Introduction
In these chapters, you will learn about the microorganisms that cause foodborne illness, as well as the conditions they require to grow. When you understand these conditions, you will begin to see how the growth of microorganisms can be controlled. You will also learn that food is considered contaminated when it contains hazardous substances. These substances may be biological, chemical or physical. The most common food contaminants are biological contaminants that belong to the microworld - bacteria, parasites, viruses and fungi. Most foodborne illnesses result from these contaminants, but biological and chemical toxins are also responsible for some foodborne illnesses.

How Contamination Occurs
Most pathogens get onto food and food-contact surfaces because of the way people handle them. For example, food handlers who do not wash their hands properly after using the restroom may contaminate food and food-contact surfaces with feces from their fingers. This is called the fecal-oral route of contamination. Food handlers can also pass on pathogens when they are in contact with a sick person. Pathogens are easily passed on by:

- person to person contact
- sneezing or vomiting onto food or food-contact surfaces
- touching dirty food-contact surfaces and equipment and then touching food
- allowing ready-to-eat food to touch surfaces that have been in contact with raw meat, seafood or poultry
- storing food or cleaning products incorrectly
- failure to spot signs of pests in the operation
- Microorganisms are small living beings that can only be seen under a microscope. While not all microorganisms cause disease, some do. These are called pathogens. Eating food contaminated with pathogens or their toxins is the leading cause of foodborne illness.

Microbial contaminants
There are four types of microorganisms that can contaminate food and cause illness: bacteria, viruses, parasites and fungi. These microorganisms can be broken into two groups: pathogens and spoilage microorganisms. Mold is an example of a spoilage microorganism. While moldy food has an unpleasant appearance, smell and taste, it seldom causes illness. However, pathogens such as Salmonella and Hepatitis A virus cannot be seen, smelled or tasted, but food contaminated by these pathogens often causes some form of illness when ingested.

Symptoms of a Foodborne Illness
Symptoms of foodborne illness vary, depending on the type of pathogen involved, but the most common are:

- Nausea, Vomiting or Diarrhea
- Fever
- Abdominal cramps
- Jaundice (a yellowing of the skin and eyes)

Not every person who has a foodborne illness will have all of these symptoms, and other symptoms may occur. How quickly foodborne illness symptoms occur is known as the onset time of the illness. Onset times depend on the type of foodborne illness and can range from 30 minutes to 6 weeks. The severity of illness can also vary, from mild diarrhea to death.

The Big Six
According to the Food and Drug Administration (FDA), there are over 40 different kinds of bacteria, viruses, parasites and fungi that can occur in food and cause a foodborne illness. Of these, six have been singled out by the FDA. They have been named "The Big Six" because they are highly infectious.

- Shigella spp.
- Salmonella Typhi
- Nontyphoidal Salmonella (NTS)
- Shiga toxin-producing Escherichia coli (STEC), also known as E. coli
Hepatitis A
Norovirus

These pathogens are often found in very high numbers in an infected person's feces and can be transferred to food easily. Because only a very small amount of the pathogen is necessary to cause severe illness, it is important that food handlers diagnosed with these illness be banned from the foodservice establishment while they are ill.

Bacteria
Of all microorganisms, bacteria are of the greatest concern to the foodservice manager. Knowing what bacteria are and understanding the environment in which they grow is the first step in controlling them.

Basic Characteristics of Bacteria:
- they are living, single cell organisms
- they are found almost everywhere, including in and on our bodies
- some keep us healthy, while others cause illness
- they cannot be seen, smelled or tasted
- they may be carried by a variety of means: food, water, soil, humans, animals or insects
- most can survive freezing, but cannot multiply at cold temperatures
- some turn into spores, a conditions which protects them from unfavorable conditions, but cannot reproduce in this form
- some cause illness by producing toxins as they multiply, die and break down, these toxins are not typically destroyed by cooking
- under favorable conditions, they can reproduce very rapidly
- the most important way to prevent bacteria from causing foodborne illness is to control time and temperature

Bacterial Growth
In order for bacteria to grow, they need:
- Food
- Appropriate level of acidity (neutral to slightly acidic)
- Proper temperature
- Adequate time
- The necessary level of oxygen
- Ample moisture

The growth can be broken down into four phases:

1. Lag Phase - when bacteria are introduced to food, they go through an adjustment period called the lag phase. In this phase, their number is stable as they prepare for growth. To control their number and prevent food from becoming unsafe, it is important to prolong the lag phase for as long as possible.
2. Log Phase - the next phase of bacterial growth. In this phase, their growth is remarkable fast. Bacteria reproduce by splitting in two. Those in the process of reproduction are said to be vegetative microorganisms. As long as conditions remain favorable, bacteria can grow very rapidly, doubling their numbers as often as every twenty minutes. This is called exponential growth. Food will rapidly become unsafe in the lag phase.
3. Stationary Phase - bacteria can grow until nutrients and moisture become scarce, or conditions become unfavorable. Eventually, the population reaches the stationary phase, in which as many bacteria are dying as are growing.
4. Death phase - the death phase is when the number of bacteria that are dying exceeds the number growing.

The time required for bacteria to adapt to a new environment (lag phase) and begin a rapid rate of growth (log phase) depends on a number of factors, such as temperature.
Vegetative States and Spore Formation

Although vegetative bacteria may survive low - even freezing - temperatures, they can be killed by high temperatures. Some types of bacteria, however, have the ability to change into a different form, called a spore. The spore's thick wall protects the bacteria against unfavorable conditions such as high or low temperatures, low moisture and high acidity. While a spore cannot reproduce, it is capable of turning back into a vegetative organism when conditions again become favorable.

Remember this acronym for what microorganisms need to grow:

**FAT TOM**

- **F** - Food
- **A** - Acidity
- **T** - Temperature
- **T** - Time
- **O** - Oxygen
- **M** - Moisture or water activity (Aw). Water activity is based on a scale of 0-1, where water is 1.0.

**Food** - To grow, pathogens need an energy source, such as carbohydrates or proteins. They are found in TCS foods such as meat, poultry, dairy products and eggs.

**Acidity** - pH - pH is the measure of food's alkalinity or acidity. pH above 7.0 is alkaline, and a pH under 7.0 is acidic. pH of 7.0 is neutral. Pathogenic bacteria grow best in food that is slightly acidic to neutral, with a pH of 4.6-7.5.

**Temperature** - The ideal temperature for pathogen growth is 41oF - 135oF, also known as the temperature danger zone. Bacteria grow even more rapidly from 70oF - 125oF.

**Time** - Usually after 4 hours in the temperature danger zone, pathogens will grow to high enough levels to cause foodborne illness. Bacteria need time to grow. The more time pathogens spend in the temperature danger zone, the more opportunity they have to grow to unsafe levels. Four (4) hours is based on the lag phase of bacteria.

**Oxygen** - Some pathogens need oxygen to grow while others don't. Rice, oil-and-garlic mixtures, and temperature-abused baked potatoes are examples of food without oxygen where pathogens can grow.

**Moisture** - Water activity (Aw) is measured on a scale of 0 to 1.0 with water having Aw of 1.0. Food with an Aw of .85 or higher is ideal for the growth of pathogens.

FATTOM is the key to controlling the growth of pathogens in food since denying any of these will help prevent growth. However, you will most likely only be able to control time and temperature. 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 food spends in the temperature danger zone.

TCS foods are foods that require Time and Temperature Control for Safety. They are also referred to as potentially hazardous foods. These foods have a natural potential for contamination because of the way they are grown, produced or processed. They are commonly involved in foodborne illness outbreaks. Some examples include, but are not limited to: sprouting seeds, baked potatoes, garlic and oil mixtures, watermelons, tomatoes and leafy greens. Salads using leftover TCS foods must be date marked and refrigerated at 41oF or lower and may be kept up to 7 days from the date the oldest TCS food was prepared.

**Bacteria**

1. **Illness:** **Typhoid Fever**

**Bacteria:** Salmonella Typhi. - Salmonella Typhi lives only in humans. People with typhoid fever carry the bacteria in their intestinal tract and bloodstream. Eating only a small amount of these bacteria can make a person ill. The severity of illness depends on the health of the person and the number of bacteria consumed. The bacteria are often in a person's feces for weeks after symptoms have ended.

**Food commonly linked with the bacteria:** ready-to-eat food, beverages

**Most common symptoms:** high fever, weakness, abdominal pain, headache, loss of appetite, rash

**Prevention Measures:** exclude food handlers who have been diagnosed with an illness caused by Salmonella Typhi from the operation, wash hands, cook food to minimum internal temperature

**Most important prevention measure:** Preventing Cross-Contamination
2. Illness:  **Salmonellosis**

*Bacteria* - Nontyphoidal Salmonella spp. - many farm animals carry the bacteria naturally. Eating only a small amount of these bacteria can make a person sick. How severe the symptoms are depends on the health of the person and the amount of the 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  

*Prevention Measures:* cook poultry and eggs to minimum temperature, prevent cross-contamination between poultry and ready-to-eat food, keep food handlers with salmonellosis out of the operation

*Most important prevention measure:* Preventing Cross-Contamination

3. Illness:  **Shigellosis**

*Bacteria* - Shigella spp. - found in the intestines of humans with shigellosis, most illnesses occur when people consume 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 found in a person's feces for weeks after symptoms have ended.

*Foods commonly linked with the bacteria:* food that is easily contaminated by the hands, such as salads containing TCS food (potato, tuna, shrimp, macaroni and chicken), food that has made contact with contaminated water, such as produce  

*Most common symptoms:* Bloody diarrhea, abdominal pain and cramps, fever (occasionally)  

*Prevention Measures:* keep food handlers who have diarrhea out of the operation, keep food handlers who have shigellosis out of the operation, wash hands, control flies inside and outside the operation

*Most important prevention measure:* Practicing personal hygiene

4. Illness:  **Hemorrhagic colitis**

*Bacteria* - Shiga-toxin producing Escherichia coli, (STEC) commonly called E. coli - found in the intestines of cattle, it can contaminate meat during slaughtering. Eating only a small portion can make a person ill. Once eaten, it produces toxins in the intestines, which cause the illness. The bacteria are often in the person's feces for weeks after symptoms have ended.

*Food commonly linked with the bacteria:* ground beef (raw and undercooked), contaminated produce  

*Most common symptoms:* diarrhea (eventually becoming bloody), abdominal cramps, kidney failure (in severe cases)  

*Prevention Measures:* cook food, especially ground beef, to minimum internal temperature, purchase produce from approved, reputable suppliers, prevent cross contamination between raw meat and ready-to-eat food, keep employees with diarrhea out of the operation, keep employees with hemorrhagic colitis out of the operation

*Most important prevention measure:* Controlling time and temperature

5. Illness:  **Bacillus cereus gastroenteritis**

*Bacteria* - Bacillus cereus - 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, a) diarrhea illness and b) vomiting illness  

*Food commonly linked with the bacteria:* a) cooked vegetables, meat products and milk; b) cooked rice dishes, including fried rice and bread pudding  

*Most common symptoms:* a) diarrhea illness - watery diarrhea, no vomiting; b) vomiting illness - nausea and vomiting  

*Prevention Measures:* cook food to minimum internal temperatures, hold food at the correct temperatures, cool food correctly.

*Most important prevention measure:* Controlling time and temperature

6. Illness:  **Listeriosis**

*Bacteria* - Listeria monocytogenes - 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 and especially pregnant women are particularly vulnerable.

*Foods commonly linked with the bacteria:* raw meat, unpasteurized dairy products and ready-to-eat food such as deli meats, hot dogs and soft cheeses  

*Most common symptoms:* pregnant women - miscarriage; newborns - sepsis, pneumonia, meningitis
**Prevention Measures**: discard products with expired use-by or expiration dates, cook raw meat to minimum internal temperature, prevent cross-contamination between raw or undercooked food and ready-to-eat food and avoid using unpasteurized dairy products

**Most important prevention measure**: Controlling time and temperature

7. **Illness**: **Clostridium perfringens gastroenteritis**

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

**Foods commonly linked with the bacteria**: meat, poultry, dishes made with meat and poultry, such as gravies and stews

**Most common symptoms**: diarrhea, severe abdominal pain

**Prevention Measures**: cool and re-heat foods correctly, hold food at proper temperatures

**Most important prevention measure**: Controlling time and temperature

8. **Illness**: **Botulism**

**Bacteria**: 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, the bacteria grow without oxygen and can produce a deadly toxin when food is time-temperature abused. Without medical treatment, death is likely.

**Foods commonly linked with the bacteria**: incorrectly canned food (swollen cans), reduced oxygen packaged (ROP) food, temperature abused vegetables, such as baked potatoes and untreated garlic and oil mixtures

**Most common symptoms**: Initially - nausea and vomiting; later - weakness, double vision, difficulty speaking and swallowing

**Prevention Measures**: Hold, cool and reheat food correctly, inspect canned food for damage

**Most important prevention measure**: Controlling time and temperature

9. **Illness**: **Staphylococcal gastroenteritis**

**Bacteria**: Staphylococcus aureus - 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. Hint: poor personal hygiene. 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.

**Foods commonly linked with the bacteria**: food requiring handling during prep, including: TCS food (egg, tuna, chicken, and macaroni) and deli meat

**Most common symptoms**: nausea, vomiting and retching and abdominal cramps

**Prevention Measures**: wash hands, particularly after touching the hair, face or body, cover wounds on hands and arms, hold, heat and cool food correctly

**Most important prevention measure**: Practicing personal hygiene

10. **Illness**: **Vibrio gastroenteritis** and **Vibrio vulnificus primary septicemia**

**Bacteria**: Vibrio parahaemolyticus and Vibrio vulnificus - found in waters where shellfish are harvested (contaminated water), 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 develop primary septicemia, a severe illness that can lead to death.

**Foods commonly linked with the bacteria**: oysters from contaminated water

**Most common symptoms**: diarrhea, abdominal cramps and nausea, vomiting, low-grade fever and chills

**Prevention measures**: cook oysters to minimum internal temperature

**Most important prevention measure**: Purchasing food from approved, reputable suppliers

**Viruses**

Viruses are the smallest of the microbial contaminants. They consist of genetic material wrapped in an outer layer of protein. While a virus cannot reproduce outside a living cell, once inside a human cell, it will produce more viruses.
Basic Characteristics of Viruses
- they are carried by humans and animals
- unlike bacteria, they rely on a living cell to reproduce
- they are not complete cells
- unlike bacteria, they do not reproduce in food
- while they do not grow in food, they can be transmitted by food and still remain infectious in food
- viruses may survive freezing and are not destroyed by normal cooking temperatures
- they can be transmitted from person to person, from people to food and from people to food contact surfaces
- they usually contaminate food through a food handler’s improper personal hygiene
- they can contaminate both food and water supplies
- people can get viruses from food, water or contaminated surfaces
- foodborne illnesses from viruses usually occur through fecal-oral routes
- when customers get sick, it is usually because food was handled by an infected person
- viruses usually contaminate food through a food handler’s improper personal hygiene
- viruses die within 2 hours if they are not in a living cell

Practicing good personal hygiene is an important way to prevent the contamination of food by foodborne viruses. It is especially important to minimize bare-hand contact with ready-to-eat foods and practice frequent handwashing. Prohibit employees who have diarrhea, vomiting or jaundice from working.

1. Illness: **Hepatitis A**
   - Virus: Hepatitis A - normally found in the feces of the people infected by it. It is commonly linked to ready-to-eat food, but is also linked with shellfish contaminated by sewage. It is often transferred by people to food or equipment coming into contact with food. Infected persons 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 and jaundice (appears late)
   - Prevention measures: keep employees who have jaundice out of the operation, keep employees who have Hepatitis A out of the operation, practice frequent handwashing, minimize bare-hand contact with ready-to-eat food and purchase shellfish from approved, reputable suppliers
   - Most important prevention measure: Practicing good personal hygiene

2. Illness: **Norovirus gastroenteritis**
   - Virus: Norovirus - a virus of particular concern, and linked with ready-to-eat food and contaminated water. It is transferred by people to food or equipment coming into contact with food. It is very contagious within a few hours after eating it, and it remains in a person’s fecal matter for days after the symptoms have ended.
   - Foods commonly linked with the virus: ready-to-eat food, shellfish from contaminated water
   - Most common symptoms: vomiting, diarrhea, nausea and abdominal pain
   - Prevention measures: keep employees with diarrhea and vomiting out of the operation, keep employees who have Norovirus out of the operation, minimize bare-hand contact with ready-to-eat food, purchase shellfish from approved, reputable suppliers and wash hands frequently
   - Most important prevention measure: Practicing good personal hygiene

**Parasites**

Basic Characteristics of Parasites
- they are living organisms and need a host to survive (the host does not have to be living)
- they grow naturally in many animals - such as pigs, cats, rodents and fish - and can be transmitted to humans
- most are very small, often microscopic, but larger than bacteria
- they pose hazards to both food and water
- they are most commonly associated with seafood, wild game and food processed with contaminated water, such as produce
The most important way to prevent foodborne illness from parasites is to purchase food from approved, reputable suppliers.

1. **Illness: Anisakiasis**  
   **Parasite:** Anisakis simplex - illness occurs whenever a person eats raw or undercooked fish containing this parasite.  
   **Food commonly linked with the parasite:** raw and undercooked fish, including Herring, Cod, Halibut, Mackerel and Pacific Salmon  
   **Most common symptoms:** tingling in the throat, soughing up worms  
   **Prevention Measures:** cook fish to minimum internal temperatures; if serving raw or undercooked fish, purchase sushi-grade fish that has been frozen to the right time-temperature requirements  
   **Most important prevention measure:** purchase from an approved, reputable supplier

2. **Illness: Cryptosporidiosis**  
   **Parasite:** Cryptosporidium parvum - found in the fecal matter of persons infected with the parasite. Food handlers can transfer it to food when they touch food that have fecal matter on them. Daycare 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.  
   **Food commonly linked with the parasite:** contaminated water and produce  
   **Most common symptoms:** watery diarrhea, abdominal cramps, nausea and weight loss  
   **Prevention Measures:** use properly treated water, keep food handlers with diarrhea out of the operation and wash hands frequently  
   **Most important prevention measure:** purchase food from an approved, reputable supplier

3. **Illness: Giardiasis**  
   **Parasite:** Giardia duodenalis, aka G. lamblia or G. intestinalis - found in the fecal matter of infected people. Food handlers can transfer the parasite to food when they touch it with fingers contaminated with fecal material.  
   **Food commonly linked with the parasite:** improperly treated water and produce  
   **Most common symptoms:** initially - fever; later - diarrhea, abdominal cramps and nausea  
   **Prevention Measures:** use properly treated water, keep food handlers with diarrhea out of the operation and wash hands frequently  
   **Most important prevention measure:** purchase from an approved, reputable supplier

**Fungi**  
Fungi range in size from microscopic, single-celled organisms to very large, multicellular organisms. They are found naturally in air, soil, plants, water and some food. Molds, yeasts and mushrooms are examples of fungi. The fungi of concern to the food service industry are typically molds and yeasts.

**Molds**  
Molds are spoilage microorganisms. Individual mold cells can be seen only with a microscope. However, fuzzy or slimy mold colonies, consisting of a large number of cells, are often visible to the naked eye. The spores produced by molds are not the same as the spores produced by bacteria. Molds use spores for reproduction.

Molds are responsible for the spoilage of food. This spoilage results in discoloration and the formation of odors and off-flavors. Molds are able to grow on almost any food at almost any storage temperature. They can also grow in environments that are moist or dry, have a high or low pH, and are salty or sweet. They typically prefer to grow in and on acidic food with low water activity. Molds often spoil fruit, vegetables, jams and jellies, meat, cheese, bread and cured, salty meats such as ham, bacon and salami because of their water activity and pH.

While most molds are just spoilage microorganisms, some molds produce toxins that can cause allergic reactions, nervous system disorders and kidney or liver damage. For example, aflatoxin, produced by some molds, can cause liver disease.
Basic Characteristics of Foodborne Molds
- they spoil food and sometimes cause illness
- they grow under almost any condition, but prefer acidic foods with low water activity
- cooler and freezer temperatures prevent or reduce the growth of molds, but do not destroy them
- some molds produce toxins such as aflatoxin
- foods such as corn and corn products, peanuts and peanut products, cottonseed, milk and tree nuts (pistachios, pecans, walnuts and Brazil nuts) have been associated with aflatoxin

Although the FDA recommends cutting away any moldy areas in hard cheese, at least one inch around them, to avoid illness caused by mold toxins, throw out all moldy food, unless the mold is a natural part of food (such as Gorgonzola, Bleu or Brie).

While mold cells and spores can be killed by heating them, toxins that may be present are not destroyed by normal cooking methods. Foods with molds that are not a natural part of the product should always be discarded.

Yeast

Some yeasts are known for their ability to spoil food rapidly. Yeasts are similar to molds in that they grow well in acidic food with low water activity, such as jellies and jams, syrup, honey and fruit juice. Food that has been spoiled by yeasts should be discarded. Signs of spoilage can include a smell or taste of alcohol. The yeast may look like a white or pink discoloration, or slime, and may bubble.

Foodborne Infection vs. Foodborne Intoxication
- **Foodborne Infection** - results when a person eats food containing pathogens which then grow in the intestines and cause illness. Typically, symptoms of a foodborne infection do not appear immediately in a reasonably healthy person.
- **Foodborne Intoxication** - results when a person eats food containing toxins that cause illness. The toxin may have been produced by pathogens found on the food or may be the result of a chemical contamination. The toxin might also be a natural part of the food. Typically, the symptoms of a foodborne intoxication appear quickly, usually within a few hours.

Toxins

A foodborne intoxication occurs when a person eats food containing toxins. Toxins in seafood, plants and mushrooms are responsible for many cases of foodborne intoxication each year. Some toxins are produced by pathogens found on food, while some fish toxins are systemic - that is, they occur as a natural part of the fish. Examples of potentially toxic fish include moray eels, freshwater minnows and puffer fish. Puffer fish, which contains tetrodotoxin in its liver, skin and other organs, is considered a delicacy, and requires a special license to butcher or process. Consuming the toxin in this fish can produce rapid and violent death.

Basic Characteristics of Toxins
- they may be systemic - naturally occurring
- they may be produced by pathogens found on the fish when it is time-temperature abused
- they may be a result of chemical contamination
- they can be a result of eating a plant or animal that produces the toxin
- seafood toxins cannot be seen, smelled or tasted
- toxins are not living organisms
- they cannot be destroyed by freezing or cooking once they form in a food

The most important way to prevent a foodborne illness caused by toxins is to purchase seafood, plants and mushrooms from an approved, reputable supplier. Also, control time and temperature while handling raw fish. Fish deliveries should be inspected for signs of time-temperature abuse - reject any fish that shows signs of being thawed and refrozen (fish with ice crystals, freezer burn or spotty color, cases that are wet or show signs of water damage). Check temperatures of fish deliveries and thaw frozen fish under refrigeration at temperatures of 41oF or lower. Because
shellfish may contain toxins that occur because of algae on which they feed, it is important to purchase shellfish from approved suppliers who can certify that the shellfish have been harvested from safe waters.

1. Illness: **Scombroid poisoning**
   *Toxin*: Histamine - also known as Histamine poisoning, it is 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. This is a naturally occurring toxin that is okay to eat unless the fish has been time-temperature abused.
   *Food commonly linked with the toxin*: Tuna, Bonito, Mackerel and Mahi Mahi
   *Most common symptoms*: Initially - reddening of the face and neck, sweating, headache, burning or tingling sensation in the mouth or throat
   *Prevention Measures*: prevent time-temperature abuse during storage and prep
   *Most important prevention measure*: purchasing from approved, reputable suppliers

2. Illness: **Ciguatera fish poisoning**
   *Toxin*: Ciguatoxin - found in certain marine algae, the toxin builds up in certain fish when they eat smaller fish that consumed the toxic algae. Ciguatoxin cannot be detected by smell or taste. Cooking and freezing will not eliminate the toxin. Symptoms may last months or years depending on how severe the illness is.
   *Foods 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, Jacks, Grouper and Snapper
   *Most common symptoms*: Reversal of hot and cold sensations, nausea, vomiting, tingling in fingers, lips or toes, and joint and muscle pain
   *Prevention Measures*: prevent time-temperature abuse during storage and prep
   *Most important prevention measure*: purchase from approved, reputable suppliers

3. Illness: **Paralytic Shellfish Poisoning (PSP)**
   *Toxin*: Saxitoxin - 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, and 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 and Scallops
   *Most common symptoms*: numbness, tingling of the mouth and face, arms and legs, dizziness, nausea, vomiting and diarrhea
   *Most important prevention measure*: purchasing from approved, reputable suppliers

4. Illness: **Neurotoxic Shellfish Poisoning (NSP)**
   *Toxin*: Brevetoxin - 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 is not destroyed by freezing or cooking, and it cannot be smelled or tasted.
   *Foods 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 and Oysters
   *Most common symptoms*: tingling and numbness of the lips, tongue and throat; dizziness, reversal of hot and cold sensations, vomiting and diarrhea
   *Most important prevention measure*: purchase from approved, reputable suppliers

5. Illness: **Amnesic Shellfish Poisoning (ASP)**
   *Toxin*: Domoic Acid - some types of shellfish can become contaminated as they filter toxic algae from the water. People get sick with ASP when they eat these shellfish. The severity of symptoms depends on the health of the person and the amount of the toxin eaten. Domoic acid cannot be smelled or tasted and it is not destroyed by freezing or cooking.
   *Foods commonly linked with the toxin*: shellfish found in the coastal waters of the pacific Northwest and the east coast of Canada, including: Clams, Mussels, Oysters and Scallops
**Most common symptoms:** initially - vomiting, diarrhea and abdominal pain; possibly later - confusion, memory loss, disorientation, seizure and coma

**Most important prevention measure:** purchase from approved, reputable supplier

**Plant Toxins**
Plant toxins are another form of biological contamination. Some illnesses have occurred after animals have eaten toxic plants and people have consumed the by-products of those animals. In general, only commercially processed honey and properly cooked beans should be used.

**Mushroom toxins**
Foodborne illness outbreaks associated with mushrooms are almost always caused by the consumption of wild mushrooms collected by amateur mushroom hunters. Most cases occur when toxic mushroom species are confused with edible species. Some mushroom toxins will destroy internal organs, others cause convulsions, hallucinations and coma, and others produce nausea, vomiting, abdominal cramping and diarrhea.

Cooking or freezing will not destroy the toxins produced by toxic wild mushrooms. Establishments should not use mushrooms picked in the wild or the products made with them unless the mushrooms have been purchased from approved, reputable suppliers.

**Chemical Contamination**
Chemical contaminations are responsible for many cases of foodborne illness. These include toxic metals, pesticides and chemicals. Chemicals used in a food service operation must be approved for use by the operation. Purchase them from approved, reputable suppliers.

**Toxic Metals**
Utensils and equipment that contain toxic metals - such as lead, zinc, copper, brass, pewter, antimony and cadmium - can cause a toxic metal poisoning. If acidic food is stored or prepared with this type of equipment, it can leach these metals from the item and become contaminated. Only food-grade utensils and equipment should be used to prepare and store food.

**Chemicals and Pesticides**
Store chemicals such as cleaning products, polishes lubricants, and sanitizers away from food and food contact surfaces. Use chemicals for their intended use only and in accordance with the manufacturer's directions. Store chemicals in a locked storage area or in their original containers. If chemicals are stored in containers that are not original, labels on chemicals must be legible. MSDS sheets must be current and accessible to all employees. Follow manufacturer's directions and local regulatory requirements when discarding chemicals.

Pesticides should be applied only by a licensed pest control operator. A good pest control program should treat the operation at least once a month. All food should be wrapped or stored prior to the application of the pesticide. Pesticides should be stored with the same care as other chemicals used in the establishment.

**Physical Contamination**
Physical contamination can occur when foreign objects are accidentally introduced into the food, or when naturally occurring objects, such as bones in fillets, pose a physical hazard. Common physical contaminants include metal shavings from cans, staples from cartons, glass, blades from plastic or rubber scrapers, fingernails, hair, bandages, dirt and bones.

**The Deliberate Contamination of Food**
While the principles of food safety help an establishment address the accidental contamination of food, managers must also be aware of how to prevent the deliberate contamination of food, known as food security. Certain people could try to tamper with your food. This includes terrorists or activists, current or former staff, vendors or competitors. In addition to biological, chemical or physical contaminants, nuclear and radioactive contaminants are also a concern.
Threats to food safety in the restaurant and food service industry might occur at any level in the food-supply chain and are the result of criminal activity. These acts are usually focused on a specific food item, process or business.

The key to protecting food is to make it as difficult as possible for even a single tampering to occur. An effective food defense program will consider all the points in your operation where food is vulnerable to intentional contamination. Managers must ensure that all employees are aware of their roles in keeping food secure in the operation by developing procedures and training that address each potential threat. The FDA has created a tool that can be used to develop a food defense program. It is based on the acronym ALERT and can be used to help you identify the points in your operation where food is at risk.

Assure - make sure that products you receive are from safe sources:
- supervise product deliveries
- use approved suppliers who practice food defense
- request that food delivery vehicles are locked or sealed

Look - monitor the security of products in the facility
- limit access to prep and storage areas, for example, by locking storage areas
- create a system for handling damaged products
- store chemicals in a secure location
- train staff to spot defense threats

Employees - know who is in your facility
- limit access to prep and storage areas
- identify all visitors and verify credentials
- conduct background checks on staff

Reports - keep information related to food defense accessible
- receiving logs
- office files and documents
- staff files
- random food defense self-inspections

Threat - identify what to do and who to contact in the event of a suspicious activity or a threat at your operation
- Hold any product you suspect to be contaminated
- contact your regulatory authority immediately
- maintain an emergency contact list

Crisis Management
Despite your best efforts, it is possible that a foodborne illness outbreak can occur at your establishment at any time. How you respond when that happens can determine whether or not you end up in the middle of a crisis. The time to prepare for a crisis is before one occurs.

Developing a Plan
When developing a plan, start by stating the basic objectives of the plan. There are a number of steps you can take to prepare for the possibility of a crisis:
- develop a crisis management team
- identify potential crisis
- develop simple instructions on what to do in each type of crisis
- assemble a contact list and post it by the phones
- develop a crisis communication plan
- assign and train a spokesman to handle media relations
- assemble a crisis kit for the establishment
- test the plan by running a simulation
Crisis Response
You may be able to avert a crisis by responding quickly when you do receive customer complaints. Express your concern and be sincere, but do not admit responsibility or accept liability. With legal guidance, consider developing an incident report to help you through the process.

Post Crisis Assessment
Once the crisis has passed, it is important to determine the causes and effects of the crisis so that your establishment can implement changes to take advantage of the lessons learned. A foodborne illness outbreak has the potential to damage your business beyond repair. Investing time and resources in a crisis management plan can ensure against that. Remember these three key rules of crisis management:

- take steps to prevent a crisis from occurring by practicing good safety habits
- prepare for the possibility of a crisis by preparing contingency plans
- if a crisis does occur, take control of the situation; use your plan to manage the crisis thoughtfully, honestly and as quickly as possible

According to the CDC, there are 5 major risk factors for unsafe food;

- purchasing food from unsafe suppliers - this accounts for 90% of foodborne illness
- cross-contamination
- failure to cook food to required internal temperatures
- holding and cooling food improperly
- poor personal hygiene

Food Allergens
Six to seven million Americans have food allergies. An allergic reaction is the body's negative reaction to a particular food protein. Depending on the person, allergic reactions to food may occur immediately after the food is eaten, or up to several hours later. The reaction could include any of the following:

- itching in or around the mouth, face or scalp
- wheezing or shortness of breath or tightening of the throat
- difficulty breathing
- hives
- swelling, particularly of the face, neck hands or feet
- nausea, vomiting or abdominal pain

Your employees should be aware of the most common food allergens and should be able to inform guests of menu items which contain these potential allergens. At a minimum, they should be able to tell customers exactly what is in a dish. Customers usually know what foods they are allergic to, it is our job to know what is in the food we serve.

The eight most common food allergens are:

- milk and dairy products
- egg and egg products
- wheat
- peanuts
- tree nuts
- fish
- shellfish
- soy and soy products

Cross-contact occurs when food allergens or food allergen residues are transferred from food containing a common allergen to the food served to the customer. To prevent cross-contact, wash, rinse and sanitize cookware, utensils and equipment after handling a food allergen. Kitchen staff must be informed when serving a guest with a food allergy. Servers should deliver food to these customers separately, by hand, to avoid cross-contact.