11.5: Foodborne Illness and Food Safety

Learning Objectives

- Describe the ideal environment for microorganisms to reproduce.
- Give examples of bacteria, viruses, parasites, and molds that have the potential to cause foodborne illness.
- Discuss government efforts to protect the health of the population, and precautions consumers can take to protect themselves.

Foodborne illness is another serious threat to health. Sometimes called “food poisoning,” foodborne illness is a common public health problem that can result from exposure to a pathogen or a toxin via food or beverages. Raw foods, such as seafood, produce, and meats, can all be contaminated during harvest (or slaughter for meats), processing, packaging, or during distribution, though meat and poultry are the most common source of foodborne illness. For all kinds of food, contamination also can occur during preparation and cooking in a home kitchen or in a restaurant. In many developing nations, contaminated water is also a major source of foodborne illness.

Many people are affected by foodborne illness each year, making food safety a very important issue. Annually, one out of six Americans becomes sick after consuming contaminated foods or beverages. Centers for Disease Control and Prevention. “Food Safety at CDC.” Last updated June 28, 2011. http://www.cdc.gov/foodsafety/facts.html. Foodborne illness can range from mild stomach upset to severe symptoms, or even fatalities. The problem of food contamination can not only be dangerous to your health, it can also be harmful to your wallet. Medical costs and lost wages due to salmonellosis, just one foodborne disease, are estimated at over $1 billion per year.

At-Risk Groups

No one is immune from consuming contaminated food. But, whether you become seriously ill depends on the microorganism, the amount you have consumed, and your overall health. In addition, some groups have a higher risk
than others for developing severe complications to foodborne disease. Who is most at risk? Young children, elderly people, and pregnant women all have a higher chance of becoming very sick after consuming contaminated food. Other high-risk groups include people with compromised immune systems due to HIV/AIDS, immunosuppressive medications (such as after an organ transplant), and long-term steroid use for asthma or arthritis. Exposure to contaminated food could also pose problems for diabetics, cancer patients, people who have liver disease, and people who have stomach problems as a result of low stomach acid or previous stomach surgery. People in all of these groups should handle food carefully, make sure that what they eat has been cooked thoroughly, and avoid taking any chances that could lead to exposure.

The Major Types of Foodborne Illness

Foodborne illnesses are either infectious or toxic in nature. The difference depends on the agent that causes the condition. Microbes, such as bacteria, cause food infections, while toxins, such as the kind produced by molds, cause intoxications. Different diseases manifest in different ways, so signs and symptoms can vary with the source of contamination. However the illness occurs, the microbe or toxin enters the body through the gastrointestinal tract, and as a result common symptoms include diarrhea, nausea, and abdominal pain. Additional symptoms may include vomiting, dehydration, lightheadedness, and rapid heartbeat. More severe complications can include a high fever, diarrhea that lasts more than three days, prolonged vomiting, bloody stools, and signs of shock.

One of the biggest misconceptions about foodborne illness is that it is always triggered by the last meal that a person ate. However, it may take several days or more before the onset of symptoms. If you develop a foodborne illness, you should rest and drink plenty of fluids. Avoid antidiarrheal medications, because they could slow the elimination of the contaminant.
Food Infection

According to the CDC, more than 250 different foodborne diseases have been identified. Centers for Disease Control and Prevention. “Food Safety at CDC.” Last updated June 28, 2011. http://www.cdc.gov/foodsafety/facts.html. Most are food infections, which means they are caused from food contaminated by microorganisms, such as bacteria, by microscopic animals called parasites, or by viruses. The infection then grows inside the body and becomes the source of symptoms. Food infections can be sporadic and often are not reported to physicians. However, occasional outbreaks occur that put communities, states and provinces, or even entire nations at risk. For example, in 1994, an outbreak of the infection salmonellosis occurred in the United States due to contaminated ice cream. An estimated 224,000 people became ill. In 1988, contaminated clams resulted in an outbreak of hepatitis A in China, which affected about 300,000 people. World Health Organization. “Food Safety and Foodborne Illness.” Fact Sheet, no. 237. Last reviewed March 2007. www.who.int/mediacentre/factsheets/fs237/en/.

The Reproduction of Microorganisms

Bacteria, one of the most common agents of food infection, are single-celled microorganisms that are too small to be seen with the human eye. Microbes live, die, and reproduce, and like all living creatures, they depend on certain conditions to survive and thrive. In order to reproduce within food, microorganisms require the following:

- **Temperature.** Between 40°F and 140°F, which is called the danger zone, bacteria grow rapidly.
- **Time.** More than two hours in the danger zone.
- **Water.** High moisture content is helpful. Fresh fruits and vegetables have the highest moisture content.
- **Oxygen.** Most microorganisms need oxygen to grow and multiply, but a few are anaerobic and do not.
- **Acidity and pH Level.** Foods that have a low level of acidity (or a high pH level) provide an ideal environment, since most microorganisms grow best around 7.0 pH and not many will grow below 4.0 pH. Examples of higher pH foods include meat, seafood, milk, and corn. Examples of low pH foods include citrus fruits, sauerkraut, tomatoes, and pineapples.
- **Nutrient Content.** Microorganisms need protein, starch, sugars, fats, and other compounds to grow. Typically high-protein foods are better for bacterial growth.

Food Intoxication

Other kinds of foodborne illness are food intoxications, which are caused by natural toxins or harmful chemicals. These and other unspecified agents are major contributors to episodes of acute gastroenteritis and other kinds of foodborne illness. Scallan, E. et al. “Foodborne Illness Acquired in the United States—Unspecified Agents.” Emerg Infect Diseases 17, no. 1. Like pathogens, toxins and chemicals can be introduced to food during cultivation, harvesting, processing, or distribution. Some toxins can lead to symptoms that are also common to food infection, such as abdominal cramping, while others can cause different kinds of symptoms and complications, some very severe. For example, mercury, which is sometimes found in fish, can cause neurological damage in infants and children. Exposure to cadmium can cause kidney damage, typically in elderly people.
The Causes of Food Contamination

Both food infections and food intoxications can create a burden on health systems, when patients require treatment and support, and on food systems, when companies must recall contaminated food or address public concerns. It all begins with the agent that causes the contamination. When a person ingests a food contaminant, it travels to the stomach and intestines. There, it can interfere with the body’s functions and make you sick. In the next part, we will focus on different types of food contaminants and examine common microbes, toxins, chemicals, and other substances that can cause food infections and intoxications. Let’s begin with pathogens, which include bacteria and viruses. About one hundred years ago, typhoid fever, tuberculosis, and cholera were common diseases caused by food and water contaminated by pathogens. Over time, improvements in food processing and water treatment eliminated most of those problems in North America. Today, other bacteria and viruses have become common causes of food infection.

Bacteria

All foods naturally contain small amounts of bacteria. However, poor handling and preparation of food, along with improper cooking or storage can multiply bacteria and cause illness. In addition, bacteria can multiply quickly when cooked food is left out at room temperature for more than a few hours. Most bacteria grow undetected because they do not change the color or texture of food or produce a bad odor. Freezing and refrigeration slow or stop the growth of bacteria, but does not destroy the bacteria completely. The microbes can reactivate when the food is taken out and thawed.

Figure 1: Salmonella was first identified in 1885 and many types of this kind of bacteria exist. The incidence of Salmonella infections has risen dramatically in the past few decades. Color-enhanced scanning electron micrograph showing Salmonella Typhimurium (red) invading cultured human cells (Credit: Rocky Mountain Laboratories, NIAID, NIH). Image is public domain.

Many different kinds of bacteria can lead to food infections. One of the most common is Salmonella, which is found in the intestines of birds, reptiles, and mammals. Salmonella can spread to humans via a variety of different animal-origin foods, including meats, poultry, eggs, dairy products, and seafood. The disease it causes, salmonellosis, typically brings about fever, diarrhea, and abdominal cramps within twelve to seventy-two hours after eating. Usually, the illness lasts four to seven days, and most people recover without treatment. However, in individuals with weakened immune

The bacterium *Listeria monocytogenes* is found in soft cheeses, unpasteurized milk, and seafood. It causes a disease called listeriosis that can bring about fever, headache, nausea, and vomiting. *Listeria monocytogenes* mostly affects pregnant women, newborns, older adults, and people with cancer and compromised immune systems.

The food infection *E. coli* is caused by *Escherichia coli*. Sources include raw or undercooked meat, raw vegetables, unpasteurized milk, minimally processed ciders and juices, and contaminated drinking water. Symptoms can occur a few days after eating, and include watery and bloody diarrhea, severe stomach cramps, and dehydration. More severe complications may include colitis, neurological symptoms, stroke, and hemolytic uremic syndrome. In young children, an *E. coli* infection can cause kidney failure and death.

The bacterium *Clostridium botulinum* causes botulism. Sources include improperly canned foods, lunch meats, and garlic. An infected person may experience symptoms within four to thirty-six hours after eating. Symptoms could include nerve dysfunction, such as double vision, inability to swallow, speech difficulty, and progressive paralysis of the respiratory system. Botulism can also be fatal.

*Campylobacter jejuni* causes the disease campylobacteriosis. It is the most commonly identified bacterial cause of diarrhea worldwide. Consuming undercooked chicken, or food contaminated with the juices of raw chicken, is the most frequent source of this infection. Other sources include raw meat and unpasteurized milk. Within two to five days after consumption, symptoms can begin and include diarrhea, stomach cramps, fever, and bloody stools. The duration of this disease is about seven to ten days.

The food infection shigellosis is caused by *Shigella*, of which there are several types. Sources include undercooked liquid or moist food that has been handled by an infected person. The onset of symptoms occurs one to seven days after eating, and can include stomach cramps, diarrhea, fever, and vomiting. Another common symptom is blood, pus, or mucus in stool. Once a person has had shigellosis, the individual is not likely to get infected with that specific type again for at least several years. However, they can still become infected with other types of *Shigella*.

*Staphylococcus aureus* causes staphylococcal food poisoning. Food workers who carry this kind of bacteria and handle food without washing their hands can cause contamination. Other sources include meat and poultry, egg products, cream-filled pastries, tuna, potato and macaroni salad, and foods left unrefrigerated for long periods of time. Symptoms can begin thirty minutes to eight hours after eating, and include diarrhea, vomiting, nausea, stomach pain, and cramps. This food infection usually lasts one to two days.

Found in raw oysters and other kinds of seafood, *Vibrio vulnificus* belongs to the same family as the bacteria which cause cholera. This food contaminant can result in the *Vibrio* infection. Symptoms can begin anywhere from six hours to a few days after consumption, and include chills, fever, nausea, and vomiting. This disease is very dangerous and can result in fatalities, especially in people with underlying health problems. Centers for Disease Control and Prevention. “Food Safety at CDC.” Last updated June 28, 2011. [http://www.cdc.gov/foodsafety/facts.html](http://www.cdc.gov/foodsafety/facts.html).
Viruses

Viruses are another type of pathogen that can lead to food infections, however they are less predominant than bacteria. **Hepatitis A** is one of the more well-known food-contaminating viruses. Sources include raw shellfish from polluted water, and food handled by an infected person. This virus can go undetected for weeks and, on average, symptoms do not appear until about one month after exposure. At first, symptoms include malaise, loss of appetite, nausea, vomiting, and fever. Three to ten days later, additional symptoms can manifest, including jaundice and darkened urine. Severe cases of a hepatitis A can result in liver damage and death.

The most common form of contamination from handled foods is the **norovirus**, which is also known as the Norwalk-like virus, or the calicivirus. Sources include raw shellfish from polluted water, salads, sandwiches, and other ready-to-eat foods handled by an infected person. The norovirus causes gastroenteritis and within one to three days it leads to symptoms, such as nausea, vomiting, diarrhea, stomach pain, headache, and a low-grade fever. Centers for Disease Control and Prevention. "Food Safety at CDC." Last updated June 28, 2011. [http://www.cdc.gov/foodsafety/facts.html](http://www.cdc.gov/foodsafety/facts.html).

Parasitic Protozoa

Food-contaminating parasitic protozoa are microscopic organisms that may be spread in food and water. Several of these creatures pose major problems to food production worldwide. They include **Anisakis**, microscopic worms that invade the stomach or the intestines. Sources of this parasite include raw fish. This parasite can result in the Anisakis infection, with symptoms that begin within a day or less and include abdominal pain, which can be severe.

**Cryptosporidium** lives in the intestines of infected animals. Another common source is drinking water, when heavy rains wash animal wastes into reservoirs. One major problem with this pathogen is that it is extremely resistant to disinfection with chlorine. **Cryptosporidium** causes the disease cryptosporidiosis, with symptoms that begin one to twelve days after exposure and include watery stools, loss of appetite, vomiting, a low-grade fever, abdominal cramps, and diarrhea. For HIV/AIDS patients and others with weakened immune systems, the disease can be severe, and sometimes can lead to death.

**Giardia lamblia** is another parasite that is found in contaminated drinking water. In addition, it lives in the intestinal tracts of animals, and can wash into surface water and reservoirs, similar to **Cryptosporidium. Giardia** causes giardiasis, with symptoms that include abdominal cramping and diarrhea within one to three days. Although most people recover within one to two weeks, the disease can lead to a chronic condition, especially in people with compromised immune systems.

The parasite **Toxoplasma gondii** causes the infection toxoplasmosis, which is a leading cause of death attributed to foodborne illness in the United States. More than sixty million Americans carry **Toxoplasma gondii**, but very few have symptoms. Typically, the body’s immune system keeps the parasite from causing disease. Sources include raw or undercooked meat and unwashed fruits and vegetables. Handling the feces of a cat with an acute infection can also lead to the disease. Centers for Disease Control and Prevention. "Parasites." Last updated November 2, 2010. [http://www.cdc.gov/parasites/food.html](http://www.cdc.gov/parasites/food.html).

Mold Toxins

Warm, humid, or damp conditions encourage mold to grow on food. **Molds** are microscopic fungi that live on animals and plants. No one knows how many species of fungi exist, but estimates range from ten- to three-hundred thousand.

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Unlike single-celled bacteria, molds are multicellular, and under a microscope look like slender mushrooms. They have stalks with spores that form at the ends. The spores give molds their color and can be transported by air, water, or insects. Spores also enable mold to reproduce. Additionally, molds have root-like threads that may grow deep into food and be difficult to see. The threads are very deep when a food shows heavy mold growth. Foods that contain mold may also have bacteria growing alongside it.

Figure \(\PageIndex{2}\): Mold can grow on fruits, vegetables, grains, meats, poultry, and dairy products, and typically appears as gray or green “fur.” Moldy nectarines that were in a refrigerator. The nectarine with black mold is also affecting the nectarine underneath. Image used with permission from Roger McLassus 1951.

Some molds, like the kind found in blue cheese, are desirable in foods, while other molds can be dangerous. The spores of some molds can cause allergic reactions and respiratory problems. In the right conditions, a few molds produce mycotoxins, which are natural, poisonous substances that can make you sick if they are consumed. Mycotoxins are contained in and around mold threads, and in some cases, may have spread throughout the food. The Food and Agriculture Organization of the United Nations estimates that mycotoxins affect 25% of the world’s food crops. They are found primarily in grains and nuts, but other sources include apples, celery, and other produce.

The most dangerous mycotoxins are aflatoxins, which are produced by strains of fungi called Aspergillus under certain temperature and humidity conditions. Contamination has occurred in peanuts, tree nuts, and corn. Aflatoxins can cause aflatoxicosis in humans, livestock, and domestic animals. Symptoms include vomiting and abdominal pain. Possible complications include liver failure, liver cancer, and even death. Many countries try to limit exposure to aflatoxins by monitoring their presence on food and feed products.US Department of Agriculture, Food Safety and Inspection Service. “Molds on Food: Are They Dangerous?” Last modified March 4, 2010. www.fsis.usda.gov/FactSheets/Molds_On_Food/.

Poisonous Mushrooms

Like molds, mushrooms are fungi and the poisonous kind produces mycotoxins that can cause food intoxication. Toxic mushrooms, also known as toadstools, can cause severe vomiting and other symptoms. However, only a few varieties are fatal. Toxic mushrooms cannot be made safe by cooking, freezing, canning, or processing. The only way to avoid food intoxication is to refrain from eating them. Mushroom guides can help wild gatherers distinguish between the edible and toxic kinds.US Department of Agriculture, Food Safety and Inspection Service. “Molds on Food: Are They Dangerous?” Last modified March 4, 2010. www.fsis.usda.gov/FactSheets/Molds_On_Food/.
Pesticides

Pesticides are important in food production to control diseases, weeds, insects, and other pests. They protect crops and ensure a large yield. However, synthetic pesticides can leave behind residues, particularly on produce, that can be harmful to human health. Foods that contain the highest levels of pesticide residue include conventionally-grown peaches, apples, bell peppers, celery, nectarines, strawberries, cherries, pears, spinach, lettuce, and potatoes. Foods that contain the lowest levels of pesticide residue include avocados, pineapples, bananas, mangoes, asparagus, cabbage, and broccoli.

Hoffman, M. MD. “Safer Foods for a Healthier You.” Web MD. © 2009 WebMD, LLC. http://www.webmd.com/health-ehome-9/pesticides-hormones-in-food. In many cases, the amount of pesticide exposure is too small to pose a risk. However, harmful exposures can lead to certain health problems and complications, including cancer. Also, infants and young children are more susceptible to the hazards of pesticides than adults. In addition, using synthetic pesticides, herbicides, and fertilizers contributes to soil and water pollution and can be hazardous to farm workers.

To protect the public and their workers, many farmers now rely on alternatives to synthetic pesticide use, including crop rotation, natural pesticides, and planting nonfood crops nearby to lure pests away. Some consumers choose to reduce their exposure to pesticides by purchasing organic produce. Organic foods are grown or produced without synthetic pesticides or fertilizer, and all growers and processors must be certified by the US Department of Agriculture (USDA). However, conventionally-grown produce should be fine for fruits and vegetables that appear on the low-residue list.

Pollutants

Pollutants are another kind of chemical contaminant that can make food harmful. Chemical runoff from factories can pollute food products and drinking water. For example, dioxins are chemical compounds created in industrial processes, such as manufacturing and bleaching pulp and paper. Fish that swim in dioxin-polluted waters can contain significant amounts of this pollutant, which causes cancer. When metals contaminate food, it can result in serious and even life-threatening health problems. A common metal contaminant is lead, which can be present in drinking water, soil, and air. Lead exposure most often affects children, who can suffer from physical and mental developmental delays as a result.

Methyl mercury occurs naturally in the environment and is also produced by human activities. Fish can absorb it, and the predatory fish that consume smaller, contaminated fish can have very high levels. This highly toxic chemical can cause mercury poisoning, which leads to developmental problems in children, as well as autoimmune effects. A condition called Minamata disease was identified in 1956 in Japan. It was named for the town of Minamata, which was the site of an environmental disaster when methyl mercury was released into the surface water near a factory. Many residents experienced neurological issues, including numbness in hands and feet, muscle weakness, a narrowing of the field of vision, damage to hearing and speech, and ataxia, which is a lack of muscle coordination. Ministry of the Environment, Government of Japan. “Minamata Disease: The History and Measures.” © 2002. Accessed December 21, 2011. http://www.env.go.jp/en/chemi/hs/minamata2002/.

PCBs, or polychlorinated biphenyls, are man-made organic compounds that are used commercially. Like methyl mercury, higher concentrations of this contaminant are found in predatory fish. Health effects include physical and neurological development in children, and this compound is potentially a carcinogen. PCB contamination also can affect the immune, reproductive, nervous, and endocrine systems. US Environmental Protection Agency. “Health Effects of
Protecting the Public Health

Most foodborne infections go unreported and undiagnosed. However, the CDC estimates that about seventy-six million people in the United States become ill from foodborne pathogens or other agents every year. In North America, a number of government agencies work to educate the public about food infections and intoxications, prevent the spread of disease, and quell any major problems or outbreaks. They include the CDC, the FDA, the USDA, and Health Canada, among other organizations.

Efforts on the Governmental Level

A number of government agencies work to ensure food safety and to protect the public from foodborne illness. The USDA and the FDA enforce laws regarding the safety of domestic and imported food. In addition, the Federal Food, Drug, and Cosmetic Act of 1938 gives the FDA authority over food ingredients. The CDC tracks outbreaks, identifies the causes of food infection and intoxication, and recommends ways to prevent foodborne illness. Other government agencies that play a role in protecting the public include the Food Safety and Inspection Service, a division of the USDA, which enforces laws regulating meat and poultry safety. The Agricultural Research Service, which is the research arm of the USDA, investigates a number of agricultural practices, including those related to animal and crop safety. The National Institute of Food and Agriculture conducts research and education programs on food safety for farmers and consumers. Also, the Environmental Protection Agency (EPA) regulates public drinking water.

Government agencies also monitor the use of pesticides. The EPA approves pesticides and other chemicals used in agriculture, and sets limits on how much residue can remain on food. The FDA analyzes food for surface residue and waxes. Processing methods can either reduce or concentrate pesticide residue in foods. Therefore, the Food Quality Protection Act, which was passed in 1996, requires manufacturers to show that pesticide levels are safe for children.

In Canada, Health Canada works with local governments, industries, and consumers to establish food safety throughout the nation. The agency’s scientists assess health risks from foodborne contaminants, conduct research, and evaluate data to better understand the effects of pathogens, chemicals, and other foodborne agents on the body. Health Canada also monitors the levels of contaminants in foods and estimates the exposure of consumers. Another organization, the Canadian Food Inspection Agency, enforces the safety policies and standards set by Health Canada. They safeguard livestock, along with crops and other plants, to protect the public.

Efforts within the Food Industry

As discussed in Chapter 14 “Nutrition and Society: Food Politics and Perspectives”, the Hazard Analysis Critical Control Points (HACCP) is a system within the food industry designed to promote food safety and prevent contamination by identifying all areas in food production and retail where contamination could occur. Companies and retailers determine the points during processing, packaging, shipping, or shelving where hazards could occur. Those companies or retailers must then take measures to prevent, control, or eliminate the potential for food contamination. The USDA requires the food industry to follow HACCP for meat and poultry, while the FDA requires it for seafood, low-acid canned-food, and juice. HACCP is voluntary for all other food products.
Efforts on the Consumer Level: What You Can Do

Consumers can also take steps to prevent foodborne illness and protect their health. Although you can often detect when mold is present, you can’t see, smell, or taste bacteria or other agents of foodborne disease. Therefore, it is crucial to take measures to protect yourself from disease. The four most important steps for handling, preparing, and serving food are:

1. **Clean.** Wash hands thoroughly. Clean surfaces often and wash utensils after each use. Wash fruits and vegetables (even if you plan to peel them).
2. **Separate.** Don’t cross-contaminate food during preparation and storage. Use separate cutting boards for produce and for meat, poultry, seafood, and eggs. Store food products separately in the refrigerator.
3. **Cook.** Heat food to proper temperatures. Use a food thermometer to check the temperature of food while it is cooking. Keep food hot after it has been cooked.

Buying Food

It is best to buy your food from reputable grocers with clean, sanitary facilities, that keep products at appropriate temperatures. Consumers should examine food carefully before they purchase it. It is important to look at food in glass jars, check the stems on fresh produce, and avoid bruised fruit. Do not buy canned goods with dents or bulges, which are at risk for contamination with *Clostridium botulinum*. Fresh meat and poultry are usually free from mold, but cured and cooked meats should be examined carefully. Also, avoid torn, crushed, or open food packages, and do not buy food with frost or ice crystals, which indicates that the product has been stored for a long time, or thawed and refrozen. It is also a good idea to keep meat, poultry, seafood, and eggs separate from other items in your shopping cart as you move through the grocery store.
Video "Start at the Store: Prevent Foodborne Illness." This video provides tips to follow when selecting and purchasing food at the supermarket to help prevent foodborne illness and protect your health (click to see video).

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**Storing Food**

Refrigerate perishable foods quickly; they should not be left out for more than two hours. The refrigerator should be kept at 40°F (or 4°C) or colder, and checked periodically with a thermometer. Store eggs in a carton on a shelf in the refrigerator, and not on the refrigerator door where the temperature is warmest. Wrap meat packages tightly and store them at the bottom of the refrigerator, so juices won’t leak out onto other foods. Raw meat, poultry, and seafood should be kept in a refrigerator for only two days. Otherwise, they should be stored in the freezer, which should be kept at 0°F (or −18°C). Store potatoes and onions in a cool, dark place, but not under a sink because leakage from pipes could contaminate them. Empty cans of perishable foods or beverages that have been opened into containers, and promptly place them in a refrigerator. Also, be sure to consume leftovers within three to five days, so mold does not have a chance to grow.

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**Preparing Food**

Wash hands thoroughly with warm, soapy water for at least twenty seconds before preparing food and every time after handling raw foods. Washing hands is important for many reasons. One is to prevent cross-contamination between foods. Also, some pathogens can be passed from person to person, so hand washing can help to prevent this. Fresh fruits and vegetables should also be rinsed thoroughly under running water to clean off pesticide residue. California Department of Pesticide Regulation. “Pesticides and Food: How We Test for Safety.” *Pesticide Info: What You Should Know about Pesticides*, no. #E09/REV. Accessed December 21, 2011. www.cdpr.ca.gov/docs/dept/factshts/residu2.
This is particularly important for produce that contains a high level of residue, such as apples, pears, spinach, and potatoes. Washing also removes most dirt and bacteria from the surface of produce.

Other tips to keep foods safe during preparation include defrosting meat, poultry, and seafood in the refrigerator, microwave, or in a water-tight plastic bag submerged in cold water. Never defrost at room temperature because that is an ideal temperature for bacteria to grow. Also, marinate foods in the refrigerator and discard leftover marinade after use because it contains raw juices. Always use clean cutting boards, which should be washed with soap and warm water by hand or in a dishwasher after each use. Another way to sanitize cutting boards is to rinse them with a solution of 5 milliliters (1 teaspoon) chlorine bleach to about 1 liter (1 quart) of water. If possible, use separate cutting boards for fresh produce and for raw meat. Also, wash the top before opening canned foods to prevent dirt from coming into contact with food.

**Cooking Food**

Cooked food is safe to eat only after it has been heated to a temperature that is high enough to kill bacteria. You cannot judge the state of “cooked” by color and texture alone. Instead, use a food thermometer to be sure. The appropriate minimum cooking temperature varies depending on the type of food. Seafood should be cooked to an internal temperature of 145°F, beef, lamb, and pork to 160°F, ground chicken and turkey to 165°F, poultry breasts to 170°F, and whole poultry and thighs to 180°F. When microwaving, rotate the dish and stir contents several times to ensure even cooking.

**Serving Food**

After food has been cooked, the possibility of bacterial growth increases as the temperature drops. So, food should be kept above the safe temperature of 140°F, using a heat source such as a chafing dish, warming tray, or slow cooker. Cold foods should be kept at 40°F or lower. When serving food, keep it covered to block exposure to any mold spores hanging in the air. Use plastic wrap to cover foods that you want to remain moist, such as fresh fruits, vegetables, and salads. After a meal, do not keep leftovers at room temperature for more than two hours. They should be refrigerated as promptly as possible. It is also helpful to date leftovers, so they can be used within a safe time, which is generally three to five days when stored in a refrigerator.

**Key Takeaways**

Foodborne illness is caused by pathogens, such as bacteria and viruses, toxins, such as those produced by molds and poisonous mushrooms, and chemical contaminants, such as pesticide residues and pollutants. A number of government agencies work to regulate food, manage outbreaks, and inform the public about foodborne illness and food safety. Consumers also should take measures to protect their health, including following the rules for four key steps: clean, separate, cook, and chill.

**Discussion Starter**

1. Discuss tactics that government agencies or consumer groups could take to educate the public about food safety. What key points do you think consumers need to know about foodborne illness and food safety? How do you think government organizations or other groups can best get that information out to the public?