans at left) and yeast are examples.

**Molds**

Molds share some basic characteristics.

- **Effects** Molds spoil food and sometimes cause illness.
- **Toxins** Some molds produce toxins, such as aflatoxins.
- **Growth** Molds grow under almost any condition. But they grow well in acidic food with little moisture. Examples are jams, jellies, and cured, salty meat such as ham, bacon, and salami.
- **Temperature** Cooler or freezer temperatures may slow the growth of molds, but they don’t kill them.

**Prevention measure** Throw out all moldy food, unless the mold is a natural part of the product (e.g., cheese such as Brie, Camembert, and Gorgonzola, as shown in the photo at left). The Food and Drug Administration (FDA) recommends cutting away moldy areas in hard cheese—at least one inch (2.5 centimeters) around them. You can also use this procedure on food such as salami and firm fruit and vegetables.

**Yeasts**

Yeasts share some basic characteristics.

- **Signs of spoilage** Yeasts can spoil food quickly. Signs of spoilage can include a smell or taste of alcohol. The yeast itself may look like a white or pink discoloration or slime, as shown in the photo of jelly at left. It also may bubble.
- **Growth** Like molds, yeasts grow well in acidic food with little moisture, such as jellies, jams, syrup, honey, and fruit or fruit juice.

**Prevention measure** Throw out any food that has been spoiled by yeast.
Apply Your Knowledge

Who Am I?

Identify the fungi from the description given and write its name in the space provided.

1. ____________________
   - I produce an alcohol-like odor.
   - I may look pink or slimy.
   - I may cause food to bubble.
   - Food containing me should be thrown out.

2. ____________________
   - Some forms of me can produce a dangerous toxin.
   - I am not killed by freezer temperatures.
   - I grow well in food such as jelly and salami.
   - Sometimes I can be cut away from food.

For answers, please turn to page 2.36.
Biological Toxins

You learned earlier in this chapter that most foodborne illnesses are caused by pathogens, a form of biological contamination. But you also must be aware of biological toxins that can make people sick. Biological toxins are made by pathogens, or they come from a plant or an animal.

Seafood toxins, plant toxins, and mushroom toxins can all cause foodborne illnesses. So you must understand what these toxins are and the illnesses they can cause. Most important, you must learn how to keep them from making your customers sick.

Seafood Toxins

Seafood toxins can’t be smelled or tasted. They also can’t be destroyed by freezing or cooking once they form in food. Below are the two groups of seafood toxins.

Fish toxins  Some fish toxins are a natural part of the fish. Others are made by pathogens on it. Some fish become contaminated when they eat smaller fish that have eaten a toxin.

Shellfish toxins  Shellfish, such as the oysters in the photo at left, can be contaminated when they eat marine algae that have a toxin.

Major Foodborne Illnesses Caused by Seafood Toxins

For each major foodborne illness caused by seafood toxins, you must understand these characteristics.

- Common source
- Food commonly linked with it
- Most common symptoms
- Most important prevention measures

The table on page 2.26 is an overview of all the illnesses in this section. It will help you see similarities and differences that make it easier to remember each illness.
### Purchasing from Approved, Reputable Suppliers

These illnesses can be prevented by purchasing products from approved, reputable suppliers.

- Scombroid poisoning  page 2.27
- Ciguatera fish poisoning  page 2.27
- Paralytic shellfish poisoning (PSP)  page 2.28
- Neurotoxic shellfish poisoning (NSP)  page 2.28
- Amnesic shellfish poisoning (ASP)  page 2.29

#### Major Foodborne Illnesses Caused by Seafood Toxins

<table>
<thead>
<tr>
<th>Illness</th>
<th>Controlling time and temperature</th>
<th>Preventing cross-contamination</th>
<th>Practicing personal hygiene</th>
<th>Purchasing from approved, reputable suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seafood Toxin Characteristics</strong></td>
<td>Commonly Linked Food</td>
<td>Fish</td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td><strong>Most Important Prevention Measure</strong></td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Most Common Symptoms</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Abdominal pain/cramps</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Fever</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Neurological symptoms</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Prevention Measures</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Handwashing</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Cooking</td>
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<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Holding</td>
<td></td>
<td></td>
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<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Cooling</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Reheating</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Approved suppliers</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Excluding foodhandlers</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
<tr>
<td>Preventing cross-contamination</td>
<td></td>
<td></td>
<td></td>
<td>Scombroid poisoning</td>
</tr>
</tbody>
</table>
### Scombroid poisoning (SKOM-broyd)

**Toxin**: Histamine (HISS-ta-meen)

Scombroid poisoning is also known as histamine poisoning. It is an illness caused by eating high levels of histamine in scombroid and other species of fish. When the fish are time-temperature abused, bacteria on the fish make the toxin. It cannot be destroyed by freezing, cooking, smoking, or curing.

#### Food Commonly Linked with the Toxin
- Tuna
- Bonito
- Mackerel
- Mahi mahi

#### Most Common Symptoms
**Initially**
- Reddening of the face and neck
- Sweating
- Headache
- Burning or tingling sensation in the mouth or throat

**Possibly later**
- Diarrhea
- Vomiting

#### Other Prevention Measures
- Prevent time-temperature abuse during storage and preparation.

### Ciguatera fish poisoning (SIG-wa-TAIR-uh)

**Toxin**: Ciguatoxin (SIG-wa-TOX-in)

Ciguatoxin is found in certain marine algae. The toxin builds up in certain fish when they eat smaller fish that have eaten the toxic algae. Ciguatoxin cannot be detected by smell or taste. Cooking or freezing the fish will not eliminate it. Symptoms may last months or years depending on how severe the illness is.

#### Food Commonly Linked with the Toxin
Predatory tropical reef fish from the Pacific Ocean, the western part of the Indian Ocean, and the Caribbean Sea, including:
- Barracuda
- Grouper
- Jacks
- Snapper

#### Most Common Symptoms
- Reversal of hot and cold sensations
- Nausea
- Vomiting
- Tingling in fingers, lips, or toes
- Joint and muscle pain

#### Other Prevention Measures
- Purchase predatory tropical reef fish from approved, reputable suppliers.
2.28 ServSafe Essentials

**Illness**  Paralytic shellfish poisoning (PSP) *(PAIR-ah-LIT-ik)*  
**Toxin**  Saxitoxin *(SAX-ih-TOX-in)*  

Some types of shellfish can become contaminated as they filter toxic algae from the water. People get sick with paralytic shellfish poisoning (PSP) when they eat these shellfish. Saxitoxin cannot be smelled or tasted. It is not destroyed by cooking or freezing. Death from paralysis may result if high levels of the toxin are eaten.

**Food Commonly Linked with the Toxin**  
Shellfish found in colder waters, such as those of the Pacific and New England coasts, including:  
- Clams  
- Mussels  
- Oysters  
- Scallops

**Most Common Symptoms**  
- Numbness  
- Tingling of the mouth, face, arms, and legs  
- Dizziness  
- Nausea  
- Vomiting  
- Diarrhea

**Other Prevention Measures**  
- Purchase shellfish from approved, reputable suppliers.

---

**Illness**  Neurotoxic shellfish poisoning (NSP) *(NUR-o-TOX-ik)*  
**Toxin**  Brevetoxin *(BREV-ih-TOX-in)*  

Some types of shellfish can become contaminated as they filter toxic algae from the water. People get sick with neurotoxic shellfish poisoning (NSP) when they eat these shellfish. Brevetoxin cannot be smelled or tasted. It is not destroyed by cooking or freezing.

**Food Commonly Linked with the Toxin**  
Shellfish found in the warmer waters of the west coast of Florida, the Gulf of Mexico, and the Caribbean Sea, including:  
- Clams  
- Mussels  
- Oysters

**Most Common Symptoms**  
- Tingling and numbness of the lips, tongue, and throat  
- Dizziness  
- Reversal of hot and cold sensations  
- Vomiting  
- Diarrhea

**Other Prevention Measures**  
- Purchase shellfish from approved, reputable suppliers.
Most Important Prevention Measure: Purchasing from approved, reputable suppliers

<table>
<thead>
<tr>
<th>Illness</th>
<th>Amnesic shellfish poisoning (ASP) (am-NEE-zik)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxin</td>
<td>Domoic acid (duh-MO-ik)</td>
</tr>
</tbody>
</table>

Some types of shellfish can become contaminated as they filter toxic algae from the water. People get sick with amnesic shellfish poisoning (ASP) when they eat these shellfish. The severity of symptoms depends on the amount of toxin eaten and the health of the person. Domoic acid cannot be smelled or tasted. It is not destroyed by cooking or freezing.

<table>
<thead>
<tr>
<th>Food Commonly Linked with the Toxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shellfish found in the coastal waters of the Pacific Northwest and the east coast of Canada, including:</td>
</tr>
<tr>
<td>- Clams</td>
</tr>
<tr>
<td>- Mussels</td>
</tr>
<tr>
<td>- Oysters</td>
</tr>
<tr>
<td>- Scallops</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Most Common Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initially</td>
</tr>
<tr>
<td>- Vomiting</td>
</tr>
<tr>
<td>- Diarrhea</td>
</tr>
<tr>
<td>- Abdominal pain</td>
</tr>
<tr>
<td>Possibly later</td>
</tr>
<tr>
<td>- Confusion</td>
</tr>
<tr>
<td>- Memory loss</td>
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<tr>
<td>- Disorientation</td>
</tr>
<tr>
<td>- Seizure</td>
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<tr>
<td>- Coma</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Prevention Measures</th>
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</thead>
<tbody>
<tr>
<td>- Purchase shellfish from approved, reputable suppliers.</td>
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</tbody>
</table>
**Mushroom Toxins**

Foodborne illnesses linked with mushrooms are almost always caused by eating toxic, wild mushrooms collected by amateur hunters. Most cases happen because toxic mushrooms are mistaken for edible ones. The symptoms of illness depend on the type of toxic mushrooms eaten.

Mushroom toxins are not destroyed by cooking or freezing. Do **not** use mushrooms or mushroom products unless you have purchased them from approved, reputable suppliers. A package of approved mushrooms is shown in the photo at left.

**Plant Toxins**

Plant toxins are another form of biological contamination. Illnesses from plant toxins usually happen because an operation has purchased plants from an unapproved supplier. Some illnesses, however, are caused by plants that haven't been cooked the right way. Here are some examples of items that can make people sick.

- Toxic plants, such as fool's parsley or wild turnips, mistaken for the edible version
- Honey from bees allowed to harvest nectar from toxic plants
- Undercooked kidney beans

Purchase plants and items made with plants only from approved, reputable suppliers. Then cook and hold dishes made from these items correctly.
Apply Your Knowledge

Who Am I?

Identify the seafood toxin from the description given and write its name in the space provided.

1. 
   - I build up in predatory tropical reef fish.
   - I have been linked with barracuda and snapper.
   - I can produce tingling lips and joint pain.
   - I cause an illness with symptoms that can last for years.

2. 
   - When certain fish are time-temperature abused, bacteria on the fish make me.
   - I have been linked with tuna and bonito.
   - I can produce a burning sensation in the mouth.
   - I cannot be destroyed by smoking or curing.

3. 
   - I am found in toxic marine algae.
   - I have been linked with scallops and other seafood.
   - I can cause paralysis and death.
   - I am found in colder waters, such as those off the New England coast.

4. 
   - I am found in the waters of the Pacific Northwest.
   - I can cause memory loss.
   - I can produce abdominal pain.
   - I have been linked with scallops.

5. 
   - I can cause the reversal of the sensations of hot and cold.
   - I have been linked with clams.
   - I can make lips go numb.
   - I can be found in the waters off the west coast of Florida.

For answers, please turn to page 2.36.
Chapter Summary

Microorganisms are small, living organisms. Harmful microorganisms are called pathogens. Understanding how pathogens grow, contaminate food, and affect people will help you understand how to prevent the foodborne-illness outbreaks caused by them. The words FAT TOM will help you remember the conditions that pathogens need to grow: food, acidity, temperature, time, oxygen, and moisture. Any type of food can be contaminated. But some types, known as TCS food, are better for pathogen growth.

The four types of pathogens discussed in this chapter are viruses, bacteria, parasites, and fungi. Viruses are the leading cause of foodborne illness. They cannot grow in food, but they can survive cooler and freezer temperatures. The key to preventing the spread of viruses is good personal hygiene. Bacteria can usually be controlled by keeping food out of the temperature danger zone. Some bacteria can change into spores to keep from dying when they don't have enough food. Others can make toxins in food that will make people who eat the food sick. Parasites need to be in the meat of another animal to survive. They can contaminate both food and water—particularly water used to irrigate produce. Purchasing products from approved, reputable suppliers is important for preventing foodborne illnesses caused by parasites. Fungi only sometimes make people sick. Mostly they spoil food. Examples are mold and yeast. Any food spoiled by mold or yeast should be thrown out, unless the mold is a natural part of the product.

Seafood toxins, plant toxins, and mushroom toxins also can cause foodborne illnesses. Fish toxins can be a natural part of the fish or made by pathogens on it. Some occur when fish eat smaller fish that have the toxin. Shellfish toxins are caused by marine algae that have a toxin, which the shellfish then eats. Foodborne illnesses linked with mushrooms are almost always caused by eating toxic, wild mushrooms collected by amateur hunters. Similarly, foodborne illnesses caused by plant toxins usually happen because an operation has purchased plants from an unapproved food supplier. Purchasing products from approved, reputable suppliers is important for preventing all these types of foodborne illnesses.

Chapter Review Activities

Now take what you have learned in this chapter and apply it to the following activities.

Read each scenario and then answer the question that follows it.

A day-care center decided to prepare stir-fried rice to serve for lunch the next day. The rice was cooked to the right temperature at 1:00 p.m. It was then covered and placed on a countertop, where it was allowed to cool at room temperature. At 6:00 p.m., the cook placed the rice in the refrigerator. At 9:00 a.m. the following day, the rice was combined with the other ingredients for stir-fried rice and cooked to 165°F (74°C) for at least 15 seconds. The cook covered the rice and left it on the stove until noon when she reheated it. Within an hour of eating the rice, several of the children complained that they were nauseous and began to vomit.

1. What pathogen caused the illness and why?

Roberto received a shipment of frozen mahi-mahi steaks. The steaks were frozen solid at the time of delivery, and the packages were sealed but contained a large amount of ice crystals, indicating they had been time-temperature abused. Roberto accepted the mahi-mahi steaks and thawed them in the refrigerator at a temperature of 38°F (3°C). The thawed fish steaks were then held at this temperature during the evening shift and were cooked to order. The chefs followed the right guidelines for prepping, cooking, and serving the fish, monitoring time and temperature throughout the process. Unfortunately, the fish steaks caused an outbreak of scombroid poisoning.

2. Why did the mahi-mahi steaks cause scombroid poisoning?
Match each foodborne illness with the best method for preventing it.

<table>
<thead>
<tr>
<th>Prevention Measure</th>
<th>Foodborne Illness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Purchasing from approved, reputable suppliers</td>
<td>1. Hemorrhagic colitis</td>
</tr>
<tr>
<td>B. Practicing personal hygiene</td>
<td>2. Neurotoxic shellfish poisoning (NSP)</td>
</tr>
<tr>
<td>C. Controlling time and temperature</td>
<td>3. Listeriosis</td>
</tr>
<tr>
<td>D. Preventing cross-contamination</td>
<td>4. Amnesic shellfish poisoning (ASP)</td>
</tr>
<tr>
<td></td>
<td>5. <em>Vibrio vulnificus</em> primary septicemia</td>
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<td></td>
<td>6. Staphylococcal gastroenteritis</td>
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<td></td>
<td>7. Norovirus gastroenteritis</td>
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<td></td>
<td>8. Salmonellosis</td>
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<td></td>
<td>9. Giardiasis</td>
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<td></td>
<td>10. Scombroid poisoning</td>
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<tr>
<td></td>
<td>11. Shigellosis</td>
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<tr>
<td></td>
<td>12. <em>Bacillus cereus</em> gastroenteritis</td>
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<tr>
<td></td>
<td>13. Botulism</td>
</tr>
<tr>
<td></td>
<td>14. <em>Clostridium perfringens</em> gastroenteritis</td>
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<tr>
<td></td>
<td>15. Hepatitis A</td>
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<tr>
<td></td>
<td>16. Anisakiasis</td>
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<tr>
<td></td>
<td>17. Cryptosporidiosis</td>
</tr>
<tr>
<td></td>
<td>18. Paralytic shellfish poisoning (PSP)</td>
</tr>
<tr>
<td></td>
<td>19. Ciguatera fish poisoning</td>
</tr>
<tr>
<td></td>
<td>20. <em>Vibrio</em> gastroenteritis</td>
</tr>
</tbody>
</table>

*For answers, please turn to page 2.37.*
Study Questions

Circle the best answer to each question below.

1. Foodborne pathogens grow well at temperatures
   A. below 32˚F (0˚C).
   B. between 1˚F to 40˚F (-17˚C to 4˚C).
   C. between 41˚F to 135˚F (5˚C to 57˚C).
   D. above 212˚F (100˚C).

2. FAT TOM stands for Food, Acidity, Temperature, Time, Oxygen and
   A. Meat.
   B. Moisture.
   C. Melatonin.
   D. Management.

3. Which pathogen is primarily found in the hair, nose, and throat of humans?
   A. Giardia duodenalis
   B. Bacillus cereus
   C. Clostridium botulinum
   D. Staphylococcus aureus

4. While commonly linked with contaminated ground beef, what pathogen has also been linked with contaminated produce?
   A. Bacillus cereus
   B. Salmonella spp.
   C. Shiga toxin-producing E. coli
   D. Clostridium perfringens

5. Which practice can reduce Salmonella spp. in poultry to safe levels?
   A. Storing food at 55˚F (13˚C) or higher
   B. Inspecting canned food for damage
   C. Cooking food to the right temperature
   D. Purchasing oysters from approved, reputable suppliers

6. Covering wounds can help prevent the spread of which pathogen?
   A. Staphylococcus aureus
   B. Norovirus
   C. Vibrio vulnificus
   D. Salmonella spp.
7 Which foodborne illness has been linked with ready-to-eat food and shellfish contaminated by sewage?
   A Hepatitis A
   B Anisakiasis
   C Shigellosis
   D Botulism

8 Viruses such as Norovirus and hepatitis A can be spread when foodhandlers fail to
   A use pasteurized eggs.
   B wash their hands.
   C determine the correct moisture level.
   D purchase beef from approved, reputable suppliers.

9 What is the best way to prevent a foodborne illness caused by seafood toxins?
   A Freezing seafood prior to cooking it
   B Purchasing smoked or cured seafood
   C Purchasing seafood from approved, reputable suppliers
   D Cooking seafood to the right minimum internal temperature

10 A person who ate raw oysters later became disoriented and suffered memory loss. What illness was most likely the cause?
   A Amnesic shellfish poisoning
   B Paralytic shellfish poisoning
   C Neurotoxic shellfish poisoning
   D Hemorrhagic shellfish poisoning

11 Foodservice operations should not use mushrooms unless they have been
   A stored at 41°F (5°C) or lower.
   B frozen before cooking or serving.
   C purchased from an approved, reputable supplier.
   D cooked to an internal temperature of 135°F (57°C).

For answers, please turn to page 2.37.
2.36 ServSafe Essentials

**Answers**

2.5 **What I Need to Grow**

2 should be marked.

2.5 **TCS or Not?**

2 and 6 should be marked.

2.10 **Viruses: Who Am I?**

1. Hepatitis A
2. Norovirus

2.18 **Bacteria: Who Am I?**

1. *Salmonella* spp.
2. *Staphylococcus aureus*
3. *Bacillus cereus*
4. *Clostridium perfringens*
5. *Clostridium botulinum*

2.22 **Parasites: Who Am I?**

1. *Giardia duodenalis*
2. *Anisakis simplex*
3. *Cryptosporidium parvum*

2.24 **Fungi: Who Am I?**

1. Yeast
2. Mold

2.31 **Seafood Toxins: Who Am I?**

1. Ciguatoxin
2. Histamine
3. Saxitoxin
4. Domoic acid
5. Brevetoxin
2.32 Chapter Review Activities

Scenarios
1. *Bacillus cereus* caused the illness. It is commonly linked with cooked rice. The pathogen was allowed to grow when the rice was cooled incorrectly and held at the wrong temperature.

2. When the mahi-mahi was time-temperature abused, the bacteria on the fish produced the toxin histamine. Because cooking does not destroy this toxin, eating the fish resulted in scombroid poisoning.

Matching
1. C  
2. A  
3. C  
4. A  
5. A  
6. B  
7. B  
8. D  
9. A  
10. A

2.34 Study Questions

1. C  
2. B  
3. D  
4. C  
5. C  
6. A  
7. A  
8. B  
9. C  
10. A  
11. C