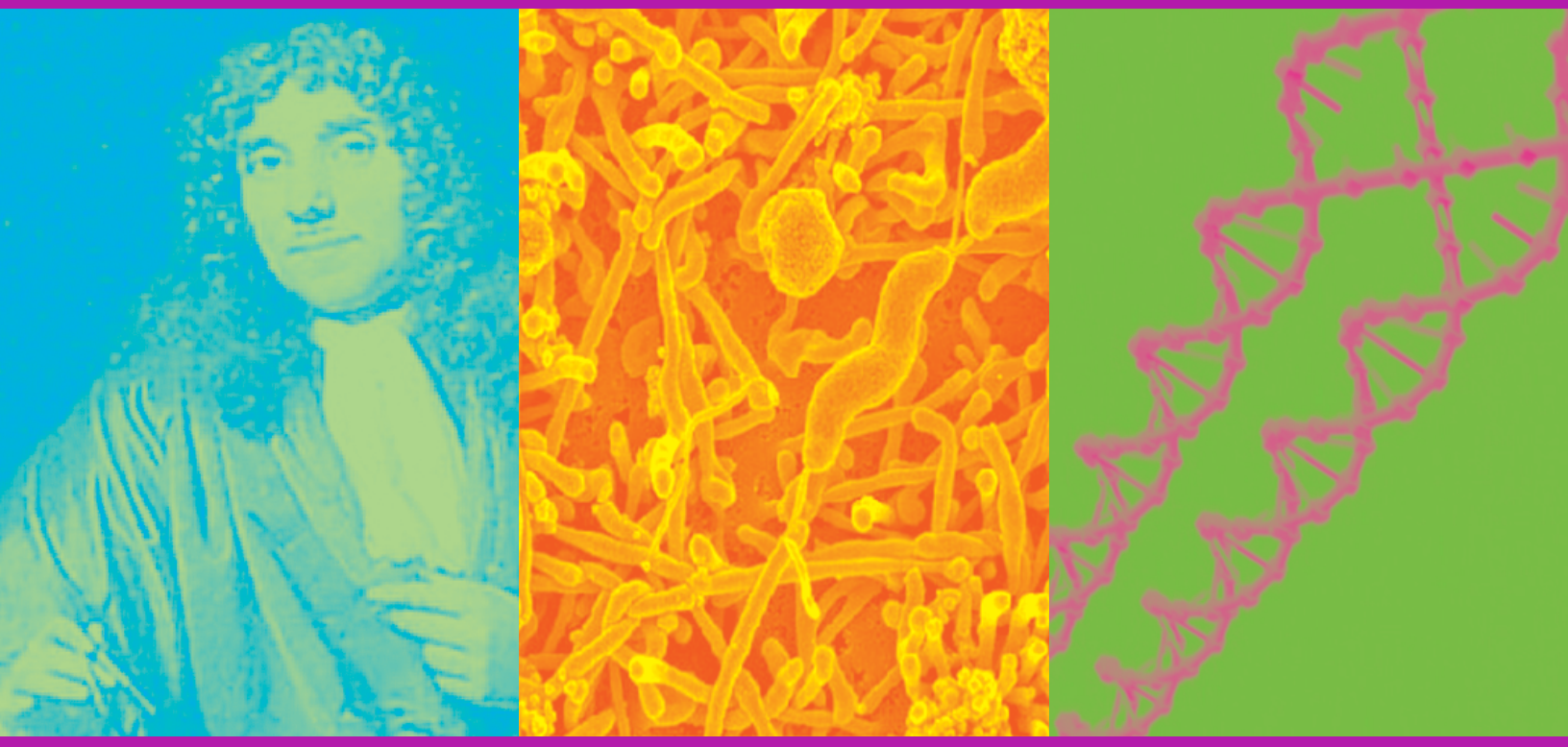
SCIENCE
AND
OUR FOOD SUPPLY

FOOD SAFETY A TO Z REFERENCE GUIDE



DEPARTMENT OF HEALTH & HUMAN SERVICES · USA

FDA

NSTA National Science Teachers Association

SCIENCE AND OUR FOOD SUPPLY

It's Food Safety at Your Fingertips!

Becoming food safety savvy is as easy as A–B–C! Let your fingers do the walking through this user-friendly reference guide that offers you a wealth of invaluable, up-to-date food safety information. Also included are in-depth sections on the step-by-step journey food travels from the farm to the table; how to prepare and handle food safely; the Fight BAC!™ Campaign's 4 Simple Steps to Food Safety: Clean, Separate (Combat Cross-Contamination), Cook, and Chill; and fascinating food safety careers!

Throughout the guide, you'll also find a host of helpful tips, intriguing visuals, fun facts, and answers to your most Frequently Asked Questions.

Fun Facts

Frequently Asked Questions

Use this guide as a research tool for reinforcing the science concepts in the video, performing the activities and labs, and to further enhance your knowledge of food safety.

The Food Safety A to Z Reference Guide serves as a companion piece to the *Science and Our Food Supply* program's following components:

Video

Dr. X and the Quest for Food Safety

Also online at:
www.fda.gov/teachsciencewithfood

Teacher's Guide Labs & Activities

- MODULE 1 UNDERSTANDING BACTERIA
- MODULE 2 FARM
- MODULE 3 PROCESSING AND TRANSPORTATION
- MODULE 4 RETAIL AND HOME
- MODULE 5 OUTBREAK AND FUTURE TECHNOLOGY

It's a feast of food safety information. Bon appétit!

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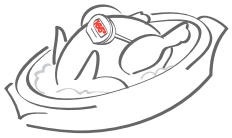
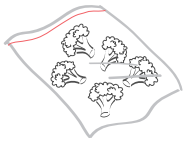
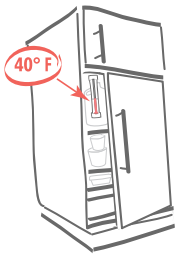


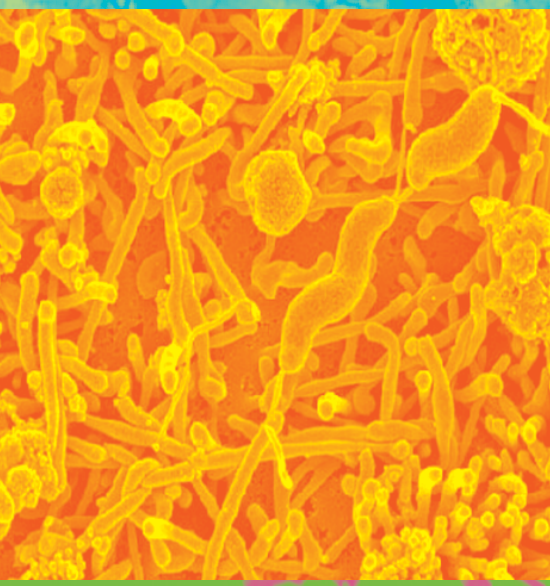




See the *Science and Our Food Supply* **Career Profiles** in the kit folder and online at **www.fda.gov/teachsciencewithfood**!

FOOD SAFETY A TO Z

COMPREHENSIVE LIST OF TERMS



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A

Acidification

A technology used by processors to preserve foods by adding acids and rendering food safe from harmful bacteria.

Food Safety Implication: During processing, the proper pH (the measure of acidity, less than 7, or alkalinity, greater than 7, of a solution) must be maintained in order to prevent the growth of harmful bacteria. Most foodborne bacteria can't grow at pH levels below 4.6. Acidification is one way to maintain safe pH levels and keep various foods safe from harmful bacteria. (Also see *pH*.)

How It Works: There are 2 ways foods are acidified:

1. Acid is added to foods as a chemical.
2. Specific microorganisms like bacteria or yeast are added to foods. These microorganisms will, in turn, produce acid. This is known as fermentation, a process used to make certain foods safer.

Some Common Acidulents and Some of Their Corresponding Foods:

- Acetic Acid (vinegar, salad dressing)
- Citric Acid (candy, orange juice)
- Phosphoric Acid (cola, soda)
- Proprionic Acid (Swiss cheese)
- Lactic Acid (yogurt, pepperoni, sauerkraut)

Additive

Any substance that is added to food and affects the food's characteristics.

Food Safety Implication: Additives are used in foods during processing to prevent food spoilage, reduce bacterial growth, and thus help prevent foodborne illness.

Two Types of Food Additives:

1. Direct Additives — These additives are intentionally added to food for a specific purpose. Some examples include:
   - Preservatives — Prevent foods from spoiling.
   - Sweeteners and Flavorings — Protect flavor or add a specific flavor or sweetness.
   - Artificial and Natural Colorings — Make foods look brighter and more attractive.
   - Nutritional Supplements — Improve the nutritional value of foods by adding vitamins or minerals.
2. Indirect Additives — These substances can become part of the food in trace amounts due to packaging, storage, or handling. For instance, minute amounts of packaging substances may find their way into foods during storage. Food packaging manufacturers must prove to the Food and Drug Administration (FDA) that all materials coming in contact with food are safe before they are permitted for use in such a manner.

? Are food additives necessary and are they safe?

Yes, food additives are necessary. Without them, food spoilage, food costs, and the loss of food to pests would be higher. FDA evaluates all food additives for safety before they are allowed in foods and has found them to be safe and effective in the quantities in which they are consumed in foods.

Agar (see **Media**)

Antibacterial (also known as **Antimicrobial**)

A general term that describes a product that kills or inhibits the growth of bacteria in foods or on inanimate surfaces or hands.

Food Safety Implication: Antibacterial household cleaning products kill bacteria on surfaces, such as cutting boards and countertops. Personal cleansing products kill germs on hands. Antibacterial products help reduce the possibility of cross-contamination. In the case of foods, salt is antibacterial and is used as a direct additive in many foods to restrict bacterial growth. The FDA also regulates many antimicrobial treatments, such as irradiation, organic acids, and peroxide.

Types of Antibacterial Cleaning Products: Antimicrobial (germ-killing) cleaning products used in the home fall into two general categories:

1. Personal Cleansing Products — Antibacterial soaps or washes that are formulated to kill or inhibit certain bacteria on the hands or body. The FDA regulates antibacterial soaps as over-the-counter drugs.
2. Antimicrobial Household and Commercial Cleaning Products — These are formulated to kill germs on inanimate surfaces. The U.S. Environmental Protection Agency (EPA) regulates antimicrobial household cleaning products.

DID YOU KNOW?

Acidification is the result of food fermentation. Fermentation is a natural process whereby acids are produced by lactic acid bacteria to make cheese, pepperoni, beer, and wine, for example.

- Without **food additives**, bread would easily mold, salt would lump, ice cream would separate into icy crystals, and marshmallows would harden into bite-sized rocks.
- Some common food additives are salt, baking soda, vinegar, and various spices. You can find out which additives have been added to retail foods by checking the ingredient list on the packaging.

For **antibacterial** household cleaning products to work effectively, they must remain in contact with the surface for a specified amount of time. The amount of time varies from product to product. Read and follow product label directions.

Antibiotic

A chemical substance, produced by living microorganisms or made synthetically, which is designed to kill or inhibit the growth of bacteria in the treatment of people and animals infected with pathogens. Antibiotics are not directly used in foods.

Food Safety Implication: In some foodborne illness cases, doctors may prescribe antibiotics to treat patients infected with foodborne pathogens. However, pathogens can mutate and develop antibiotic-resistant strains that antibiotics are not always able to kill. Resistant bacteria also emerge because of overuse and misuse of antibiotics. Once bacteria develop resistance to antibiotic treatment, they can continue to live and/or multiply even in the presence of the antibiotic.

How It Works: Almost immediately after Alexander Fleming's discovery of penicillin in 1928, researchers observed that some bacteria could suddenly withstand this and other "wonder drugs." Today, at least two dozen different kinds of bacteria have developed resistance to one or more antibiotics. Widespread pathogens, such as *Staphylococcus*, are becoming increasingly resistant to antibiotics.

How Bacteria Resist Antibiotics: There are several ways bacteria can resist antibiotics. Mutation is one way. Sometimes, by chance, bacterial genes mutate during reproduction, subtly altering the genetic nature of the bacterium. Occasionally a mutation may help the bacterium resist a particular drug. While susceptible bacteria die, this surviving microbe continues to reproduce, again and again, until an army of resistant bacteria squares off against the now-ineffective drug.

Microbes also have the ability to share "resistance genes." One way they do this is by conjugation, in which a microorganism carrying a resistance gene meets a susceptible mate, bonds with it, then transfers its genes.

? How will the doctor treat my infections if one antibiotic does not work?

Your doctor may try higher doses of antibiotics, a different type of antibiotic, or combinations of antibiotics. In addition, he or she may try to administer the antibiotic in a different way, such as through an injection.

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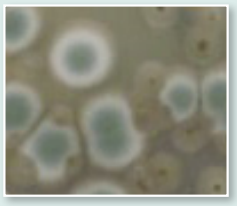


Today, more than 100,000,000 pounds of penicillin are produced each year!

Penicillium Mold

A

"At-Risk" Populations

(also called **highly susceptible populations**)

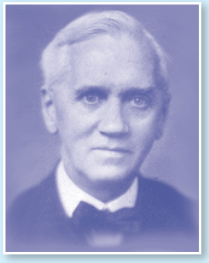
Any group who may be more susceptible to more serious symptoms or side effects from an illness than the general population. At-risk groups for foodborne illness include: very young children, pregnant women, older adults, and people with weakened immune systems.

Food Safety Implication: Extra care should be taken to ensure that at-risk people do not contract foodborne illness.

Why Some People are "At Risk" for Foodborne Illness: Our immune systems help fight diseases, but some people's immune systems may be weakened — or in the case of children, not yet fully developed. As a result, their bodies cannot effectively fight illness.

- Infants and Children — Their immune systems are not fully developed, and they produce less acid in their stomachs, which makes it easier for harmful microorganisms to get through their digestive system and invade their bodies..
- Pregnant Women — Pregnancy, by itself, is a period when a woman's immune system is suppressed. The fetus is at risk because harmful microorganisms can cross the placental membranes and infect the developing child, who does not have a fully developed immune system.
- Older Adults — Poor nutrition, lack of protein in diet, and poor blood circulation may result in a weakened immune system.
- People with Certain Diseases — The immune systems of people with certain illnesses, such as HIV/AIDS and those on cancer chemotherapy, can be weakened. Thus, their bodies are not able to effectively fight illnesses.

DID YOU KNOW?



In 1928, **Sir Alexander Fleming**, a scientist, discovered mold growing as a contaminant in a lab dish containing *Staphylococcus* bacteria. The mold growth oozed a juice that killed the surrounding *Staphylococcus* cells. From the active ingredient in this mold, penicillin — a widely used **antibiotic** — was born!

Sir Alexander Fleming (1881-1955)

B

Bacteria (plural) or Bacterium (singular)

Single-cell, independently replicating microorganisms that lack a membrane-bound nucleus and other organelles.

Food Safety Implication: Most bacteria are harmless and can even be beneficial, such as those used to make yogurt. However, harmful bacteria can cause foodborne illness in humans. In fact, out of all the microorganisms of concern for food safety, bacteria and viruses pose the greatest threat to human health. Food can become contaminated with foodborne bacteria mainly from:

- **Animals** — manure or saliva, or disease microorganisms within the animals. For example, if meat contains harmful bacteria, and it is not thoroughly cooked to kill the bacteria, foodborne illness may result once the food is eaten.
- **Soil** — contaminated by animal droppings, which can be transferred to the crops that we eat and also by normal soil residents.
- **Water** — contaminated by animal droppings, which can be transferred to humans when the water is consumed or sprayed on crops.
- **Humans** — from infected hands that touch the food we eat.

Where They Live: Bacteria are found everywhere. They live on and in the human body. For example, about 600 types of bacteria live on the skin, and saliva contains about 6 different kinds of bacteria. Water, wind, insects, plants, and animals can carry bacteria. They also live on clothes, human hair, room-temperature foods, and surfaces in our homes, schools, and workplaces.

How They Grow: Most bacteria multiply through a process called binary fission, a form of asexual reproduction in which the deoxyribonucleic acid (DNA) that holds all of the cell's genetic information doubles, the cell splits, and two independent cells are formed. One cell can double within 20 to 30 minutes. You can't see, taste, or smell bacteria in food, but they can be present in food and multiply rapidly under the right conditions. That's why it's important to properly handle all foods.

To Survive and Reproduce, Bacteria Need:

- **Nutrients** — Bacteria need many of the same nutrients as humans in order to thrive, such as glucose, amino acids, and some vitamins and minerals. For example, bacteria grow rapidly in high protein foods, such as meat, poultry, eggs, dairy, and seafood.
- **Moisture** — Most bacteria thrive in moist environments. Dry foods, such as sugar, flour, dry cereal, rice, cookies, and biscuits do not have enough moisture to allow bacteria to grow. On the other hand, if dry foods become contaminated from infected hands or equipment, for example, bacteria can survive on the food and make people ill, but they can't grow or multiply until the food is eaten.
- **pH** — Most bacteria will not grow at pH levels below 4.6. Microorganisms thrive in a pH range above 4.6. That's why acidic foods like vinegar and fresh fruits (especially citrus) seldom provide a favorable climate for pathogenic bacteria. (Also see *pH*.)
- **Temperature** — Bacteria can multiply at temperatures between about 34° F (1° C) and 125° F (52° C). They divide rapidly at 80° to 105° F (27° to 41° C). Proper cooking kills bacteria in food and chilling foods slows the growth of bacteria. Both methods decrease the risk of foodborne illness.
- **Time** — Bacteria can double their numbers in 20 minutes under optimal conditions. Foodborne pathogenic bacteria grow best at human body temperature (98.6° F, 37° C) and can divide 2 to 3 times per hour. Food that's left out at room temperature for long periods of time creates an inviting environment for bacterial growth.

How to Control Bacteria in Foods: One way is to keep cold food cold, meaning below the temperature where bacteria can grow. Usually, this is below 40° F (4° C), but some pathogenic bacteria can grow slowly at 32° F (0° C), the temperature at which water freezes.

DID YOU KNOW?

Anton van Leeuwenhoek used his development of good-quality microscopes to discover **bacteria** in 1674.

Anton van Leeuwenhoek (1632–1723)

James A. Sullivan/Cells Alive

A single **bacterium** can grow to millions in 10 to 12 hours!

Bacterium multiplying

Good Bacteria: Most bacteria are beneficial to us in our everyday lives, both inside our bodies and in other applications. Here are some examples of good bacteria:

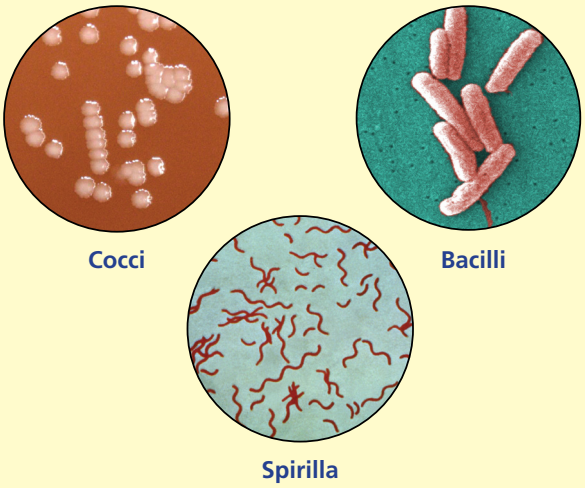
- ***E. coli*** (not the O157:H7 variety) plays an important role in our digestive system. It is present in the human small intestine. *E. coli* helps create vitamin K in the body and aids in digestion.
- ***Streptomyces*** is soil bacteria used to make Streptomycin, an antibiotic used to treat infections.
- ***Lactobacillus* acidophilus** turns milk into yogurt.

Bacteria also assist with the production of certain foods such as cheese, buttermilk, sauerkraut, vinegar, and pickles. In certain crop plants like legumes, bacteria can take nitrogen from the air to the roots and change it into ammonia, which is one of several important compounds required for healthy plant growth.

Bacteria also play a role in recycling. They have the ability to decompose waste in the environment by breaking it down into nutrients that are useful to soil (also known as composting).

Harmful Bacteria: Pathogenic bacteria — those that are harmful — cause disease. They have the ability to cause disease by invading human tissue or producing toxic substances that can alter normal body functions. (See *Pathogen* for a list of the 12 Most Unwanted Bacteria that cause foodborne illness.)

Diseases Caused by Pathogenic Bacteria Include: Foodborne illness, tuberculosis, cholera, bacterial meningitis, Legionnaire's disease, rheumatic fever, typhoid, tetanus, pneumonia, strep throat, stomach ulcers, tooth decay, and skin infections.



Bacteria typically have one of three distinct shapes: cocci (round), bacilli (rod-shaped), or spirilla (spiral). Bacterial cells differ from other cells in that they do not have a well-defined nucleus enclosing their genetic material. Instead, bacteria have a nucleoid, which is a circular loop of double-stranded helical DNA that carries the genes.

Some people say that alcohol or vinegar can kill bacteria. Is this true?

Yes, ethanol and isopropyl alcohol and vinegar, which is an acetic acid, do kill bacteria. Ethanol alcohol at 70% is more effective at killing bacteria than at 90 to 100% because the alcohol gets inside the cell better. Isopropyl alcohol is even more effective at killing bacteria because it is less volatile. While alcohol is a good disinfectant for inactivating many bacteria, it will not inactivate bacterial spores that are resistant. At acidic pH levels, many bacteria are inactivated by vinegar (acetic acid).

Bacteriophage

(also known as **Bacterial Virus** or **Phage**)

Any group of viruses that infect bacteria.

How It Works: Thousands of varieties of phage exist, each of which may infect only one type or a few types of bacteria. During infection, a phage attaches to a bacterium and injects its genetic material into the cell. The phage takes over the metabolic machinery of the bacteria and produces new phage particles, which cause the bacteria to lyse (break open). This process releases many new phage, which seek out other bacteria to invade and repeat the cycle.

Phage Uses: Soon after making their independent discoveries of phages in the early 1900s, scientists Frederick Twort and Felix d'Herelle tried to use phages in treating human bacterial diseases, such as the bubonic plague and cholera. However, phage therapy was not successful. After the discovery of antibiotics in the 1940s, phage therapy was virtually abandoned. But with the rise of drug-resistant bacteria in the 1990s, the therapeutic potential of phages is receiving renewed attention.

"Best If Used By" Date

A calendar date on the packaging of a food product, which represents the recommended time limit a food should be used within for best flavor or quality. It is not a purchase or safety date. (Also see Expiration, "Sell By," *and* "Use By" Dates.)

Binary Fission (see **Bacteria**)

B

Binomial Nomenclature

The naming system for bacteria, which allows scientists to carefully name any newly found bacterium so that it won't be confused with known bacteria. (Also see Genus *and* Species.*) In binomial nomenclature, the names of bacteria have a first (the genus) and last (species) name. For example, for the bacterium,* Escherichia coli, Escherichia *is the genus and* coli *is the species. The first letter of genera (plural of genus) names are always capitalized, while species names receive a lower-case first letter. Since names are always in Latin, the names are italicized, like all foreign terms.*

Biotechnology (also known as **Food Engineering** or **Genetic Engineering**)

The techniques used by scientists to modify deoxyribonucleic acid (DNA) or the genetic material of a bacterium, plant, or animal in order to achieve a desired trait.

Food Safety Implication: Biotechnology is used to improve the quality and quantity of food.

How It Works: To change a plant's traits, scientists use a gun-like instrument to insert 1, 2, or 3 genes into the plant to give it new, advantageous characteristics. For animal production, scientists can select the traits they want and "genetically engineer" or introduce those genes into the animals.

Some Advantages of Biotechnology:

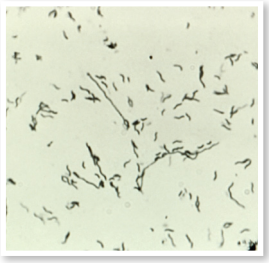
- Increases harvest yields of food.
- Improves the taste, nutrition, texture, size, or color of produce. For example, biotechnology can cause a tomato to stay on the vine longer, which helps it develop more flavor and a brighter color.
- Lengthens the season of fruits and vegetables and helps cows produce more milk.
- Allows plants to absorb more nutrients from the soil, thus decreasing the need for fertilizers.
- Increases the ability of plants to resist pests and disease.

Botulism (see ***Clostridium botulinum***)

C

Campylobacter jejuni

This foodborne pathogen is the one of the most common bacterial causes of diarrhea in the United States, resulting in 1 to 6 million illnesses each year. Children under 1 year old have the highest rate of Campylobacter *species infections.*



Campylobacter jejuni

Sources: Raw milk, untreated water, and raw and undercooked meat, poultry, or shellfish.

Illness:

Incubation: Generally 2 to 5 days after ingestion.

Symptoms: Diarrhea (sometimes bloody), abdominal cramps, fever, muscle pain, headache, and nausea.

Duration: 2 to 10 days.

Canning

A method of preserving food by placing it in airtight, vacuum-sealed containers and destroying microorganisms through heat processing at 250° F (121° C).

Human Pathogen Association: *Clostridium botulinum*

Food Safety Implication: Many raw foods, especially raw vegetables, contain heat-resistant spores of *Clostridium botulinum*. (See photo on page 10.) While canning can help foods last longer, if it is not done properly, the spores will grow and produce a deadly toxin. If the toxin is consumed, a person could develop botulism, a serious foodborne illness. If a person's diaphragm is affected, he or she will not be able to breathe and could die. Fortunately, botulism is a very rare disease in the United States and is treatable if diagnosed early. (Also see *Clostridium botulinum*.)

How It Works: First, food is washed and prepared before packing it in a sterile (free of microorganisms) tin-coated steel can or glass jar. To prevent food spoilage and kill any pathogenic organisms, the container is then subjected to high heat — at least 250° F (121° C) — for a certain amount of time. Cooking times vary depending on the food.

Food Safety Precautions: Exercise safe canning practices at home by following these tips:

- Use a pressure cooker to heat low-acid foods, such as red meats, seafood, poultry, milk, and all fresh vegetables, except for most tomatoes. (Tomatoes are usually considered an acidic food, but some are now known to have pH values slightly above 4.6.) Low-acid foods (with pH values higher than 4.6) are not acidic enough to prevent the growth of the bacterium, *Clostridium botulinum*.
- Acidic foods can be safely processed in a boiling-water canner because the combination of 212° F (100° C) heat and acidity will inactivate bacteria and spores. Some examples of high-acid foods include: all fruits (except figs), most tomatoes, jams, jellies, marmalades, fruit butters, and fermented and pickled (treated with brine or vinegar solution to inhibit the growth of microorganisms) vegetables, such as pickles and sauerkraut. Acidic foods (with a pH of 4.6 or lower) contain enough acidity to destroy bacteria more rapidly when heated.
- Always label canned items with the name of the food and the date it was canned. Store canned food in a cool, clean, and dry place.
- Don't use food from cans with dents, bulges, leaks, or rust spots.
- Canned or bottled food can stay fit to eat for up to 2 years, but for best quality, use canned food within a year.

Pressure Cooker

Pressure Canner

Notes on Canning

- The acidity level in foods can be increased by adding lemon juice, citric acid, or vinegar.
- Pressure alone does not kill microorganisms. As steam generates in a sealed vessel, the pressure builds and temperatures above 212° F (100° C) are achieved. The bacteria and spores are destroyed by the high temperatures applied to the food for the proper amount of time.
- Pressure cooking preserves the texture, color, flavor, aroma, and nutrients of food because it can reach a temperature of about 250° F (121° C), thus shortening the required cooking time. Be sure to follow the cooker manufacturer's directions.

?

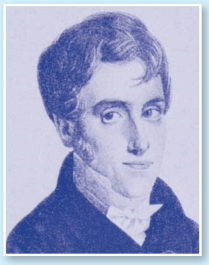
Are there nutritional differences between fresh foods and canned foods?

The heating process during canning destroys from one-third to one-half of vitamins A and C, riboflavin, and thiamin. For every year the food is stored, canned food loses an additional 5 to 20% of these vitamins. However, the amounts of other vitamins are only slightly lower in canned food than in fresh food.

Most produce will begin to lose some of its nutrients when harvested. When produce is handled properly and canned quickly after harvest, it can be more nutritious than fresh produce sold in stores.

When refrigerated, fresh produce will lose half or more of some of its vitamins within 1 to 2 weeks. If it's not kept chilled or preserved, nearly half of the vitamins may be lost within a few days of harvesting. For optimum nutrition, it is generally recommended that a person eat a variety of foods.

DID YOU KNOW?



Nicolas Appert, a French candy maker, invented the **canning** process. How did it all start? In 1810, the government of Napoleon offered a financial reward to anyone who could figure out how to preserve food for its army and navy. Appert won the prize for his new method of preserving foods by cooking and then reheating the food in sealed-glass jars.

Nicolas Appert (1752–1841)

C

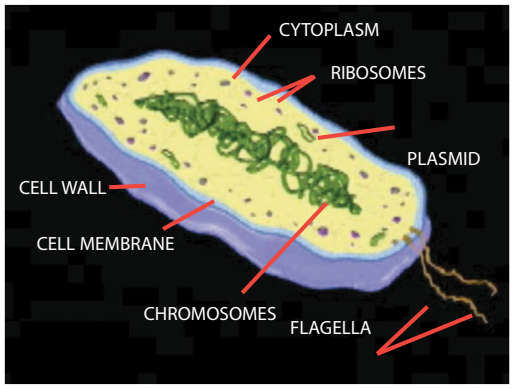
Cell

In biology, it is the basic unit of which all living things are composed.

The Main Parts of a Prokaryotic (lacking a distinct nucleus) Cell are:

- **The cytoplasm** — the fluid inside the cell that contains the parts for converting food material into energy and new cell materials.
- **The cell membrane and/or wall** — surrounds the cytoplasm and holds everything together and controls the passage of material into and out of the cell.

Note: A prokaryotic cell does not have a well-defined nucleus enclosing its genetic material.



A Prokaryotic Bacterial Cell

Cell Membrane/Wall (see Cell)

Center for Food Safety and Applied Nutrition (CFSAN)

One of the 7 Centers within the Food and Drug Administration that regulates domestic food, imported foods, and cosmetics sold across state lines. This regulation takes place from the products' point of U.S. entry or processing to their point of sale.

With a work force of about 800, the Center promotes and protects public health and economic interest by ensuring that food is safe, nutritious, wholesome, and accurately labeled. It also ensures that cosmetics are safe and honestly, accurately, and informatively labeled.

DID YOU KNOW?

- To cover the head of a pin, it would require a sheet of about 10,000 human **cells**.
- A human being is composed of more than 75 trillion cells.

Center for Veterinary Medicine (CVM)

A Center of The Food and Drug Administration that reviews applications to market drugs for use in pets and food-producing animals to ensure the safety and effectiveness of the approved drugs. CVM is also responsible for the regulation of food for animals (including food for pets) and to ensure that it does not harbor zoonotic (animal-related) pathogens that can be transmitted to people or harm the animals. (Also see Zoonoses/Zoonosis.*)*

CVM also contributes to the surveillance activities of the Food Safety Initiative. The Center has developed and coordinated the National Antimicrobial Resistance Monitoring System (NARMS), a collaboration between the FDA, the U.S. Department of Agriculture/Agricultural Research Service, and the Centers for Disease Control and Prevention. NARMS monitors trends in antimicrobial resistance among foodborns bacteria from humans, retail meats, and animals.

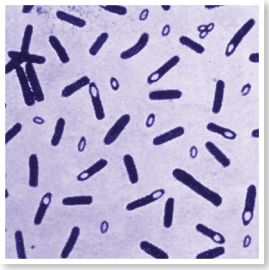
Centers for Disease Control and Prevention (CDC)

An agency of the U.S. Department of Health and Human Services (HHS) that promotes health and quality of life by preventing and controlling disease, injury, and disability. When there is an outbreak of foodborne illness, the CDC uses traceback techniques to identify the source of foodborne bacteria in foods to prevent further exposure or spread of infection. (Also see Health and Human Services *and* PulseNet.*)*

Clostridium botulinum

This bacterium lives in the soil and in the bottom of lakes, oceans, etc. It is also sometimes found in moist, low-acid food containing less than 2% oxygen and stored between 40° F (4° C) and 120° F (49° C). This bacterium produces a toxin that causes botulism, a disease characterized by muscle paralysis.

Proper heat processing destroys Clostridium botulinum *in canned food. Freezer temperatures inhibit its growth in frozen food. Low moisture controls its growth in dried food. High oxygen controls its growth in fresh foods.*



Clostridium botulinum

Clostridium botulinum (cont'd)

Sources: Home-canned and prepared foods, vacuum-packed and tightly-wrapped food, meat products, seafood, and herbal cooking oils.

Illness:

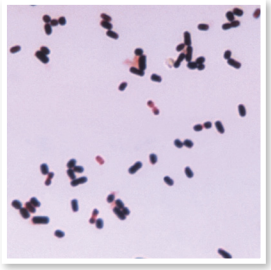
Incubation: 12 to 72 hours after ingesting.

Symptoms: Dry mouth, double vision followed by nausea, vomiting, and diarrhea. Later, constipation, weakness, muscle paralysis, and breathing problems may develop. It's important to get immediate medical help because botulism can be fatal. With proper treatment, most victims survive.

Duration: It can take from 1 week to a full year to recover.

Clostridium perfringens

A foodborne pathogen that persists as heat-stable spores. If foods are only moderately cooked and allowed to remain at room temperature, the spores can germinate and produce a harmful toxin.



Clostridium perfringens

Sources: Meat and meat products.

Illness:

Incubation: Usually occurs 8 to 16 hours after eating contaminated food.

Symptoms: Abdominal pain, diarrhea, and sometimes nausea and vomiting.

Duration: The illness is usually mild and lasts a day or less; however, symptoms can be more serious in older adults or people with weakened immune systems.

Cold Chain

Maintaining proper temperatures throughout the farm-to-table continuum to prevent the growth of foodborne bacteria along the way.

Food Safety Implication: Along the farm-to-table continuum, it's critical that food is kept at the proper temperature to keep it ready for market and safe to eat. For example, fresh produce is quickly cooled after harvesting to slow down the ripening process and reduce the spread of decay. The temperatures are carefully controlled throughout processing operations. The temperature inside shipping containers is controlled to maintain proper temperature during transit. The cold chain continues when food is stored, displayed, and served at retail outlets. Consumers also need to properly transport and store food at home.

Cold Pack (also known as **Freezer Gel**)

A cold source that is used in coolers to help keep foods and beverages cold.

A cold pack is useful in helping food stay cold when you're on the run!

Food Safety Implication: Perishable food should be kept at 40° F (4° C) or colder to slow the growth of harmful bacteria. A cold pack in your cooler helps foods stay cold.

Food Safety Precautions:

- When transporting perishable foods, always use cold packs or ice in your cooler.
- Use cold packs in lunch boxes to keep sandwiches, other perishables, and beverages cold.

Coliforms

The most common form of bacteria found in untreated water. The presence of this group of non-pathogenic bacteria in drinking water is an indicator that the water may be contaminated by sewage and/or other similar material and should not be ingested. Fecal coliform bacteria, of which E. coli *is one type, live in the intestines of warm-blooded animals. Pathogenic coliforms can cause diarrhea and other serious health problems if the bacteria are ingested.*

DID YOU KNOW?

Clostridium botulinum can form spores that can survive the boiling temperature (212° F, 100° C). Therefore, home-canned meat, poultry, fish, and vegetable products require pressure canning to reach 250° F (121° C) for a long enough period of time to kill the spores.

Clostridium perfringens are caused by failure to keep food hot. These bacteria can grow better above 120° F (49° C). It's important to keep foods out of the Danger Zone, the temperature range usually between 40° F (4° C) and 140° F (60° C).

Competitive Exclusion

The process in which non-pathogenic bacteria naturally found in the mature animal's gastrointestinal (GI) tract are provided to newborn animals to prevent infection from pathogens.

Food Safety Implication: The idea behind competitive exclusion is to prevent harmful bacteria, like *Salmonella*, from colonizing and infecting young animals. This in turn reduces foodborne illness caused by animal products. However, it's important to note that even treated animals can become contaminated during food processing or in the kitchen, so food handlers must continue to practice the 4 Cs of Food Safety when preparing raw meat or animal products, such as raw eggs. (See the 4 Cs section beginning on page 52.)

How It Works: Competitive exclusion has been used with chickens; however, it may have application for other animals, such as pigs and even humans.

Young chickens are born with an undeveloped gastrointestinal (GI) tract. As part of normal development, bacteria will colonize the (GI) tract. The non-pathogenic bacteria mixture is sprayed on day-old chicks. The chicks ingest the drug as they preen (groom themselves). These good bacteria colonize the chick's (GI) tract where *Salmonella* would usually live.

When *Salmonella* arrive in the intestine, the "good" bacteria have already colonized the gut. They have taken up residence in the available binding sites. They have eaten the available food, and they have created an environment favorable for themselves. In turn, the *Salmonella* have no food, no binding sites, and an unfriendly environment, so they cannot survive.

Competitive exclusion gives the chicks the beneficial gut "microflora" (bacteria and other microorganisms that normally inhabit the intestines) they need at a time when they are most vulnerable to *Salmonella* colonization. It also gives them the natural disease resistance of a mature, healthy bird — making it virtually impossible for *Salmonella* to multiply. Competitive exclusion also reduces *Salmonella* in the environment because there are fewer infected birds to contaminate the farm.

Chicks being sprayed with beneficial bacteria, which will prevent infection from *Salmonella*.

Composting

A managed, agricultural process in which organic materials, including animal manure and other wastes, are digested aerobically (with oxygen) or anaerobically (without oxygen) by microbial action. Composting can be done successfully on a large scale by farmers and waste management companies, or on a small scale at home.

Food Safety Implication: When composting is carefully controlled and managed and the appropriate conditions are achieved, the high temperature generated can kill most pathogens in a few weeks.

However, composting that is not done properly can pose a health risk. For example, animal or human wastes that are thrown into a compost pile at home may be contaminated with pathogenic bacteria, which may not be killed during the composting process and can contaminate the plants or water around them. Thus, the use of improperly prepared compost as a garden fertilizer creates the risk of foodborne illness.

Conjugation

The process in which deoxyribonucleic acid (DNA) is transferred from one bacterium to another through a specialized tube. Conjugation, sometimes referred to as "mating," is a parasexual form of reproduction.

Contamination

The unintended presence of harmful substances or microorganisms in food.

Critical Control Point (see **Hazard Analysis and Critical Control Point**)

Cross-Contamination

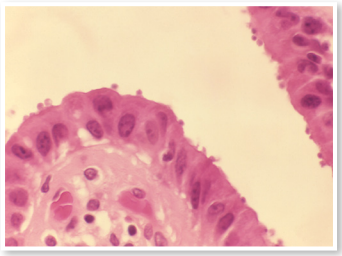
The transfer of bacteria from foods, hands, utensils, or food preparation surfaces to a food. This can be a particular problem with liquids from raw meat, poultry, and seafood, in that harmful bacteria can be transmitted to previously uncontaminated foods or surfaces. (Also see the 4 Cs section beginning on page 52.)

DID YOU KNOW?

The practice of **composting** can be traced back 2,000 years to the ancient Romans and Greeks. By the 19th century, most U.S. farmers knew that composting was a useful method for nourishing soil and building healthy plants, but they didn't know how or why it worked. It's only been within the past 60 years that scientists have understood the process!

Cryptosporidium

A parasite that is the cause of severe, life-threatening disease, particularly in people with HIV/AIDS.



Cryptosporidium

Sources: Fecally contaminated water, food, or environmental surfaces.

Illness:

Incubation: 2 to 10 days after ingestion.

Symptoms: Diarrhea, nausea, abdominal cramps, low-grade fever. The illness is more chronic in people with HIV/AIDS, also resulting in voluminous watery diarrhea, weight loss, anorexia, and malaise.

Duration: 2 to 14 days. In "at-risk" people, symptoms may subside and return over weeks to months.

Cyclospora

A single-cell parasite that causes cyclosporiasis, a diarrheal illness.

Sources: Fresh produce or water that was contaminated with infected human stool.

Illness:

Incubation: 1 to 14 days, usually at least 1 week.

Symptoms: Diarrhea, loss of appetite, substantial loss of weight, bloating, increased gas, stomach cramps, nausea, vomiting, muscle aches, low-grade fever, and fatigue.

Duration: may be remitting and relapsing over weeks to months.

Cytoplasm (see Cell)

Danger Zone

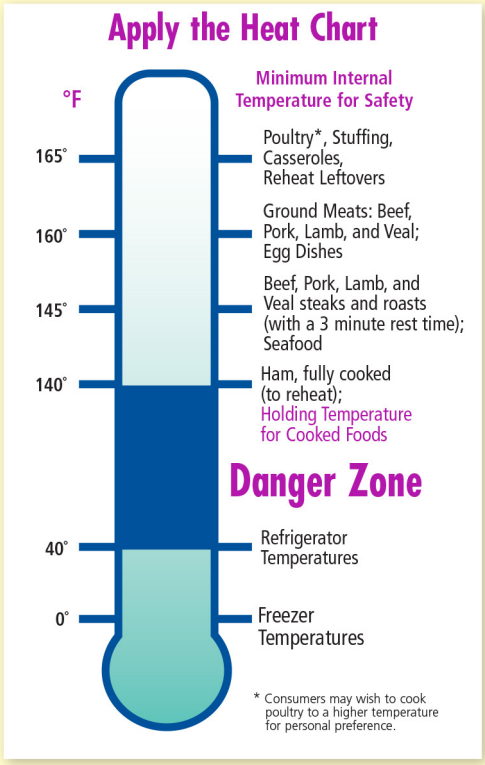
The temperature range in which most bacteria can grow.

Food Safety Implication: Some bacteria can double their numbers within minutes and form toxins that cause illness within hours. That's why it's important to keep food below or above the temperatures at which bacteria can grow. Usually this is below 40° F (4° C) (some pathogenic bacteria can grow at 32° F [0° C] or above 140° F [60° C]).

Food Safety Precautions:

- Cook food to safe internal temperatures (see Recommended Safe Cooking Temperatures at right). Use a food thermometer to check.
- Keep hot foods hot. Maintain hot cooked food at 140° F (60° C) or above.
- Reheat cooked food to 165° F (74° C). Never let the temperature fall below 140° F (60° C).
- Keep cold foods cold. Store food in the refrigerator (40° F [4° C] or below) or freezer (0° F [-18° C] or below).
- Don't leave food out at room temperature for more than 2 hours.

Note: For more about handling foods safely, see the 4 Cs section beginning on page 52.

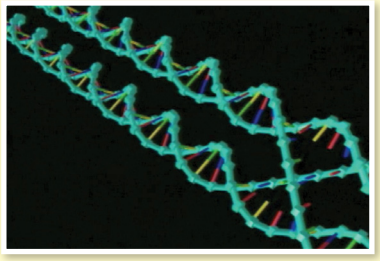


Recommended Safe Cooking Temperatures

D

Deoxyribonucleic Acid (DNA)

A molecule that forms a double helix composed of units called nucleotides. Each nucleotide is composed of a sugar (deoxyribose) connected to 1 of 4 nitrogenous bases by a phosphate molecule. DNA encodes genetic information in all living cells and in many viruses (Also see Nucleic Acid *and* Ribonucleic Acid*).*



A bacterium's genetic information is contained on a ladder-like DNA molecule like the one shown here.

Food Safety Implication: In bacteria, the DNA molecule encodes the information for factors that enable it to grow, reproduce, and confer virulence (ability to cause illness). Each organism's DNA can be used to distinguish it from related organisms. When there is an outbreak of foodborne illness, epidemiologists can determine the source of bacteria in foods by examining the pathogen's DNA "fingerprint."

The Fabulous Five

The discovery of the double-helical structure of DNA began in 1951. The 5 people responsible for its discovery were:

- Francis Crick
- Rosalind Franklin
- Linus Pauling
- James Watson
- Maurice Wilkins

Disinfectant (see Sanitizer)

E

E. coli O157:H7 (see *Escherichia coli* O157:H7)

Emerging Pathogen

An illness-causing microorganism that is either:

- *previously unknown to be a human pathogen;*
- *not expected to occur in a particular food;*
- *has caused a dramatic increase in new cases of illness.*

Food Safety Implication: Microorganisms continue to adapt and evolve, sometimes increasing in their ability to make an individual sick. Microorganisms previously not recognized as human pathogens or pathogens unexpectedly found in particular foods have caused outbreaks of foodborne illness. Some examples are *Listeria monocytogenes, Escherichia coli* O157:H7, and the parasite *Cyclospora*.

How It Works: Since the late 1970s, newly recognized foodborne pathogens have emerged worldwide. Some contributing factors for these emerging pathogens include:

- The transfer of genetic material from pathogenic bacteria through transformation, transduction, and conjugation (see individual terms for definitions). These 3 processes can produce cells that are stronger and more resistant than the original bacterial cells. As a result, new bacterial strains are often resistant to antibiotics. For example, some strains of *Salmonella* species are now resistant to multiple important antimicrobial drugs.
- Our food system has changed. The United States now imports foods from all over the world. Some bacteria are commonly found in one part of the world, but not in others. When we import foods, we can also import the foodborne pathogens associated with the foods.

Epidemiology

The study of the occurrence and causes of diseases or other health-related conditions, states, or events in specified populations. One of the chief functions of this study is to identify populations at high risk for a given disease, so that the cause may be known and preventive measures implemented.

DID YOU KNOW?

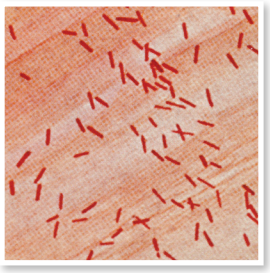
About 60 years ago, there were only 5 known organisms that caused foodborne illness. Today, there are at least 25 known foodborne pathogens — including more than 20 newly discovered ones. There has been a phenomenal increase in these pathogens: *Campylobacter jejuni, Yersinia enterocolitica, E. coli* O157:H7, *Vibrio cholerae, Listeria monocytogenes,* and the noroviruses.

***E. coli* O157:H7** was first recognized as a pathogen in 1982. This bacterium can also be transmitted from person to person. People who swim in pools contaminated with feces — from a baby's diaper, for example — can become infected with this organism.

Escherichia coli O157:H7

(also known as **Pathogenic *E. coli***)

A bacterium that can produce a deadly toxin. Infections from E. coli *O157:H7 are estimated at 95,000 cases per year.*



***E. coli* O157:H7**

While most *E. coli* are normal residents of our small intestine and aid in digestion and enable our bodies to create vitamin K, there are some strains, such as *E. coli* O157:H7, that can cause severe illness in people and animals.

Sources: Meat, especially undercooked or raw hamburger, uncooked produce, raw milk, unpasteurized juice, and contaminated water.

Illness:

Incubation: Usually 3 to 4 days after ingestion, but may occur anywhere from 1 to 10 days after ingestion.

Symptoms: Often severe abdominal cramps, bloody diarrhea, and nausea. *E. coli* O157:H7 can also manifest as non-bloody diarrhea or be symptomless. In young children, older adults, and people with weakened immune systems, this pathogen can cause kidney damage that can lead to death.

Duration: 5 to 10 days.

Expiration Date

The calendar date on the packaging of a food that indicates the last date a food should be eaten or used. (Also see "Best If Used By," "Sell By," *and* "Use By" Dates.*)*

Food Safety Implication: Foods that are purchased or used after the expiration date could contain spoilage bacteria or pathogens and may not be safe to eat.

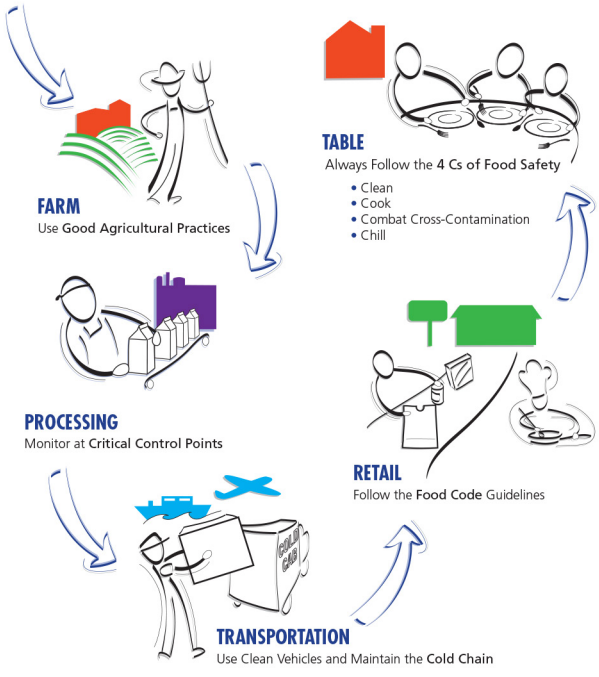
Food Safety Precautions:

- Don't buy foods after the expiration date has passed.
- At home, throw out foods after the expiration date has passed.

Farm-to-Table Continuum

A multi-step journey that food travels before it is consumed. (Also see the Farm-to-Table Continuum illustration on page 51, which highlights key concepts at each step.)

Food Safety Implication: Each sector along the farm-to-table continuum plays a role in ensuring that our nation's food supply is fresh, of high quality, and safe from hazards. If a link in this continuum is broken, the safety and integrity of our nation's food supply can be threatened.



The Five Farm-to-Table Steps

F

Farm-to-Table Initiative

One of the directives in President Clinton's 1997 Food Safety Initiative. The Initiative involves identifying possible contamination points along the farm-to-table continuum and implementing process controls for preventing problems that might affect our nation's food supply.

Fight BAC!™ Campaign

The Partnership for Food Safety Education's national public education project, which brings together industry, government, and consumer groups to educate Americans about the importance of using safe food-handling practices.

The campaign focuses on the 4 Cs of Food Safety, 4 simple steps people can take to fight foodborne bacteria and reduce the risk of foodborne illness. The 4 steps to food safety are: Clean, Separate (Combat Cross-Contamination), Cook, and Chill. (Also see the 4 Cs section beginning on page 52.)

BAC! is the campaign's yucky green bacteria character who tries his best to spread contamination wherever he goes!

The Federal Government Partners are:

- U.S. Department of Agriculture
- U.S. Department of Health and Human Services
  - Food and Drug Administration/Center for Food Safety and Applied Nutrition (CFSAN)
  - National Center for Infectious Diseases/Centers for Disease Control and Prevention (CDC)
- U.S. Environmental Protection Agency

Food Acidity

The level of acid contained in certain foods. The acid in foods helps prevent the growth of pathogenic bacteria. Acidic foods have a pH below 4.6. Some examples of high-acid foods include: all fruits (except figs), most tomatoes, jams, jellies, marmalades, fruit butters, and fermented and pickled vegetables, such as pickles and sauerkraut (Also see Acidification.*).*

Foodborne Illness (also known as Foodborne Disease or Food Poisoning)

Infection or intoxication caused by the transfer of microbial or chemical contaminants (substances that spoil or infect) from food or drinking water to a human. In most cases, the contaminants are bacteria, parasites, or viruses.

Food Safety Implication: Microorganisms in food may cause illness when they are eaten and get established in the body.

Food Safety Precautions: To prevent foodborne illness, follow the 4 Cs:

1. **Clean** — Wash hands, utensils, and surfaces with hot, soapy water before and after handling food.
2. **Combat Cross-Contamination** — Separate raw meat, poultry, and fish/seafood from ready-to-eat foods. Don't cross-contaminate.
3. **Cook** — Cook foods to safe internal temperatures. Keep hot foods hot. Use a food thermometer to check. (See *Danger Zone* for safe internal cooking temperatures for meat, poultry, seafood, eggs, and leftovers.)
4. **Chill** — Refrigerate foods promptly. Keep cold foods cold. (See the "Refrigerator and Freezer Storage Chart" on page 70 in the 4 Cs section for proper food quality storage times.)

Note: For more detailed tips, see the 4 Cs section beginning on page 52.

Common Symptoms: Most cases of foodborne illness in healthy adults are self-limiting and of a short duration. An important warning sign of foodborne illness is bloody diarrhea. Other common acute symptoms, which can range from mild to severe, are: diarrhea, cramps, nausea, fever, vomiting, and body aches.

When to Notify a Doctor: Some foodborne illnesses, such as *E. coli* O157:H7, can be life-threatening, particularly for young children, older adults, and those with weakened immune systems. Symptoms that are severe or prolonged may need to be treated. People who believe they may have contracted a foodborne illness should call their physician.

It's important to note that botulism poisoning can be fatal. The symptoms include: dry mouth, double vision followed by nausea, vomiting, and diarrhea. Later, constipation, weakness, muscle paralysis, and breathing problems may develop. It's important to **get immediate medical help**. With proper treatment, most victims survive (Also see *Clostridium botulinum*).

What to Do If You Think You Have a Contaminated Product: The first rule of thumb is: Don't use the product. If you have a question about meat, poultry, or eggs, call the U.S. Department of Agriculture (USDA) Meat and Poultry Hotline at **1-888-MPHotline** or **1-888-674-6854**. The TTY number is **1-800-256-7072**. For questions regarding all other foods, call the Food and Drug Administration (FDA) Food Information Line at **(888) SAFE FOOD**.

Foodborne Illness (cont'd)

Dispelling Foodborne Illness Myths

Many people have common misconceptions regarding foodborne illness. Here are some common foodborne illness myths, along with their corresponding facts.

Myth: *Foodborne illness is always the result of the last food you ate.*

Fact: Symptoms of foodborne illness usually occur 24 hours or more after eating a particular food and can last up to 10 days. Within 24 hours, you would have eaten a wide range of foods, and any of these foods could have contributed to the illness. Thus, it's often difficult to determine which food actually caused the illness.

Myth: *The only time food is not safe to eat is when it looks or smells spoiled.*

Fact: Many people assume that because food spoilage is visible, this is the only time that food is not safe to eat. Food that looks and smells fresh may contain harmful pathogens that you cannot see. Food-spoilage bacteria are not the same as foodborne bacteria. Food-spoilage bacteria are responsible for the *deterioration* of food. This includes milk going sour or lunch meat turning green or slimy. Spoilage is more of a food-quality issue than a food-safety issue.

Basic sanitary practices and proper refrigeration will reduce or hinder bacterial growth and subsequent spoilage. Most people will not get sick from food-spoilage bacteria, but it is recommended that you don't eat any food that is spoiled, as it may cause some people to have a reaction, such as nausea.

Foodborne illness bacteria *contaminate* food and make it unsafe to eat. If these bacteria are present in large enough numbers, they can cause someone who eats the contaminated food to become ill. The best way to keep foodborne illness bacteria from multiplying in food is to follow these simple rules: Keep hot foods *hot*, keep cold foods *cold*, and keep hands and food-preparation areas clean. (See the 4 Cs section beginning on page 52.)

Myth: *Foodborne illness isn't serious, and it's something that doesn't happen very often.*

Fact: Foodborne illness can affect anyone at any time. If you eat food that is contaminated, you could become sick. People in the at-risk groups are particularly vulnerable. In addition, what most people think is a 24-hour stomach flu can actually be foodborne illness. (Also see the FAQ section below and CDC's Foodborne Illness Statistics on next page.)

?

Are some foods more likely to cause foodborne illness than others?

Just about any food can become contaminated if handled improperly. However, foods rich in protein, such as meat, poultry, fish, and seafood, are frequently involved in foodborne illness outbreaks for 2 reasons:

1. Protein-rich foods tend to be of animal origin. Therefore, microorganisms of animal origin are frequently found in animal foods.
2. Animal foods are rich in protein that bacteria break down into amino acids, which are an important nutrient source to some bacteria.

Bacteria also need moisture in order to survive and reproduce. Thus, they thrive in foods with high moisture content. These include starchy, egg-rich foods and cream-based foods, such as potato or pasta salads, cream-based soups, and custard or cream pies.

How sick can I get from eating contaminated food?

There are many variables. Your age, general health, and how much contaminated food you ate are all factors. The most common symptoms are diarrhea, nausea, vomiting, and abdominal pain, but you don't necessarily get all the symptoms. At-risk people can become very ill and can even die from foodborne illness because their immune systems are less able to fight off the bacteria.

Can the symptoms of foodborne illness be mistaken for the flu?

Yes. Foodborne illness often shows itself as flu-like symptoms such as nausea, vomiting, diarrhea, or fever, so many people may not recognize that the illness is caused by bacteria or other pathogens in food.

Experts from the Centers for Disease Control and Prevention (CDC) report that many of the intestinal illnesses commonly referred to as stomach flu are actually caused by foodborne pathogens. People do not associate these illnesses with food because the onset of symptoms often occurs 2 or more days after the contaminated food was eaten.

If I forget to follow some of the basic food safety rules, won't heating or reheating foods kill foodborne bacteria?

To be safe, always follow the 4 Steps to Food Safety rules (page 20) when preparing, serving, and cooking foods. Proper heating and reheating will kill foodborne bacteria. However, some foodborne bacteria produce poisons or toxins that are not destroyed by high cooking temperatures if the food is left out at room temperature for an extended period of time. An example is the foodborne bacteria *Staphylococcus*. This bacterium produces a toxin that can develop in cooked foods that sit out at room temperature for more than 2 hours.

F

Foodborne Illness Stats

The following statistics are estimates based on reported cases of foodborne illnesses in the United States:

Number of:	People per Year
Diseases caused by food and resulting in hospitalizations	128,000
Gastrointestinal illnesses	48,000,000
Deaths	3,000

— Centers for Disease Control and Prevention (CDC)

Who Regulates What?

Food and Drug Administration (FDA)	U.S. Department of Agriculture (USDA)
• All food, except meat, poultry, and processed eggs • Chemicals • Food additives • Food and drugs for pets and farm animals • Household devices (e.g., microwave ovens)	• Meat • Poultry • Processed eggs

Food Code

A reference guide published by the Food and Drug Administration (FDA). The guide instructs retail food establishments, such as restaurants, grocery stores, and institutions, such as nursing homes and schools, on how to prevent foodborne illness. It consists of a model code which is adopted by nearly 3,000 State, local and tribal jurisdictions as the legal basis for their food inspection program for safeguarding public health. It ensures that food is safe and unadulterated (free from impurities) and honestly presented to the consumer. It also provides references, public health reasons and explanations for code provisions, guidelines, and sample forms. The FDA first published the Food Code in 1993 and revises it every 4 years.

Food Defense

Food defense is the protection of food products from intentional adulteration by biological, chemical, physical, or radiological agents.

Food and Drug Administration (FDA)

An agency of the U.S. government, with offices and laboratories nationwide, that is authorized by Congress to inspect, test, approve, and set safety standards for all food, except meat, poultry, and processed eggs, which are under the jurisdiction of the U.S. Department of Agriculture (USDA). The agency also ensures that all of these products are labeled truthfully with the information that people need to use them safely and properly.

Food Engineering (see **Biotechnology**)

Food Inspection

The process of checking and assuring that the nation's food supply is safe to eat and that proper sanitary conditions are enforced.

Food Safety Implication: The U.S. Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and state and local regulatory agencies are responsible for protecting the safety and wholesomeness of food. Agency scientists test samples to see if any substances are present in unacceptable amounts. If contaminants are identified, the agencies take corrective action. The agencies also inspect foods that are imported to the United States from other countries to make sure they are in compliance with government standards, and set labeling standards to help consumers know what is in the foods they buy.

Food Isolate

A microorganism that is derived from food for the purpose of identifying or characterizing it.

Food Manufacturing

The large-scale preparation of food products from raw animal and plant material utilizing principles of food technology.

DID YOU KNOW?

The **Food Code** has a provision for restaurants and food stores to display Consumer Advisories — which are advisory messages to consumers, usually at the point of sale or service, to help them make a more informed decision about consumption of food that may affect their health. Often found in menus, on placards, or on posters, these messages concern foods such as raw or under-cooked meats, poultry, seafood, shellfish, or eggs; or unpasteurized juice.

FoodNet

The Foodborne Diseases Active Surveillance Network, a collaborative project conducted by the Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (FDA), the U.S. Department of Agriculture Food Safety and Inspection Service (USDA/FSIS), and participating states. The Network produces national estimates of the burden and sources of specific diseases in the United States through active surveillance and other studies.

FoodNet collects data for the following foodborne diseases: *Campylobacter, Escherichia coli* O157:H7, *Listeria, Salmonella, Shigella, Yersinia, Vibrio,* and parasites, such as *Cryptosporidium* and *Cyclospora*.

The Network was established in 1995 and is a collaborative program among CDC, FDA, USDA, and 10 state health departments, which include: Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, and Tennessee and selected counties in California, Colorado, and New York. They represent a total population of 48 million people (approximately 15% of the U.S. population).

Food Poisoning

The traditional term for the illness caused by eating contaminated food. Today, "foodborne illness" is the term used by food safety experts. (Also see Foodborne Illness.*)*

Food Research

The careful systematic study, investigation, and compilation of information about foods and their components.

Food Safety

A system to ensure that illness or harm will not result from eating food. Everyone along the farm-to-table continuum — farm (production), processing, transportation, retail, and table (home) — plays a role in keeping our nation's food supply safe.

Food Safety Initiative

Started by President Clinton in 1997, this project provided new funds for needed improvements in food safety and to unify the various food safety initiatives being carried out by federal agencies sharing responsibility for food safety. As a result, there have been improvements in surveillance, research, inspection, outbreak response, risk assessment, and education.

Food Safety and Inspection Service (FSIS)

The public health agency in the U.S. Department of Agriculture that is responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged, as required by the Federal Meat Inspection Act, the Poultry Products Inspection Act, and the Egg Products Inspection Act.

Food Safety Modernization Act (FSMA)

The FDA Food Safety Modernization Act (FSMA), the most sweeping reform of our food safety laws in more than 70 years, was signed into law by President Obama on January 4, 2011. It aims to ensure the U.S. food supply is safe by shifting the focus from responding to contamination to preventing it.

DID YOU KNOW?

The Public Health Security and Bioterrorism Preparedness and Response Act (the Bioterrorism Act) of 2002 includes very specific requirements to help ensure the safety of the U.S. food supply. Here's a summary of those rules — and how they impact industry:

Registration of Food Facilities Final Rule
Requires domestic and foreign facilities that manufacture, process, pack, or hold food for human or animal consumption in the U.S. to register with FDA.

Prior Notice of Imported Food Final Rule
Requires that FDA receive advance notice of all imported food before it arrives in the U.S. to enable FDA to determine which shipments should be inspected upon arrival.

Establishment and Maintenance of Records Final Rule
Requires persons in the U.S. that manufacture, process, pack, transport, distribute, receive, hold, or import food to establish and maintain records identifying the immediate previous sources and immediate subsequent recipients of food received or released.

Administrative Detention Final Rule
Establishes procedures that FDA would use to administratively detain food when FDA has credible evidence or information that the food presents a threat of serious adverse health consequences or death to humans or animals.

F

Food Science

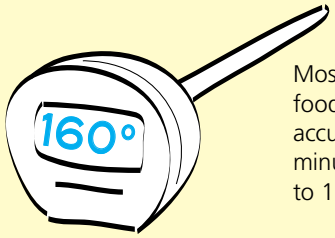
The discipline in which biology, physical sciences, and engineering are used to study the nature of foods, the causes of their deterioration, and the principles underlying food processing.

Food Technology

The application of food science to the selection, preservation, processing, packaging, distribution, and the use of safe, nutritious, and wholesome food.

Food Thermometer

A special device that measures the internal temperature of cooked foods, such as meat, poultry, and any combination dishes to ensure that a safe temperature is reached.



Most Digital Instant Read food thermometers are accurate to within plus or minus 1° to 2° F (-17.22° C to 16.66° C).

Food Safety Implication: A food thermometer ensures that a sufficient temperature is reached, so that harmful bacteria like *Salmonella* and *Escherichia coli* O157:H7 are destroyed.

How to Check the Accuracy of a Food Thermometer: Immerse the thermometer stem a minimum of 2 inches in boiling water, touching neither the sides nor the bottom of the glass. At sea level, the temperature should read 212° F (100° C). Thermometers should be checked periodically, following the manufacturer's recommendations. Many food thermometers have a calibration nut under the dial that can be adjusted. Check the package for instructions.

Four Steps to Food Safety

(also known as **4 Cs of Food Safety**)

The Fight BAC!™ Campaign's 4 food safety messages for preventing foodborne illness. (Also see Fight BAC!™ Campaign.*)*

1. **Clean** — Wash hands, kitchen utensils, and surfaces with hot, soapy water *before* and *after* handling food.
2. **Combat Cross-Contamination** — *Separate* raw meat, poultry, and seafood from ready-to-eat foods. *Don't cross-contaminate*.
3. **Cook** — Cook foods to safe internal temperatures. Keep hot foods *hot*. Use a food thermometer to check. (See the "Apply the Heat" chart on page 58 for safe internal cooking temperatures.)
4. **Chill** — Refrigerate foods promptly. Keep cold foods cold. (See the "Refrigerator and Freezer Storage Chart" on page 70 for proper food-quality storage times.)

Note: For more detailed tips, see the 4 Cs section beginning on page 52.

Freezer Gel (see **Cold Pack**)

DID YOU KNOW?

Around 1925, **Clarence Birdseye** of Gloucester, MA, introduced a wide range of **frozen foods** for the home. His process consisted of the rapid freezing of packaged food between 2 refrigerated metal plates. Though Birdseye did not develop the first frozen foods, his freezing process was a highly efficient one that preserved the original taste of a variety of foods, including fish, fruits, and vegetables.

Clarence Birdseye (1886 – 1956)

Frozen foods have been sold since the 1920s. At first, the main product was vegetables, but later new foods, like fish sticks, were specially developed for freezing.

Freezing

A method of food preservation accomplished by rapidly lowering the food temperature to below 32° F (0° C), at a minimum, and then storing food at a temperature of 0° F (-18° C).

Food Safety Implication: Freezing is a critical food preservation method, since it stops microbial growth. Freezing does not kill microorganisms — therefore, it's important to properly handle meat, poultry, and seafood when cooking and defrosting these foods. (Also see the 4 Cs section beginning on page 52.)

How It Works: Freezing keeps food safe by causing foodborne illness microbes to enter a dormant stage.

Food Safety Precautions:

- Keep your freezer unit set to 0° F (-18° C). Check the temperature of your unit regularly with an appliance thermometer.
- To keep harmful bacteria from growing and multiplying, store foods that you won't be using right away in the freezer.
- Don't overload your freezer unit. Cold air must circulate to keep the food frozen.
- Refer to the "Refrigerator and Freezer Storage Chart" on page 70 for proper food-quality storage times.
- Thaw foods safely. For proper thawing tips, see the 4 Cs section beginning on page 52.

Fumigation

The standard agricultural method of applying chemicals and other treatments to crops to drive away and kill disease-spreading insects and other pests.

Also, fumigation is sometimes used at the processing stage to rid foods, such as spices, fruits, and vegetables, from contamination from insects. Spices are notorious for the presence of pathogens because bacteria easily permeate foods contacting the ground.

Fungus (singular) or Fungi (plural)

Simple plants called "Saprophytes" that lack chlorophyll (the green coloring that plants use to make food). Because fungi lack chlorophyll, they cannot produce their own food. Therefore, they must take carbohydrates, proteins, and other nutrients from the animals, plants, or decaying matter on which they live.

Food Safety Implication: Some fungi play a major role in a number of foods that we eat. However, other fungi can cause great damage and disease.

Fungi can be microscopic or as big as a mushroom.

Will food that's stored in a freezer for a long period of time be safe to eat?

Safe food that was properly handled and stored at 0° F (-18° C) will remain safe. Only the quality of foods suffers with lengthy freezer storage. Tenderness, flavor, aroma, juiciness, and color of frozen foods can all be affected.

Does freezing affect the level of nutrients contained in foods?

Fortunately, the freezing process itself does not reduce nutrients; and, for meat and poultry products, there is little change in protein value during freezing.

Does "freezer burn" make food unsafe?

Freezer burn is a food-quality issue, not a food safety issue. It appears as grayish-brown leathery spots on frozen food. It occurs when air reaches the food's surface and dries out the product. This can happen when food is not securely wrapped in air-tight packaging. Color changes result from chemical changes in the food's pigment. Although undesirable, freezer burn does not make the food unsafe. It merely causes dry spots in foods. Cut away these areas either before or after cooking the food. When freezing food in plastic bags, push all the air out before sealing.

What is freeze-drying?

Freeze-drying is another method of preserving food. During this process, water is removed from food while the food is still frozen by a process known as sublimation. The frozen food is cooled to about -20° F (-29° C). Then it is placed on trays in a refrigerated vacuum chamber, and heat is carefully applied. As a result, any water in the food is changed directly from ice to water vapor without first changing into water. Freeze-dried products include: soups, tea, and instant coffee.

F

Fungi (cont'd)

Where They Live: Fungi are found in the air, soil, plants, animals, water, and in some foods.

Types of Fungi: Fungi are any of about 50,000 species of organisms that include:

- Yeast — single-cell fungi; can cause skin infections;
- Mushrooms — multi-cell fungi;
- Molds and Mildew — multi-cell fungi; mold and mildew spores are allergens (substances that induce allergies);
- Smuts — Disease-causing fungi of corn, wheat, and onion; and
- Rusts — Disease-causing fungi of wheat, oats, beans, asparagus, snapdragon, and hollyhock.

Good Fungi: Many fungi are beneficial. For instance, yeast is a fungus that causes bread to rise by producing carbon dioxide from the carbohydrates in the dough. Other fungi, such as mushrooms and truffles, are considered delicacies. Certain molds found in cheeses, such as Camembert and Roquefort, age cheeses and serve as flavor enhancers.

Note: Cheese made from unpasteurized milk may contain harmful bacteria in addition to fungi. At-risk groups should avoid eating cheeses made from unpasteurized milk, such as Camembert and Roquefort. (Also see the Safe Food Chart on page 67.)

Harmful Fungi: Fungi like smuts and rusts destroy many crops and other plants. Others produce diseases in people and animals. Some mushrooms are poisonous and can cause serious illness or death if eaten. Molds spoil many kinds of food. In damp climates, mildews and other fungi can ruin clothing, book bindings, and other materials.

G

Gene

A unit of hereditary information that occupies a fixed position on a chromosome. Almost all genes are composed of deoxyribonucleic acid (DNA), except in the case of some viruses, whose genes are made of a closely related compound called ribonucleic acid (RNA).

Genetic Engineering (see **Biotechnology**)

Genus (singular) or Genera (plural)

A biological classification ranking between family and species, consisting of a group of closely related species, which differ from one another in only slight characteristics. The first name of a bacterium is called the genus. (Also see Binomial Nomenclature *and* Species.*)*

Germ

Any microorganism that cannot be seen with the naked eye. Germs include bacteria, viruses, fungi, algae, and protozoa.

Food Safety Implication: The kitchen, bathroom, laundry room — any place that provides a warm, moist environment — is an ideal place for germs to live. They can pass from surface to surface and even from your hands to your food.

Food Safety Precautions:

- Wash your hands thoroughly with hot, soapy water before and after you prepare food and after you use the bathroom, change diapers, handle pets, cough, sneeze, or blow your nose.
- Consider using durable, disposable paper towels instead of dishcloths or sponges, which can harbor bacteria. Throw away the paper towels (and the germs) after you have finished cleaning, and wash dishcloths frequently in the hot cycle of your washing machine.

Good Agricultural Practices (GAPs)

General guidance provided by the Food and Drug Administration that is used to direct domestic and international food producers in growing, harvesting, sorting, packing, and storage operations to reduce microbial food safety hazards.

Good Manufacturing Practices (GMPs)

Guidance that provides criteria for complying with provisions of the Federal Food, Drug, and Cosmetic Act, which requires that all human foods be free from adulteration (impurities). These regulations form the basis of production and preparation of safe food and include criteria for disease control, cleanliness (personal hygiene and dress codes), education, and training.

DID YOU KNOW?

Ancient Greeks and others used to think that sickness was caused by the weather, but now it's known that **germs** are the cause of disease.

Few germs are harmful. For example, some are used in vaccines to protect people from getting sick, and the *E. coli* bacterium (not the O157:H7 variety) is a normal resident of our small intestine that enables our bodies to create vitamin K and aids in digestion.

Every day our bodies make about one billion new "defender" cells to help fight disease-causing germs.

Handwashing

The act of cleaning hands by applying soap and water, rubbing thoroughly, and then rinsing with water. This practice gets rid of dirt and germs.

Food Safety Implication: Hands are the part of the body that are most exposed to microorganisms because they touch many things every day. Some diseases are spread when disease-causing microorganisms on a person's hands get into food that he or she touches. When the food is eaten, the microorganisms enter the body and cause foodborne illness. Thorough handwashing with hot, soapy water prevents bacteria from transferring from hands to foods.

Food Safety Precautions:

- Wash your hands for 20 seconds with hot, soapy water (for kids' hands, use warm, soapy water instead). Thoroughly scrub hands, wrists, fingernails, and between fingers.
- Wash hands *before* and *after* you prepare food and especially after preparing raw meat, poultry, eggs, and seafood.
- Wash hands after using the bathroom, changing diapers, handling pets, or whenever you have touched something that may be contaminated.
- Rinse and dry hands with a clean towel or consider using durable, disposable paper towels for drying hands, so germs are thrown away.

?

One of the food safety rules is to wash hands in hot, soapy water. Does hot water kill bacteria?

Hot water that is comfortable for washing hands is not hot enough to kill bacteria. The body oils on your hands hold soils and bacteria, so hot or warm, soapy water is more effective than cold, soapy water at removing those oily soils and the bacteria in them.

How can I clean my hands when water is not available, such as when traveling or picnicking away from home?

You can use disposable wipes or a hand gel sanitizer. You use the gel without water. The alcohol in the gel kills the germs on your hands. You can find disposable wipes and hand gel sanitizers in most supermarkets and drugstores.

Hazard Analysis and Critical Control Point (HACCP)

A science-based and systematic approach to prevent potential food safety problems by anticipating how biological, chemical, or physical hazards are most likely to occur and by installing appropriate measures to prevent them from occurring.

The Seven Principles of HACCP:

1. Hazard Analysis — Identify steps in the food-production process where hazards could occur, assess their severity and human health risk, and determine a preventative measure.
2. Determination of Critical Control Points — Identify critical control points in the process at which the potential hazard can be controlled or eliminated.
3. Specification of Critical Limits — Institute control measures and establish criteria to measure control at those critical points. For example, minimum cooking times and temperatures could be established for a cooked food.
4. Monitoring — Monitor critical control points by establishing procedures for how the critical measures will be monitored and who will be responsible.
5. Corrective Actions — Take corrective action when the criteria are not being met, including disposal or reprocessing of the food in question and fixing the problem.
6. Verification — Routinely check the system for accuracy to verify that it is functioning properly and consistently.
7. Documentation — Establish effective record-keeping procedures that document and provide a historical record of the facility's food safety performance.

Health and Human Services (HHS)

The Department of Health and Human Services is the United States government's principal agency for protecting the health of all Americans and providing essential human services, especially for those who are least able to help themselves. The Food and Drug Administration and the Centers for Disease Control and Prevention are both a part of this agency.

DID YOU KNOW?

It has been estimated that proper **handwashing** could eliminate close to half of all cases of foodborne illness.

Women wash their hands more often than men (74% versus 61%).

A study of 305 school children found that youngsters who washed their hands 4 times a day had 24% fewer sick days due to respiratory illness and 51% fewer days due to upset stomach.

— Centers for Disease Control and Prevention

H

Healthy People 2020

A statement of national health objectives for the United States. Coordinated by the U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, the agenda for this initiative is designed to identify the most significant preventable threats to health and to establish national goals to reduce these threats.

A goal of this initiative is to improve food safety and reduce foodborne illnesses. The six main food safety topic area objectives are:

1. Reduce infections caused by key pathogens transmitted commonly through food.
2. Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter, Listeria,* or *Salmonella* species associated with food commodity groups.
3. Prevent an increase in the proportion of nontyphoidal *Salmonella* and *Campylobacter jejuni* isolates from humans that are resistant to antimicrobial drugs.
4. Reduce severe allergic reactions to food among adults with a food allergy diagnosis.
5. Increase the proportion of consumers who follow key food safety practices.
6. Increase the proportion of fast-food and full-service restaurants that follow food safety practices that prevent foodborne illness outbreaks.

Hybridization

The process of interbreeding desirable traits found in plants or animals to create one offspring from 2 different breeds, varieties, species, or genera.

Hygiene

Practices, such as cleanliness and maintenance of skin, hair, and nails, that promote health and prevention of disease.

Food Safety Implication: It's important to practice good hygiene, especially handwashing, at home and while working in foodservice facilities, so that food doesn't become contaminated with foodborne bacteria.

Food Safety Precautions:

- Thoroughly wash hands with hot, soapy water before and after handling food. (See *Handwashing*.)
- Keep skin, hair, and nails clean, especially when preparing, serving, and cooking foods.

> **!** Poor personal **hygiene** contributes to approximately 50% of all foodborne illness outbreaks.

I

Incidence

The number of new cases of foodborne illness in a given population during a specified period of time. For example, the number of new cases per 100,000 people per year.

Infection

Attachment and growth of pathogenic microorganisms, including bacteria, protozoans, viruses, and parasites, on or within the body of a human or animal.

Inspection (see **Food Inspection**)

Intoxication

A condition in which the body is poisoned by a toxin. The substance can disrupt the functioning of the intestinal cells or can be absorbed into the blood and carried to parts of the body. Intoxication caused by bacterial toxins usually results in headache, dizziness, vomiting, and stomach pains.

Irradiation

A process in which ionizing energy is used to reduce pathogens and other harmful substances in food by causing breaks in the cell's deoxyribonucleic acid (DNA).

Food Safety Implication: Food irradiation is a technology, like heating, that can destroy harmful bacteria in raw foods. Irradiation complements, but is not a replacement for, proper food preparation, storage, and distribution practices by producers, processors, and consumers.

How It Works: An intense pulse of energy is emitted, either from a gamma radiation source like Cobalt 60 or from an electrical source like an electron beam accelerator. The energy penetrates the food and destroys any bacteria.

Four Main Purposes of Food Irradiation are to:

1. **Preserve** — Irradiation can be used to destroy or inactivate organisms that cause spoilage and decomposition, thereby extending the shelf life of foods.
2. **Sterilize** — Foods that are sterilized by irradiation can be stored for years without refrigeration. Sterilized food is useful in hospitals for patients with severely impaired immune systems, such as people with HIV/AIDS or people undergoing chemotherapy. Irradiated foods can also be used by the military and for space flights.

Irradiation (cont'd)

1. **Control Sprouting, Maturation, and Insects** — Irradiation offers an alternative to chemicals for use with potatoes, tropical and citrus fruits, grains, spices, and seasonings. However, since no residue is left in the food, irradiation does not protect against reinfestation as insect sprays and fumigants do.
2. **Reduce Microorganisms** — Irradiation can be used to effectively reduce pathogens that cause foodborne illness, such as *Salmonella*.

Food Irradiation Timeline

1920s: French scientists discover that irradiation preserves foods.

1963: Irradiation is approved by the Food and Drug Administration (FDA) to control insects in wheat and wheat powder. Although irradiation was not used in the United States at this time, 400,000 tons of wheat per year were irradiated in Ukraine to kill insects.

1964: This is the first time irradiation was used in the United States. The FDA approves irradiation to extend the shelf life of white potatoes.

1970s: The National Aeronautics and Space Administration (NASA) adopts irradiation to sterilize meat for astronauts to eat in space. Irradiation is still used by NASA today.

1997: FDA approves irradiation for use on red meat.

2000: The U.S. Department of Agriculture's Food Safety and Inspection Service (FSIS) approves the irradiation of beef. FDA approves irradiation for the treatment of shell eggs and seeds for growing sprouts.

2005: FDA approves irradiation for the treatment of molluscan shellfish. Irradiation is used to control pathogens, such as *Vibrio* species and other foodborne pathogens in fresh or frozen molluscan shellfish (e.g., oysters, mussels, and clams).

2008: FDA approves irradiation for use on fresh iceberg lettuce and fresh spinach to control microorganisms and extend shelf-life.

2012: FDA approves irradiation for use on unrefrigerated, uncooked meat, meat by-products, and certain meat products. Additionally, poultry products can now be irradiated at higher maximum doses, and the requirement for oxygen-permeable packing was removed. Both of these regulations offer more flexibility for meat and poultry processors who will use irradiation as a complement to proper storage, processing, and distribution.

Isolate (see **Food Isolate**)

Is irradiated food safe to eat?

Food cannot be irradiated unless the Food and Drug Administration (FDA) approves it. The FDA has evaluated irradiation safety for more than 40 years and found the process safe and effective for many foods. Health experts also say that in addition to reducing *E. coli* O157:H7 contamination, irradiation can help control the potentially harmful bacteria *Salmonella* and *Campylobacter*, 2 chief causes of foodborne illness.

Irradiation does not make food radioactive, compromise nutritional quality, or noticeably change the taste, texture, or appearance of food, as long as it's applied properly to a suitable product. It's important to note that irradiation cannot be used with all foods. For example, it causes undesirable flavor changes in dairy products and it causes tissue softening in some fruits, such as peaches and nectarines.

The Radura is the international symbol for irradiation.

How will I know if food has been irradiated?

As part of its approval, FDA requires that irradiated foods include labeling with either the statement "treated with radiation" or "treated by irradiation," along with the international symbol for irradiation, the Radura (see image above.) Irradiation labeling requirements apply only to foods sold in stores. For example, irradiated spices or fresh strawberries should be labeled. Irradiation labeling does not apply to restaurant foods.

J

Junctional Space

The area of space that lies between cells of a tissue, such as the intestine. It is composed of the tight junction, which provides a barrier that prevents the loss of fluid from the blood side of the intestine to the lumen side. Several toxins, such as the ZOT toxin produced by Vibrio cholerae, *cause diarrhea by disrupting the ability to seal the junctional space associated with the cells of the intestines.*

Juvenile Gastroenteritis

A term used to describe gastroenteritis in infants. Campylobacter jejuni *has been found to cause many cases of juvenile gastroenteritis. In fact, this bacterium may be a more important cause of juvenile gastroenteritis than* Salmonella *species.*

K

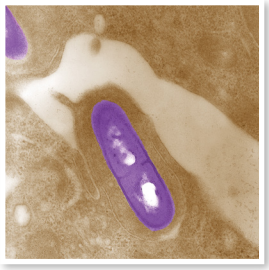
Kitchen Sanitation

(For instructions for people working in foodservice from FDA's Food Code, *see page 61. For consumer tips, see the 4 Cs section beginning on page 52.)*

L

Listeria monocytogenes

Unlike most bacteria, this pathogen can grow slowly at refrigerator temperatures. It can also cause serious problems in vulnerable people, especially pregnant women, newborns, people with weakened immune systems, and older adults.



Listeria monocytogenes

Sources: *Listeria monocytogenes* is often found in refrigerated, ready-to-eat foods.

Illness

Incubation: Gastrointestinal symptoms may appear 9 to 72 hours after consumption of contaminated food, with invasive disease appearing 2 to 6 weeks after ingestion.

Symptoms: Fever, headache, fatigue, muscle aches, nausea, vomiting, diarrhea, meningitis (a bacterial disease in which any of the 3 membranes that envelop the brain and spinal cord become inflamed), and miscarriages, resulting in a 20% mortality rate in fetuses.

Duration: Variable.

DID YOU KNOW?

Dishcloths and sponges can be contaminated with ***Listeria*** and other pathogens, which then can spread throughout the kitchen. Be sure to wash dishcloths often in the hot cycle of your washing machine. Or, wipe kitchen surfaces with a paper towel. Then throw away the towel.

Log Reduction

"Log" stands for logarithm, which is the exponent of 10. For example, log 2 represents 10^2 or 10 x 10 or 100. Log reduction stands for a 10-fold or one decimal or 90% reduction in numbers of recoverable bacteria in a test food vehicle. Another way to look at it is: 1 log reduction would reduce the number of bacteria 90%. This means, for example, that 100 bacteria would be reduced to 10 or 10 reduced to 1.

Food Safety Implication: The 5-log reduction is the value used for some food safety standards. It is an estimate of the potential number of organisms that would contaminate an 8 oz. juice serving and the level of reduction that it would take to render the product safe. The 5 log refers to 10 to the 5th power or reduction in the number of microorganisms by 100,000-fold. For example, if a juice product contained 100,000 pertinent microorganisms, a 5-log reduction would reduce the number of pertinent microorganisms to 1. (See the Log Reduction Chart below.) While the 5 log is specific to unpasteurized juice, the value has been used by the Food Safety and Inspection Service (FSIS) as a performance standard in roast beef.

Two Practical Ways of Looking at 5-Log Reduction:

1. Reduction of 100,000 bad bugs in one contaminated serving to 1 bad bug in a serving.
2. Reduction of 100,000 contaminated servings to 1 contaminated serving.

Log Reduction Chart

Log Reduction	% Reduction of Bacteria
1	90
2	99
3	99.9
4	99.99
5	99.999

Media

Growth media or culture media is a liquid or solid designed to support the growth of microorganisms, cells, or small plants. There are different kinds of media (with different ingredients) for growing different types of cells. The various kinds of media give scientists the "best chance" for growing and identifying a specific kind of bacteria more quickly. Some specialized media can be Differential and/or Selective. ***Differential media*** *contains ingredients that allow us to distinguish between two types of bacteria. For example, a pH indicator can be used to change color when coliforms are grown. Coliforms ferment lactose; whereas,* Salmonella *generally does not. Thus, non-fermentation of lactose on specific agars rules out coliforms and may indicate the presence of* Salmonella *during diagnostic testing.* ***Selective media*** *contains an ingredient that "selects" against certain organisms. For example, most media used to isolate Gram-negative organisms contain salts and/or dyes that inhibit the growth of Gram-positive organisms.*

Methylene Blue

A basic thiazine dye commonly used as a biological stain and an oxidation-reduction indicator.

Microorganism

A microscopic life form that cannot be seen with the naked eye. Types of microorganisms include: bacteria, viruses, protozoa, fungi, yeasts, and some parasites and algae.

Microwave Oven

The microwave oven is one of the great inventions of the 20th century; over 90% of homes in America have at least one. Microwave ovens can play an important role at mealtime, but special care must be taken when cooking or reheating meat, poultry, fish, and eggs to make sure they are prepared safely. Microwave ovens can cook unevenly and leave "cold spots" where harmful bacteria can survive. For this reason, it is important to use a food thermometer and test food in several places to be sure it has reached the recommended safe temperature to destroy bacteria and other pathogens that could cause foodborne illness.

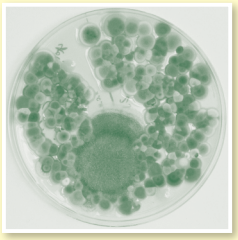
Mold

A fungus-type microorganism whose growth on food is usually brightly colored and fuzzy.

Food Safety Implication: Molds grow well on most types of food. Certain molds produce a toxin under the surface of the food. Toxins can cause foodborne illness.

Food Safety Precautions:

- Discard most moldy foods. You can sometimes save hard cheese, salamis, and firm fruits and vegetables by cutting the mold out, but if mold growth is extensive, throw the food away.
- Never taste food that looks or smells strange to see if you can still use it. When in doubt, throw it out.
- Uncovered foods that are left out of the refrigerator are exposed to mold spores in the air. To help prevent mold contamination, cover foods. Remember, don't leave any perishables out at room temperature for more than 2 hours.
- Clean the inside of your refrigerator with hot, soapy water regularly and discard any moldy foods. Mold spores from infected food can build up in your refrigerator, thus shortening the life of other foods.
- Refrigerate canned and vacuum-packed items after opening. Air that gets in after you break the seal can promote mold growth.
- Keep those great mold spreaders, such as dishcloths, dishrags, sponges, and mops, clean and fresh. A musty smell means they're moldy. Launder them frequently in the hot cycle of your washing machine.



Molds may grow on many foods, including bread and acidic foods like jams, jellies, and canned foods.

Microscopic Mold

How It Grows: Mold requires only minimal moisture and air to grow. For the first 2 to 3 days, most molds look white. The surface mold you see is just the tip of the iceberg. The latter part of the mold plant is made up of threads that invade the food below the surface. These "roots" nourish the mold plant. In those few molds that produce poisons, the mycotoxins are contained in and around these threads.

- **Microorganisms** cannot grow on dry foods due to the lack of moisture. Most bacteria thrive in moist environments. That's why dry foods like cereals or spices can sit out at room temperature. However, if dry foods become contaminated — from infected hands or equipment, for example — bacteria can survive on the food and make people ill, but they can't grow or multiply until the food is eaten.
- Microorganisms like yeast, for example, are sometimes intentionally added to foods to cause fermentation, and mold is a microorganism that is used to make penicillin, a powerful antibiotic.

DID YOU KNOW?

It's easier for **mold** to permeate soft foods like jellies and soft cheeses. Discard these types of food if you see any signs of mold — it can easily spread through the entire product. With hard foods like some cheeses, you can cut away the moldy areas. However, discard them if mold growth is extensive or the food has lost its original color and texture.

M

Molds (cont'd)

Molds prefer higher temperatures; however, some can also grow in the refrigerator. Molds also can survive in salt and sugar better than most other food invaders. So you may find mold in refrigerated jams and jellies (high sugar content) and in cured, salty meats like ham, bacon, and salami.

Beneficial Molds: Many molds perform useful functions, such as:

- Age and flavor cheeses;
- Help in making bread and preparing soy sauce;
- Produce penicillin;
- Manufacture citric acid, which is used to flavor soft drinks.

Harmful Molds: Many molds are harmful to us and can:

- Hasten food spoilage;
- Cause allergic and respiratory problems;
- Produce mycotoxins or poisons under the right conditions. Very few molds have this capability.

Mutation

An alteration in the hereditary material of a cell, which is transmitted to the cell's offspring. Mutations take place in the genes, which are made up of deoxyribonucleic acid (DNA) molecules. During bacterial reproduction, genes may mutate, and occasionally a mutation may develop more harmful bacteria or help the bacteria become resistant to a specific antibiotic.

Mycotoxins

Naturally occurring toxins produced by fungi (molds) in food and animal feed. Some examples include: aflatoxins, fumonisins, deoxynivalenol, and patulin.

N

National Antimicrobial Resistance Monitoring System (NARMS)

A system that allows the Food and Drug Administration (FDA) to detect when foodborne bacteria — which can cause disease in humans — begin to develop resistance to antimicrobials used in food animals. The program combines the resources of the FDA, the Centers for Disease Control and Prevention (CDC), and the U.S. Department of Agriculture (USDA) to create a nationwide monitoring system.

National Center for Food Safety and Technology (NCFST)

A consortium of the FDA, Illinois Institute of Technology, and food industry members working together to make food safer for the consumer.

National Food Safety Education Month℠ (NFSEM)

Founded in 1994 by the International Food Safety Council — a coalition of restaurant and food industry professionals, the month of September is dedicated to focusing public attention on foodborne illness and the Fight BAC!™ campaign's 4 Steps to Food Safety: clean, separate (combat cross-contamination), cook, and chill. (Also see Fight BAC!™ Campaign.*)*

Noroviruses

Noroviruses are a group of viruses (previously known as Norwalk-like viruses) that can affect the stomach and intestines. These viruses can cause people to have gastroenteritis, an inflammation of the stomach and the large intestine. Gastroenteritis is sometimes called a calicivirus infection or food poisoning, even though it may not always be related to food.

DID YOU KNOW?

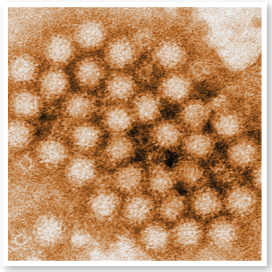
Noroviruses are named after the original strain "Norwalk virus," which caused an outbreak of gastroenteritis in a school in Norwalk, Ohio, in 1968.Currently, there are at least four norovirus-genogroups (GI, GII, GIII, and GIV), which in turn are divided into at least 20 genetic clusters.

Noroviruses:

- can only sit in food. They can't multiply in food as bacteria do. The viruses are killed by thorough cooking;
- survive freezing;
- are highly infectious and the body doesn't build immunity to them very well;
- resist chlorine and other sewage treatment agents.

Noroviruses (cont'd)

Norovirus is sometimes called the "stomach flu," although it is not related to the flu (a common respiratory illness cause by the influenza virus). At least 50% of all foodborne outbreaks of gastroenteritis are thought to be attributable to noroviruses. Noroviruses spread extremely easily through food, surfaces such as door handles or other things hands often touch, and aerosolized droplets in the air.



Noroviruses

Sources: Raw oysters/shellfish, cole slaw, salads, baked goods, frosting, contaminated water and ice, and person-to-person contact.

Illness

Incubation: 1 to 2 days after ingestion.

Symptoms: Diarrhea, nausea, vomiting, abdominal pain, headache, and fever.

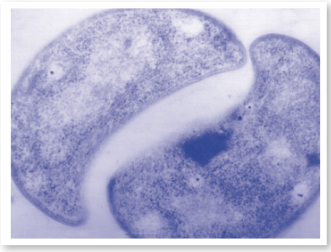
Duration: 1 to 3 days.

Nucleic Acid

A polymer substance found in animal and plant cells that holds the genetic information. Two classes of nucleic acids are ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). (Also see Deoxyribonucleic Acid *and* Ribonucleic Acid.*)*

Nucleoid

A circular loop of double-stranded helical deoxyribonucleic acid (DNA) in a cell that is not enclosed in a membrane.



A Nucleoid Structure

Nucleus (see **Cell**)

Outbreak

An incident in which 2 or more cases of a similar illness result from eating the same food.

Food Safety Implication: Foodborne illness outbreaks are caused by foods that are contaminated internally or that become contaminated during harvesting, processing, or preparation. When there is an outbreak of foodborne illness, public health scientists use epidemiological, microbiological, and traceback technologies to control the outbreak and remove the food from the distribution channels.

For example, PulseNet is a national network of public health laboratories that performs DNA "fingerprinting" on bacteria. This network helps to characterize foodborne bacteria and establishes links between related cases over a wide geographical area. This allows for the identification and removal of foods that cause multiple cases of illness from the marketplace. (Also see *PulseNet*.)

Oxygen Tension

The measure of the amount of oxygen that is available for an organism to use in growth.

Food Safety Implication: Aerobic organisms are those organisms that can grow in the presence of O_2. Some, in fact, will not grow without it. Anaerobic organisms are those organisms that grow in the absence of O_2. In fact, some are killed by the presence of O_2.

Foods are usually contaminated by or contain mixed populations of microorganisms. As each population grows, a few species will predominate. As these microbial populations use up their food, they begin to die off, and a second microbial species will succeed the first. This process is called ecological succession. Many times, a population of aerobicorganisms will use up all the available oxygen that the succeeding population will need, and thus will select a more anaerobic succeeding species.

DID YOU KNOW?

Many foodborne illness **outbreaks** are not reported because people often feel like they have the flu, and they often do not know that their illness was caused by harmful bacteria or other pathogens in food.

Packaging

Wrappers or containers used to protect food from dirt, germs, and damage. Packaging also keeps oxygen out and increases the shelf life of food.

Food Safety Implication: Packaging techniques use heat to kill pathogenic bacteria or other methods, such as placing food in sterile packaging, to protect food from microorganisms that could cause spoilage or foodborne illness. Also, since bacteria thrive on oxygen, some types of packaging reduce the amount of oxygen available to bacteria to slow bacterial growth and extend the storage life of the food. Labels on product packages also provide information about how to safely use the product.

Food Safety Precautions:

- Always read the label on retail packaging. Handling, storage, and cooking procedures can differ greatly for every product, and proper handling can ensure product safety.
- Check the expiration, "sell by," and "use by" dates stamped on the package, and don't take risks by using old products.
- Don't buy or use foods whose packaging has been broken, torn, or damaged.

Types of Packaging Commonly Used Today Include:

1. Shelf-Stable Packaging — Traditional shelf-stable packaging consisted of cans or glass jars. The newest shelf-stable packaging uses plastic containers. So, instead of opening a can of soup or stew, pouring it into a pan and heating it, you can pull a plastic soup package off the shelf and pop it into a microwave. Such products can be safely stored on the shelf without refrigeration. Assuming there are no breaks or tears in the package, these products should maintain top quality for more than a year.
2. Packaging That Requires Refrigeration
   - Sous Vide (a French phrase for "under vacuum") — With this method, fresh raw ingredients or partially cooked ingredients are vacuum-sealed in a plastic pouch. The pouch is heat-processed, then quickly chilled and transported under refrigeration. Sous vide products *must* be kept refrigerated. Like other vacuum-packed products, sous vide products will last 3 to 4 weeks refrigerated. To serve, you simply heat the bag in boiling water.
   - Vacuum Packaging (a.k.a. Modified Atmosphere Packaging) — Oxygen in the package is mixed with a gas (normally carbon dioxide and/or nitrogen) that slows spoilage, discoloration, and the growth of harmful bacteria. Vacuum packages now include raw pork tenderloin, fully cooked roast chicken, tuna spreads, and tortellini. Some foods may require additional cooking or heating before serving, so always check the label.

DID YOU KNOW?

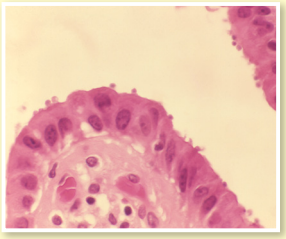
In the early 1800s, the British Navy needed unbreakable canned goods for sea voyages, which spurred the development of tinned cans for **packaging**. By the 1860s, the production of tinned goods was a booming industry in the United States.

Common Types of Packaging Materials Include:

- Aluminum — Bottle caps and easy-to-open tops for cans.
- Glass Containers — Durable, chemical-resistant, can be kept highly sanitary, and are ideal for the storage of solid and liquid foods.
- Cardboard — Comes in a variety of shapes and sizes and serves as containers for food.
- Plastic — Has been used extensively as a shipping material for liquids and perishable foods because of its high durability and insulation qualities.
- Tin-Plated Steel Cans — Used predominantly for food storage.

Parasite

A plant or animal that lives on or in another plant or animal, while making no beneficial contribution to that host.



Cryptosporidium, a parasite, can cause a severe, life-threatening disease, particularly in people with with HIV/AIDS.

Food Safety Implication: Food can become contaminated with parasites. Some parasites have an indirect life cycle. For example, they need an intermediate host (the food species) where they develop into a stage that is infectious to humans. Humans who consume the infested food, either raw or undercooked, become infected.

In parasites that are directly infectious, the parasite is physically transferred by the food through contamination with a human or other host waste.

Some Examples of Parasites That May Contaminate Food Are: *Trichinella spiralis* (trichinosis), which can be found in pork and *Anisakis* roundworm, which can be found in fish. For more about other common parasites, see *Cyclospora, Cryptosporidium,* and *Toxoplasma gondii*.

Partnership for Food Safety Education (see Fight BAC!™ Campaign)

Pasteurization

The process of destroying microorganisms that could cause disease. This is usually done by applying heat to a food.

Food Safety Implication: Pasteurization is the heat processing of a liquid or food to kill pathogenic bacteria to make a food safe to eat. Using pasteurization to kill pathogenic bacteria has helped reduce the transmission of diseases, such as typhoid fever, tuberculosis, scarlet fever, polio, and dysentery. (Also see *Typhoid Fever*.)

It's important to note that foods can become contaminated even after they have been pasteurized. For example, all pasteurized foods must be refrigerated. If temperature is abused (e.g., if milk or eggs are not kept refrigerated), pasteurized foods can become contaminated. Therefore, it's important to always handle food properly by following the 4 Cs. (See pages 52–61.)

How It Works: Foods are heat-processed to kill pathogenic bacteria. Foods can also be pasteurized using gamma irradiation. Such treatments do not make the foods radioactive. The pasteurization process is based on the following time and temperature relationship.

- High-Temperature-Short-Time Treatment (HTST) — Using higher heat for less time to kill pathogenic bacteria. For example, milk is pasteurized at 161° F (72° C) for 15 seconds.
- Low-Temperature-Long-Time Treatment (LTLT) — Using lower heat for a longer time to kill pathogenic bacteria. For example, milk is pasteurized at 145° F (63° C) for 30 minutes.

Note: The times and temperatures depend on the type of food and the final result you want to achieve, such as retaining a food's nutrients, color, texture, and flavor and using a high enough temperature for a long enough time to kill pathogenic bacteria.

Processes Used to Pasteurize Foods Include:

- Flash Pasteurization — Involves a high temperature, short-time treatment in which pourable products, such as juices, are heated for 3 to 15 seconds to a temperature that destroys harmful microorganisms. After heating, the product is cooled and packaged. Most drink boxes and pouches use this pasteurization method as it allows extended unrefrigerated storage while providing a safe product.
- Steam Pasteurization — This technology uses heat to control or reduce harmful microorganisms in beef. This system passes freshly slaughtered beef carcasses that are already inspected, washed, and trimmed, through a chamber that exposes the beef to pressurized steam for approximately 6 to 8 seconds. The steam raises the surface temperature of the carcasses to 190° to 200° F (88° to 93° C). The carcasses are then cooled with a cold-water spray. This process has proven to be successful in reducing pathogenic bacteria, such as *E. coli* O157:H7, *Salmonella*, and *Listeria*, without the use of any chemicals. Steam pasteurization is used on nearly 50% of U.S. beef.
- Irradiation Pasteurization — Foods, such as poultry, red meat, spices, and fruits and vegetables, are subjected to small amounts of gamma rays. This process effectively controls vegetative bacteria and parasitic foodborne pathogens and increases the storage time of foods.

Some Examples of Foods That Are Commonly Pasteurized:

- Whole Eggs Removed from Shells and Sold As a Liquid — Large quantities of eggs are sold to restaurants and institutions out of the shell. The yolk and whole-egg products are pasteurized in their raw form. The egg white is pasteurized in its raw form if it is sold as a liquid or frozen product. Liquid pasteurized eggs (in cartons) may also be sold to consumers; they may be found in the refrigerator section of some supermarkets and are labeled "pasteurized."
- Dried Eggs — If eggs are sold dried, the egg white with the glucose removed is normally heat-treated in the container by holding it for 7 days in a hot room at a minimum temperature of 130° F (54° C).

Louis Pasteur, a chemist, developed **pasteurization** while researching the cause of beer and wine spoilage. The process was applied first in wine preservation. When milk producers adopted the process, pasteurization eliminated a substantial quantity of foodborne illness.

Louis Pasteur (1822–1895)

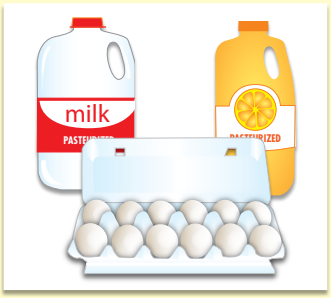
DID YOU KNOW?

Pasteurization (cont'd)

- **Whole Eggs Pasteurized in the Shell** — Traditionally, eggs sold to customers in the shell have not been pasteurized. However, new time/temperature pasteurization methods are making this possible. Egg whites coagulate at 140° F (60° C). Therefore, heating an egg above 140° F would cook the egg, so processors pasteurize the egg in the shell at a low temperature, 130° F (54° C), for a long time, 45 minutes. This new process is being used by some manufacturers, but it is not yet widely available.

Note: Pasteurizing eggs reduces the risk of contamination from pathogenic bacteria, such as *Salmonella*, which can cause severe illness and even death. Pasteurized eggs in the shell may be used in recipes calling for raw eggs, such as Caesar salad, hollandaise or béarnaise sauces, mayonnaise, egg nog, ice cream, and egg-fortified beverages that are not thoroughly cooked.

- Milk — Pasteurization improves the quality of milk and milk products and gives them a longer shelf life by destroying undesirable enzymes and spoilage bacteria. For example, the liquid is heated to 145° F (63° C) for at least 30 minutes or at least 161° F (72° C) for 15 seconds.



Today, many foods, such as eggs, milk, juices, spices and ice cream, are pasteurized.

Sometimes higher temperatures are applied for a shorter period of time. The temperatures and times are determined by what is necessary to destroy pathogenic bacteria and other more heat-resistant disease-causing microorganisms that may be found in milk. The liquid is then quickly cooled to 40° F (4° C).

Other liquids, such as juices, are heat-processed in a similar manner. Temperatures and times vary, depending on the product and the target organism. Other types of milk pasteurization include:

- **Ultrapasteurization** — This involves the heating of milk and cream to at least 280° F (138° C) for at least 2 seconds, but because of less stringent packaging, they must be refrigerated. The shelf life of milk is extended 60 to 90 days. After opening, spoilage times for ultrapasteurized products are similar to those of conventionally pasteurized products.
- **Ultra-High-Temperature (UHT) Pasteurization** — Typically involves heating milk or cream to 280° to 302° F (138° to 150° C) for 1 or 2 seconds. The milk is then packaged in sterile, hermetically sealed (airtight) containers and can be stored without refrigeration for up to 90 days. After opening, spoilage times for UHT products are similar to those of conventionally pasteurized products.

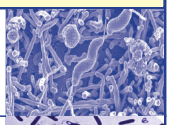
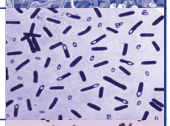
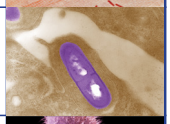
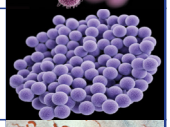
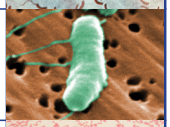
Pathogen

Any microorganism that is infectious or toxigenic and causes disease. Pathogens include parasites, viruses, and some fungi/yeast and bacteria.

Food Safety Implication: If food is not properly handled, pathogens can contaminate food and cause foodborne illness when the food is eaten. (See *The 12 "Most Unwanted" Bacteria* below.)

The 12 "Most Unwanted" Bacteria

(For in-depth information on each bacterium, see the individual terms.)

1.	*Campylobacter jejuni*	
2.	*Clostridium botulinum*	
3.	*Clostridium perfringens*	
4.	*Escherichia coli* O157:H7 (a.k.a. *E. coli* O157:H7)	
5.	*Listeria monocytogenes*	
6.	*Salmonella* Enteritidis	
7.	*Salmonella* Typhimurium	
8.	*Shigella*	
9.	*Staphylococcus aureus*	
10.	*Vibrio cholerae*	
11.	*Vibrio vulnificus*	
12.	*Yersinia enterocolitica*	

Perishable

Food that is subject to decay, spoilage, or growth of pathogenic bacteria unless it is properly refrigerated or frozen.

Food Safety Implication: Perishable foods can spoil quickly and become unsafe to eat if they are not properly stored.

Food Safety Precautions:

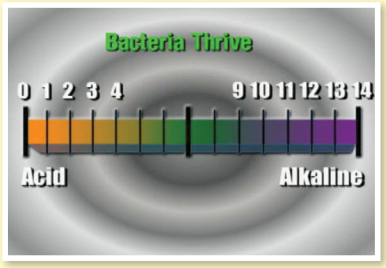
- When shopping, buy perishable foods last and only when you can take them home right away.
- Always store perishable foods in the refrigerator or freezer to prevent bacterial growth.
- Avoid leaving perishables out at room temperature for more than 2 hours.

Perishable Foods Include:

- Dairy Products
- Produce
- Meat
- Seafood
- Poultry

pH

The measure of the acidity (less than 7) or alkalinity (greater than 7) of a solution. Acidity is measured on a pH scale of 0 to 14, with a neutral pH being 7. The pH is acidic if it is lower than 7. The more acidic, the lower the number on the scale.



Most bacteria will not grow at pH levels below 4.6. Microorganisms thrive in a pH range above 4.6.

Food Safety Implication: Most bacteria will not grow in acidic foods with a pH level below 4.6. Microorganisms thrive in a pH range above 4.6. That's why acidic foods, such as vinegar and citrus fruits, are not favorable foods for pathogenic bacteria to grow in. However, bacteria may survive in the food.

Some examples of high-acid foods include: all fruits, except figs, most tomatoes, pickles, sauerkraut, jams, jellies, marmalades, fruit butters, and fermented and pickled (treated with brine or vinegar solution to inhibit the growth of microorganisms) vegetables.

Phage Typing

A classification procedure that uses bacteriophages (viruses that infect bacteria) to distinguish between bacterial isolates that belong to the same genus and species.

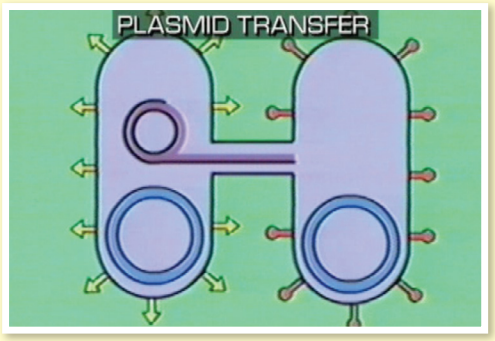
Each bacterial strain will exhibit resistance to some phages and be susceptible to infection by others. A battery of standard phages is used to test bacterial isolates. The profile of resistance and susceptibility is called the phage type.

Food Safety Implication: Phage typing helps food scientists determine if bacterial isolates obtained from groups of ill people are different or indistinguishable from each other.

Plasmid Transfer with *E. coli*

Plasmids carry a number of genetic elements, which can be transferred between and among related bacteria. For example, E. coli *cells can naturally transfer some plasmids from cell to cell by the process of conjugation.*

Food Safety Implication: Plasmid transfer may cause new foodborne pathogens to emerge, and sometimes genetic elements that plasmids transfer from one bacterium to another can make the receiving bacterium pathogenic or resistant to antibiotics.



Point of Service (POS)

The establishment where an implicated food is consumed or sold to the consumer. An establishment can include restaurants, grocery stores, caterers, banquets, or a private residence.

Preservation

A variety of methods used at the processing stage and at home to keep food safe from harmful bacteria and extend the storage life of food. (Also see Canning *and* Freezing.*)*

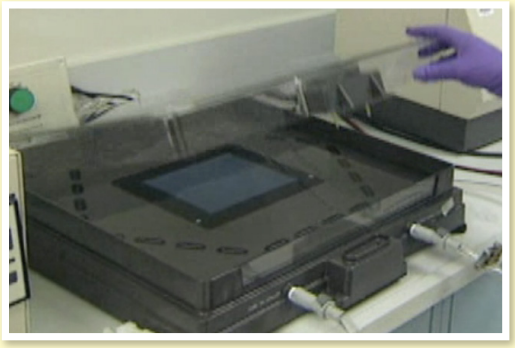
Food Safety Implication: Foods are preserved so that they can be safely eaten at a later time. Some preservation methods include: canning, drying, freezing, smoking, and pickling (treating foods with brine or vinegar solution to inhibit the growth of microorganisms).

Food Safety Precaution: Read and follow all instructions on food labels for storage, handling, and cooking of foods.

Pulse-Field Gel Electrophoresis (PFGE)

The DNA "fingerprinting" method that scientists use to determine the source of bacteria in foods.

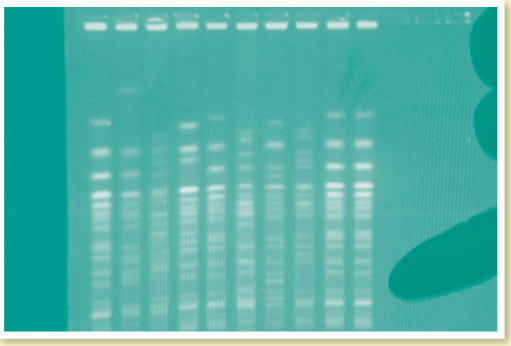
Pulse-Field Gel Electrophoresis



Food Safety Implication: Bacterial DNA "fingerprints" are generated by pulse-field gel electrophoresis (PFGE), which can distinguish between different strains of a bacterium, such as *E. coli*. Similar PFGE patterns suggest that 2 different *E. coli* isolates — such as one from a patient and one from food — come from a common source, and identifying these connections can help determine the cause of an outbreak. Finding similar patterns can also help scientists determine whether an outbreak is occurring, even if the affected persons are geographically far apart.

How It Works: The DNA is first digested into pieces by reacting the isolated DNA with enzymes that are able to specifically break the DNA molecule into individual pieces. The digested DNA is placed at one end of the gel. A pulsing electric field applied across the gel drives the DNA pieces into the gel over a period of hours. The smallest pieces slip through the pores of the gel more quickly, so the pieces are separated as distinct bands in the gel, based on size. The resulting pattern of 30 to 50 bands, which resembles a bar code is the "fingerprint."

A DNA "Fingerprint"



PulseNet

A national network of public health laboratories that performs DNA "fingerprinting" on foodborne bacteria. The network permits rapid comparison of these "fingerprint" patterns through an electronic database at the Centers for Disease Control and Prevention (CDC). This network was set up in 1996.

PulseNet National Logo

PulseNet™ USA
The National Molecular Subtyping Network for Foodborne Disease Surveillance
CDC

DID YOU KNOW?

In prehistoric times, people preserved food by drying it in the sun or storing it in cool caves. Today, science has developed other methods of **preservation**, such as canning, freeze-drying, and irradiation.

Salt is a good food preservative.
Salt is considered antibacterial because it restricts bacterial growth in many foods. It preserves foods by lowering the amount of "free" water molecules in foods. Bacteria need moisture in order to thrive, so without enough "free" water, they cannot grow well in foods that contain salt.

PulseNet (cont'd)

Food Safety Implication: PulseNet helps to better detect the source of foodborne bacteria in foods, which cause foodborne illness. Any one of the laboratories (approximately 87 laboratories at this publication, with at least one in each state) in CDC's PulseNet network can fingerprint *E. coli* in less than 24 hours, whereas the process used to take days or weeks.

Using DNA "fingerprint" technology, PulseNet helps public health authorities recognize when cases of foodborne illness are occurring at the same time in geographically separate locales. These illnesses may be caused by the same strain of bacteria and may be due to a common exposure, such as a common food that was eaten. An epidemiologic investigation of those cases can then determine what they have in common. Control measures can be initiated and outbreaks stopped.

How It Works: Laboratories participating in PulseNet perform DNA "fingerprinting" by pulse-field gel electrophoresis (PFGE) on disease-causing bacteria isolated from humans and from suspected food using standardized equipment and methods. Once PFGE patterns are generated, they are entered into an electronic database of DNA "fingerprints" at the state or local health department and transmitted to the CDC where they are filed in a central computer. Every state has at least one public health laboratory that can match up bacteria from sick people in many locations using PulseNet's DNA fingerprinting techniques and database. PulseNet tracks what is being reported to CDC today compared to what was reported in the past to look for changes. This means that PulseNet keeps a cumulative database representing nearly half a million isolates of bacteria from food, the environment, and human foodborne illness. If patterns from laboratories in different locations during a defined time period are found to match, PulseNet alerts participants of a possible multi-state outbreak, so that a timely investigation can be done.

Foodborne Illness-Causing Bacteria Currently Being Tracked by PulseNet: PulseNet detects subtypes of *E. coli* O157:H7 and other Shiga toxin-producing *E. coli, Campylobacter jenuni, Clostridium botulinum, Listeria monocytogenes, Salmonella, Shigella, Vibrio cholera,* and *Vibrio parahaemolyticus.*

Why is PulseNet effective?
PulseNet is effective because all of the laboratories in its network follow the same procedures and standards — making it possible to compare fingerprints uploaded by labs in different places. In PulseNet, the quality and uniformity of the data is ensured by a quality assurance and quality control (QA/QC) program.

The Step-by-Step Process for Tracing a Food Implicated in a Foodborne Illness Outbreak:

1. A person experiencing the symptoms associated with foodborne illness (diarrhea, abdominal cramps, nausea, fever, vomiting, or body aches) goes to the doctor. The doctor makes an initial diagnosis and stool cultures from the patient are sent to a clinical laboratory.
1. Medical lab tests are done on the stool culture. If the presence of foodborne bacteria is determined by the local clinical lab, an isolate of that bacterial culture is sent to the state health department lab for further testing, including PFGE. The state health department lab sends the PFGE results electronically to CDC.

   The DNA "fingerprint" (PFGE result) is compared at CDC with other "fingerprint" samples from the other states that do PFGE testing (approximately 87 laboratories at this publication). If there are other states reporting this same pattern, CDC automatically notifies the state health departments, along with the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA), the 2 agencies that are responsible for the safety of food that travels interstate.

   In other instances, local and state health departments identify an outbreak or cluster of sporadic cases and the suspected food source without PFGE testing. When other similar outbreaks or clusters of sporadic cases are identified in a particular state or other states, PFGE testing is then used to link them along with the fact that a common food is involved.
2. When there are several isolates with the same PFGE pattern, state health departments investigate to identify a common exposure, such as a common food that was eaten. Local health department representatives use standard questionnaires to interview both sick and well persons. First, they want to find out whether the foodborne illness was due to a point of service (POS) mistake. The point of service could be such places as your table at home, a picnic, or a restaurant. Health department representatives look for common answers — for example, a common meal that was eaten by all or a common event that was attended.
3. If it is determined that the foodborne illness was due to food that was served at a banquet or restaurant, for example, local health department representatives will interview the food workers. They use standard questionnaires to find out what and how foods were prepared. In some cases, if there was a sick food worker on the job on the day in question, stool cultures from the food worker may be requested to determine if he or she was sick from the same organism and if his or her PFGE matches the people who became sick. If the worker was the source of the contamination, a food source investigation would not be needed.

Is PulseNet the only national network that tracks pathogens?

No. Currently, PulseNet tracks only *E. coli* O157:H7 (and other Shiga toxin-producing *E. coli*), *Campylobacter jejuni, Clostridium botulinum, Listeria monocytogenes, Salmonella, Shigella, Vibrio cholera,* and *Vibrio parahaemolyticus*. The Public Health Laboratory Information System (PHLIS), a national network of public health laboratories, tracks all organisms. PulseNet is a part of PHLIS. Both networks help to better detect a foodborne outbreak in multiple states.

P

1. Once the common food is identified and the food source is suspected, CDC notifies FDA or USDA (the agency that is notified depends on which agency has jurisdiction over the food), who in turn uses trace-back techniques to determine the source of the food.
2. Once the traceback investigation has determined the source of the outbreak, steps are taken to prevent further exposure or spread of the infection. For example, if the source is a specific food being distributed, a recall of that food will be implemented. If the source is an infected food worker, that person will be removed from any foodservice duties until they have recovered and tested negative for that bacteria.

PulseNet International: Since foodborne illnesses do not respect any borders, PulseNet International performs a similar role for worldwide foodborne illnesses. With labs in more than 80 countries, PulseNet International participates in the investigation of outbreaks of foodborne infections and facilitates early recognition of foodborne disease clusters that may represent common source outbreaks through molecular surveillance of infections at the global level.

PulseNet in the Future

How does PulseNet adapt to changing technology? As technology evolves, PulseNet is committed to identifying and standardizing the best molecular techniques to identify outbreaks. With the development of next generation sequencing techniques and culture independent diagnostic testing, many changes exist on the horizon for the network. Today, PulseNet is an effective tool to detect outbreaks because it uses bacterial fingerprinting solutions that are rapid, easily standardized, and able to be performed by laboratory technicians in state and local health departments and by PulseNet international participants. Any future PulseNet network must also fulfill these requirements.

Pure Food and Drug Act

The passage of this act in 1906 allowed the government to gain control over the economic adulteration (impurities) of food and use of chemicals. This act set up mechanisms for protecting the food supply. The Food and Drug Administration enforces this act.

Q

Q Fever (also known as Rickettsial Pneumonia or Balkan Grippe)

An acute, systemic disease caused by the bacterium Coxiella burnetii, *which grows only inside eukaryotic host cells.*

This microorganism is the key target for milk pasteurization in the United States. Inactivation of *Coxiella burnetii* will ensure that tuberculosis bacteria will not be viable in milk.

Sources: Many species of ticks in various parts of the world keep the infection alive in nature by spreading the rickettsiae (parasitic bacteria) from animal to animal. Humans and their domestic livestock are infected only accidentally. Because the rickettsiae are found in cow and goat milk, the ingestion of dairy products may play a role in the infection of humans and livestock. Q fever seems to be in large part an infection associated with particular occupations, such as those in the meat and dairy industry.

Illness

Incubation: Typically sudden, but may be gradual.

Symptoms: Fever, chills, headache, muscle aches, loss of appetite, disorientation, and profuse sweating. Although Q fever is, on the whole, a mild disease, it can sometimes result in severe and protracted illness. The outlook for recovery is excellent; the mortality rate is believed to be less than 1%.

Duration: 2 to 4 weeks.

DID YOU KNOW?

- The temperature required for pasteurization of milk was increased to destroy *Coxiella burnetii* organisms that cause **Q fever**. Pasteurizing milk at 145° F (63° C) for at least 30 minutes or at 161° F (72° C) for 15 seconds is sufficient to destroy *Coxiella burnetii*.
- "Q" stands for "query" because of the many unanswered questions posed by the new disease at the time of its first description.

Qualitative Analysis

The process of testing for a substance to determine what it is and what its components are. The results are reported in terms of the presence or absence of particular components, based on the size of the sample used in the analysis, the number of samples analyzed, and the testing method. An example of qualitative analysis would be testing for the presence of the bacterial pathogen Listeria monocytogenes *in a specific food.*

Qualitative Risk Assessment

Risk assessment that's based on qualitative data or giving a qualitative result. The results are often stated in an estimated range, such as "there is a moderate to high risk of a certain outcome occurring." (Also see Risk Assessment.*)*

Quantitative Analysis

The process of testing for a substance to determine how much of it there is and the numerical value of each of its components. An example would be testing for the amount or concentration of a certain chemical or microorganism, such as E. coli, *in a food. In microbiology, this process is known as "enumeration." The results for a chemical might be given in concentration units, e.g., parts per million (PPM), micrograms per gram (of the food).*

Quantitative Risk Assessment

Risk assessment that uses modeling to determine the probability(s) of what can go wrong, how likely it is to happen, and how severe is the health impact. The results are stated in numerical terms, such as "there is a 42% probability that one illness may occur from eating a serving of X food with a certain health outcome." (Also see Risk Assessment.*)*

Recall

The action of removing a product from retail or distribution. The action is conducted by a manufacturer or distributor to protect the public from products that may cause health problems or possible death.

Food Safety Implication: The purpose of a recall is to remove food from commerce when there is reason to believe it may be injurious to health or unfit for human consumption or misbranded (false or misleading labeling and/or packaging). When there is an outbreak of foodborne illness, a recall of a food may be implemented to prevent further exposure or spread of the infection.

The Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA) inspects and regulates meat, poultry, and processed eggs. All other food products fall under the regulatory authority of the Food and Drug Administration (FDA). If the source of the outbreak is a specific food being distributed, FDA or FSIS (depending on which agency has jurisdiction over the food) can request a firm to recall the food.

Most product recalls regulated by FDA or FSIS are carried out voluntarily by the manufacturer or distributor. On the other hand, if a company does not comply with a requested recall, the FDA can seek a court order authorizing the Federal Government to seize the product. FSIS has the legal authority to detain and/or seize meat and poultry products in commerce when there is reason to believe they are hazardous to public health or if other consumer protection requirements are not met. With the Food Safety Modernization Act of 2011, for the first time ever, FDA was given mandatory recall authority for food products (other than infant formula) that may cause serious health problems or possible death. However, it is expected that this authority will need to be invoked infrequently since the food industry largely honors voluntary recall requests.

Refrigeration

The process of chilling (or freezing) food for preservation.

Food Safety Implication: Prompt refrigeration *slows* or *stops* bacterial growth. This, in turn, helps prevent food spoilage and foodborne illness.

Unlike other foodborne bacteria, *Yersinia enterocolitica* and *Listeria* can grow at refrigerator temperatures. These bacteria can be killed by cooking foods to safe internal temperatures (for the recommended cooking temperatures, see the "Apply the Heat" chart on page 58).

Reportable Food Registry (RFR)

The Reportable Food Registry (the RFR or the Registry) is an electronic portal to which industry must, and public health officials may, report when there is a reasonable probability that an article of human food or animal food/feed (including pet food) will cause serious adverse health consequences or death to humans or animals. Congress mandated that FDA establish the RFR in Section 1005 of the FDA Amendments Act of 2007.

The RFR covers all foods regulated by FDA except infant formula and dietary supplements, which are covered by other mandatory reporting systems. The RFR does not receive reports about drugs or other medical products, reports about products under the exclusive jurisdiction of the U.S. Department of Agriculture, or reports from consumers, for whom FDA has other reporting systems.

Ribonucleic Acid (RNA)

A complex compound of high molecular weight that functions in transcription and translation in cellular protein synthesis. RNA differs from DNA by the substitution of uridine for thymine. RNA serves as a carrier of genetic codes in some viruses. (Also see Deoxyribonucleic Acid *and* Nucleic Acid.*)*

Food Safety Implication: Some viruses have genetic information encoded on RNA, rather than on DNA molecules. The Caliciviruses are a group of RNA viruses that can cause foodborne illness. One of the techniques for detecting and identifying Caliciviruses is to use a reverse transcriptase enzyme to form a DNA molecule from the isolated viral RNA, and then use polymerase chain reaction methods to make many copies of this DNA molecule and use them to identify the virus.

Risk Assessment

A process of estimating the severity and likelihood of harm to human health or the environment occurring from exposure to a substance or activity that, under plausible circumstances, can cause harm to human health or to the environment. (Also see Qualitative Risk Assessment *and* Quantitative Risk Assessment.*)*

Risk assessment includes estimates of variability of uncertainty and is based on the best reasonably obtainable and sound scientific knowledge available. Assessing and managing risks associated with food safety is the core of the Food and Drug Administration's public health protection duties.

Frederick McKinley Jones, an African-American inventor from Cincinnati, OH, was the first person to invent a practical, mechanical **refrigeration** system for trucks and railroad cars, which eliminated the risk of food spoilage during long-distance shipping trips. Jones was issued the patent on July 12, 1940.

Frederick McKinley Jones (1892–1961)

DID YOU KNOW?

R

Risk Assessment (cont'd)

Food Safety Implication: Food can never be proven to be entirely safe. It can only be proven to be safe or hazardous to some degree under certain conditions. Assessing risks helps government agencies and manufacturers reduce potential hazards from foods.

How It Works: Risk assessment involves taking scientific knowledge in quantitative terms and applying it to a computer model. "What if" questions are applied, such as "How many people would get sick from eating crops that were fertilized with unprocessed manure?" The results to these questions can be applied to risk-management strategies. Risk management is the process of weighing policy alternatives as a result of risk assessment and selecting and implementing appropriate control options. For example, it's the act of washing your hands to prevent foodborne illness or wearing a helmet to avoid the risk of a head injury.

Understanding Risk Assessment:

Risk assessment analyzes the following:

- What can go wrong?
- How likely is it to happen?
- How severe are the consequences?
- What is the magnitude of the outcome should the unwanted event occur?

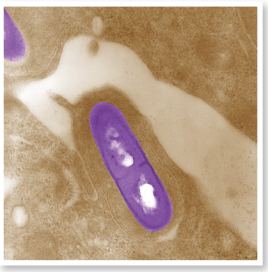
For instance, compare the risk of putting a test tube of harmful bacteria, such as *E. coli* O157:H7, in a glass of water and drinking it versus putting the same amount of the bacteria in a swimming pool and swallowing some water while swimming. The chance of getting sick is much greater from drinking the glass of water because of the higher concentration of bacteria in the glass.

Also, each time someone doesn't wash his or her hands before preparing food, he or she is deciding that the 20 seconds needed to perform this task is too much time to "waste" to prevent a foodborne illness. This person may not know the risk involved or believes the risk is very low.

S

Salmonella

A group of bacteria that can cause diarrheal illness in people.



Salmonella

Sources: Raw and undercooked eggs, raw meat, poultry, seafood, raw milk, dairy products, and produce.

Illness

Incubation: 12 to 72 hours after eating contaminated food.

Symptoms: Diarrhea, fever, and abdominal cramps. Symptoms can be more severe and cause death among people in the at-risk groups.

Duration: 4 to 7 days.

More on *Salmonella*:

- There are approximately 2,000 different serotypes of *Salmonella* bacteria. *Salmonella* serotype Typhimurium and *Salmonella* serotype Enteritidis are the most common in the United States.
- Most types of *Salmonella* live in the intestinal tracts of animals and birds and are transmitted to humans by contaminated foods of animal origin. *Salmonella* Enteritidis can silently infect the ovaries of healthy-appearing hens and contaminate the eggs before the shells are formed (Also see *Competitive Exclusion*).
- *Salmonella* Muenchen is a rare species of *Salmonella* that doesn't show up in the general population very often. Beginning in late June 1999, this bacterium caused an outbreak that involved a total of 423 illnesses in 22 states and 3 Canadian provinces.

  Salmonella was found, for the first time, in unpasteurized juice. This outbreak resulted in a nationwide recall of the unpasteurized juice.

Salmonella Enteritidis (see *Salmonella*)

DID YOU KNOW?

In the late 1800s, **Dr. Theobald Smith**, a researcher under Dr. Daniel E. Salmon in the USDA's Bureau of Animal Industry, was the first American to identify ***Salmonella*** as a separate strain or genus. Although Smith actually identified the bacteria, Salmon's name as administrator was listed first on the research paper, so the new bacterium was named for Salmon.

Dr. Theobald Smith (1859–1934)

Salmonella Muenchen (see *Salmonella*)

Salmonella Typhimurium (see *Salmonella*)

Sample

A specimen that is taken from food and tested for the purpose of identifying a foodborne pathogen or various kinds of chemical contaminants in food.

How is a sample different from an isolate?

Samples are food, whereas isolates are bacteria that have been taken from a food or a patient (e.g., clinical isolate). A sample could be some of the suspected food or all the food that's left after a foodborne outbreak. During an outbreak, microbiologists try to isolate the pathogen from the sample or food in order to identify it. (Also see *Food Isolate*.)

Sanitation

The act of maintaining a clean condition in a food-handling situation in order to prevent disease and other potentially harmful contaminants.

Sanitizer

Chemical or physical agents that reduce microorganism contamination levels present on inanimate environmental surfaces.

Food Safety Implication: Using hot, soapy water is sufficient for cleaning food-contact surfaces, cutting boards, utensils, etc. Periodically, kitchen sanitizers can be used for added protection against bacteria. Sanitizers help kill bacteria, so that bacteria doesn't spread to food.

Two Classes of Sanitizers:

1. Sanitizers of Non-Food Contact Surfaces — Traditionally, the performance standard used by the Environmental Protection Agency (EPA) for these sanitizers has required a reduction of the target microorganism by 99.9% or 3 logs (1000, 1/1000, or 10^3) after 5 minutes of contact time.
2. Sanitizing Rinses for Previously Cleaned Food-Contact Surfaces — Traditionally, the EPA performance standard for these sanitizers has required a 99.999% or 5-log (10^5) reduction of the target microorganism in 30 seconds. (See *Log Reduction*.)

Disinfectants: In comparison, disinfectants come in a variety of categories and are also agents that help eliminate undesirable microorganisms from inanimate environmental surfaces. Because these surfaces are inanimate, they are considered contaminated, not infected. Measurement of disinfectant performance varies by product type (spray, dilution product, impregnated wipe, etc.).

Disinfectant performance is typically not defined in terms of a specific percentage or log-reduction target, and unlike the sanitizers for food-contact surfaces, products that are termed disinfectants are usually not intended for use in association with food-contact surfaces.

Note: Read and follow label directions to determine the specific microorganism a product kills and how to use the product effectively. Sanitizers and disinfectants must remain in contact with a surface for a specified period of time in order to kill organisms. Be sure to check the label.

Satellite Tracking (also known as **Satellite Monitoring**)

Equipment that automatically records refrigeration system functions and the air temperature inside refrigerated containers that transport foods across the country. This information provides a detailed record of the refrigeration system's performance during the trip.

Food Safety Implication: To avoid the risk of food spoilage and microbial growth during shipment, satellite tracking monitors the temperature inside refrigerated containers.

"Sell By" Date

A calendar date on the packaging of a food product that indicates the last day the product can be sold.

The "sell by" date tells the retailer how long to display a product. It guides the rotation of shelf stock and allows time for the product to be stored and used at home. The date is quality driven, not a food safety concern. (Also see *"Best If Used By," Expiration*, and *"Use By" Dates*.)

DID YOU KNOW?

You can use one teaspoon of liquid chlorine bleach per quart of clean water to **sanitize** surfaces. The bleach solution needs to sit on the surface to be sanitized for about 10 minutes to be effective. ***Note:*** Don't wash raw produce with soap, detergents, or bleach solutions. Rinse raw produce under running water.

S

Serogroup

A sub-species classification system that uses serum (the clear, yellowish liquid that separates from the clot when blood coagulates) from immunized animals to distinguish between bacterial isolates that belong to the same genus and species.

Food Safety Implication: For outbreak analysis, serotyping serves as a fast, easy method for classifying bacterial isolates for the purpose of comparing strains recovered from foods, patients, and the environment. It also helps epidemiologists determine if a foodborne illness is an isolated occurrence or part of an outbreak.

How It Works: Each bacterial strain elicits a specific immune response when it is introduced into an animal. A bacterium expresses specific proteins and carbohydrates on its surface to which antibodies may react. Public health scientists have assembled a specific set of antibodies that react with certain bacteria. The profile of which serum/sera the bacterial isolate reacts with is called its serogroup or serotype. Groups of bacteria that react to a certain antibody are considered to be members of that serogroup.

Shelf Stable

A food that is able to be stored unrefrigerated on the shelf for a period of time and remain suitable for consumption.

Food Safety Implication: Many foods are processed and packaged for food safety and preservation purposes. In order for food to be considered shelf stable, the various techniques used should inhibit microorganisms from growing in the product at non-refrigerated temperatures of storage (extended periods over 41° F [4° C]).

Some Shelf-Stable Foods Include:

- Canned vegetables, fruits, and juices
- Canned meat
- Cereals
- Cookies
- Crackers
- Nuts
- Raisins

?

Why can shelf-stable foods be stored on the shelf at room temperature?

There are numerous techniques that make some foods shelf stable. The primary technique is to lower the water content of the food (some foods, like flour, are naturally low in water). Bacteria need water to grow and if there isn't enough water present, then the bacteria will not grow.

Foods can also be acidified. (See *Acidification*.) Or, food can be heated to ultra-high temperatures, so that it becomes sterile. Some irradiation treatments work in this manner. Once the food is made sterile, however, it has to be hermetically sealed (airtight). If not, the food can become recontaminated and pathogens and other bacteria can grow quickly.

How long can shelf-stable foods be safely stored on the shelf?

According to the Food and Drug Administration (FDA), food can be safe forever from a food-borne-illness standpoint — but if shelf-stable food has been on the shelf for an extended period of time, you might not want to eat it because the quality may not be good. In this case, the "best if used by" date on the label of the product is an indication whether or not the quality of the food is good. Food quality deals with the taste, texture, and nutritional value of food. For example, freezer burn, rancidity, and food spoilage are all quality-related issues. The FDA does not require an expiration date for shelf-stable foods, since the storage time for these foods is a quality issue, not a food safety concern.

An Example of Shelf-Stable Foods

Shigella

This bacterium is carried only by humans and causes an estimated 400,000 cases of diarrheal illnesses in the United States per year. Poor hygiene, especially improper handwashing, causes Shigella *to be easily passed from person to person via food. Once the bacterium is in the food, it multiplies rapidly at room temperature.*

Shigella

Sources: Salads, milk and dairy products, raw oysters, ground beef, poultry, and unclean water.

Illness

Incubation: 1 to 2 days after eating contaminated food.

Symptoms: Diarrhea, fever, abdominal cramps, vomiting, and bloody stools.

Duration: 4 to 7 days.

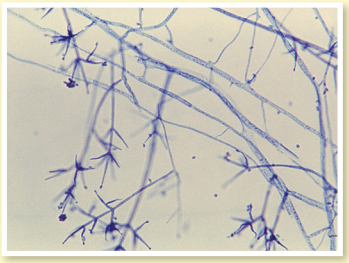
> ***Shigella*** outbreaks are usually caused by an ill food worker who, after using the bathroom, does not practice safe handwashing techniques and subsequently touches food with his or her hands.

Species

A group of organisms that are genetically related. The second word in the binomial name of a bacterium is called the species name. (Also see Binomial Nomenclature *and* Genus.*)*

Spore

A thick-walled protective structure produced by certain bacteria and fungi to protect their cells.



Spores like these are found everywhere in the environment, including in foods.

Food Safety Implication: Some spores can germinate into pathogenic bacteria, such as the highly potent *Clostridium botulinum*, which is primarily a threat in improperly canned foods and can cause botulism. Other spore-forming pathogens include *Clostridium perfringens* and *Bacillus cereus*. These pathogenic bacteria can cause foodborne illness when the contaminated food is eaten.

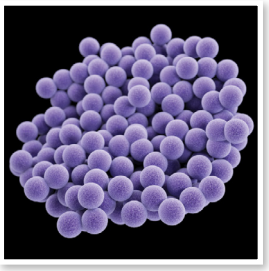
In addition, some spores often survive cooking, freezing, and some sanitizing measures. For example, the spores of certain bacteria can survive boiling for 6 hours. When conditions are favorable for bacterial growth, the spore will germinate and the bacterial cell will divide.

> If spores can survive cooking, freezing, and some sanitizing measures, how can spores be prevented from the start?
>
> Conquering spores is not an easy process because spore growth can occur anywhere. There are food safety precautions you can take. Do not hold food in the danger zone, the temperature range in which most bacteria can grow. This range is usually between 40° F (4° C) and 140° F (60° C). Some pathogenic bacteria can grow at 32° F (0° C) or above 140° F (60° C). Spores can germinate into pathogenic bacteria in the danger zone and multiply in food. For example, any cooked dish will generally have all the bacteria killed, but not the spores. When in doubt, throw the food out! (Also see *Danger Zone*.)
>
> Spore growth is also relevant to improperly canned foods. The Food and Drug Administration (FDA) makes sure that canned foods are processed in a safe manner. Consumers should be careful not to buy cans with dents, bulges, leaks, or rust spots. A failure in the canning process can allow spores to generate gas and germinate into pathogenic bacteria. (Also see *Canning*.)

S

Staphylococcus aureus

This bacterium is carried on the skin and in nasal passages of humans and often found in infected cuts and burns. These wounds should always be covered with a water-proof bandage or plastic gloves to avoid contact with food. Staphylococcus aureus *produces a toxin that causes vomiting in as little as 30 minutes after ingestion. It also multiplies rapidly in food that's left out at room temperature.*



Staphylococcus aureus

Sources: Dairy products, salads, cream-filled pastries and other desserts, high-protein foods, such as cooked ham, raw meat and poultry, and humans (skin, infected cuts, pimples, noses, and throats).

Illness

Incubation: Usually rapid — within 30 minutes to 6 hours after eating contaminated food.

Symptoms: Nausea, abdominal cramps, vomiting, and diarrhea.

Duration: 24 to 48 hours.

DID YOU KNOW?

Staphylococcus can produce toxins that *are not* destroyed by high cooking temperatures. To prevent toxins from developing in food, don't leave food sitting out at room temperature for more than 2 hours.

Strain

A variant of a species of bacteria. Some may be pathogenic and some may be benign. For example, most E. coli *are neutral or helpful to people, but* E. coli *O157:H7 is a strain of* E. coli *that is harmful to people.*

Surveillance

A system of monitoring the health of the population, which is used to prevent foodborne illness outbreaks from increasing.

Food Safety Implication: By monitoring the health of the population, foodborne illness can be reduced by recognizing outbreaks and responding to them. This can be done by determining the source, eliminating the source, and preventing the spread of illness by infected individuals.

Survey

A tool used by epidemiologists to understand the state of health of the population or to identify the source of a foodborne outbreak.

Food Safety Implication: Epidemiologists actively "survey" (seek out) individuals to see if they are sick or well. If people are suspected of being sick from food, then epidemiologists will survey sick and well people to determine what they ate. The results of the survey should implicate a specific food, location, or time of consumption.

Thermometer (see Food Thermometer)

Toxin

A poison that is produced by microorganisms, carried by fish, or released by plants.

Food Safety Implication: As pathogens multiply, they can give off harmful toxins or become infectious. If pathogens get into our food and multiply, people can get sick when they eat the food. To prevent toxins from developing in food, consumers should not hold food in the danger zone, the temperature range in which most bacteria can grow. The danger zone range is usually between 40° F (4° C) and 140° F (60° C). Some pathogenic bacteria grow at 32° F (0° C) or above 140° F (60° C). Toxins can develop in foods sitting out at room temperature for more than 2 hours. When in doubt, throw the food out.

Some Examples of Toxins in Food:

- Mycotoxins — produced by fungi (molds) in food and animal feed (see *Mycotoxins*).
- Staphylococcal Toxin — produced by *Staphylococcus aureus*. This toxin is the result of improperly refrigerated foods and is a food-handling problem.

Some Examples of Diseases Caused by Toxins:

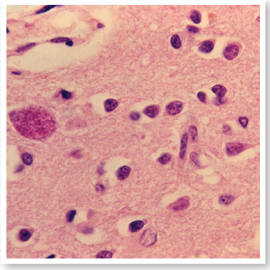
- Botulism — caused by the toxin from *Clostridium botulinum*. The toxin produced by *Clostridium botulinum* is one of the most potent and deadly toxins known to humankind. (See *Canning* and *Clostridium botulinum*.)
- Scombroid Poisoning — caused by histamine in conjunction with other amino acids produced by bacterial decomposition in some improperly refrigerated fish, such as mackerel and tuna (especially the scombroid species).

? Do all toxins in food survive the cooking process?

No, all toxins in food do not survive the cooking process. In fact, the botulism toxin caused by *Clostridium botulinum* can be inactivated by cooking. Boiling food for 10 minutes eliminates this toxin. However, many other toxins are heat stable. For example, *Staphylococcus* can produce toxins that are not destroyed by high cooking temperatures. To prevent toxins from developing in food, don't leave food sitting out at room temperature for more than 2 hours. On a hot day (90° F or higher), food should not sit out for more than 1 hour.

Toxoplasma gondii

A parasite that causes toxoplasmosis, a very severe disease that can cause central nervous system disorders, such as mental retardation and visual impairment in children.



Toxoplasma gondii

Sources: Raw or undercooked pork, lamb, or venison and cat, rat, rodent, or bird feces.

Illness

Incubation: Approximately 1 to 3 weeks.

Symptoms: Swollen glands, fever, and muscle aches. People in the at-risk groups may experience more severe symptoms.

Duration: A few weeks.

Many normally edible fish and shellfish become poisonous after feeding on toxic plants or algae. When a person eats a toxic fish or shellfish, the poison attacks the nervous system and causes a sometimes fatal condition called ciguatera.

This condition is found in some finfish, notably barracuda and amberjack. Ciguatera is one of many **toxins** that fish and shellfish can transmit.

DID YOU KNOW?

More than 60 million people in the United States are probably infected with the ***Toxoplasma gondii*** parasite, but very few have symptoms because the immune system usually keeps the parasite from causing illness.

Toxoplasmosis can also be transmitted congenitally from an infected pregnant woman to her baby.

T

Traceback

A term used in epidemiology to describe the process by which the origin or source of a cluster of contaminated food is identified.

Food Safety Implication: Tracebacks may stop the additional sale and distribution of contaminated food, thus preventing further exposure or spread of the infection. For example, if an outbreak is determined to be caused by a suspected food, investigators conducting the traceback analysis would determine where the restaurant or grocery store purchased the food, who supplied the wholesaler, and finally, on which farm it was grown.

Since wholesalers and retailers often buy food from multiple vendors, the traceback to the farm step requires extensive detective work. The various stages that the food traveled would be examined to deduce where the pathogen was transferred to the product.

When is a traceback investigation necessary?

A traceback investigation is necessary when it is determined that the cause of an outbreak was not due to a point of service (POS) mistake. The POS could be a restaurant, grocery store, caterer, or your table at home. Once the common food is identified and the food source is suspected, the Centers for Disease Control and Prevention notifies the Food and Drug Administration or U.S. Department of Agriculture (whichever agency has jurisdiction over the food). The agency uses traceback techniques to determine the source of the food.

Transduction

A process in which genes from a bacterium are incorporated into the genome or chromosome of a bacteriophage (a virus that attacks bacteria) and then carried to another host cell when the bacteriophage initiates a new cycle of infection. (Also see Bacteriophage.*)*

Transformation

The passing of genetic material in the form of deoxyribonucleic acid (DNA) between bacteria. One bacterium, called the donor cell, gives DNA fragments to another bacterium, called the recipient cell.

Transovarian Transfer

When certain pathogens, notably Salmonella *Enteritidis, can infect the ovaries of hens and thus, infect the eggs as they are being formed in the ovaries. (Also see* Competitive Exclusion *and Salmonella.)*

Food Safety Implication: Transovarian transfer occurs without harming the bird or stopping the egg production. The pathogens end up inside the egg (on the surface of the yolk), so that no amount of washing of the egg shell will remove or kill the *Salmonella* Enteritidis bacteria. Not all eggs laid by an infected hen carry the bacteria, which makes it more difficult to pinpoint the problem.

Typhoid Fever

A life-threatening illness caused by the bacterium Salmonella *Typhi. In the United States, about 400 cases of typhoid fever are identified each year, and 75% of these cases are acquired while traveling internationally.*

***Salmonella* Typhi**

Sources: Food or beverages that have been contaminated with bacteria that gets into the water used for drinking or washing food or handled by a person who is shedding (excreting the bacteria in their stool) *Salmonella* Typhi.

DID YOU KNOW?

The New York American, June 20, 1909

Mary Mallon, also known as **Typhoid Mary**, was a famous typhoid carrier who allegedly contributed to the most famous outbreaks of carrier-borne disease in medical history.

Mary was first recognized as a carrier of the typhoid bacteria during an epidemic of **typhoid fever** in 1904 that spread through Oyster Bay, New York, where she worked from household-to-household as a cook.

She was a healthy carrier of the disease, which meant she had at some point had a mild case of typhoid and still carried the disease, although she was not affected. This also meant she could spread the disease.

Fifty-one original cases of typhoid and 3 deaths were directly attributed to her (countless more were indirectly attributed), although she was immune to the typhoid bacillus, *Salmonella* Typhi.

Typhoid Mary (1870 est.–1938)

Typhoid Fever (cont'd)

Illness

Incubation: 1 to 4 weeks, usually 2 weeks.

Symptoms: Fever, stomach pains, headache, loss of appetite, and weakness. In some cases, patients have a rash of flat, rose-colored spots.

Duration: Once asymptomatic (presenting no symptoms of disease), it can be ongoing. See the "Did You Know?" on Typhoid Mary on page 44 and the Frequently Asked Question at right.

Typhoid Mary (see Typhoid Fever)

? If a person who was infected by *Salmonella* Typhi begins to feel okay, does this mean he or she has stopped shedding the bacteria?

Not necessarily. Even if symptoms seem to go away, a person may still be carrying *Salmonella* Typhi. If so, the illness could return and he or she could pass the disease to other people. In fact, if the person works at a job where he or she handles food or cares for small children, that person may be barred legally from going back to work until a doctor has determined that the person no longer carries any typhoid bacteria. Therefore, it's important for the person to consult a doctor to ensure that the bacteria no longer remain in his or her body.

T

Ultra High Pressure (UHP) Treatment

A process used at the processing stage that utilizes very high pressure to kill bacteria in foods.

Today, some food producers are using a method called Ultra High Pressure (UHP) Treatment to kill harmful bacteria in foods.

Food Safety Implication: Ultra High Pressure destroys bacteria, but does so using pressure, rather than high temperatures or chemical additives. Thus, foods, such as juices, salsas, cold cuts, and other moist foods, are made safer without affecting the vitamins and flavor.

How It Works: Using specially designed equipment, packaged food is exposed to 50,000 to 100,000 psi (pounds per square inch) of pressure for a short time. The ultra high pressure interferes with the metabolism and structure of bacteria and destroys these living cells, but does not crush the food.

As long as the food is mostly air-free and contains water, hydrostatic pressure doesn't crush food because the water in the food protects it from physical damage. However, living bacteria are destroyed by the effects of high pressure on their cellular functions.

U.S. Department of Agriculture (USDA)

A department of the United States government that has many varied responsibilities, including food safety. The primary agency in USDA responsible for food safety is the Food Safety and Inspection Service. (See Food Safety and Inspection Service.*)*

"Use By" Date

This is the last date a consumer is recommended to use a product while it is at peak quality. This date is recommended for best flavor or quality. It is not a "sell by" or food safety date. (Also see "Best If Used By," Expiration, *and* "Sell By" Dates.*)*

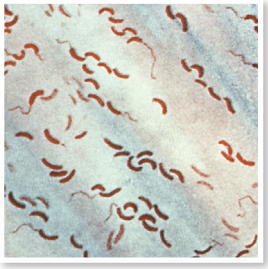
U

V

Vacuum Packaging (see Packaging)

Vibrio cholerae

This bacterium occurs naturally in the aquatic and marine environment. It causes cholera, a severe disease that, if untreated, could cause death.



Vibrio cholerae

Sources: Raw and undercooked seafood or other contaminated food and water. The contamination is the result of the food or drinking water mixing with water from sources that receive the untreated feces of cholera victims.

Illness

Incubation: 6 hours to 5 days after eating contaminated food.

Symptoms: They are often absent or mild. Some people develop a severe illness with profuse diarrhea, vomiting, and leg cramps. Loss of body fluids can lead to dehydration and shock. Without treatment, death can occur within hours.

Duration: 3 to 7 days.

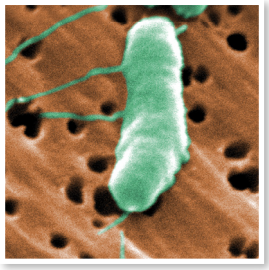
Vibrio vulnificus

A bacterium that is in the same family as those that cause cholera. It normally lives in warm seawater and is part of a group of vibrios that are called "halophilic" because they require salt.

Vibrio vulnificus can cause infection in people who eat raw, contaminated seafood, often shellfish, or have an open wound that is exposed to seawater. It is a rare cause of disease, but it is also underreported.

DID YOU KNOW?

Human **viruses** cannot grow in foods. Since viruses are very host-specific, a human virus will rarely multiply even in foods that are still alive (like oysters). However, they can persist for a long time.



Vibrio vulnificus

Sources: Raw fish and shellfish, especially raw oysters.

Illness

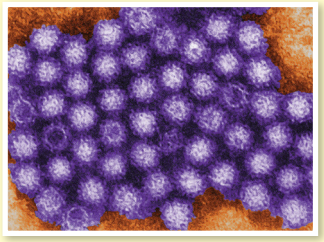
Incubation: 1 to 7 days after ingestion or exposure to organism.

Symptoms: Diarrhea, abdominal pain, nausea, vomiting, fever, and sudden chills. Some victims develop sores on their legs that resemble blisters.

Duration: 2 to 8 days.

Virus

A non-cellular particle that consists minimally of protein or nucleic acid (DNA or RNA). In order to survive, it must replicate inside another cell, such as a bacterium or a plant and animal cell. (Also see Noroviruses.*)*



The Norwalk Virus is a potent norovirus that is a public health threat.

Food Safety Implication: Food serves as a transportation device to get viruses from one host to another. Once the contaminated food is eaten, a virus can multiply in living cells and cause foodborne illness in humans. Food can become contaminated with viruses in a number of ways, such as:

- A Food Handler — who picks, processes, prepares, or serves food and is shedding (excreting the virus in their stool). If the person practices poor hygiene, he or she may transfer the virus to food.
- Contaminated Water — used to irrigate or wash foods.

Virus (cont'd)

- Seafood — grown or collected from contaminated water and in which viruses have colonized. Foods such as oysters, which pump a lot of water each day through their bodies and filter out microorganisms, are very likely to collect viruses from the water.
- Cross-Contamination — of safe food by contaminated food (or liquids dripping from such foods). For example, raw seafood juices that come in contact with fresh fruits or vegetables. Sometimes, this phenomenon makes it more difficult to pinpoint the actual food involved in a foodborne outbreak.

How It Causes Disease: Viruses cause disease in humans by tricking healthy cells into duplicating the virus's nucleic acid instead of its own, which lets the virus multiply. Once the virus is duplicated, the healthy cell usually dies.

Some Examples of Foodborne Viruses:

- Noroviruses
- Hepatitis A
- Rotavirus (mainly affects young children)

Some Examples of Human Viruses:

- Influenza (causes the flu)
- HIV (causes AIDS)
- Polio (causes poliomyelitis)
- Rhinovirus (causes colds)
- Rubella (causes German measles)

What's the difference between viruses and bacteria?

The differences between viruses and bacteria are numerous. Viruses are the smallest and simplest life form known. They are 10 to 100 times smaller than bacteria. The biggest difference between viruses and bacteria is that viruses must have a living host — like a plant or animal — to multiply, while most bacteria can grow on non-living surfaces.

Also, unlike bacteria, which attack the body like soldiers mounting a pitched battle, viruses are guerilla fighters. They don't attack so much as infiltrate. They literally invade human cells and turn the cell's genetic material from its normal function to producing the virus itself.

In addition, bacteria carry all the machinery needed for their growth and multiplication, while viruses carry mainly information — for example, DNA or RNA, packaged in a protein and/or membranous coat. Viruses harness the host cell's machinery to reproduce. In a sense, viruses are not truly "living," but are essentially information (DNA or RNA) that float around until they encounter a suitable living host.

Why are shellfish and salads especially "friendly" to viruses?

Shellfish are especially "friendly" to viruses because shellfish pump water through their bodies, and thus concentrate food and contaminants, such as viruses, from the water. Once the virus is on or in the shellfish — a live host — it may persist for a longer time than if it were suspended in the water. Some shellfish are eaten raw or lightly cooked, which increases the risk of foodborne illness.

Produce used for salads, lettuce, spinach, etc., grow low to the ground where they are more likely to come in contact with contaminated organic fertilizers, such as manure. Also, sometimes produce is irrigated with contaminated waters or picked by farm workers with poor hygiene practices. The complex, multi-layered surfaces of salad produce are more difficult to clean after picking than, for example, the surface of an apple or potato. Finally, because salads are usually eaten raw, there is no heating step that would inactivate the viruses.

W

Water Activity (a_w)

The amount of water that's available to support bacterial growth in different foods.

Food Safety Implication: Bacteria require a certain amount of "free" water in order to grow. The more available water, the faster the bacteria will grow. Bacteria, yeast, and mold multiply rapidly at a high water activity — above 0.86. Meat, produce, and soft cheeses have water activity between 0.86 and 1.0, and thus support rapid bacterial growth.

How It Works: Water activity is measured on a scale of 0 to 1.0 and is derived from a measurement of the amount of moisture in a food product and the amount of solutes (a dissolved substance). The greater the solutes in a specific amount of moisture, the lower the water activity.

Water activity is lowered by the addition of solutes, such as salt or sugar. These food constituents bind water molecules together, making it unavailable for use by microorganisms. Preservation methods that use large amounts of salts or sugars work by reducing the water activity.

Water Quality

The nature or state of water for consumption or use on foods along the farm-to-table continuum.

Food Safety Implication: Along the farm-to-table continuum, water quality dictates the potential for pathogen contamination. For example, at the farm, growers use good agricultural practices (GAPs) to minimize the risk of contaminated water being used on the produce. At processing facilities, good manufacturing practices (GMPs) are followed to minimize microbial contamination from water used during processing. (Also see *Good Agricultural Practices* and *Good Manufacturing Practices*.)

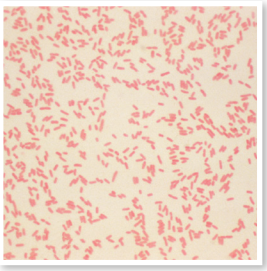
X, Y

Xerophilic

The ability of an organism to survive under dry conditions.

Yersinia enterocolitica

This pathogen causes yersiniosis, a disease characterized by diarrhea and/or vomiting.



Yersinia enterocolitica

Sources: Raw meat and seafood, dairy products, produce, and untreated water.

Illness

Incubation: 1 to 2 days after eating contaminated food.

Symptoms: Fever, diarrhea, vomiting, and abdominal pain, which may be particularly severe for children.

Duration: 1 to 3 weeks, with chronic cases lasting longer.

Zoonoses (plural) or Zoonosis (singular)

Infections in animals that can be transmitted to humans.

Food Safety Implication: Animal diseases remain a concern principally because of the economic losses they cause and the possible transmission of disease-causing organisms to humans. The Food and Drug Administration's Center for Veterinary Medicine regulates the feed that animals eat to ensure that it does not harbor zoonotic pathogens that can be transmitted to people. (Also see *Center for Veterinary Medicine*.)

How Animal Diseases Can Be Transferred to Humans:

- **Human Consumption of Raw or Undercooked Meat, Poultry, or Seafood** — For example, if meat contains a harmful pathogen, and it is not thoroughly cooked to kill the pathogen, foodborne illness/disease may result once the food is eaten.
- **Humans Being Bitten or Stung by an Insect or Animal** — For example, dog bites may seriously injure tissues and can also transmit bacterial infections and rabies, a disease of viral origin. The bite of a diseased rat may transmit any of several diseases to man, including plague, salmonellosis, leptospirosis, and rat-bite fevers; the bites of venomous snakes and fish can lead to human discomfort and death.
- **Human Contact with the Flesh of an Animal** — The flesh of various types of fish is toxic to man. For example, Japanese puffers contain the poisonous chemical compound tetrodotoxin; scombroid fish harbor Proteus morganii, which causes gastrointestinal diseases; and mullet and surmullet can cause nervous disturbances.

Some Examples of Zoonotic Diseases:

- **Anthrax** — from ruminants, horses, and swine.
- **Brucellosis** — from domestic livestock.
- **Psittacosis** — from birds of the parrot family.
- **Rabies** — from small mammals, such as dogs, foxes, bats, and rodents.
- **Tularemia** — from rabbits and wild rodents.

DID YOU KNOW?

About three-fourths of the important known **zoonoses** are associated with domesticated animals, including pets.

FOOD SAFETY FOR YOU!

Here's your chance to become food safety savvy! Delve into these in-depth sections. Begin by exploring the Farm-to-Table Continuum.

Everyone Plays a Role in Reducing Foodborne Bacteria!

The Farm-to-Table Initiative involves identifying possible contamination points along the farm-to-table continuum and implementing controls for preventing problems that might affect our nation's food supply. Use the illustration on the next page to explore the steps food travels from the farm to the table. Refer to the *Dr. X and the Quest for Food Safety* video and the *Food Safety A to Z* section (pages 4-49) to learn more about the key concepts highlighted in blue at each step.

Everyone Plays a Role in Reducing Foodborne Bacteria!

FARM

Use **Good Agricultural Practices**

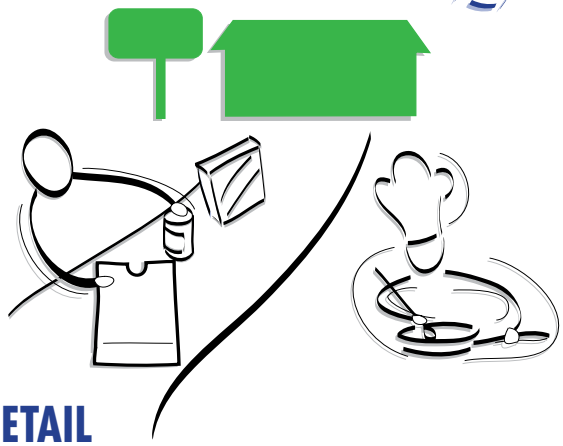
TABLE

Always Follow the **4 Cs of Food Safety**

- Clean
- Cook
- Combat Cross-Contamination
- Chill

PROCESSING

Monitor at **Critical Control Points**



RETAIL

Follow the **Food Code** Guidelines

TRANSPORTATION

Use Clean Vehicles and Maintain the **Cold Chain**

FOOD SAFETY FROM FARM TO TABLE

www.fda.gov/food

www.nsta.org

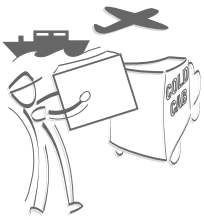
THE "411" ON THE 4 Cs!

Clean, Cook, Combat Cross-Contamination, and Chill

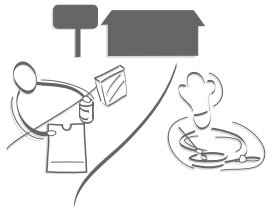
Food Safety Concerns *You*!

Everyone shops for, prepares, and eats food. That's why it's so important to follow the basics of food safety. Harmful bacteria that may be present in food can cause foodborne illness when the food is eaten.

All along the food chain, food safety experts are working to keep our food safe on the farm ... through the processing plant ... during transportation ... and at the supermarket and restaurant (see the Farm-to-Table illustration on the previous page). Once you take food home from the supermarket and restaurant, you also have an important role to play.

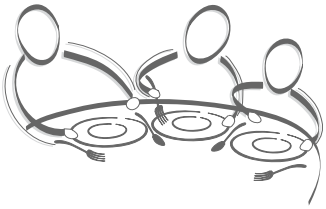


Foodborne illness can affect anyone at any time, but certain people are more likely to get sick from foodborne bacteria. And once they're sick, they face the risk of serious health problems, even death. Such at-risk people include: pregnant women, young children, people with chronic illnesses and weakened immune systems, and older adults. Also, underlying illnesses such as diabetes, some cancer treatments, and kidney disease may increase a person's risk of foodborne illness.



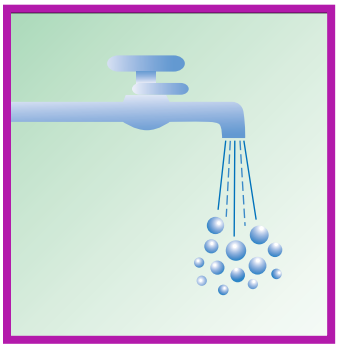
To fight bacteria that cause foodborne illness, just follow these 4 Fight BAC!™ Steps to Food Safety (also known as the 4 Cs of Food Safety):

- Clean
- Separate (Combat Cross-Contamination)
- Cook
- Chill



Also, encourage your family and friends to be "BAC fighters" too!

Welcome to the wonderful world of the 4 Cs.



CLEAN

Wash hands and surfaces often

You can't see, taste, or smell them. They're sneaky little critters, and they can spread throughout the kitchen and get onto cutting boards, utensils, sponges, countertops, and food. They're foodborne bacteria and if eaten, they can cause foodborne illness.

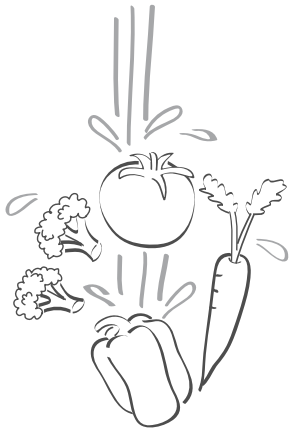
Use these TIPS to keep your hands, surfaces, and utensils squeaky clean!

Wash Up!

- Make sure there's handwashing soap and paper towels or a clean cloth at every sink in your home.
- Wash your hands with hot, soapy water (for at least 20 seconds) before and after handling food and after using the bathroom, changing diapers, or handling pets. Thoroughly scrub hands, wrists, fingernails, and in between fingers. Rinse and dry hands with paper towels or a clean cloth.

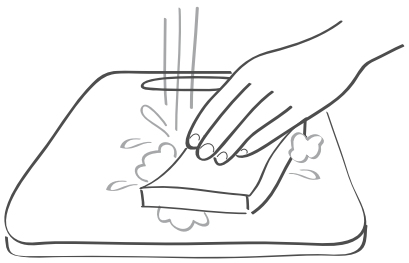
Fruits & Veggies

- Rinse raw produce under running water. Don't use soap, detergents, or bleach solutions. For thick or rough-skinned vegetables and fruits, use a small vegetable brush to remove surface dirt. Try to cut away any damaged or bruised areas on produce. Bacteria can thrive in these places.

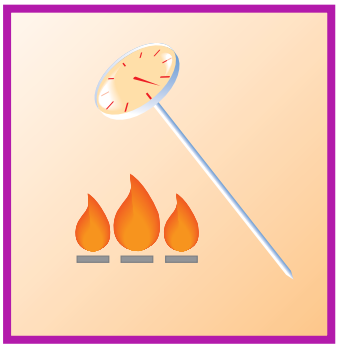


Surface Cleaning

- Consider using paper towels to clean up kitchen surfaces and throw the germs away with the towels. If you use cloth towels, launder them often, using hot water. Note: Don't dry your hands with a towel that was previously used to clean up raw meat, poultry, or seafood juices.
- Wash your cutting boards, dishes, utensils, and countertops with hot, soapy water after preparing each food item and before you go on to the next food. Periodically, kitchen sanitizers can be used for added protection against bacteria. You can also use one teaspoon of liquid chlorine bleach per quart of clean water to sanitize surfaces. The bleach solution needs to sit on the surface to be sanitized for about 10 minutes to be effective.
- Replace excessively worn cutting boards (including plastic, non-porous acrylic, and wooden boards). Bacteria can grow in the hard-to-clean grooves and cracks.
- In your refrigerator, wipe up spills immediately, clean refrigerator surfaces with hot, soapy water, and, once a week, throw out perishable foods that should no longer be eaten.
- Keep pets off kitchen counters and away from food.



20% of consumers don't wash hands and kitchen surfaces before preparing food. Clean hands and surfaces is your first step in safe food handling.



COOK

Cook to Proper Temperatures

Cooking food safely is a matter of degrees! Food safety experts agree that foods are properly cooked when they're heated for a long enough time and at a high enough temperature to kill harmful bacteria that cause foodborne illness. This temperature can vary from food to food, too.

The best way to keep your food safe is to use these "hot" food safety TIPS.

Cook It Right . . .

Color is not a sure indicator of whether food is safe to eat. The only way to know that meat, poultry, casseroles, and other foods are properly cooked all the way through is to use a clean food thermometer.

Ground Beef

Oftentimes, when meat is "ground up" to make hamburger, bacteria that may have been present on the surface of the meat can end up inside the burger. When this happens, bacteria are less likely to be killed by cooking if the proper temperature is not achieved.

Cook ground beef to at least 160° F (71° C). Use a food thermometer to check. The Centers for Disease Control and Prevention link eating undercooked, pink ground beef with a higher risk of illness. If a thermometer is not available, do not eat ground beef that is still pink inside.

Meat and Poultry

Cook roasts and steaks to an internal temperature of at least 145° F (63° C), with a 3 minute rest time. Poultry should be cooked to a minimum internal temperature of 165° F (74° C). Consumers may wish to cook poultry to a higher temperature for personal preference.

Eggs

Cook eggs until the yolks and whites are firm. Don't use recipes in which eggs remain raw or partially cooked, unless you use pasteurized eggs.

Seafood

Cook fish until it's opaque and flakes easily with a fork.

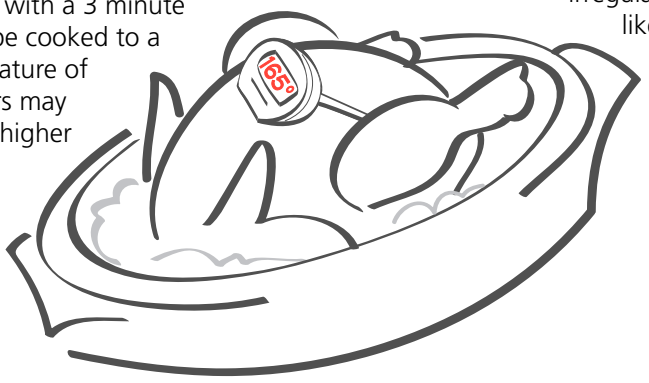
Leftovers

Leftovers should be reheated to 165° F (74° C). Bring sauces, soups, and gravies to a boil.

Microwave Musts

We all enjoy the benefits of using the microwave for cooking and reheating foods in minutes, even seconds. However, microwaves often cook food unevenly, thus creating hot and cold spots in the food.

Bacteria can survive in the cold spots. This uneven cooking occurs because the microwaves bounce around the oven irregularly. Microwaves also heat food elements like fats, sugars, and liquids more quickly than carbohydrates and proteins. Extra care must be taken to even out the cooking so that harmful bacteria is destroyed.



DID YOU KNOW?

In 1945, **Dr. Percy Spencer**, a grade school-educated engineer, thought up the idea for the **microwave** when he found that magnetron waves from one of his radar experiments melted a chocolate bar in his pocket.

Dr. Percy Spencer (1894 – 1970)

In terms of saving cooking time, the development of the microwave oven has been a tremendous asset for American households. Today, an estimated 95% of households in the United States have microwave ovens.

Should I wash raw meat, poultry, or seafood before cooking it?

Washing raw poultry, beef, pork, lamb, veal, or seafood before cooking is not recommended. Although washing these raw food items may get rid of some of the pathogens, it also allows the pathogens to spread around the kitchen. Cooking these foods to a safe internal temperature destroys any bacteria that may be present. Also, don't forget to wash your hands with hot, soapy water before, in between, and after preparing these foods. (See the "Apply the Heat" chart on page 58 for recommended cooking temperatures.)

How do microwaves work?

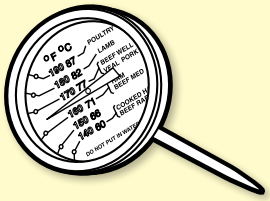
Microwaves are very-high-frequency radio waves that swing back and forth at a frequency of about 2 billion cycles per second. During this process, they make certain molecules move, and once they're moving, they're hot. Microwaves enter food from the outside, and penetrate instantly into a chunk of food, heating and cooking as they go.

When cooking or reheating foods in the microwave, keep these TIPS in mind:

- Cover food with plastic wrap or a glass covering and add a little liquid to food. This creates steam, which readily kills pathogens.
- To ensure uniform heating, turn the dish several times during cooking. Stir soups and stews periodically during reheating to ensure even heating.
- When done cooking, make sure the food is hot and steaming. Use a food thermometer and test the food in 2 or 3 different areas to verify that it has reached a safe internal temperature (see the "Apply the Heat" chart on page 58 for the recommended cooking temperatures).
- When defrosting food in the microwave, cook the food immediately. When you thaw food in the microwave, some areas of the food may become warm and begin to cook during the defrosting process. The internal temperature of the food probably hasn't reached the temperature needed to destroy bacteria and, indeed, may have reached optimal temperatures for bacteria to grow. So don't let the food sit in the danger zone!

IT'S A MATTER OF DEGREES!

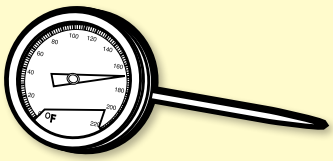
Use a food thermometer to make sure foods have been properly cooked to a safe internal temperature. An added plus — taking the temperature assures that you won't overcook your food! Here are several types of thermometers that are available.



Dial Oven-Safe

This type of thermometer is inserted into the food at the beginning of the cooking time and remains in the food throughout the cooking.

By checking the thermometer as the food cooks, you will know exactly when the meat is properly cooked. This oven-safe thermometer is used for thick cuts of meat, such as roasts or turkeys. It's not appropriate for thin foods, like boneless chicken breast, because the temperature-sensing coil on the stem is between 2 and 2½ inches long and the stem is relatively thick.



Dial Instant-Read

This thermometer is used to periodically check the temperature. It's not designed to stay in the food during cooking.

When you think food is cooked to the correct temperature, check it with the instant-read thermometer. Insert the thermometer into the thickest part of the food, to the point marked on the probe — usually to a depth of 2 inches. About 15 to 20 seconds are required for the temperature to be accurately displayed.

An instant-read thermometer can be used with thin foods, such as chicken breasts or thin hamburger patties — simply insert the probe sideways, making sure the tip of the probe reaches the center of the meat.

Digital Instant-Read

This thermometer is used to periodically check the temperature. It does not stay in the food during cooking. Check the temperature when you think the food is cooked.

The advantage of the digital thermometer is that the heat-sensing device is in the tip of the probe. Place the tip of the probe in the center of the thickest part of the food at least ½ inch deep. About 10 seconds are all that's required for the temperature to be accurately displayed.

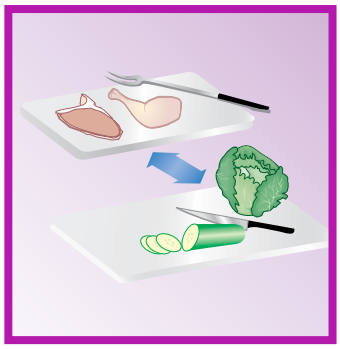
The Digital Instant-Read thermometer is good to use for checking the temperature of a thick food like turkey or a thick hamburger patty. Insert the probe from the top or sideways to a depth of ½ inch.

Pop-up Timers

These are reliable within 1 to 2 degrees, but it's best to check using a food thermometer.

1 out of every 4 hamburgers turns brown before it's been cooked to a safe internal temperature.

Color is not a sure indicator of whether food is safe to eat. Always use a food thermometer.



COMBAT CROSS-CONTAMINATION

Separate, Don't Cross-Contaminate

Did you know that improper handling of raw meat, poultry, and seafood can set the stage for cross-contamination? As a result, bacteria can spread to food and throughout the kitchen.

Here's how to prevent harmful bacteria from S - P - R - E - A - D - I - N - G !

Safely Separate

- Separate raw meat, poultry, and seafood from other foods in your grocery store shopping cart and in your refrigerator.

Take Two

- If possible, use one cutting board for raw meat products and another one for fresh fruits and vegetables.

Lather Up

- Always wash hands, cutting boards, dishes, and utensils with hot, soapy water after they come in contact with raw meat, poultry, seafood, eggs, and unwashed fresh produce.

Clean Your Plate

- Place cooked food on a clean plate. If you put cooked food on an unwashed plate that previously held raw meat, poultry, or seafood, bacteria from the raw food could contaminate the cooked food.

Seal It

- To prevent juices from raw meat, poultry, or seafood from dripping onto other foods in your refrigerator, place these raw foods in sealed containers or plastic bags.

Marinating Mandate

- Don't use sauce that was used to marinate raw meat, poultry, or seafood on cooked foods, unless it is boiled before applying. Never taste marinade or sauce that was used to marinate raw meat, poultry, or seafood.

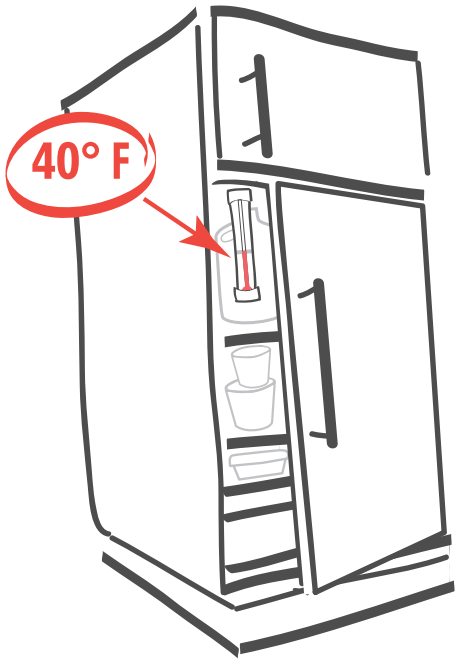
CHILL

Refrigerate Promptly

Keep perishables in the refrigerator! At room temperature, pathogenic bacteria in food can double in number every 30 to 40 minutes. The more bacteria there are, the greater the chance you could become sick.

Follow these COOL rules:

- Refrigerate food quickly because cold temperatures keep most harmful bacteria from multiplying. A lot of people think it will harm their refrigerator to put hot food inside, but it's not true. Hot food won't harm your refrigerator. More important, prompt refrigeration of foods will keep your food and you safer (See the "Refrigerator and Freezer Storage Chart" on page 70 for recommended storage times).
- Set your home refrigerator no higher than 40° F (4° C) and the freezer unit at 0° F (-18° C). Check the temperature occasionally with an appliance thermometer.
- Refrigerate or freeze perishables, prepared food, and leftovers within 2 hours.
- Divide large amounts of leftovers into shallow containers for quick cooling in the refrigerator.
- Marinate foods in the refrigerator.
- Don't pack the refrigerator too full. Cold air must circulate to keep food safe.
- At family outings or barbecues, use a cooler to keep perishable foods cold. Always use ice or cold packs and fill your cooler with food. A full cooler will maintain its cold temperatures longer than one that is partially filled.



For safe thawing, follow the THAW LAW:

- Never thaw foods at room temperature. You can safely thaw food in the refrigerator. 4 to 5 pounds of frozen food takes about 24 hours to thaw.
- You can also thaw food outside the refrigerator by immersing it in cold water. Change the water every half hour to keep the water cold.
- You can thaw food in the microwave, but if you do, be sure to cook the food immediately after it's thawed.

! 23% of consumers' refrigerators are not cold enough! To discourage the growth of foodborne bacteria, your refrigerator should be set at 40° F (4° C).

?

How does marinating tenderize meat?

The marinade's acid chemically softens the connective tissue in meats. To be effective, sufficient marinating time is necessary. Most dishes require an hour to overnight, depending on the food. Always remember to marinate foods in the refrigerator.

Why is it unsafe to marinate foods at room temperature? Doesn't the acid in the marinade kill any bacteria that might be present?

Bacteria grow rapidly at room temperature, so for food safety purposes, food should always be refrigerated while marinating. (Refrigeration slows bacterial growth.) Marinade that has been used on raw meat, poultry, and seafood contains raw juices. These juices may contain bacteria that, if eaten, could make you sick. The acid in marinade doesn't kill bacteria, it merely slows or stops bacterial growth.

EXTRA! EXTRA!

Your Year-Round Food Safety Guide

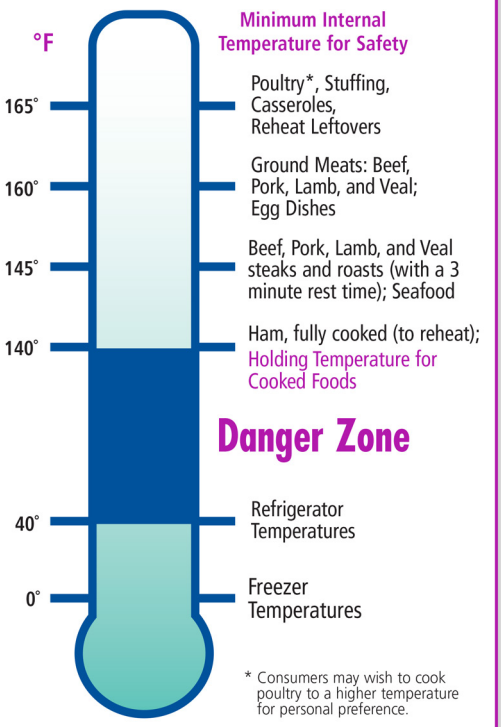
Check out these food safety tips for work, play, and home — and remember to spread the word, not the bacteria!

Don't Go There! Inside the DANGER ZONE

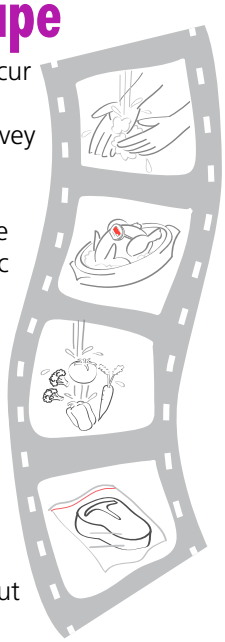
It's important to keep food below or above the danger zone, the temperatures at which bacteria can grow. This is usually between 40° and 140° F (4° and 60° C). Some pathogenic bacteria can grow at 32° F (0° C), the temperature at which water freezes. So remember the 2-Hour Rule: Discard any perishable foods left out at room temperature for longer than 2 hours. When temperatures are above 90° F (32° C), discard food after 1 hour!

The temperatures shown in the chart below are recommended for consumer cooking. They are not intended for processing, institutional, or foodservice preparation.

Apply the Heat Chart



Food Safety Bloopers Caught on Tape



Many foodborne illnesses probably occur at home. To test this theory, the Food and Drug Administration funded a survey in which scientists videotaped families preparing food in their kitchens. The 100 families initially thought they were being taped on how to make a specific recipe, and they also thought their kitchens were relatively "foodsafe." What scientists discovered suggests why foodborne illness hits home for so many Americans.

Here are some eye-opening mistakes that were caught on tape:

- One woman handled raw chicken and then fixed a baby's bottle without washing her hands.
- Dozens of people dried their hands with the same dish towel they used to clean up raw meat juices.
- One person dropped a baby's bottle in raw eggs and neglected to use soap when he/she rinsed the bottle off.
- Only 45% of the people washed their hands before working in the kitchen and 16% of those who washed didn't use soap.
- 30% did not wash the lettuce they used, and some placed salad ingredients in raw-meat-contaminated containers.
- 25% of the people didn't know how to tell if chicken was cooked to a safe internal temperature, so they undercooked it.

Don't Get Caught!

If your food preparation and handling practices were "captured on tape," how well would *you* do?

Putting the 2-Hour Rule into Action

HOT FOODS: When you purchase hot cooked food, keep it hot. Eat and enjoy your food within 2 hours to prevent harmful bacteria from multiplying. If you're not eating a food within 2 hours — and you want to keep it hot — keep the food in the oven with the temperature set at or above 140° F (60° C). Use a food thermometer to check the temperature. Side dishes, like stuffing, must also stay hot in the oven. Covering food will help keep it moist.

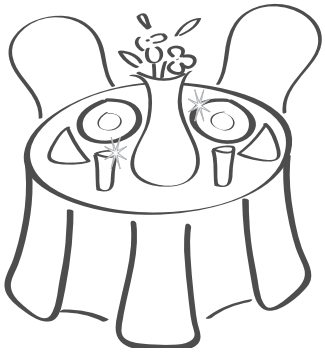
COLD FOODS should be eaten within 2 hours of preparation, or refrigerated or frozen for eating at another time.

Safe Eats

Eating Out/Bringing In

We all eat out and bring in food. In the past, most food was prepared in the home — but today, fifty cents of every food dollar is spent on food prepared outside the home. This includes ready-to-eat foods from restaurants and supermarkets. Here's the way to make these meals even more enjoyable.

Eating Out



Eating in a restaurant, cafeteria, or a fast-food place is usually a safe and enjoyable experience. All foodservice establishments are required to follow food safety guidelines set by state and local health departments. But you should also take actions to ensure that your food is safe. Keep these rules in mind: **Clean, Cook,** and **Chill**.

Clean: When you eat out, look at your physical surroundings before you even sit down. If they're not up to your cleanliness standards, you might want to eat somewhere else.

Cook: No matter where you eat, always order your food cooked thoroughly, especially meat, poultry, fish, and eggs. When you're served a hot meal, make sure it's served to you piping hot and thoroughly cooked, and if not, send it back.

Don't eat undercooked or raw foods, such as raw oysters. People with liver disorders or weakened immune systems are especially at risk for getting sick. Also, avoid eating raw or undercooked eggs. They can be a hidden hazard in foods like Caesar salad, custards, and some sauces. If these foods are made with pasteurized eggs, however, they are safe. If you are unsure about the ingredients in a particular dish, ask before ordering it.

Chill: Salad bars in restaurants and other retail establishments must keep perishable salad bar items at 41° F or below.

Bringing In

It seems like meal portions are getting bigger and bigger, and many people are packing up leftovers to eat later. Care must be taken when handling these leftovers.

The Doggie Bag: If you will not be arriving home within 2 hours of being served, it is safer to leave the leftovers at the restaurant.

Get Food Home Fast: Remember that the inside of a car can get very warm and bacteria can grow rapidly. For safety's sake, it's best to go directly home after eating out and put your leftovers in the refrigerator.

- Nearly 40% of people ages 15-24 eat their main evening meal out 3 or more times per week.
- 76% of consumers now eat their main meals away from home at least once per week. Young shoppers, singles, and men are among those who eat out most often.
- 14% of shoppers opt for takeout or home delivery pretty much every time or fairly often.

Let's Do Lunch!

We're on the go and often carry our lunches to work or school — or pack lunches for others.

Use these TIPS to pack a safe lunch!

- **Keep them clean!** Make sure your hands, food preparation surfaces, utensils, and lunch boxes are clean. Use hot, soapy water to effectively get rid of bacteria. Also, remember to thoroughly rinse fresh fruits and vegetables under running water before packing them.
- If you're making sandwiches the night before, **keep the sandwiches in the refrigerator** and pack them to go in the morning.
- **Keep hot foods hot.** Use an insulated thermos for soup, chili, or stew. First, fill the thermos with boiling water and let it stand for a few minutes. Then empty the thermos, and fill it with piping hot food. Keep the lid tightly closed until lunchtime.

- When packing lunch boxes, **take cold foods right from the refrigerator and freezer and pack them in a box.** Include a cold pack.
- **Freeze single-sized juice packs overnight** and place the frozen drink in with your lunch. The juice will thaw by lunchtime, but it will still be cold. The frozen drink will also keep the rest of the lunch cold.
- **Don't let food sit in warm temperatures for very long.** Eat it or put it right back in your lunch box with a frozen cold pack. Any perishable food (e.g., meat, poultry, or egg sandwiches) that were not eaten at lunch should be discarded if proper storage is not available.

Keeping Baby Safe

If you're a parent, sibling, or babysitter, it's important to practice food safety. Infants and young children are especially vulnerable to foodborne illness because their immune systems are not fully developed. Also, their stomachs produce less acid, which makes it easier for harmful microorganisms to get through their digestive systems and invade their bodies.

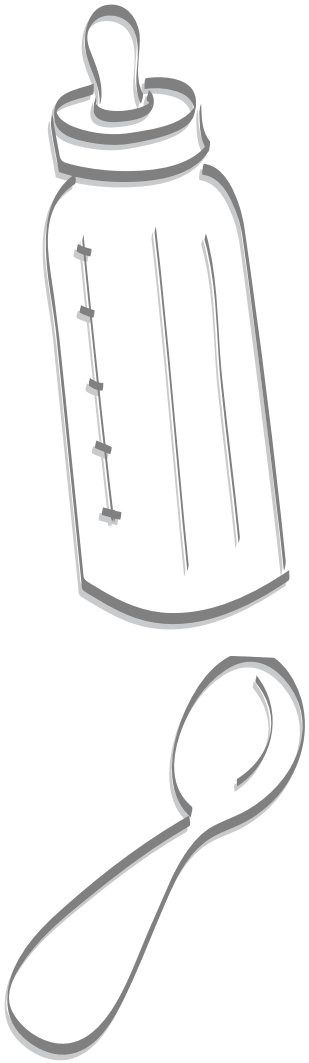
Here are some important food safety TIPS when taking care of young children:

Wash Up

- Wash your hands with hot, soapy water after changing a diaper or after any activity in which your hands could have picked up germs. You don't want to transmit those germs to an infant or a child. Frequently wash children's hands with warm (not hot) soapy water.
- Wash eating areas with hot, soapy water.
- Use detergent and hot water to wash and rinse all utensils (including the can opener) that come in contact with a baby's foods.
- Clean bottles after every use. Harmful bacteria can infect an infant during the next feeding if the bottle is not washed properly.
- You can reuse the nipples of disposable bottles, but be aware that bacteria from the formula could be lurking and growing in the nipples. Thoroughly clean the nipples after each use.

Feeling Under the Weather?

If you're sick, pass up babysitting for a young child until you're feeling better, so you don't expose the child to illness. In addition, don't be involved in any food preparation that may expose the child to harmful bacteria.



Baby's Food

- Fill a bottle with just enough milk for one serving. Harmful bacteria from a baby's mouth can be introduced into food or bottles where it can grow and multiply even after refrigerating and reheating. So, if the baby doesn't finish the bottle, throw away any leftovers.
- Milk, formula, or food left out at room temperature or without a cold pack for more than 2 hours should not be used.
- Follow the manufacturer's recommendations for preparing bottles before filling them with formula or milk. Observe the "Use By" dates on formula cans.
- Do not feed a baby directly from a jar of baby food and put it back in the refrigerator again. Saliva on the spoon or in the jar can contaminate the remaining food. Instead, put just enough food on a dish for one serving using a clean spoon before feeding the baby.
- If using commercial baby foods, check each new jar to see if the safety button on the lid is down. If the jar lid doesn't "pop" when opened, do not use. Discard jars with chipped glass or rusty lids.
- Do not feed a baby honey or syrup — at least for the first 12 months. Honey and syrups can contain spores of *Clostridium botulinum*. The immune systems of adults and older children can prevent the spores from growing once ingested. However, in an infant, these spores can grow and cause infant botulism.

DID YOU KNOW?

If you don't wash your hands, your actions could result in infant diarrhea! Your hands can pick up bacteria from the following things and spread bacteria to the baby:

- diapers;
- raw meat, poultry, eggs, and seafood;
- animals — such as dogs, cats, turtles, snakes, and birds;
- soil.

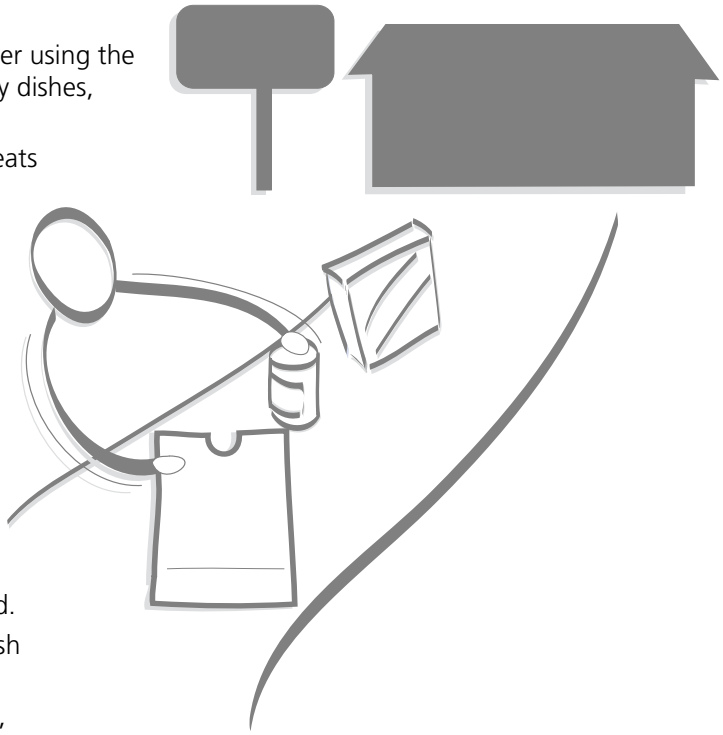
Know The Code

The Food Code

Foodservice employees must take extra care when working with food because harmful bacteria can spread to food and make people sick when the food is eaten. Remember: One person working in a foodservice establishment can infect multiple people if he or she doesn't follow safe food-handling practices, especially proper handwashing. Everyone plays a role in keeping our food safe.

Here are TIPS from the FDA's Food Code for people working in foodservice and food stores:

- Don't go to work if you're not feeling well. Sick food workers can transmit diseases to food — and other people. Those experiencing diarrhea, vomiting, jaundice, or sore throat with fever should be kept away from food preparation and clean items that touch food.
- Wash your hands frequently — when entering the kitchen, after using the toilet, after handling raw meat and poultry, after handling dirty dishes, before putting on gloves, after handling anything dirty, etc.
- Know the correct cooking temperatures for foodservice for meats and poultry (145° F for beef, pork, fish and single order eggs; 155° F for ground meats; and 165° F for poultry and stuffed foods) and the correct temperature for refrigerated foods (41° F or less). Use a calibrated thermometer to check temperatures.
- Prepare food with clean equipment, dishes, and utensils. Store food in clean containers and use clean utensils.
- Use deli tissue, spatulas, tongs, dispensing equipment, or single-use gloves to help keep potentially contaminated bare hands from touching ready-to-eat foods.
- Provide a proper barrier to cover any skin lesions, open wounds, boils, or infected wounds on your hands and arms.
- Don't wear artificial fingernails or jewelry when preparing food.
- Don't sneeze or cough into foods. If you sneeze or cough, wash your hands again with hot, soapy water right away.
- To prevent the growth of bacteria, clean and sanitize receiving, storage, cutting, checkout, and display areas regularly.



4 "Super" Facts

- During the 1940s, the establishment of supermarkets was on the rise across the United States.
- Consumers rank food safety as a high concern, and nearly 75% are confident that the goods in their supermarket are safe.
- A clean, neat store was one of the top 3 features that customers deemed important when choosing a primary supermarket.
- Does your supermarket use paper or plastic bags when packing groceries? On April 25, 1882, William B. Purvis, an African American inventor from Philadelphia, Pennsylvania, patented a machine that made paper bags.

What food safety precautions should I take when shopping at the supermarket?

While shopping, you should keep raw meat, poultry, seafood, and eggs separate from ready-to-eat foods in your grocery shopping cart and your grocery bags. Consider placing these raw foods inside plastic bags to keep the juices contained. Also, transport food home right away and refrigerate perishables immediately to prevent any bacteria from rapidly multiplying in the food. When the weather's hot, place the groceries in the air-conditioned compartment of your car rather than the hot trunk.

THE SAFE FOOD CHART

Eat Right and Join the Fight ... Against Foodborne Bacteria

The key to healthy eating means not only eating nutritiously, but keeping your food safe from harmful foodborne bacteria. Foodborne illness can affect us all; however, at-risk people — such as young children, pregnant women, older adults, and people with weakened immune systems — are more likely to get sick from harmful foodborne bacteria and may face serious complications.

New information on food safety is constantly emerging. Recommendations and precautions for people at high risk are updated as scientists learn more about preventing foodborne illness. People in the at-risk groups need to be aware of and follow the most current information.

Learning how to safely prepare and handle food is so important for everyone! That's where the Safe Food Chart comes in handy. Each section highlights invaluable food safety tips and precautions for various foods. Some precautions may apply to all consumers; others may apply to people in the at-risk groups.

The following 4 food categories are featured:

- Ready-to-Eat Foods (page 63)
- Meat, Poultry, and Seafood (pages 64-65)
- Dairy and Raw Egg Products (pages 66-67)
- Fruits, Vegetables, and Juices (pages 68-69)

In this section, you'll also find:

- **The "Refrigerator and Freezer Storage Chart"** (page 70)
  Offers recommended storage times for foods to keep them safe from spoilage or harmful bacteria
- **Facts and FAQs**
  Fun facts and answers to your most Frequently Asked Questions are interspersed throughout this section.

Also, don't miss:

- **The "Apply the Heat Chart"** (page 58)
  Provides the proper cooking temperatures for meat, poultry, fish, and eggs

On the next pages, check out the way to enjoy food... safely!

For more information about food safety, contact:

- The **U.S. Food and Drug Administration Food Information Line** at (888) SAFE FOOD.
- The **U.S. Department of Agriculture (USDA) Meat and Poultry Hotline** at 1-888-MPHotline or 1-888-674-6854. The TTY number is 1-800-256-7072.
- **Gateway to Government Food Safety Information** www.foodsafety.gov

The Safe Food Chart

READY TO EAT FOODS

Food Safety Implications

Some ready-to-eat foods, such as hot dogs, luncheon meats, cold cuts, fermented and dry sausage, and other deli-style meat and poultry products, can contain bacteria that can be especially harmful if they are consumed by people in the at-risk groups. It's important to reheat precooked foods because they can become contaminated with bacteria after they have been processed and packaged at the plant.

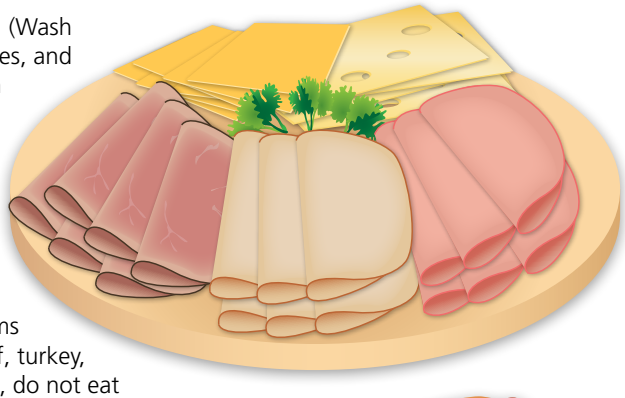
Human Pathogen Associations

- *Listeria monocytogenes* (deli meat, hot dogs, and luncheon meats)

Food Safety Precautions

All Ready-to-Eat Foods

- Wash your hands with hot, soapy water after handling ready-to-eat foods. (Wash hands for at least 20 seconds.) Also, thoroughly wash cutting boards, dishes, and utensils. Thorough washing helps eliminate any bacteria that might get on your hands or other surfaces from the food before it's been reheated.
- See the "Refrigerator and Freezer Storage Chart" on page 70 for the recommended storage times for these foods.



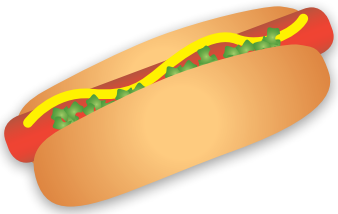
Specific Foods

Deli Meat and Poultry Products

- Pregnant women, older adults, and people with weakened immune systems should reheat deli meat and poultry products, such as hot dogs, roast beef, turkey, and chicken breasts, until they're steaming hot. If you cannot reheat them, do not eat these foods.

Hot Dogs

- Even though hot dogs are cooked when purchased, people, especially those in the at-risk groups (pregnant women, older adults, and people with weakened immune systems), should reheat hot dogs until they're steaming hot before eating them.



The average American eats approximately 60 **hot dogs** every year, and most Americans favor mustard on top, although children favor ketchup.

The Safe Food Chart

MEAT, POULTRY, AND SEAFOOD

Food Safety Implications

Foods rich in protein, such as meat, poultry, and seafood, are more frequently involved in foodborne illness outbreaks than non-protein-rich foods for 2 reasons:

1. Protein-rich foods tend to be of animal origin, and the bacteria from the animals can be found in these foods.
2. Animal foods are rich in proteins, which are an important nutrient source for some bacteria. In addition, if hands, cutting boards, dishes, utensils, and surfaces are not thoroughly and properly cleaned after coming in contact with these raw foods, the bacteria from these foods can be transferred to ready-to-eat foods.

Human Pathogen Associations

- *Campylobacter jejuni* (beef and poultry)
- *Clostridium botulinum* (seafood)
- *Clostridium perfringens* (meat)
- *Escherichia coli* O157:H7 (ground beef and pork)
- *Listeria monocytogenes* (pork, poultry, and seafood)
- Noroviruses (seafood)
- *Salmonella* (beef, pork, poultry, and seafood)
- *Staphylococcus aureus* (beef, pork, and poultry)
- *Vibrio cholera* (seafood)
- *Vibrio vulnificus* and other vibrios (seafood)
- *Yersinia enterocolitica* (meat and seafood)

If cooked meat and poultry look pink, does it mean that the food is not done?
The color of cooked meat and poultry is not a sure sign of its degree of doneness. For instance, hamburgers and fresh pork can remain pink even after cooking to temperatures of 160° F (71° C) or higher. The meat of smoked turkey is always pink because components within the smoke bind to the muscle pigment to form a stable pink pigment. Only by using a food thermometer can you accurately determine that meat has reached a safe internal temperature.

Do I have to cut off the government grade or inspection stamp on meat before cooking it?
No, the ink stamp is a harmless vegetable dye. Therefore, it is safe to eat.

What gives a slice of ham an iridescent sheen? Is this a sign of food spoilage bacteria?
The glistening, greenish, rainbowlike color that appears from a cut surface of a ham slice is a sign of oxidation and not necessarily spoilage. When the meat is exposed to oxygen or light, some of the nitrate-modified iron content of the meat undergoes a chemical change that alters the ham's pigmentation.

How can I tell if fish is fresh?
To be sure the safety of seafood is being properly preserved, only buy fish that is refrigerated or properly iced. Fish should be displayed on a thick bed of fresh ice that is not melting, and preferably in a case or under some type of cover.

- Fish should smell fresh and mild, not fishy, sour, or ammonia-like.
- A fish's eyes should be clear and bulge a little (except for a few naturally cloudy-eyed fish types, such as walleye pike).
- Whole fish and filets should have firm, shiny flesh and bright red gills free from slime. Dull flesh could mean the fish is old. Note: Fish fillets that have been previously frozen may have lost some of their shine, but they are fine to eat.
- The flesh should spring back when pressed.
- Fish fillets should display no darkening or drying around the edges. They should have no green or yellowish discoloration, and should not appear dry or mushy in any areas.

Is it safe to eat Japanese foods like sushi and sashimi?
It depends. People in the at-risk groups should not eat raw or partially cooked fish or shellfish. Sashimi is a Japanese specialty that always has raw fish, but not all sushi contains raw seafood. Some sushi is completely vegetarian. The two main safety concerns for people who eat raw or uncooked seafood are parasites and harmful microorganisms. Parasites in some undercooked fish species can harm both healthy and at-risk people. Commercially prepared raw fish species that can harbor parasites may have been previously frozen to kill any parasites, but not all such fish may have been treated. However, freezing does not kill all harmful microorganisms. It is always best to cook seafood thoroughly to minimize the risk of foodborne illness. (For more information on raw fish consumption, see page 65 of this Guide.)

DID YOU KNOW?

- The **hamburger** got its name when German immigrants from Hamburg, Germany, brought this popular patty to the United States in the 1850s. In the United States, the meat was placed inside a bun, and the hamburger was born!
- **Clams, mussels,** and other **mollusks** obtain their food by filtering large quantities of water. In doing so, they can concentrate more bacteria and viruses than finfish. This makes raw mollusks unsafe to eat for people in at-risk groups.

Food Safety Precautions

All Meat, Poultry, and Seafood

- Always wash hands, cutting boards, dishes, and utensils with hot, soapy water before and after they come in contact with raw meat, poultry, or seafood.
- Separate raw meat, poultry, and seafood from other foods in your grocery-shopping cart, refrigerator, and while preparing and handling foods at home.
- If possible, use one cutting board for raw meat products and another one for fresh fruits and vegetables.
- Place cooked food on a clean plate. If you put cooked food on an unwashed plate that previously held raw meat, poultry, or seafood, bacteria from the raw food could contaminate the cooked food.
- Don't use sauce that was used to marinate raw meat, poultry, or seafood on cooked foods, *unless* it is boiled before applying.
- Cook raw meat, poultry, and seafood to safe internal temperatures. Use a clean food thermometer to check, and wash it with hot, soapy water between uses. For the recommended cooking temperatures, see the "Apply the Heat Chart" on page 58.

Specific Foods

Ground Meat

Meat can have harmful bacteria on the surface from the slaughter process, equipment from the processing plant, or germs on hands, utensils, or kitchen surfaces. When meat is "ground up" at the supermarket and handled at home, this surface bacteria can end up *inside* the meat. This is what makes ground beef, for example, particularly at risk for *E. coli* O157:H7 contamination.

Proper cooking will kill harmful bacteria on the surface of a solid cut of meat, such as steak, because the surface gets direct heat. However, harmful bacteria on the inside of the meat are less likely to be killed by cooking if proper internal temperatures are not achieved.

That's why it's important to be especially careful that the internal temperature of ground meat reaches a high enough degree to kill bacteria. To destroy harmful bacteria that may be present in ground meat:

- All consumers should cook ground meat to at least 160° F (71° C). Use an accurate, instant-read food thermometer to check. Make sure the food thermometer goes straight into the meat, but does not come out the other side and touch the pan.
- The Centers for Disease Control and Prevention link eating undercooked, pink ground beef with a higher risk of illness. If a thermometer is not available, do not eat ground beef that is still pink inside.

Poultry

Bacteria can be found on raw or undercooked chicken. To keep poultry safe:

- Cook poultry to a minimum internal temperature of 165° F (74° C). Consumers may wish to cook poultry to a higher temperature for personal preference.
- Avoid purchasing whole poultry that's pre-stuffed but not cooked. If the product is left out at room temperature, the warm environment, along with the raw meat juices mixing with the stuffing, present a perfect environment for bacterial growth.

Pork

Consumers may contract trichinosis (a disease caused by the parasite *Trichinella spiralis*) from eating undercooked pork. Pork must be cooked to a safe internal temperature to eliminate disease-causing parasites and bacteria that may be present.

- Cook pork to a minimum internal temperature, measured with a food thermometer, of 145° F (63° C), with a 3-minute rest time.

Raw Finfish and Shellfish

(including oysters, clams, mussels, and scallops)

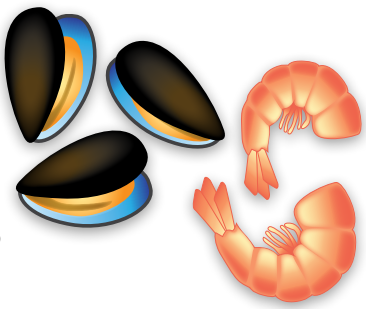
Generally, seafood is very safe to eat, but raw or undercooked seafood can be unsafe.

Seafood grown or collected from contaminated water can get colonized by viruses in the water. Shellfish foods, such as oysters, pump a lot of water through their bodies each day and filter out microorganisms. Thus, they are very likely to collect viruses from the water. Some oysters, for example, are eaten raw or lightly cooked, which increases the risk of foodborne illness. And viruses are not the only culprits. Bacteria and parasites are threats to raw seafood, as well. To keep seafood safe:

- Buy only fresh seafood that is refrigerated or properly iced.
- Cooking fish until it's opaque and flaky helps destroy any existing pathogenic bacteria that may be present.

It's always best to cook seafood thoroughly to minimize the risk of foodborne illness. However, for people who choose to eat raw fish anyway, one rule of thumb is to eat fish that has been previously frozen. Some species of fish can contain parasites, and freezing will kill any parasites that may be present. However, freezing does not kill all harmful microorganisms, so the safest route is to cook seafood.

Some people are at greater risk for foodborne illness, and should not eat raw or partially cooked fish or shellfish. These susceptible groups include: pregnant women, young children, older adults, people whose immune systems are compromised, and people who have decreased stomach acidity.



The Safe Food Chart

DAIRY AND RAW EGG PRODUCTS

Food Safety Implications

Milk and Dairy Products

Unpasteurized milk and dairy products may contain harmful pathogens and are not safe to eat, drink, or use in making foods. Today, milk and other dairy products sold in interstate commerce are pasteurized (heat-processed to kill pathogenic bacteria).

Raw Eggs

Bacteria need moisture in order to survive and reproduce. Thus, they thrive in foods with high moisture content, such as eggs or starchy, egg-rich foods.

Today, scientists know that *Salmonella* Enteritidis, a harmful bacterium, can be transmitted from infected laying hens directly to the interior of the eggs *before* the shells are formed. Even eggs with clean, uncracked shells can be infected.

The U.S. Centers for Disease Control and Prevention now estimate that 1 egg in 20,000 may be contaminated. Although the number of eggs affected is quite small, there have been cases of foodborne illness related to infected eggs.

Human Pathogen Associations

- *Campylobacter jejuni* (raw milk)
- *Escherichia coli* O157:H7 (raw milk)
- *Listeria monocytogenes* (raw milk and cheese)
- *Salmonella* (raw milk and raw and undercooked eggs)
- *Staphylococcus aureus* (dairy products)
- *Yersinia enterocolitica* (dairy products)

DID YOU KNOW?

- **Milk** has been pasteurized since the 1800s — when Louis Pasteur, a scientist, discovered that mild heating killed pathogenic bacteria.
- Many people relate food spoilage (sour milk, for example) to foodborne bacteria. Illness-causing (pathogenic) bacteria are not the same as food-spoilage bacteria. In fact, foods that look and smell fresh may contain pathogens. To keep food safe, always follow the 4 Cs of Food Safety.

- There are about 300 million people in the United States. On the average, each person consumes more than 233 pounds of **milk** and **cream** each year.
- About 283 million laying hens produce approximately 76.26 billion **eggs** per year in the United States.

Food Safety Precautions

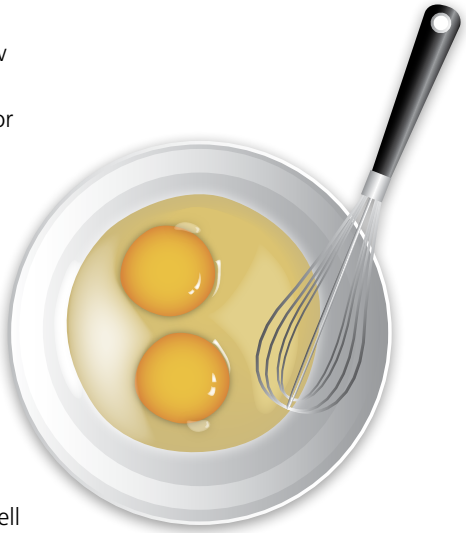
All Dairy and Raw Egg Products

Milk and Dairy Products

- Don't drink any beverages or eat any foods that contain unpasteurized milk. Read the labels to make sure the drink or food has been pasteurized.
- Pasteurization kills pathogenic bacteria found in milk, but it may not kill all the spoilage bacteria. To prevent the growth of bacteria, keep milk and milk products refrigerated.
- Milk that's processed using the Ultra High Temperature method (shelf-stable milk) can be stored at room temperature for the time period indicated on the label. After opening, the product must be refrigerated.

Raw Eggs

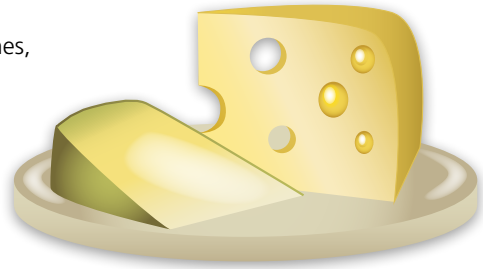
- Wash hands, utensils, food preparation areas, and equipment with hot, soapy water *before* and *after* they come in contact with raw eggs and egg-containing foods.
- To kill any bacteria that may be present, cook eggs thoroughly until the yolks and whites are firm. Cook scrambled eggs until they're firm throughout.
- When preparing cakes, pies, or homemade cookies, don't taste the batter, filling, or raw cookie dough if it contains raw, unpasteurized eggs.
- People in the at-risk groups should avoid eating or tasting foods that may contain raw or lightly-cooked eggs, such as*:
  - Batter, filling, or raw cookie dough made with raw eggs
  - Eggnog and other egg-fortified beverages that are not thoroughly cooked
  - Dressings and sauces made with raw eggs:
    - — Caesar salad dressing
    - — Béarnaise sauce
    - — Hollandaise sauce
    - — Homemade mayonnaise
  - Homemade ice cream, mousse, or meringue



Note: You can use commercially prepared forms of the foods listed above. They're often already cooked or pasteurized. You can also safely use eggs that are pasteurized in the shell or from a carton in recipes that call for raw eggs. Pasteurized eggs may be found in the refrigerator section of your local supermarket and are labeled "pasteurized."

Specific Foods

Cheese



Cheese made from pasteurized milk can become contaminated with Listeria monocytogenes, a harmful bacterium. Pregnant women, older adults, and people with weakened immune systems are advised not to eat soft cheeses, such as feta, Brie, Camembert, blue-veined, and Mexican-style cheeses, unless they are made with pasteurized milk. (It's okay for all consumers to eat hard cheeses, processed cheeses, cream cheese, and cottage cheese.)

Mold growth can affect the quality of food, and some molds can cause illness. To prevent excess moisture buildup and mold growth:

- Keep cheese and cheese dishes covered with plastic wrap.
- Refrigerate cheese — don't leave it sitting out at room temperature for more than 2 hours.

The Safe Food Chart

FRUITS, VEGETABLES, AND JUICES

Food Safety Implications

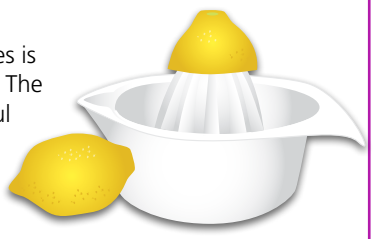
Fresh Fruits and Vegetables

Raw fruits and vegetables can become contaminated along the farm-to-table continuum. Produce used for salads — lettuce and spinach, for example — grow low to the ground, where they are likely to come in contact with contaminated fertilizers. Sometimes they're irrigated with contaminated waters or picked by farm workers with poor hygiene practices.

The complex, multi-layered surfaces of salad produce are more difficult to clean after picking than produce with a smooth suface, such as apples or potatoes. Because fresh fruits and vegetables are usually eaten raw, they can pose a health risk if they're not properly handled. Therefore, all produce needs to be thoroughly washed and safely prepared and handled before it is eaten.

Fruit and Vegetable Juices

Ninety-eight percent of the juice sold in the United States is pasteurized (heat-processed to kill pathogenic bacteria). The remaining 2% is unpasteurized and may contain harmful bacteria. For example, when fruits and vegetables are fresh-squeezed, harmful bacteria from the outside of the produce can become a part of the finished product. If it's ingested, children, older adults, and people with weakened immune systems risk serious illness or even death.



Human Pathogen Associations

- *Cryptosporidium,* parasite (juice/cider and produce)
- *Cyclospora,* parasite (produce)
- *Escherichia coli* O157:H7 (juice/cider and produce)
- Noroviruses (produce)
- *Salmonella* (juice and produce)
- *Shigella* (produce)

DID YOU KNOW?

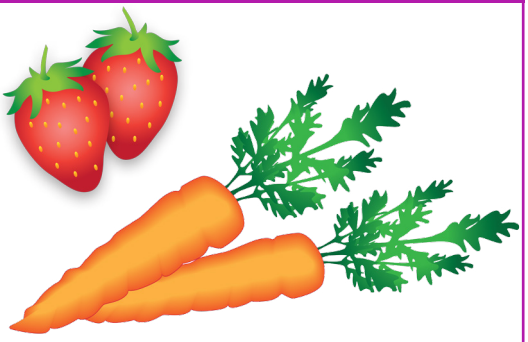
E. coli O157:H7 is very resistant to acid, so it can survive in an acidic medium like **orange** or **apple juice** for a long time.

!

On the average, each person in the United States consumes more than 126 pounds of **potatoes**, 95 pounds of other **vegetables**, and 92 pounds of fresh **fruit** each year.

Food Safety Precautions

All Fruits, Vegetables, and Juices



Fresh Fruits and Vegetables

- Thoroughly rinse raw fruits and vegetables under running water before eating them. Don't use soap, detergents, or bleach solutions.
- If necessary — and appropriate — use a small vegetable brush to remove surface dirt.
- Try to cut away damaged or bruised areas — bacteria can thrive in these places.

Fruit and Vegetable Juices

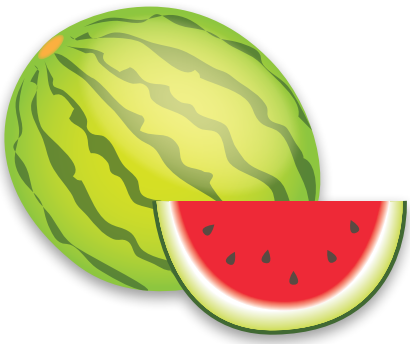
- Children, older adults, and people with weakened immune systems should only drink juices that have been pasteurized or otherwise treated to kill pathogenic bacteria.
- If you or someone in your family is in one of the at-risk groups and you cannot determine if a juice has been processed to destroy harmful bacteria, either don't use the product or bring it to a boil to kill any harmful bacteria that may be present.
- **Pasteurized or Treated Juice**

  Pasteurized juice can be found in the refrigerated sections of stores. Like milk, pasteurized juice must be refrigerated.

  Treated juice consists of shelf-stable juice normally found in non-refrigerated, shelf-stable containers, such as juice boxes, bottles, or cans. It is treated at a much higher temperature than pasteurized juice and is packaged in special airtight containers.
- **Unpasteurized or Untreated Juice** is normally found in the refrigerated sections of grocery, health-food stores, cider mills, or farm markets. Unpasteurized or untreated juice must have the following warning on the label:

> **WARNING:** This product has not been pasteurized and therefore, may contain harmful bacteria that can cause serious illness in children, the elderly, and persons with weakened immune systems.

Specific Foods

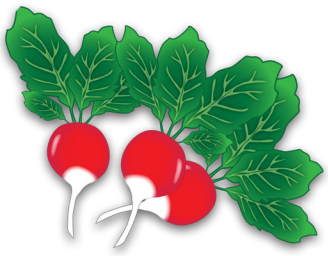


Cantaloupe and Other Melons

Any bacteria on the outside of fruits can be transferred to the inside when the fruit is peeled or cut. To prevent this:

- Thoroughly rinse fruits that require peeling or cutting — such as cantaloupe and other melons — under running water before eating them.
- As an added precaution, use a small vegetable brush to remove surface dirt.

Raw Sprouts (including alfalfa, clover, and radish)



Sprouts that are often served raw as an addition to salads, wraps, and sandwiches are a potentially hazardous food. Bacteria can often get into the sprout seeds through cracks in the shell before the sprouts are grown. Once this occurs, these bacteria are nearly impossible to wash out. To be safe, children, older adults, pregnant women, and persons with weakened immune systems should:

- Avoid eating raw sprouts of any kind
- Cook sprouts thoroughly
- When eating out, check sandwiches and salads for raw sprouts. Request that raw sprouts not be added to your food.

REFRIGERATOR & FREEZER STORAGE CHART

Since product dates aren't a guide for safe use of a product, consult this chart and follow these tips. These short but safe time limits will help keep refrigerated food 40° F (4° C) from spoiling or becoming dangerous.

- Purchase the product before "sell-by" or expiration dates.
- Follow handling recommendations on product.
- Keep meat and poultry in its package until just before using.
- If freezing meat and poultry in its original package longer than 2 months, overwrap these packages with airtight heavy-duty foil, plastic wrap, or freezer paper, or place the package inside a plastic bag.

Because freezing 0° F (-18° C) keeps food safe indefinitely, the following recommended storage times are for quality only.

Product	Refrigerator	Freezer
Eggs		
Fresh, in shell	4 to 5 weeks	Don't freeze
Raw yolks, whites	2 to 4 days	1 year
Hard cooked	1 week	Don't freeze well
Liquid pasteurized eggs or egg substitutes,		
opened	3 days	Don't freeze
unopened	10 days	1 year
Mayonnaise, commercial		
Refrigerate after opening	2 months	Don't freeze
TV Dinners, Frozen Casseroles		
Keep frozen until ready to heat		3 to 4 months
Deli & Vacuum-Packed Products		
Store-prepared (or homemade) egg, chicken, tuna, ham, macaroni salads	3 to 5 days	Don't freeze well
Pre-stuffed pork & lamb chops, chicken breasts stuffed w/dressing	1 day	Don't freeze well
Store-cooked convenience meals	3 to 4 days	Don't freeze well
Commercial brand vacuum-packed dinners with USDA seal, unopened	2 weeks	Don't freeze well
Raw Hamburger, Ground & Stew Meat		
Hamburger & stew meats	1 to 2 days	3 to 4 months
Ground turkey, veal, pork, lamb	1 to 2 days	3 to 4 months
Ham, Corned Beef		
Corned beef in pouch with pickling juices	5 to 7 days	Drained, 1 month
Ham, canned, labeled "Keep Refrigerated,"		
unopened	6 to 9 months	Don't freeze
opened	3 to 5 days	1 to 2 months
Ham, fully cooked, whole	7 days	1 to 2 months
Ham, fully cooked, half	3 to 5 days	1 to 2 months
Ham, fully cooked, slices	3 to 4 days	1 to 2 months
Hot Dogs & Lunch Meats (in freezer wrap)		
Hot dogs,		
opened package	1 week	1 to 2 months
unopened package	2 weeks	1 to 2 months
Lunch meats,		
opened package	3 to 5 days	1 to 2 months
unopened package	2 weeks	1 to 2 months

Product	Refrigerator	Freezer
Soups & Stews		
Vegetable or meat-added & mixtures of them	3 to 4 days	2 to 3 months
Bacon & Sausage		
Bacon	7 days	1 month
Sausage, raw from pork, beef, chicken or turkey	1 to 2 days	1 to 2 months
Smoked breakfast links, patties	7 days	1 to 2 months
Summer sausage labeled "Keep Refrigerated,"		
unopened	3 months	1 to 2 months
opened	3 weeks	1 to 2 months
Fresh Meat (Beef, Veal, Lamb, & Pork)		
Steaks	3 to 5 days	6 to 12 months
Chops	3 to 5 days	4 to 6 months
Roasts	3 to 5 days	4 to 12 months
Variety meats (tongue, kidneys, liver, heart, chitterlings)	1 to 2 days	3 to 4 months
Meat Leftovers		
Cooked meat & meat dishes	3 to 4 days	2 to 3 months
Gravy & meat broth	1 to 2 days	2 to 3 months
Fresh Poultry		
Chicken or turkey, whole	1 to 2 days	1 year
Chicken or turkey, parts	1 to 2 days	9 months
Giblets	1 to 2 days	3 to 4 months
Cooked Poultry, Leftover		
Fried chicken	3 to 4 days	4 months
Cooked poultry dishes	3 to 4 days	4 to 6 months
Pieces, plain	3 to 4 days	4 months
Pieces covered with broth, gravy	3 to 4 days	6 months
Chicken nuggets, patties	3 to 4 days	2 months
Fish & Shellfish		
Lean fish	1 to 2 days	6 months
Fatty fish	1 to 2 days	2 to 3 months
Cooked fish	3 to 4 days	4 to 6 months
Smoked fish	14 days	2 months
Fresh shrimp, scallops, crawfish, squid	1 to 2 days	3 to 6 months
Canned seafood	*after opening*	*out of can*
(Pantry, 5 years)	3 to 4 days	2 months

FDA

www.fda.gov/food

NSTA National Science Teachers Association

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2014