Chapter 2

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Sanitation and Safety

In the last chapter, we talked about professionalism in food service. Professionalism is an attitude that reflects pride in the quality of your work. One of the most important ways of demonstrating professional pride is in the area of sanitation and safety. Pride in quality is reflected in your appearance and work habits. Poor hygiene, poor grooming and personal care, and sloppy work habits are nothing to be proud of.

Even more important, poor sanitation and safety can cost a lot of money. Poor food-handling procedures and unclean kitchens cause illness, unhappy customers, and even fines, summonses, and lawsuits. Food spoilage raises food costs. Poor kitchen safety results in injuries, medical bills, and workdays lost. Finally, poor sanitation and safety habits show lack of respect for your customers, for your fellow workers, and for yourself.

In this chapter, you will study the causes of food-borne diseases and kitchen injuries, and you will learn ways of preventing them. Prevention, of course, is the most important thing to learn. It is not as important to be able to recite the names of disease-causing bacteria as it is to be able to prevent their growth in food.

After reading this chapter, you should be able to

1. Describe steps to prevent food poisoning and food-borne diseases in the following areas: personal hygiene, food handling and storage techniques, cleaning and sanitizing techniques, and pest control.
2. Demonstrate safe workplace habits that prevent injuries from the following: cuts, burns, operation of machinery and equipment, and lifting.
3. Identify safe workplace habits that minimize the likelihood of fires and falls.

Sanitation

Rules of personal hygiene and sanitary food handling were not invented just to make your life difficult. There are good reasons for all of them. Instead of starting this chapter with lists of rules, we first talk about the causes of food-borne diseases. Then, when we get to the rules, you will understand why they are important. This will make them easier to remember and to practice.

The rules presented in this chapter are basic guidelines only. Local health departments have more detailed regulations. *All food-service operators are responsible for knowing the health department regulations in their own city and state.*

The information presented here is practical as well as theoretical. It should not merely be learned but also put to use systematically. One effective system food-service establishments can use to ensure food safety is the Hazard Analysis Critical Control Point (HACCP) system. This practical program identifies possible danger points and sets up procedures for corrective action. HACCP is introduced later in this chapter.

Food Hazards

Preventing food-borne illness is one of the most important challenges facing every food service worker. In order to prevent illness, a food worker must understand the sources of food-borne disease.

Most food-borne illness is the result of eating food that has been ***contaminated***. To say a food is contaminated means it contains harmful substances not originally present in it. In other words, contaminated food is food that is not pure. In this section, we first discuss the various substances that can contaminate food and cause illness. Afterward, we consider how these substances get into food to contaminate it and how food workers can prevent contamination and avoid serving contaminated food.

Any substance in food that can cause illness or injury is called a ***hazard***. Food hazards are of four types:

1. Biological hazards
2. Chemical hazards
3. Physical hazards
4. Allergens

Notice it was said *most* food-borne illness is caused by eating food contaminated with foreign substances. Some illness is caused not by contaminants but by substances that occur naturally in foods. These include plant toxins (*toxin* means “poison”), such as the chemicals in poisonous mushrooms, and certain natural food components to which some people are allergic. This section considers all these kinds of food hazards.

Pathogens

The most important kind of biological hazards to consider are microorganisms. A ***microorganism*** is a tiny, usually single-celled organism that can be seen only with a microscope. A microorganism that can cause disease is called a ***pathogen***. Although these organisms sometimes occur in clusters large enough to be seen with the naked eye, they are not usually visible. This is one reason why they can be so dangerous. Just because food looks good doesn’t mean it is safe.

Four kinds of microorganisms can contaminate food and cause illness:

1. Bacteria
2. Viruses
3. Fungi
4. Parasites

Most food-borne diseases are caused by bacteria, so most of our attention in this chapter is focused on them, but the other types can be dangerous as well. Many of the measures we take to protect food from bacteria also help prevent the other three kinds of microorganisms.

BACTERIA

Bacteria are everywhere—in the air, in the water, in the ground, on our food, on our skin, inside our bodies. Scientists have various ways of classifying and describing these bacteria. As food workers, we are interested in a way of classifying them that may be less scientific but is more practical to our work.

1. **Harmless bacteria.**
   Most bacteria fall into this category. They are neither helpful nor harmful to us. We are not concerned with them in food sanitation.
2. **Beneficial bacteria.**
   These bacteria are helpful to us. For example, many live in the intestinal tract, where they fight harmful bacteria, aid the digestion of food, and produce certain nutrients. In food production, bacteria make possible the manufacture of many foods, including cheese, yogurt, and sauerkraut.
3. **Undesirable bacteria.**
   These are the bacteria that are responsible for food spoilage. They cause souring, putrefying, and decomposition. These bacteria may or may not cause disease, but they offer a built-in safety factor: They announce their presence by means of sour odors, sticky or slimy surfaces, and discoloration. As long as we use common sense and follow the rule that says "when in doubt, throw it out," we are relatively safe from these bacteria.
   We are concerned with these bacteria for two reasons:
   - Food spoilage costs money.
   - Food spoilage is a sign of improper food handling and storage. This means the next kind of bacteria is probably present.
4. **Disease-causing bacteria, or pathogens.**
   These are the bacteria that cause most food-borne illness, the bacteria we are most concerned with.

Pathogens do not necessarily leave detectable odors or tastes in food. In other words, you can't tell if food is contaminated by smelling, tasting, or looking at it. The only way to protect food against pathogenic bacteria is to use proper hygiene and sanitary food-handling and storage techniques.

Each kind of bacterial pathogen causes disease in one of three ways:

1. *Intoxications* are caused by poisons (toxins) the bacteria produce while they are growing in the food, before it is eaten. It is these poisons, not the bacteria themselves, that cause the diseases.
2. *Infections* are caused by bacteria (or other organisms) that get into the intestinal system and attack the body. Disease is caused by the bacteria themselves as they multiply in the body.
3. *Toxin-mediated infections* are also caused by bacteria that get into the body and grow. Disease is caused by poisons the bacteria produce as they grow and multiply in the body. Most food-borne diseases are toxin-mediated infections.

BACTERIAL GROWTH

Bacteria multiply by splitting in half. Under ideal conditions for growth, they can double in number every 15 to 30 minutes. This means that one single bacterium could multiply to one million in less than 6 hours!

Conditions for Growth

1. **Food.**
   Bacteria require food in order to grow. They like many of the foods we do. Foods with sufficient amounts of proteins are best for bacterial growth. These include meats, poultry, fish, dairy products, and eggs, as well as some grains and vegetables.

2. **Moisture.**
Bacteria require water to absorb food. Dry foods do not support bacterial growth. Foods with a very high salt or sugar content are also relatively safe, because these ingredients make the bacteria unable to use the moisture present.

The availability of water to bacteria is indicated by a measure called ***water activity***, abbreviated a_w. The scale runs from 0 (meaning no water available) to 1.0. Most pathogens grow best in an environment from 0.85 to 1.0 a_w.

3. **Temperature.**
Bacteria grow best at warm temperatures. *Temperatures between 41°F and 135°F (5°C and 57°C) promote the growth of disease-causing bacteria*. This temperature range is called the ***Food Danger Zone***. (In Canada, 40–140°F or 4–60°C is the temperature danger zone. Until recently, these temperatures were also the standard in the United States.)

4. **Acidity or alkalinity.**
In general, disease-producing bacteria like a neutral environment, neither too acidic nor too alkaline (see sidebar top left). The acidity or alkalinity of a substance is indicated by a measurement called *pH*. The scale ranges from 0 (strongly acidic) to 14 (strongly alkaline). A pH of 7 is neutral. Pure water has a pH of 7.

5. **Oxygen.**
Some bacteria require oxygen to grow. These are called ***aerobic***. Some bacteria are ***anaerobic***, which means they can grow only if there is no air present, such as in metal cans. Botulism, one of the most dangerous forms of food poisoning, is caused by anaerobic bacteria. A third category of bacteria can grow either with oxygen or without it. These bacteria are called ***facultative***. Most bacteria in food that cause disease are facultative.

6. **Time.**
When bacteria are introduced to a new environment, they need time to adjust to their surroundings before they start growing. This time is called the ***lag phase***. If other conditions are good, the lag phase may last 1 hour, or somewhat longer.

If it weren't for the lag phase, there would be much more food-borne disease than there is. This delay makes it possible to have foods at room temperature *for very short periods* in order to work on them.

BACTERIA AND PH

In general, food-borne pathogens grow best in an environment with a pH of 4.6 to 10. Every type of bacteria is different, however, and some grow when there is a higher or lower pH than this range. Salmonella bacteria, for example, can grow when there is a pH of 4.1-9.0. In general, however, acidity is an enemy of bacterial growth.

BACTERIA AND TEMPERATURE

The world is full of bacteria, and many kinds do not fit the food safety guidelines outlined here. Some bacteria, for example, need cool or cold temperatures to grow. These are called **psychrophiles**. Others thrive at high temperatures. These are called **thermophiles**. Some extreme thermophiles even grow at temperatures above the boiling point of water (212°F or 100°C). Nevertheless, most food-borne pathogens are **mesophiles**, bacteria that grow fastest at moderate temperatures (77–113°F or 25–45°C).

Potentially Hazardous Foods or TCS Foods

Foods that provide a good environment for the growth of disease-causing microorganisms are called ***potentially hazardous foods***. Looking back at our list of conditions for growth of bacteria, we can see that protein foods with sufficient moisture and neutral pH are the most likely to host bacteria that cause disease. Of the conditions in the list, the one over which we have most control is *temperature*.

These foods are also called *TCS foods*. The abbreviation stands for Time/Temperature Control for Safety. In other words, our guidelines for keeping foods out of the Food Danger Zone temperatures, except for limited times, must be followed to keep these foods safe.

Potentially hazardous foods fall into two general categories, plus four specific items that do not fit into these categories. All these foods, plus any foods prepared with any of them, are potentially hazardous:

1. Any food derived from animals, or any food containing animal products, including meat, poultry, fish, shellfish, eggs, and dairy products.
2. Any food derived from plants that has been cooked, partially cooked, or otherwise heat-treated. This category includes not only cooked vegetables but also such items as cooked pasta, cooked rice, and tofu (soybean curd).
3. Raw seed sprouts.
4. Sliced melons (because the edible flesh can be contaminated by organisms on the rind's exterior, which was in contact with soil).
5. Cut tomatoes (for the same reason as sliced melons).
6. Garlic and oil mixtures (because the oil seals the garlic from the air, fostering the growth of anaerobic bacteria, as explained above).

Foods that are not potentially hazardous include dried or dehydrated foods, foods that are strongly acidic, and commercially processed foods that are still in their original unopened, sealed containers.

LOCOMOTION

Bacteria can move from place to place in only one way: They must be carried. They can't move on their own.

Foods can become contaminated by any of the following means:

Hands	Air
Coughs and sneezes	Water
Other foods	Insects
Equipment and utensils	Rats and mice

PROTECTION AGAINST BACTERIA

Because we know how and why bacteria grow, we should be able to keep them from growing. Because we know how bacteria get from place to place, we should be able to keep them from getting into our food.

There are three basic principles of food protection against bacteria. These principles are the reasons behind nearly all the sanitation techniques we discuss in the rest of this chapter.

1. **Keep bacteria from spreading.**
   Don't let food touch anything that may contain disease-producing bacteria, and protect food from bacteria in the air.

2. **Stop bacteria from growing.**
   Take away the conditions that encourage bacteria to grow. In the kitchen, our best weapon is temperature. *The most effective way to prevent bacterial growth is to keep foods below 41°F (5°C) or above 135°F (57°C).* These temperatures won't necessarily kill bacteria; they'll just slow their growth greatly.

3. **Kill bacteria.**
   Most disease-causing bacteria are killed if they are subjected to a temperature of 170°F (77°C) for 30 seconds, or higher temperatures for shorter times. This enables us to make food safe by cooking and to sanitize dishes and equipment with heat. The term ***sanitize*** means to kill disease-causing bacteria.

   Certain chemicals also kill bacteria. These may be used for sanitizing equipment.

BACTERIAL DISEASES

Table 2.1 describes some of the most common bacterial diseases. For each disease, pay particular attention to the way it is spread, the foods involved, and the means of prevention. General practices and procedures for prevention of food-borne diseases are discussed in a later section.

VIRUSES

Viruses are even smaller than bacteria. They consist of genetic material surrounded by a protein layer. Unlike bacteria, they can't reproduce or multiply unless they are inside a living cell, but they can be carried on almost any surface and can survive for days or even months. Viruses are inactive or dormant until they enter a living cell. Then they use that cell to make more viruses and release them into the organism. The new viruses can then enter new cells and continue to multiply.

Because viruses do not multiply in food like bacteria, food-borne viral diseases are usually caused by contamination from people, food contact surfaces, or, in the case of seafood, contaminated water.

Table 2.2 identifies the most important food-borne viral diseases.

PARASITES

Parasites are organisms that can survive only by living on or inside another organism. The organism a parasite lives in and takes nourishment from is called the *host*. Parasites may

Table 2.1 Bacterial Diseases

Bacteria Disease	Cause/ Characteristics	Source of Bacteria	Foods Usually Involved	Prevention
Botulism	Caused by toxins produced by the bacterium *Clostridium botulinum*, ***botulism*** attacks the nervous system and is usually *fatal*, even if only a small amount of poisoned food is eaten. The bacteria are anaerobic and do not grow in high-acid foods. Most outbreaks are caused by improper canning techniques. The toxin (although not the bacteria) is destroyed by boiling (212°F/100°C) for 20 minutes.	soil on vegetables and other foods	home-canned, low-acid vegetables (very rare in commercially canned foods)	Use only commercially canned foods. Discard without tasting any bulged or damaged cans or foods with off odors.
Staphylococcal food poisoning (staph)	Caused by toxins produced in foods by the bacterium *Staphylococcus aureus*, ***staph*** is probably the most common food poisoning, characterized by nausea, vomiting, stomach cramps, diarrhea, and prostration.	usually food workers	custards and desserts made with dairy products, potato salad, protein salads, ham, hollandaise sauce, and many other high-protein foods	Practice good hygiene and work habits. Do not handle foods if you have an illness or infection. Clean and sanitize all equipment. Keep foods below 41°F (5°C) or above 135°F (57°C).
Escherichia coli	This bacterium causes severe illness, either as an intoxication or an infection. Severe abdominal pain, nausea, vomiting, diarrhea, and other symptoms result from ***E. coli*** intoxication. As an infection, *E. coli* causes intestinal inflammation and bloody diarrhea. While the illness normally lasts from 1 to 3 days, in some cases it can lead to long-term illness.	intestinal tracts of humans and some animals, especially cattle; contaminated water	raw or undercooked red meats, unpasteurized dairy products, sometimes fish from contaminated water, prepared foods such as mashed potatoes and cream pies	Cook foods, including red meats, thoroughly; avoid cross-contamination. Practice good hygiene.
Salmonella	The food infection caused by ***salmonella*** bacteria exhibits symptoms similar to those of staph poisoning, though the disease may last longer. Most poultry carry this bacterium.	contaminated meats and poultry; fecal contamination by food workers	meats, poultry, eggs, poultry stuffings, gravies, raw foods, and shellfish from polluted waters	Practice good personal hygiene, proper food storage and handling, and insect and rodent control. Wash hands and sanitize all equipment and cutting surfaces after handling raw poultry. Use certified shellfish.
Clostridium perfringens	An infection characterized by nausea, cramps, stomach pain, and diarrhea. The bacteria are hard to destroy because they are not always killed by cooking.	soil, fresh meats, human carriers	meats and poultry, reheated or unrefrigerated gravies and sauces	Keep foods hot (above 135°F/57°C) or cold (below 41°F/5°C).
Streptococcal (strep) infection	The symptoms of strep are fever and sore throat.	coughs, sneezes, infected food workers	any food contaminated by coughs, sneezes, or infected food workers, then served without further cooking	Do not handle food if you are infected. Protect displayed food (salad bars, pastry carts, etc.) from customers' sneezes and coughs.
Shigellosis	Caused by various species of *Shigella* bacteria. The symptoms of this disease are diarrhea, abdominal pain, fever, nausea, vomiting, cramps, chills, and dehydration. The illness can last 4 to 7 days or longer if not treated.	human intestinal tract, flies, and water contaminated by feces	salads and other raw or cold cooked foods, dairy products, poultry	Good personal hygiene. Good sanitary food handling practices. Control flies. Use foods from sanitary sources.

Bacteria Disease	Cause/ Characteristics	Source of Bacteria	Foods Usually Involved	Prevention
Listeriosis	Caused by *Listeria monocytogenes* bacteria. This disease has many symptoms, including nausea, vomiting, diarrhea, headache, fever, chills, backache, and inflammation of the tissues around the brain and spinal cord. It can cause spontaneous abortion in pregnant women. The disease may not appear for days or even several months after the contaminated food is eaten, and it can last indefinitely if not treated properly. May be fatal in people with poor immune systems.	soil, water, and damp environments; carried in intestinal tracts of humans and animals, particularly poultry	unpasteurized dairy products; raw vegetables and meats; seafood; ready-to-eat foods that were contaminated and then not cooked further	Use good food-handling practices to avoid cross-contamination; use pasteurized dairy products; keep facilities clean and dry.
Bacillus cereus gastroenteritis	Caused by *Bacillus cereus*. Symptoms include nausea, vomiting, diarrhea,and stomach cramps or pain. This disease usually lasts less than a day.	soil and dust, grains, and cereals	grains and starches, including pastries and foods with starch thickeners; meats, milk, vegetables, and fish	Temperature control: Cook foods to proper internal temperatures; chill foods quickly and properly.
Camphylobacteriosis	Caused by *Camphylobacter jejuni*. This disease usually lasts 2 to 5 days, or up to 10 days, and causes diarrhea, fever, nausea, vomiting, abdominal pain, muscle pain, and headache.	meat and dairy animals and poultry	unpasteurized dairy products; raw poultry; contaminated water	Cook foods to proper internal temperatures; use pasteurized dairy products; safe food-handling practices to avoid cross-contamination; avoid using contaminated water.
Vibrio gastroenteritis and septicemia	Caused by two species of *Vibrio* bacteria. Symptoms include diarrhea, nausea, vomiting, stomach cramps, and headache. Severe cases of the disease can involve chills, fever, sores on skin, decreased blood pressure, and septicemia (blood poisoning). The illness lasts from 1 to 8 days and can be fatal in people with poor immune systems.	shellfish, especially from the Gulf of Mexico	raw or undercooked shellfish	Avoid eating raw or undercooked shellfish; avoid cross-contamination.
Yersiniosis	Caused by the bacteria *Yersinia enterocolitica*. The disease lasts from a few days to several weeks and is characterized by fever and severe abdominal pain and sometimes headache, sore throat, vomiting, and diarrhea.	domestic pigs, soil, contaminated water, rodents	meats, especially pork; fish, oysters, unpasteurized milk, tofu, untreated water	Cook meats, especially pork, to proper internal temperatures; avoid cross-contamination; proper sanitation procedures and food handling; avoid contaminated water.

pass from one host organism to another and complete a different stage of their life cycle in each organism. Human parasites are generally transmitted to them from animal hosts.

Human parasites are usually very small, and although they may be microscopic, they are larger than bacteria. They can usually be killed by proper cooking or by freezing.

The most important diseases caused by human parasites transmitted by food are found in Table 2.3.

FUNGI

Molds and yeasts are examples of fungi. These organisms are associated primarily with food spoilage rather than food-borne disease. Most molds and yeasts, even those that cause spoilage, are not dangerous to most human beings. Some, in fact, are beneficial—for example, those responsible for the veining in blue cheese and the fermentation of bread dough.

Table 2.2 **Viruses**

Virus	Cause/ Characteristics	Source of Contamination	Foods Usually Involved	Prevention
Hepatitis A	This is a severe disease that can last for many months.	contaminated water or ice, shellfish from polluted waters, raw fruits and vegetables, milk and milk products, infected food workers	shellfish eaten raw, any food contaminated by an infected person	Practice good health and hygiene. Use only certified shellfish from safe waters.
Norovirus (also called Norwalk virus gastroenteritis)	This disease affects the digestive tract, causing nausea, vomiting, stomach cramps, diarrhea, and fever.	human intestinal tract, contaminated water	water, shellfish from polluted waters, raw vegetables and fruits	Practice good health and hygiene. Use only certified shellfish from safe waters. Use sanitary, chlorinated water. Cook foods to safe internal temperatures.
Rotovirus gastroenteritis	The symptoms of this disease are vomiting and diarrhea, abdominal pain, and mild fever. Around the world, rotovirus infections are the leading cause of digestive disease in infants and children. The illness lasts from 4 to 8 days.	human intestinal tract and contaminated water	water and ice, raw and cold prepared foods, such as salads	Practice good health and hygiene. Use sanitary, chlorinated water. Cook foods to safe internal temperatures.

Some molds, however, produce toxins that can cause allergic reactions and severe disease in those people who are susceptible. For example, certain molds produce a toxin called *aflatoxin* in such foods as peanuts and other nuts, corn, cottonseed, and milk. This toxin can cause serious liver disease in some people.

OTHER BIOLOGICAL HAZARDS

In addition to the biological hazards associated with bacteria and other organisms, some hazards occur naturally in foods and are not the result of contamination. These hazards include plant toxins, seafood toxins, and allergens.

Plant Toxins

Put simply, some plants are naturally poisonous to human beings. The only way to avoid plant toxins is to avoid the plants in which they occur, as well as products made with those plants. In some cases, the toxins can be transferred in milk from cows that have eaten the plant (such as jimsonweed and snakeroot) or in honey from bees that have gathered nectar from the plants (such as mountain laurel).

The best-known plant toxins are those found in certain wild mushrooms. There are many kinds of poisonous mushrooms, and eating them causes symptoms that range from mild intestinal discomfort to painful death. Some mushroom toxins attack the nervous system, some attack and destroy the digestive system, and some attack other internal organs.

Other toxic plants to avoid are rhubarb leaves, water hemlock, apricot kernels, and nightshade.

Seafood Toxins

Some toxins occur in fish or shellfish that have eaten a kind of algae that contains the toxins. Because these toxins are not destroyed by cooking, the only method of protection against them is to purchase fish and shellfish from approved suppliers who can certify the seafood comes from safe water.

Some fish naturally contain toxins. The best-known fish toxin is the one present in pufferfish, known in Japanese as *fugu*. Raw fugu is considered a delicacy in Japan, but it must be prepared only by certified chefs who have been trained to remove the glands that produce the toxin without breaking them so they don't contaminate the flesh of the fish. This toxin attacks the nervous system and can be fatal.

Some other species of fish, such as moray eels, contain natural toxins and should be avoided.

Table 2.3 **Parasites**

Parasite	Cause/ Characteristics	Source of Contamination	Foods Usually Involved	Prevention
Trichinosis	*Trichinosis* is often mistaken for the flu at first, but it can last for a year or more. It is caused by a tiny worm that becomes embedded in the muscles of pigs.	infected pork from hogs that ate unprocessed garbage. Modern farming practices have eliminated most, but not all, of this problem.	pork products	Trichinosis organisms are killed if held at 137°F (58°C) for 10 seconds. To be safe, cook all pork products to an internal temperature of at least 150°F (65°C). Some authorities recommend a higher temperature (165°F/74°C). Canadian pork is considered free of trichinosis and does not need to be cooked to these temperatures.
Anisakiasis	Anisakiasis is caused by a tiny roundworm. Symptoms are a tingling sensation in the throat, vomiting up worms, abdominal pain, nausea.	ocean fish, especially bottom-feeding fish	raw or undercooked fish, such as cod, haddock, fluke, herring, flounder, monkfish, and salmon	Cook fish properly. Fish to be eaten raw should be frozen at –4°F (–20°C) or lower for 7 days or 31°F (–1°C) or lower for 15 hours in a blast freezer.
Giardiasis	Giardiasis is caused by a protozoan (a type of single-celled organism) that gets into the intestinal tract. Symptoms include fatigue, nausea, intestinal gas, cramps, feeling of weakness, and weight loss. Symptoms usually last 1 to 2 weeks, but the human host may be infectious for months.	domestic pets; wild animals, especially bears and beavers; human intestinal tracts	water and ice; salads and other raw vegetables	Use sanitary water supplies; practice good personal hygiene; wash raw produce well.
Toxoplasmosis	Toxoplasmosis is caused by a protozoan. A human host sometimes shows no symptoms, but the disease can cause enlarged lymph nodes, severe muscle pain and headaches, and skin rash. Pregnant women and people with poor immune systems are most severely affected.	animal feces, mammals, birds	raw or undercooked contaminated meat	Good personal hygiene; cook meats to proper internal temperatures.
Cyclosporiasis	Cyclosporiasis is caused by a protozoan. Symptoms include diarrhea, weight loss, appetite loss, intestinal gas, cramps, nausea, vomiting, muscle aches, and fatigue. May last a few days to more than a month and may recur every month or two.	contaminated water, human intestinal tract	water, ocean fish, raw vegetables and fruits, and unpasteurized milk	Good personal hygiene. Use safe water supplies. Wash produce properly.
Intestinal cryptosporidiosis	Cryptosporidiosis is caused by a protozoan. This disease may last 4 days to 3 weeks. The host may have no symptoms or may have severe diarrhea. Can be long-lasting and very severe, even fatal, in people with poor immune systems.	intestinal tracts of humans and livestock; water contaminated by runoff from farms or slaughterhouses	water, raw vegetables and fruits, and milk	Good personal hygiene; wash produce properly; use safe water supplies.

Chemical and Physical Hazards

Some kinds of chemical poisoning are caused by the use of defective or improper equipment or equipment that has been handled improperly. The following toxins (except lead) create symptoms that show themselves very quickly, usually within 30 minutes of eating poisoned food. By contrast, symptoms of lead poisoning can take years to appear. To prevent these diseases, do not use the materials that cause them.

1. **Antimony.**
   Caused by storing or cooking acid foods in chipped gray enamelware.
2. **Cadmium.**
   Caused by cadmium-plated ice cube trays or containers.
3. **Cyanide.**
   Caused by silver polish containing cyanide.
4. **Lead.**
   Caused by lead water pipes, solder containing lead, or utensils containing lead.
5. **Copper.**
   Caused by unclean or corroded copper utensils, acid foods cooked in unlined copper utensils, or carbonated beverages in contact with copper tubing.
6. **Zinc.**
   Caused by cooking foods in zinc-plated (galvanized) utensils.

Other chemical contamination can result from exposure of foods to chemicals used in commercial food-service establishments. Examples include cleaning compounds, polishing compounds, and insecticides. Prevent contamination by keeping these items physically separated from foods. Do not use them around food. Label all containers properly. Rinse cleaned equipment thoroughly.

Physical contamination is contamination of food with objects that may not be toxic but may cause injury or discomfort. Examples include pieces of glass from a broken container, metal shavings from an improperly opened can, stones from poorly sorted dried beans, soil from poorly washed vegetables, insects or insect parts, and hair. Proper food handling is necessary to avoid physical contamination.

Allergens

An ***allergen*** is a substance that causes an allergic reaction. Allergens affect only some people, and these people are said to be *allergic* to that specific substance. Not all allergens are biological hazards, but the most important ones are, so we discuss them together in this section.

Allergic reactions to food may occur as soon as the food is eaten or, in some cases, merely touched, or they may not occur until hours after the food is eaten. Common symptoms of allergic reaction to foods include itching, rash or hives, shortness of breath, tightness in the throat, and swelling of the eyes and face. In severe cases, allergic reactions may lead to unconsciousness or death.

Foods to which some people are allergic include wheat products, soy products, peanuts and other nuts, eggs, milk and dairy products, fish, and shellfish. Nonbiological allergens include food additives such as nitrites, used in cured meats, and monosodium glutamate (MSG), often used in Asian foods.

Because these products are common and are perfectly safe for most people, it is difficult to avoid serving them. For the sake of people who are sensitive to these foods, food-service personnel, especially all dining room staff, must be well informed of the ingredients in all menu items and be able to inform customers as needed. If any staff member does not know, when asked by a customer, if a food might contain an allergen, that employee should tell the customer so and then find someone who does know or else urge the customer to order a different item.

ALLERGIES AND INTOLERANCES

Health professionals make a distinction between food allergies and intolerances. Allergies are reactions by the body's immune system. The body sees a food substance as a foreign invader and attacks it, harming the body in the process. A food intolerance, on the other hand, is the inability of the body to process the food properly. For example, some people can't drink milk because of lactose intolerance. This means they can't digest milk sugar, or lactose. By contrast, a milk allergy is the reaction by the immune system to milk proteins.

KEY POINTS TO REVIEW

- What six conditions are necessary for the growth of bacteria?
- What are potentially hazardous foods?
- What are the three ways to protect against bacteria?
- Besides bacteria, what other hazards can make food unsafe?

Personal Hygiene

Earlier in this chapter, we said most food-borne disease is caused by bacteria. Now we expand that statement slightly to say that *most food-borne disease is caused by bacteria spread by food workers*.

At the beginning of this chapter, we defined *contamination* as harmful substances not present originally in the food. Some contamination occurs before we receive the food, which means proper purchasing and receiving procedures are important parts of a sanitation program. But most food contamination occurs as a result of ***cross-contamination***, defined as the transference of hazardous substances, mainly microorganisms, to a food from another food or another surface, such as equipment, worktables, or hands. Examples of situations in which cross-contamination can occur include the following:

- Mixing contaminated leftovers with a freshly cooked batch of food.
- Handling ready-to-eat foods with unclean hands.
- Handling several types of food without washing hands in between.
- Cutting raw chicken, then using the same cutting board, unsanitized, to cut vegetables.
- Placing ready-to-eat foods on a lower refrigerator shelf and allowing juices from raw fish or meat to drip onto them from an upper shelf.
- Wiping down work surfaces with a soiled cloth.

For the food worker, the first step in preventing food-borne disease is good personal hygiene. Even when we are healthy, we have bacteria all over our skin and in our nose and mouth. Some of these bacteria, if given the chance to grow in food, will make people ill.

1. Do not work with food if you have any communicable disease or infection.
2. Bathe or shower daily.
3. Wear clean uniforms and aprons.
4. Keep hair neat and clean. Always wear a hat or hairnet. Hair longer than shoulder length must first be tied back and then secured under a net or hat.
5. Keep mustaches and beards trimmed and clean. Better yet, be clean-shaven.
6. Remove all jewelry: rings, low-hanging earrings, watches, bracelets. Avoid facial piercings; if you have them, don't touch them.
7. Wash hands and exposed parts of arms before work and as often as necessary during work, including:
    - After eating, drinking, or smoking.
    - After using the toilet.
    - After touching or handling anything that may be contaminated with bacteria.
8. Cover coughs and sneezes, then wash your hands.
9. Keep your hands away from your face, eyes, hair, and arms.
10. Keep fingernails clean and short. Do not wear nail polish.
11. Do not smoke or chew gum while on duty.
12. Cover cuts or sores with clean bandages. If the sore is on the hands, you must wear gloves.
13. Do not sit on worktables.

Procedure for Washing Hands

1. Wet your hands with hot running water. Use water as hot as you can comfortably stand, but at least 100°F (38°C).
2. Apply enough soap to make a good lather.
3. Rub hands together thoroughly for 20 seconds or longer, washing not only the hands but the wrists and the lower part of the forearms.
4. Using a nail brush, clean beneath the fingernails and between the fingers.
5. Rinse hands well under hot running water. If possible, use a clean paper towel to turn off the water to avoid contaminating the hands by contact with soiled faucets.
6. Dry hands with clean single-use paper towels or a warm-air hand dryer.

Use of Gloves

If used correctly, gloves can help protect foods against cross-contamination. If used incorrectly, however, they can spread contamination just as easily as bare hands. Health departments in some localities require the use of some kind of barrier between hands and any foods that are ready to eat—that is, foods that will be served without further cooking. Gloves, tongs, and other serving implements, and bakery or deli tissue can serve as barriers. To be sure gloves are used correctly, observe the following guidelines.

Guidelines for Using Disposable Gloves

1. Wash hands before putting on gloves or when changing to another pair. Gloves are not a substitute for proper handwashing.
2. Remove and discard gloves, wash hands, and change to a clean pair of gloves after handling one food item and before starting work on another. In particular, never to fail to change gloves after handling raw meat, poultry, or seafood. Gloves are for single use only. Remember the purpose of using gloves is to avoid cross-contamination.
3. Change to a clean pair of gloves whenever gloves become torn, soiled, or contaminated by contact with an unsanitary surface.

Food Storage

The following rules of safe food storage have two purposes:

1. To prevent contamination of foods.
2. To prevent growth of bacteria that may already be in foods.

Temperature control is an important part of food storage. Perishable foods must be kept out of the Food Danger Zone—41°F to 135°F (5°C to 57°C)—as much as possible, because these temperatures support bacterial growth. See Figure 2.1 for a chart of important temperatures.

The Four-Hour Rule

Food is handled in many stages between the time it is received and the time it is finally served. This progression, called the *flow of food*, is discussed further in a later section. During each stage, food might be allowed to remain in the Food Danger Zone for a time. To protect food and keep it safe, follow the ***four-hour rule***: Do not let food remain in the Food Danger Zone for a cumulative total of more than 4 hours between receiving and serving.

For example, imagine a food that is left on the loading dock for 30 minutes before being put into cold storage, removed from storage and left on the worktable for an hour before being prepared, and finally cooked at a low temperature so that it takes 3 hours to reach a safe internal temperature (see p. 29). This food has spent a total of 4½ hours in the danger zone and should be considered unsafe.

Receiving

1. Safe food handling begins the moment food is unloaded from the delivery truck. In fact, it begins even earlier than this, with the selection of good, reputable suppliers. Keep the receiving area clean and well lit.
2. Inspect all deliveries. Try to schedule deliveries during off-peak hours to allow proper time to inspect the items. For the same reason, try to schedule deliveries so they arrive one at a time.
3. Reject shipments or parts of shipments that are damaged or not at the proper temperature. Frozen foods should show no signs of having been thawed and refrozen.
4. Label all items with the delivery date or a use-by date.
5. Transfer items immediately to proper storage.

Dry Food Storage

Dry food storage pertains to those foods not likely to support bacterial growth in their normal state. These foods include

Flour

Sugar and salt

Cereals, rice, and other grains

Dried beans and peas

Ready-prepared cereals

Breads and crackers

Oils and shortenings

Canned and bottled foods (unopened)

1. Store dry foods in a cool, dry place, off the floor, away from the wall, and not under a sewer line.
2. Keep all containers tightly closed to protect from insects, rodents, and dust. Dry foods can be contaminated, even if they don't need refrigeration.

Freezer Storage

1. Keep frozen foods at 0°F (–18°C) or lower.
2. Keep all frozen foods tightly wrapped or packaged to prevent freezer burn.
3. Label and date all items.
4. Thaw frozen foods properly. Do not thaw at room temperature, because the surface temperature will go above 41°F (5°C) before the inside is thawed, resulting in bacterial growth. These methods may be used:
   - In a refrigerator
   - Under cold running water
   - In a microwave oven, but only if the item is to be cooked or served immediately

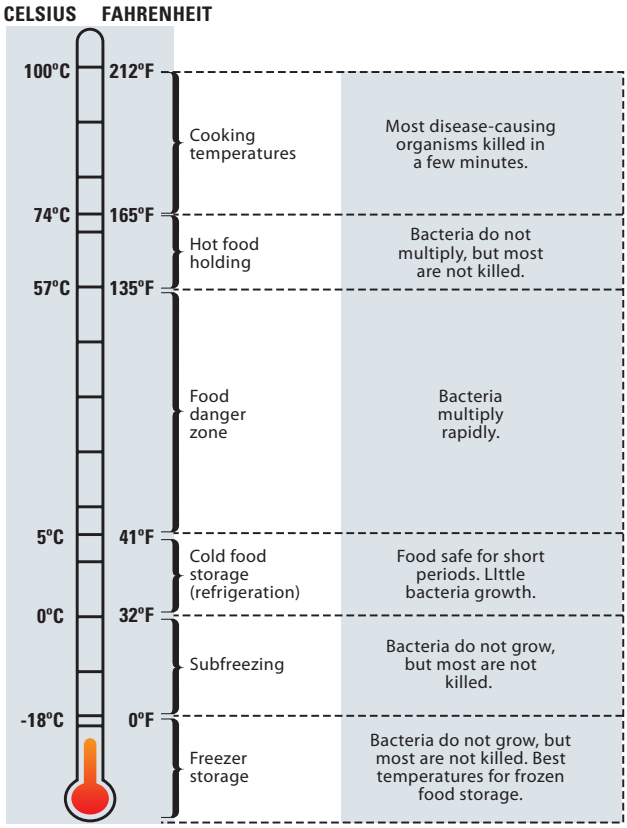

Figure 2.1 Important temperatures in sanitation and food protection.

Refrigerator Storage

1. Keep all perishable foods properly refrigerated. Note the lower limit of the Food Danger Zone (41°F/5°C) is only the upper limit for refrigerator storage. Most foods keep even better at lower temperatures. The major exception is fresh fruits and vegetables, which are not considered potentially hazardous foods. See Table 2.4 for preferred storage temperatures for various foods.

Table 2.4 Food Storage Temperatures

Raw vegetables and fruits (see note)	40°–45°F	4°–7°C
Eggs	38°–40°F	3°–4°C
Milk and cream	36°–40°F	2°–4°C
Poultry and meat	32°–36°F	0°–2°C
Fish and seafood	30°–34°F	–1°–1°C

Note: Potatoes, onions, and winter squash are best held at cool temperatures (50°–65°F or 10°–18°C).

2. Do not crowd refrigerators. Leave space between items so cold air can circulate.
3. Keep refrigerator doors shut except when removing or putting in foods.
4. Keep shelves and interiors of refrigerators clean.
5. Store raw and cooked items separately, if possible.
6. If raw and cooked foods must be kept in the same refrigerator, keep cooked foods above raw foods. If cooked foods are kept below raw foods, they can become contaminated by drips and spills. Then, if they are not to be cooked again before serving, they may be hazardous.
7. Keep refrigerated foods wrapped or covered and in sanitary containers.
8. Do not let any unsanitary surface, such as the bottoms of other containers, touch any food.
9. Chill foods as quickly as possible over ice or in a cold-water bath before placing in the refrigerator. A gallon of stock placed in a refrigerator hot off the stove may take 10 hours to go below 41°F (5°C), giving bacteria plenty of time to grow.
10. When holding foods such as protein salads in a cold bain-marie or refrigerated table for service, do not heap the food above the level of the container. The food above this level will not stay cold enough.

Hot Food Holding

1. To keep foods hot for service, use steam tables or other equipment that will keep all parts of all foods above 135°F (57°C) at all times.
2. Keep foods covered.
3. Bring foods to holding temperature as quickly as possible by using ovens, steamers, rangetop pots and pans, or other cooking equipment. Do not warm cold foods by placing them directly in the steam table. They will take too long to heat, and bacteria will have time to grow.
4. Do not let ready-to-eat foods come in contact with any contaminated surface.

KEY POINTS TO REVIEW

- What is cross-contamination?
- What are the important rules of personal hygiene? List as many as you can.
- What is the Food Danger Zone?
- What is the four-hour rule?

Food Handling and Preparation

We face two major sanitation problems when handling and preparing food. The first is *cross-contamination*, defined on page 25.

The second problem is that, while we are working on it, food is usually at a temperature between 41°F and 135°F (5°C to 57°C), or in the Food Danger Zone. The lag phase of bacteria growth (p. 18) helps us a little but, to be safe, we must keep foods out of the danger zone whenever possible.

1. Start with clean, wholesome foods from reputable purveyors. Whenever applicable, buy government-inspected meats, poultry, fish, dairy, and egg products.
2. Handle foods as little as possible. Use tongs, spatulas, or other utensils instead of hands when practical.

3. Use clean, sanitized equipment and worktables.
4. Clean and sanitize cutting surfaces and equipment after handling raw poultry, meat, fish, or eggs and before working on another food.
5. Place only food items and sanitary knives or other tools on cutting boards. Do not set food containers, tool boxes, or recipe books, for example, on cutting boards, as the bottoms of these items are not likely to be sanitary.
6. Clean as you go. Don't wait until the end of the workday. Keep clean cloths and sanitizing solution handy at your workstation and use them often.
7. Wash raw fruits and vegetables thoroughly.
8. When bringing foods out of refrigeration, do not bring out more than you can process in 1 hour.
9. Keep foods covered unless in immediate use.
10. Limit the time that foods spend in the Food Danger Zone. Observe the four-hour rule (p. 26).
11. Cook foods to minimum internal cooking temperatures (see next section).
12. Taste foods properly. With a ladle or other serving implement, transfer a small amount of the food to a small dish. Then taste this sample using a clean spoon. After tasting, do not use either the dish or the spoon again. Send them to the warewashing station or, if using disposables, discard them.
13. Boil leftover gravies, sauces, soups, and vegetables before serving.
14. Don't mix leftovers with freshly prepared foods.
15. Chill all ingredients for protein salads and potato salads before combining.
16. Cool and chill foods quickly and correctly, as explained in the following section. Chill custards, cream fillings, and other hazardous foods as quickly as possible by pouring them into shallow, sanitized pans, covering them, and refrigerating. Do not stack the pans.

Minimum Internal Cooking Temperatures

The ***minimum internal cooking temperature*** is the internal temperature for a given food product at which microorganisms are killed. The product must be held at that temperature for a specified period for the food to be considered safe. See Table 2.5.

Be sure to measure internal temperatures in at least two or three places, always inserting the thermometer into the thickest part of the food. Use sanitary thermometers that are accurate to within 2°F or 1°C.

Cooling Procedures

If cooked foods are not to be served immediately or kept hot for service, they must be cooled quickly so they do not spend too much time in the Food Danger Zone. The rate at which foods cool depends on their total volume in relation to how much surface area they have to transfer heat away. In other words, a large batch of food cools more slowly because it has less surface area per unit of volume. One of the hazards of cooking foods in large volumes is cooling them so slowly they spend too much time in the Food Danger Zone.

To help gauge the time you may safely take to cool large volumes of food, use either the ***two-stage cooling method*** or the ***one-stage cooling method***.

For the two-stage cooling method, cool foods from 135°F (57°C) to 70°F (21°C) in no more than 2 hours, and then from 70°F (21°C) to below 41°F (5°C) within an additional 4 hours, for a total cooling time of no more than 6 hours. The temperature range between 70°F (21°C) and 125°F (52°C) is the most dangerous part of the Food Danger Zone. This method ensures the food spends a minimum of time in that temperature range. If food has not cooled to 70°F (21°C) within 2 hours, it must be reheated to 165°F (74°C) and held at that temperature at least 15 seconds and then cooled again.

Table 2.5 Minimum Internal Cooking Temperatures

Product	Temperature and Time
Raw shell eggs for immediate service; any fish and meat not mentioned below	145°F (63°C) for 15 seconds
Pork, ground fish, ground meat	160°F (71.1°C) for 15 seconds
Ratites (ostrich, emu); injected meats; raw eggs not prepared for immediate service; inspected game animals; mechanically tenderized meats	155°F (68°C) for 15 seconds
Poultry; wild game; stuffed fish; stuffed meat; stuffed pasta; stuffed poultry; stuffed ratites (ostrich, emu); stuffing containing fish, meat, poultry, or ratites; any dish containing previously cooked foods	165°F (74°C) for 15 seconds
All raw animal foods cooked in a microwave	165°F (74°C). Rotate or stir the food midway through cooking process, cover to retain moisture, and let stand covered for 2 minutes following cooking to allow for post-cooking heat to rise.
Whole beef roasts, pork roasts, and ham	Any of the following combinations of time and temperature: 130°F (54.4°C) for 112 minutes 131°F (55°C) for 89 minutes 133°F (56.1°C) for 56 minutes 135°F (57.2°C) for 36 minutes 136°F (57.8°C) for 28 minutes 138°F (58.9°C) for 18 minutes 140°F (60°C) for 12 minutes 142°F (61.1°C) for 8 minutes 144°F (62.2°C) for 5 minutes 145°F (62.8°C) for 4 minutes

For the one-stage cooling method, cool foods to below 41°F (5°C) in no more than 4 hours. If the food does not reach this temperature in 4 hours, it must be reheated to 165°F (74°C) and held at that temperature at least 15 seconds and then cooled again. The one-stage method should be used if the item was made from potentially hazardous foods that were at room temperature when preparation was begun.

Guidelines for Cooling Foods

1. Never put hot foods directly into the cooler. Not only will they cool too slowly but also they will raise the temperature of other foods in the cooler.
2. If they are available, use quick-chill units or blast chillers to cool foods quickly before transferring them to cold storage.
3. Use ice-water baths to bring down the temperature of hot foods quickly.
4. Stir foods as they are cooling to redistribute the heat and help them cool more quickly.
5. Divide large batches into smaller batches. This increases the amount of surface area for the volume of food and helps it cool more quickly. Pouring foods into flat, shallow pans also increases surface area and cooling speed.

Cleaning and Sanitizing Equipment

Cleaning means removing visible soil. *Sanitizing* means killing disease-causing bacteria. Two ways of killing bacteria are by *heat* and by *chemicals*.

Manual Dishwashing

Figure 2.2 shows the setup of a three-compartment sink for washing dishes, glassware, and eating utensils by hand.

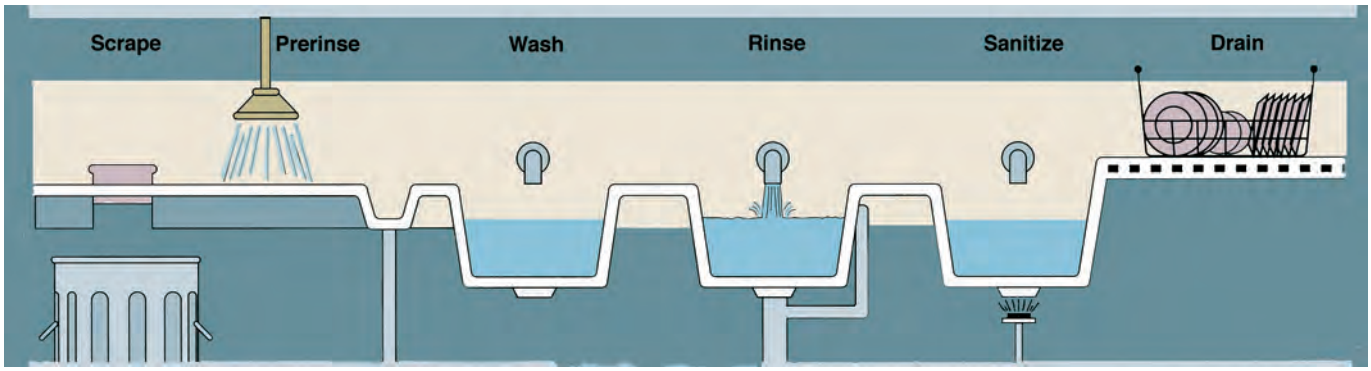

Figure 2.2 Setup of a three-compartment sink for manual dishwashing.

Procedure for Manual Dishwashing

1. **Scrape and rinse.**
   The purpose of this step is to keep the wash water cleaner longer.
2. **Wash.**
   Use warm water at 110°–120°F (43°–49°C) and a good detergent. Scrub well with a brush to remove all traces of soil and grease.
3. **Rinse.**
   Use clean, warm water to rinse off detergent. Change the water frequently, or use running water with an overflow, as in Figure 2.2.
4. **Sanitize.**
   Place utensils in a rack and immerse in hot water a---t 171°F (77°C) for 30 seconds. (A gas or electric heating element is needed to hold water at this temperature.)
5. **Drain and air dry.**
   Do not towel dry. This may recontaminate utensils. Do not touch food contact surfaces of sanitized dishes, glasses, and silverware.

Mechanical Dishwashing

The steps in washing dishes by machine are the same as in the hand method, except the machine does the washing, rinsing, and sanitizing.

Procedure for Mechanical Dishwashing

1. Scrape and rinse.
2. Rack dishes so the dishwasher spray will strike all surfaces.
3. Run the dishwasher for a full cycle.
4. Critical temperatures:
   For machines that sanitize by heat, final rinse must be at least 180°F (82°C), although some stationary rack machines operate correctly at 165°F (74°C). Follow the instructions for your model.
   For machines that sanitize by chemical disinfectant, washing temperature should be above 120°F (49°C), and sanitizing temperatures should be between 68° and 120°F (20-49°C). Sanitizing chemicals are not as effective above 120°F (49°C).
5. Air dry and inspect dishes. Do not touch food contact surfaces.

Washing Kitchen Utensils and Equipment

1. Use the same three-compartment sink setup and procedure as for manual dishwashing.
2. Do not use scouring powder or steel wool. These may make scratches where bacteria can hide. Also, pieces of steel wool break off and can remain in the pan and thus get into food.

3. Utensils with baked-on foods should be scraped and rinsed, soaked in the first compartment to loosen the baked-on food, and then scraped and rinsed again.
4. Kitchen equipment may be sanitized with *chemical disinfectants* (see sidebar) instead of heat. Use an approved disinfectant, and follow the instructions on the label.

CHEMICAL SANITIZING

The three most commonly used chemical sanitizers or disinfectants are *chlorine, iodine,* and *quaternary ammonium,* usually known as *quats.* Each of these chemicals has advantages and disadvantages. Read package instructions for each, and follow the appropriate guidelines for their use. All chemicals must be used with care.

Chlorine is widely used and inexpensive. It kills a broad range of pathogens and is effective in hard water, but it is less effective above 115°F (46°C).

Iodine is more expensive than chlorine and can stain surfaces with its brown color. However, it is not as quickly inactivated by dirt as chlorine is.

Quats works well in a wide range of temperatures, and it does not corrode metals, while chlorine and iodine can both be corrosive. However, it does not kill certain organisms.

Cleaning and Sanitizing Stationary Equipment and Work Surfaces

1. Unplug electrical equipment before cleaning. You could seriously injure yourself if you accidentally hit the power switch while you are cleaning a piece of equipment.
2. Disassemble equipment when possible. (This obviously doesn't apply to such equipment as worktables.) All immersible parts should be cleaned and sanitized like kitchen utensils.
3. Wash all food contact surfaces, using a detergent solution and clean cloths.
4. Sanitize all surfaces with a double-strength sanitizing solution and with clean cloths used only for this purpose.
5. Allow to air dry.
6. Reassemble equipment.

Rodent and Insect Control

Rats, mice, flies, and cockroaches can spread disease by contaminating food and food contact surfaces. Any sign of rodent or insect infestation is usually considered a serious violation of health codes.

There are four basic methods of pest control. We start with the most important and most effective.

Build Them Out

1. Block all possible rodent entrances, including structural defects in the building.
2. Put screens on all windows and doors.
3. Make sure all doors are self-closing, or install fly fans or air curtains.
4. Inspect incoming supplies for signs of insect infestation.

Eliminate Harborage and Breeding Places

1. Repair holes and all other structural defects in walls and floors.
2. Eliminate narrow spaces between and behind equipment, counters, and other fixtures, and hollow spaces made by false bottoms in counters, cabinets, and so on.
3. Store food and supplies off the floor.
4. Seal all cracks and crevices. Repair loose tiles, wall coverings, and so on.
5. Remove all fly-breeding places inside and out: garbage, manure, and general filth.

Eliminate Food Supplies

1. Keep all foods tightly covered or wrapped.
2. Keep garbage containers tightly covered, and use metal (ratproof) garbage cans.

3. Clean up all spilled food.
4. General sanitation: Keep floors, walls, and equipment clean.

Exterminate

Hire a qualified, licensed exterminator who knows how to use poisons, insecticides, and traps. Most poisons should not be used in a food production operation, so it's better not to do the job yourself.

Extermination is a temporary solution only. For permanent freedom from rodents and insects, you must rely on the other methods of control.

KEY POINTS TO REVIEW

- What does *minimum internal cooking temperature* mean?
- How should cooked foods be cooled?
- What are the steps in the procedure for manual dishwashing? for mechanical dishwashing?
- What are the four ways to protect against rodents and insects? Which of these is the most effective?

Setting Up a System for Food Safety

Once you have learned the information in the first part of this chapter, you must apply it in the kitchen.

Many food-service operations have designed food safety systems that enable food workers to keep a close check on food items whenever there is a risk of contamination or of the growth of pathogens. In the most effective systems, nothing is left to chance. At each stage of food production and storage, workers refer to written guidelines that explain what to look for and what action to take if the standards are not met. Having written guidelines helps everyone avoid costly mistakes.

The HACCP System

One effective food safety system is called the *Hazard Analysis Critical Control Point* system, or ***HACCP*** (pronounced HASS-up). Versions of this system have been widely adopted throughout the food-service industry.

The following discussion is a brief introduction to the basic concepts of HACCP. For a more detailed explanation, you may refer to other published material listed in the Bibliography (pp. 1059–1060). The discussion below is based on information presented in those books.

THE STEPS OF THE HACCP SYSTEM

The purpose of HACCP is to identify, monitor, and control dangers of food contamination. It is a system of seven steps:

1. Assess hazards.
2. Identify critical control points (CCPs).
3. Set up standards or limits for CCPs.
4. Set up procedures for monitoring CCPs.
5. Establish corrective actions.
6. Set up a recordkeeping system.
7. Verify the system is working.

These steps are the basis of the following discussion.

THE FLOW OF FOOD

HACCP begins with a concept called the ***flow of food***. This term refers to the movement of food through a food-service operation, from receiving through storage, preparation, and service, until it gets to the final consumer.

The flow of food is different for each item being prepared. Some menu items involve many steps. For example, a luncheon dish of creamed chicken and vegetables over rice might have the steps shown in Figure 2.3.

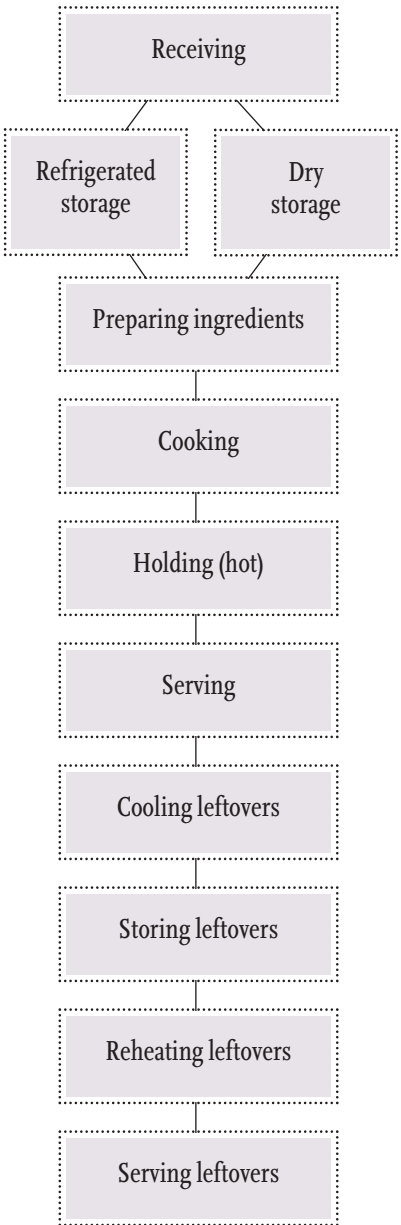

Figure 2.3 Flow of food.

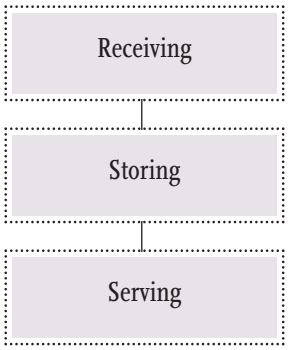

Figure 2.4 Basic flow of food.

Even the simplest items undergo several steps. For example, a cake bought already prepared from a commercial baker and served as dessert will go through at least the three steps in Figure 2.4 on its way to the customer.

ASSESSING HAZARDS

At each step of the flow of foods through the operation, risks can lead to dangerous conditions, or *hazards*. Assessing hazards is the process of identifying which of these dangerous conditions can occur every step of the process.

These hazards can be divided into three categories:

1. *Contamination*, such as cross-contamination from a soiled cutting surface, torn packaging that permits insect infestation, working on food without washing hands, and spilling cleaning chemicals on food.
2. *Growth of bacteria and other pathogens* due to such conditions as inadequate refrigeration or storage, and holding hot foods below 135°F (57°C).
3. *Survival of pathogens or the continued presence of toxins*, usually because of inadequate cooking or heating or inadequate sanitizing of equipment and surfaces.

Note these hazards correspond to the sanitation techniques discussed on page 19 (keep bacteria from spreading, stop bacteria from growing, kill bacteria). The important difference is that the hazards addressed by HACCP include chemical and other hazards in addition to disease-causing organisms. Naturally, however, most of the hazards we are concerned with are those that affect potentially hazardous foods (see page 18).

IDENTIFYING CRITICAL CONTROL POINTS

Once the potential hazards are identified, the next step is to decide at what stages a worker can control the hazards. These points are called *control points*. For any given hazard, there may be several control points, or several chances to control the hazard. The last control point at which a worker can control a particular hazard is especially important to determine because this is the last chance to prevent a possible danger. These control points are called ***critical control points (CCPs)***. Identifying CCPs is the second step in a HACCP program.

In simple language, setting up a HACCP system starts with reviewing the flow of food to figure out where something might go wrong, and then deciding what can be done about it. In the language of HACCP, these steps are called *assessing the hazards* and *identifying critical control points*.

SETTING STANDARDS OR LIMITS FOR CCPS

The next step in designing a HACCP food safety system is setting up procedures for CCPs. At each such point, food workers need to know what standards must be met, what procedures to follow to meet the standards, and what to do if they aren't met. To reduce the chances for making mistakes, these standards and procedures are written out. Whenever possible, they should be included in the operation's recipes. In Chapter 5, you will see how CCPs are incorporated into a standardized recipe.

Some procedures are general and include the sanitation rules discussed earlier in this chapter. For example: Wash hands before handling food and after handling raw foods; hold foods above 135°F (57°C) or below 41°F (5°C). Others apply to specific items. For example: Cook a beef roast to an internal temperature of at least 145°F (63°C) and ensure that it stays at that temperature for at least 4 minutes. The minimum internal cooking temperatures discussed on page 30 are an important part of the standards of a HACCP system.

SETTING UP MONITORING PROCEDURES

Careful observation is needed to know when standards are met. This often involves measuring. The only way to know, for example, that a roast has reached the required internal temperature is to measure it, using a clean, sanitized thermometer.

Managers must ensure all employees are trained to follow procedures and have the equipment needed to do the job.

Establishing monitoring procedures includes determining how a CCP is to be monitored or measured, when it is to be monitored, who is responsible for doing the measuring, and what equipment is needed to do the monitoring.

TAKING CORRECTIVE ACTION

A ***corrective action*** is a procedure that must be followed whenever a critical limit is not met. Corrective actions should be identified in written procedures that clearly tell the worker what must be done in each situation.

For example, a monitoring procedure might show the internal temperature of a roast turkey just out of the oven is 155°F (68°C). But the critical limit for roast turkey is 165°F (74°). The corrective action might be to return the turkey to the oven until the temperature reaches the critical limit.

Other corrective actions might be more complicated, but the written procedure should describe clearly what steps must be taken and who must take them.

SETTING UP A RECORDKEEPING SYSTEM

Keeping records of all the procedures described previously is important if a HACCP system is to succeed. Time and temperature logs, records of corrective actions taken, and documentation of when and how measuring devices were calibrated are examples of the kinds of records that enable an establishment to ensure food safety. Each establishment should develop clear, easy-to-use forms for entering all needed information.

VERIFYING THE SYSTEM WORKS

Accurate records enable you to make sure a HACCP system is working as intended. Review records regularly to check that all CCPs are being correctly monitored and that corrective actions are taken according to the proper procedures and adequate to control hazards. Revise procedures as necessary.

Accurate records also demonstrate to health inspectors that your operation is following correct safe procedures. In addition, records help you determine what went wrong if a food-borne illness does occur.

In addition, whenever purchasing specifications are changed, new items are added to the menu, or new equipment is put into use, review procedures and change them if needed. For example, if an operation starts buying larger beef steamship rounds for roasting, the internal temperature of the roasts will not meet critical limits unless the roasting time allowed for the beef is increased.

As this brief introduction to HACCP implies, establishing such a system to control all aspects of food production requires more information than this chapter has space for. Refer to the Bibliography for more detailed information.

Learning More About Food Safety

It is important for you to understand that food safety and sanitation is a large and complex topic. The first half of this chapter is only an introduction to the study of food safety. To advance in a food-service career, you must demonstrate a detailed knowledge of the subject well beyond what can be presented in such a short space. Entire textbooks are devoted to kitchen sanitation and safety. Many organizations, including local and regional health departments and organizations such as the National Restaurant Association (in the United States), sponsor training programs leading to certificates of competency in food safety. Food-service employees in supervisory positions in the United States may be required to hold such a certificate by state or local law. In Canada, many provinces have their own safety regulations, and food-service operators should be familiar with these as well as with federal regulations. The health and safety of your clientele depend on your diligent study.

SAFETY

Kitchen work is usually considered a relatively safe occupation, at least in comparison with many industrial jobs. Nevertheless, the kitchen presents many hazards. Minor injuries from cuts and burns are common, and more serious injuries are all too possible. The quantity of hot equipment and powerful machinery, combined with the busy, sometimes frantic pace, make it important for everyone to work carefully and with constant attention to the rules of safety.

In the United States, the Occupational Safety and Health Administration (OSHA) established sets of rules governing workplace safety. Employers are required to follow these rules and guidelines. In Canada, information on comparable legislation, both national and provincial, is provided by the Canadian Centre for Occupational Health and Safety (CCOHS).

The Safe Workplace

Most of this section is concerned with ways workers can prevent certain kinds of accidents, such as cuts, burns, and falls. However, it is much easier to develop and practice habits that prevent accidents if safety is built into the workplace.

The management of a food-service operation must see to it that the structure and equipment have necessary safety features.

1. Structure, equipment, and electrical wiring in good repair.
2. Adequate lighting on work surfaces and in corridors.
3. Nonslip floors.
4. Clearly marked exits.
5. Equipment supplied with necessary safety devices.
6. Heat-activated fire extinguishers over cooking equipment, especially deep fryers.
7. Conveniently located emergency equipment, such as fire extinguishers, fire blankets, and first-aid kits.
8. Clearly posted emergency telephone numbers.
9. Clearly posted emergency procedures, including the Heimlich maneuver for victims of choking. One or more employees should have received formal training in this procedure. In addition, it is a good idea to train one or more employees in cardiopulmonary resuscitation (CPR).
10. Smooth traffic patterns to avoid collisions between workers.

Preventing Cuts

1. Keep knives sharp. A sharp knife is safer than a dull one because it requires less pressure and is less likely to slip.
2. Use a cutting board. Do not cut against a metal surface. Place a damp towel under the board to keep it from slipping.
3. Pay attention to your work when using a knife or cutting equipment. Have only one knife at a time on the cutting board. Knives not in use should be on the worktable near but not on the cutting board.
4. Cut away from yourself and other workers.
5. Use knives only for cutting, not for such jobs as opening bottles.
6. Don't try to catch a falling knife. Step back and let it fall.
7. Don't put knives in a sink, under water, or in any other place they can't be seen.
8. Clean knives carefully, with the sharp edge away from you.
9. Store knives in a safe place, such as a rack, when not in use.
10. Carry knives properly. Hold the knife beside you, point down, with the sharp edge back and away from you. Don't swing your arm. Whenever possible, carry knives in a sheath. Warn people when you are walking past them with a knife in hand.

11. Keep breakable items, such as dishes and glassware, out of the food production area.
12. Don't put breakable items in the pot sink.
13. Sweep up—don't pick up—broken glass.
14. Discard chipped or cracked dishes and glasses.
15. Use special containers for broken dishes and glasses. Don't throw them in with other garbage.
16. If there is broken glass in the sink, drain the sink before trying to take out the glass.
17. Remove all nails and staples when opening crates and cartons, and dispose of them.

Preventing Burns

1. Always assume a pot handle is hot. Don't just grab it with your bare hand.
2. Use dry pads or towels to handle hot pans. Wet ones will create steam, which can burn you.
3. Keep pan handles out of the aisle so people won't bump into them. Also, keep handles away from the open flames of gas burners.
4. Don't fill pans so full they are likely to spill hot foods.
5. Get help when moving heavy containers of hot food.
6. Open lids away from you to let steam escape safely.
7. Use care when opening compartment steamers.
8. Make sure gas is well vented before trying to light ovens or pilot lights. Strike matches before turning on the gas. Also, strike matches away from your body.
9. Wear long sleeves and a double-breasted jacket to protect yourself from spilled or spattered hot foods or fat. Also, wear sturdy leather shoes with closed toes.
10. Dry foods before putting them in frying fat, or hot fat may splatter on you.
11. When placing foods in hot fat, let them fall away from you so fat will not splash on you.
12. Keep liquids away from the deep fryer. If a liquid were spilled into the fryer, the sudden rush of steam could spray hot fat on anyone nearby.
13. Always warn people when you are walking behind them with hot pans or when you are walking behind someone who is working with hot items.
14. Warn service staff about hot plates.

Preventing and Dealing with Fires

1. Know where fire extinguishers are located and how to use them.
2. Use the right kind of fire extinguisher. There are four classes of fire, and fire extinguishers should be labeled according to the kind of fire for which they can be used.
    - *Class A*: wood, paper, cloth, ordinary combustibles
    - *Class B*: burning liquids, such as grease, oil, gasoline, solvents
    - *Class C*: switches, motors, electrical equipment, and so forth
    - *Class K*: cooking appliances involving combustible cooking products such as vegetable or animal oils and fats

    Never use water or a Class A fire extinguisher on a grease fire or electrical fire. You will only spread the fire.

3. Keep a supply of salt or baking soda handy to put out fires on rangetops.
4. Keep hoods and other equipment free from grease buildup.
5. Don't leave hot fat unattended on the range.
6. Smoke only in designated areas. Do not leave burning cigarettes unattended.
7. If a fire alarm sounds and if you have time, turn off all gas and electrical appliances before leaving the building.
8. Keep fire doors closed.
9. Keep exits free from obstacles.
10. Establish and post a plan for emergency evacuation, clearly identifying routes and exits. The plan should include procedures for evacuating customers and other non-employees.

Preventing Injuries from Machines and Equipment

1. Do not use any equipment unless you understand its operation.
2. Use all guards and safety devices on equipment. Set slicing machines at zero (blade closed) when not in use.
3. Don't touch or remove food from any kind of equipment while it is running, not even with a spoon or spatula.
4. Unplug electrical equipment before disassembling or cleaning.
5. Make sure the switch is off before plugging in equipment.
6. Do not touch or handle electrical equipment, including switches, if your hands are wet or if you are standing in water.
7. Wear properly fitting clothing. Tuck in apron strings to avoid getting them caught in machinery.
8. Use equipment only for its intended purpose.
9. Stack pots and other equipment properly on pot racks so they are stable and not likely to fall.

Preventing Falls

1. Clean up spills immediately.
2. Throw salt on a slippery spot to make it less slippery while a mop is being fetched.
3. Keep aisles and stairs clear and unobstructed.
4. Don't carry objects too big to see over.
5. Walk, don't run.
6. Stand on a safe ladder, not a chair or piles of boxes, to reach high shelves or to clean high equipment.

Preventing Strains and Injuries from Lifting

1. Lift with the leg muscles, not the back. Figure 2.5 shows proper lifting technique.
2. Don't turn or twist your back while lifting. Make sure your footing is secure.
3. Use a cart to move heavy objects long distances, or get help.

Figure 2.5 Proper lifting technique.

(a) Squat on one knee, and then lift with the leg muscles. **(b) Do not bend over and lift with the back.**

KEY POINTS TO REVIEW

- What does the term *flow of food* mean?
- What does the term *critical control point* mean?
- What are the seven steps of the HACCP system?
- What workplace habits can help you prevent injuries from cuts and burn and from kitchen equipment?
- How can you prevent fires in the kitchen?

TERMS FOR REVIEW

contaminated
hazard
microorganism
pathogen
bacteria
intoxication
infection
toxin-mediated infection
water activity (a_w)
Food Danger Zone
aerobic
anaerobic
facultative
lag phase
potentially hazardous food
sanitize
parasite
botulism
staph
E. coli
salmonella
trichinosis
physical contamination
allergen
cross-contamination
four-hour rule
minimum internal cooking temperature
two-stage cooling method
one-stage cooling method
HACCP
flow of food
critical control point (CCP)
corrective action
Class A, B, C, and K fires

QUESTIONS FOR DISCUSSION

1. True or false: Holding food in a steam table above 135°F (57°C) kills disease-causing bacteria and eliminates the problem of food poisoning. Explain your answer.
2. True or false: Canning foods eliminates air so disease-causing bacteria can't grow. Explain your answer.
3. Which of the following foods can become contaminated by disease-causing organisms?

Chocolate éclairs	Dinner rolls
Potato salad	Shrimp cocktail
Roast beef	After-dinner mints
Lettuce	Saltine crackers
Turkey sandwich	Rice pudding

4. How often should you wash your hands when working on food?
5. Why is temperature control one of the most effective weapons against bacterial growth? What are some important temperatures to remember?
6. What is the importance of cleaning and sanitizing equipment and cutting boards immediately after working on raw poultry?
7. You are making egg salad, and you have just cooked the eggs. What step do you take before chopping the eggs and mixing them with the other ingredients? Why?
8. Is it possible for a dish to be clean but not sanitized? sanitized but not clean?
9. Explain the concepts of *hazards* and *critical control points*. Give at least three examples of each.
10. What are the three general categories of potentially hazardous foods? Give examples of each category. Give examples of foods that are not potentially hazardous.
11. True or false: The lower limit of the Food Danger Zone is the proper refrigeration temperature for perishable foods. Discuss.