FOOD SAFETY HAZARDS AND CONTROLS FOR THE HOME FOOD PREPARER

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PREFACE

Food and water are necessary to keep the human body functioning. People must have a balanced diet that includes a complex range of nutrients to provide energy, promote growth, maintain health and resist disease or illness, and promote longevity.

It is also known that food and water can carry, or be sources of, harmful microorganisms, chemical compounds and particulate matter. This booklet will discuss the hazards that are present in food and water, and how it is possible to control or eliminate these hazards by using correct methods of food selection, preparation, service and storage.

Government agencies and regulations at the local, state and national level have been established to institute the rules to produce a safer supply of food. However, government regulations and inspections are not always accurate and cannot guarantee that all food that is currently for sale in retail food markets and foodservice units is safe for consumption. Therefore, consumers become the focal point for controlling food safety hazards. This means that consumers must know the hazards in the food supply and must use correct hazard controls.

Many consumers have no formal training in proper methods of safe food preparation. Most consumer knowledge is based on what they learned from their family members, the media (television, radio and newspapers), and occasionally from government publications. Some of these food preparation methods do control hazards, and some are incorrect and are very dangerous.

The purpose of this book is to provide home food preparers, who are the "critical hazard controllers," with an accurate assessment of the hazards that exist in food and water, and to provide them with correct knowledge that is necessary to prepare food safely for themselves, their families and friends, by applying the principles of Hazard Analysis and Critical Control Points (HACCP).

Many food safety facts such as safe food cooking times and temperatures differ from the old, out-of-date information found in government food publications. The facts in this booklet are based on current food science research reports by noted scientists. References are available. The government has not disputed these facts, but has not made changes based on the facts.

GLOSSARY

The following terms are used in this text as indicated.

Clean. Free from litter or clutter, loose dirt, food particles and grease. This is the critical step in sanitizing surfaces and equipment. Visual cleanliness is not a guarantee of safety because a surface that has been wiped with a rag, for instance, can look clean, but leave a film of microorganisms. When a surface is washed clean, as described in this booklet, the dangerous microorganisms will have been reduced to a safe level.

Control. The act of preventing, eliminating or reducing hazards to a safe level.

Critical control point. A point, step or procedure at which control can be applied and a food safety hazard can be prevented, eliminated or reduced to acceptable levels. This can include a person who washes his/her hands prior to handling food or handles food properly, a step in preparing a recipe or a procedure such as proper refrigeration, or the growing of chickens in a environment free of illness-causing microorganisms (i.e., pathogens).

Feces. Excrement, solid metabolic waste products of humans, animals, birds and insects.

Food contact surface. The surface of equipment and utensils that any food touches during storage, preparation, cooking, holding and serving (e.g., bowls, knives, grills, ports, steam table pans and utensils).

Food spoilage. Food that has decayed or decomposed. Rate of spoilage depends on surrounding environmental factors such as temperature, atmosphere and moisture. Spoiled food does not cause foodborne illness. There must be a sufficient level of hazardous material to cause such an illness.

Hazard. A biological, chemical or physical (hard foreign object) property that may cause an unacceptable health risk to the consumer.

Hazard Analysis and Critical Control Points (HACCP). A method of determining the hazards in a food or process and to control them. It reduces the risk of foodborne illness by training food preparers to recognize the hazards and use scientifically validated controls. HACCP includes knowing the current causes of foodborne illness in the United States, growth conditions of hazardous microorganisms, application of shopping and storage procedures, and kitchen processing procedures, necessary for safe and quality food.

Pasteurization. A thermal treatment of food that effectively reduces numbers of pathogenic microorganisms in food to a safe level.

Pathogen. A microorganism in food and water that is capable of causing disease or illness in humans. They may be grouped into the 2 basic categories:

Infective pathogens cause illness when they multiply within the body. Examples include *Salmonella* spp., *Campylobacter jejuni* and hepatitis A virus. They cause illness, at least diarrhea, no sooner than 8 hours after ingestion. The time period for onset of symptoms may be many days.

Toxin-producing pathogens produce toxins when they multiply in food. These toxins are not usually inactivated by cooking. Any food in which there is a possibility of toxin formation must be discarded. Examples of pathogenic bacteria that produce toxins include *Staphylococcus aureus*, *Clostridium botulinum* and *Bacillus cereus*. Illness from intoxication can result in at least vomiting, in less than 30 minutes. It might be delayed up to 8 hours.

Poison. A compound that is capable of causing illness, injury and even death. Poisons do not come from microorganisms. They are not controlled by heat. In a few cases, such as pesticides, they can be washed off of food.

Risk. The likelihood of the degree of illness response to a given hazard, up to and including death.

Sanitize. Making a food surface safe from pathogenic microorganisms for food contact. Cleaning with soap / detergent and clean water is the critical control to have a safe surface. Thermal or chemical procedures, as used in the food industry, are not necessary. The surface will not be sterile. Informal public health standards accept 100 microorganisms per 8 square inches of food contact surfaces as safe. Chemical sanitizers are very sensitive to organic matter and if the surface is not clean, chemicals will not be effective in reaching the microorganisms on the surface and inactivating them.

Spore. Some bacterial cells have the ability to form spores. The spore state is a period of no growth, similar to hibernation, in which the cell dries up, and the cell wall becomes thickened. Spores are very resistant to heat and chemicals.

Sterilize. The reduction of all multiplying vegetative microorganisms and dormant but viable spores to a safe level. This is accomplished by heating the food to 250ºF for 2.4 minutes, which reduces the probability of the survival of the spores of *Clostridium botulinum* 10^{12} to 1. This is the process used to create room temperature-stable canned food.

Vegetative cell. In contrast to the dormant spore, which has no metabolic activity until activated when food is cooked, the vegetative cell is in an active metabolic state in which the bacteria are growing and multiplying at a rate depending on the food temperature, acidity, water, additives, etc.

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I. Is There Really a Food Safety Problem?

Absolutely! It is estimated that there are from 6.5 to 81 million cases of foodborne illness and injury in the U.S. each year, and from 525 to more than 7,000 associated deaths. Foodborne disease or injury occurs when a person consumes food that contains **pathogenic** disease-causing **microorganisms**, harmful **chemicals** or **hard foreign objects** that can cause choking, injury to the mouth, or other internal injury. Lists of these harmful agents and foodborne illnesses are found in ***Appendix A (Chemical Hazards)***, ***Appendix B (Physical Material Hazards)***, ***Appendix C (Pathogens in Food)*** and ***Appendix D (Illnesses or Diseases Attributed to Food)***.

Food may look, smell, taste and in all other ways appear completely wholesome. However, microorganisms, chemicals and hard foreign objects are found in and on **raw food** as it is grown and harvested, whether it is imported or comes from U.S. sources. The amount of contamination depends on what the food acquires during growing, harvesting, processing by the manufacturer, handling by the distributor, and during storage. **Food handlers**, whether they pick crops from the fields, slaughter animals, or prepare food at home, in a restaurant, or in a hospital kitchen, are also sources of pathogens, chemicals and hard foreign objects. They can contribute to the hazardous condition of the food through unsafe food handling and preparation practices. Consumers themselves must handle food safely, keep it hot or cold, and eat it promptly. Otherwise, surviving microorganisms in the food will multiply and cause illness.

In order to make sure that no one is made seriously ill, hazards must be prevented and/or controlled through correct knowledge of how to safely grow, harvest, slaughter, deliver, handle, prepare, serve and store food ingredients and products, and how to perform these tasks correctly 100% of the time.

Today, because of the way food is grown, harvested and supplied to the consumer, the person who prepares the food, the cook, becomes the **hazard control point**. Lack of hazard control at the source of supply in the food system is so severe that the food preparer will remain the hazard control point for many years to come. This booklet informs the home food preparer about hazards in food from the wholesale system and how to control these hazards so that the food can be made safe with as little over-processing as possible.

II. The Food System Hazard Control Points

Hazards from Growing and Harvesting

Plant and animal food sources that are grown, harvested and handled on the farm are subject to contamination from various sources. The soil and fertilizers in which plants are grown contain safe and unsafe vegetative microorganisms, pathogenic spores, chemicals and hard foreign objects. People who harvest food from the fields may be contaminated with pathogens that they transfer to the food. Their hands may be contaminated with various pathogens for several reasons. Perhaps they did not wash their hands after using the toilet and prior to harvesting the food, or they have infected cuts on their hands. They may cough or sneeze on the food. They may have open sores on their skin. Their hands can become contaminated as they handle the crops because of pathogenic microorganisms remaining on the plants from the soil and organic fertilizers. Fields are not usually equipped with hygienic facilities such as toilets and fingertip washing stations, etc., where workers can maintain a safe level of personal hygiene. There are no government regulations to adequately control these problems.

How Contaminated Is the Food?

The table, ***FOOD PRODUCT PATHOGEN CONTAMINATION***, on page 2, shows typical contamination levels of raw food. By examining this table, it is evident that no raw food should be considered safe until it is made safe by the cook or food preparer.

Animals carry pathogens from soil and manure in and on their bodies. Beef animals are allowed to be slaughtered by the USDA when they are sick and shedding pathogens in their body wastes, [e.g., when beef and dairy cattle have BVD (bovine viral diarrhea)]. Seemingly healthy animals may also be affected. These pathogens can contaminate the meat when the animal is slaughtered. Insects, rodents, birds, cats and wild animals carry disease-causing pathogens that can infect cattle, sheep and pigs in the barns and feedlots. Additional sources of contamination of plants and animals used as food include animal feeds, litter, and farm chemicals.

FOOD PRODUCT PATHOGEN CONTAMINATION

Microorganism	Source	Percent contaminated
Salmonella spp.	Raw poultry Raw pork Raw shellfish	40 to 100 3 to 20 16
Staphylococcus aureus	Raw chicken Raw pork Raw beef	73 13 to 33 16
Clostridium perfringens	Raw pork / chicken	39 to 45
Campylobacter jejuni	Raw chicken / turkey	45 to 64
Escherichia coli O157:H7	Raw beef / pork / poultry	1.5 to 3.7
Bacillus cereus	Raw ground beef Raw rice	43 to 63 100
Listeria monocytogenes	Fresh potatoes Fresh radishes	26 30
Yersinia enterocolitica	Raw pork Raw milk Raw vegetables	49 48 46
Vibrio spp.	Raw seafood	33 to 46
Giardia lamblia and Norovirus	Water	30

Sometimes foods, particularly plant foods such as **grains** and **nuts**, if held too long on the farm before they are sold and distributed, spoil due to mold growth. Some molds produce toxins when they grow. Consumption of products containing these **mold toxins (aflatoxins)** is now known to cause liver cancer. There are government standards and methods for measuring the amount of mold toxin in food. At the present time, this type of mold contamination of food seems to be adequately controlled by the government. When tree nuts and grains are stored at correct low humidity for approved periods of time, mold growth is controlled.

Poultry and Egg Hazards

Poultry and eggs are good, nutritious foods. However, there is sometimes a lack of control of pathogens in the environment in which chickens are raised and eggs produced. For example, poultry feed and water become contaminated from cockroaches, flies, birds and rodents (mice and rats) in poultry houses. As a result, the poultry becomes diseased, and occasionally eggs become contaminated. Two types of pathogenic bacteria often associated with eggs and poultry are *Salmonella* spp. and *Campylobacter jejuni.*

The poultry and eggs can appear to be wholesome, but until they are processed so that the pathogens are killed, these food items can be dangerous. It is now known that *Salmonella enteritidis* can infect the oviduct of laying hens, and may be present in the eggs produced by these chickens. Approximately 1 in 20,000 intact shell eggs (no cracks or checks) in the retail food system can contain hazardous levels of *Salmonella enteritidis.* It is also a common practice to wash poultry during processing, and to wash eggs to remove obvious fecal material. While this washing procedure slightly reduces the number of pathogens on the poultry and eggs, it does not make these products safe to eat without further processing (i.e., pasteurization or acidification).

Fish and Shellfish Hazards

Fish and fish products can pose a threat to consumers, because the waters in which fish are caught may be contaminated. The water used in "fish farms" to breed and raise fish may be more controlled than uncontrolled environments of lake or seawater, but this is no guarantee that the fish will be free of harmful pathogens and substances. On fish farms, environmental contamination will depend on the pathogen content of the feed that the fish are given and pathogens from wild birds if they are allowed access to the water.

Fish are often taken from "unsafe waters" or held and stored improperly after being caught. Ciguatoxin is present in some species of ocean fish that have fed on dinoflagellates. Fish such as tuna, mahi mahi, and amberjack are sometimes held too long on the decks of boats and as a result, partially decay, allowing histamine to form before the fish reach a processing facility. Ciguatoxin and histamine are not destroyed when the fish are processed in canneries or cooked at home and in retail food operations. When fish is cooked, the food preparer has to hope that the fish was taken from "safe" waters and handled correctly by the fisheries and processing industries according to HACCP (Hazard Analysis and Critical Control Points) procedures.

Shellfish are a particular problem, because many people like to eat them raw. Shellfish taken from polluted waters can carry pathogenic bacteria and viruses. They should NEVER be eaten raw. Some shellfish contain dangerous toxins that can cause death if consumed.

Although there are government regulations that have some control over the growing and harvesting sites for shellfish, they are inadequate and often unenforceable. These regulations do not deal with hazards such as viruses and parasites common in water that can contaminate the shellfish. Government regulations require a shellfish tag on the shipping container and the identification of the shipper. However, because there are no regulations that require correct testing of the water from which the shellfish were harvested, the shellfish tag has virtually no safety value.

Fishermen who catch fish and harvest shellfish must be aware of possible hazards and use the best methods available to ensure the sale of safe commodities. Raw fish and shellfish can never be expected to be totally free of pathogens. However, consumers should and do expect these products to be safe for consumption after cooking or proper methods of preservation.

Hazards on Fruits and Vegetables

Fruits and vegetables have always been randomly contaminated. Frequently, manure from animals that may or may not have been diseased is used to fertilize fields. For example, *Salmonella* in chicken or cow manure may be transferred to the surface of melons. When the cook cuts the melon, the *Salmonella* is transferred to the interior of the melon where it will multiply if the melon is kept above 45°F. Cut melons should be served and eaten immediately after preparation or should be stored in a refrigerator below 45°F.

An incident was documented a few years ago when apples in an orchard fell on the ground and became contaminated with *Escherichia coli* O157:H7, because diseased cows were allowed to roam the orchard and spread manure on the ground. These apples picked from the ground were then used to make unpasteurized, natural cider. (The apples were not washed before they were placed in the cider press.) Over 100 people consuming this cider became ill. The source of the illness was traced to the cow manure in the orchard.

When there is a big rainstorm, ground water from a dairy farm with sick cows can flow across the road and contaminate the lettuce-growing field of another farm. Hundreds of people can become ill after consuming this contaminated lettuce. Water used for farm irrigation systems is usually not treated to reduce pathogens. If 2 to 3 weeks pass after fruits and vegetable fields are irrigated, pathogenic microorganisms on plants tend to decrease in numbers. However, if the fruits or vegetables are harvested soon after irrigation with contaminated water, there will be some transfer of pathogenic microorganisms.

Washing strawberries does little to reduce surface contamination. In addition to contamination from handling by field workers, there is also the problem of consumer contamination when people are allowed to sort through and pick out the fruit in open containers at the grocery store. There are no provisions for customer hand and fingertip washing in grocery stores allowing this type of fruit selection. Perhaps, plastic gloves should be required for customers who want to handle and pick over this food.

Because of the widespread and long-term use of nitrates in soil fertilizers, there is also an occasional problem of some vegetables having toxic levels of nitrate or nitrite. Water running off in fields during a rainstorm can carry high levels of nitrites and nitrates to water systems. If the water is properly tested and treated, nitrites and nitrates are not a threat and can be controlled, but the farmer must test and know that the water is safe.

There is also the problem of wood, metal and rocks in fruits and vegetables. This is understandable, considering the growing and handling process.

Hazards from Slaughtering and Processing

When food animals and plant products leave the farms, waters and fields, they are taken to food processing plants. Some products, such as locally grown fruits and vegetables, are taken directly to the consumer marketplace.

Contamination of raw meat, poultry and fish in slaughtering and processing plants is difficult to control or prevent. The outside of the animal is contaminated, and it is difficult or impossible to slaughter the animal without getting pathogens on the muscle tissue. If slaughtering is not done precisely and with care, the pathogens found on the hides and in the intestines of animals can **cross-contaminate** the immediate vicinity, including other already slaughtered animals, food handlers and equipment.

Drains and improperly cleaned and sanitized equipment in processing plants can also be sources of contamination. Prior to distribution, food may be only minimally processed, as is the case of fruits and vegetables being washed and cooled. More extensive processing includes preparation of frozen fruit juice concentrates, frozen vegetables and frozen dinner entrees.

Examples of hazardous processing conditions that lead to problems include:

1. Managers who do not know the hazards in their food and do not have specified validated controls
2. Workers who are not trained in hazard control
3. Facility and equipment contamination, poor hygienic practices by food handlers
4. Equipment malfunctions, causing cross-contamination or allowing time for pathogens to grow in the food
5. Failure of the process itself to adequately pasteurize the food and destroy infective vegetative pathogens.

Hazards in Transportation and Distribution

Food is wrapped, boxed, labeled, crated, and undergoes a variety of treatments before it is ready to be shipped to retail food facilities. It often travels great distances over extended periods of time at temperatures that will allow some pathogens to multiply before it reaches the local warehouse and food market. As a result, the probability of food spoilage increases the longer food is held.

Note: Pathogenic bacteria begin to grow, very slowly, at about 30°F. Unsafe food storage temperatures are actually 30° to 130°F. Spoilage bacteria begin to multiply at 23°F. Therefore, as raw food thaws, it actually begins to spoil. Bacteria generally multiply 5 times faster at 40°F than at 30°F. This means that the colder food is maintained, the longer it will remain safe and be of higher quality.

Handling by packagers, drivers and other workers increases the risk of quality loss and the possibility of pathogen cross-contamination. Truckers are known to turn off refrigeration units to save costs. They sometimes back-haul hazardous chemicals in the same truck used for transporting food. There is very little government surveillance to ensure food safety during distribution.

It is impossible to produce food with zero pathogens. Therefore, the aim for a safer food supply is to produce food with a level of pathogen contamination that provides a scientifically "acceptable risk", such as 1 person in a million people dying per year. People need to be aware of the risks involved in consuming food, and to handle food to reduce these risks.

Hazards at the Market

Food arriving at the grocery store is handled and unboxed by receiving personnel and is rejected or accepted. The receiving area accepts unpasteurized raw food that has often been handled frequently and traveled great distances. With each step on its way to the shelf, the quality of raw food deteriorates. Cans are bumped and dented, packages crushed, lids loosen on glass jars, plastic bags are cut or broken, etc. This may result in possible contamination of the contents which, in turn, may result in foodborne illness if the consumer is not observant when selecting, rejecting and opening containers of food.

Foods begin to spoil the minute they are harvested or slaughtered. The **shelf life** of various foods differs due to food composition, processing and storage methods. Canned goods and dried foods, such as uncooked beans and pasta, are more stable than fresh fruits and vegetables or refrigerated meats and dairy products. Canned goods, after 20 years of storage at room temperature, can be as nutritious as fresh canned products, assuming the container is sound. However, quality deteriorates. Old canned food is soft in texture, and has off-color and a poor flavor. It should be eaten only in an emergency.

Sometimes food products are prepared at the grocery store's deli or bakery. Aside from the hazards associated with raw food ingredients, there are the additional hazards introduced by food handlers who may mishandle the food. This occurs when workers do not wash their hands and fingertips correctly before handling the food and when they do not refrigerate or store the products correctly. Hazards are also created when buttons from their uniform, or gum or jewelry fall into food. At the present time, no retail food market is required to have a hazard control program and train their employees to control hazards.

The Human Factor

People, because they participate in the production of food from growing to consumption, are a continuing source of pathogens. As previously mentioned, there is also the problem of the shopper who often is allowed to handle food and contaminate it during the selection process.

One out of 50 people who is feeling fine, each day, is actually a carrier of pathogens and passes billions of illness-producing microorganisms in his/her fecal material and urine. Government regulations recommend, as a control, that food handlers should stay home and not handle food when they feel ill. This control method is ineffective because many people in early stages of an infection are shedding pathogens in their feces and feel fine.

Theoretically, toilet paper keeps feces off fingertips. In reality, as we all know, there are no instructions for using toilet paper safely, and it tears and slips. People's hands and fingertips also become contaminated with high numbers of pathogens when they change babies' diapers, clean up vomit from family members, sneeze into their hands, pick at pimples, and clean up after pets. After any one of these actions, people do not always wash their hands and fingertips before they handle food.

Additionally, people can transmit pathogenic *Staphylococcus aureus* bacteria from infected cuts and sores to food when they prepare it, by allowing the infected area to come in contact with food that will later be served to people. When they sneeze or cough on food, they contaminate the food.

III. The Hazards

Chemical Hazards

Toxic compounds in food. Most food will cause death if consumed in excess and not as a part of a balanced diet. ***Appendix A (Chemical Hazards)*** is a table listing common chemical hazards. Toxic compounds are present in grains, legumes, fruits and vegetables. When a variety of foods in moderate amounts are consumed as a part of a normal diet, these toxic compounds do not accumulate in the body and hence, cause no problems. Some toxic compounds, such as hemagglutins in kidney beans and soybeans, are inactivated by moist heat. These items should not be eaten without cooking.

There is also much concern and discussion about chemical contamination of food by insecticides, rodenticides and herbicides. While there are some rare incidents of excessive amounts of these chemicals on or in food, more than adequate control measures are taken by both the government and industry to prevent this occurrence.

Nutritional considerations. Another vital aspect of chemical hazards is over- or under-nutrition. Vitamins and minerals in food are chemicals. It is important that each person eat a balanced diet as defined by current U.S. dietary guidelines. Most Americans consume too much red meat and fat. Being overweight is a hazard to one's health. Current dietary guidelines in the United States recommend that both fat and red meat consumption be reduced, and that consumption of fruits, vegetables, and whole grains and cereals be increased. It is said that 75% of the human diseases stem from food. If a people want to live a long, disease-free life, choosing and consuming the right types of food in moderation and preparing food correctly are essential to the control of this hazard.

Food allergy or sensitivity. About 3.5 to 4% of the population are allergic to compounds (usually certain proteins) found in milk, eggs, flours, nuts, fish, etc. Allergic reactions vary with each individual's sensitivity. Some allergic reactions are mild (e.g., watery eyes, nasal discharge, headaches, etc.). However, some people are very sensitive, and if they consume an offending food, life-threatening **anaphylactic shock** can occur within minutes after the food is consumed. Prepared foods must have an ingredient label, and complete disclosure of ingredients used to prepare food should be available to hypersensitive individuals if they request this information. Labeling of food and disclosing recipe ingredients enables hypersensitive people to avoid foods with offending components. When planning a party at home, prepare a label listing all the ingredients for each dish in order to inform people with food sensitivities. The use of kitchen chemicals such as monosodium glutamate, food color (yellow dye #5) and aspartame in food items should be disclosed.

Hard Foreign Objects in Food

Appendix B (Physical Material Hazards) is a list of some of the hard foreign objects in food. Insurance companies pay more money for mouth and throat injuries due to hard foreign objects in the food than for any type of foodborne illness. The reason is that the evidence is conclusive when a consumer pulls a rock from his/her mouth after breaking a tooth. The food supplier cannot deny liability. In cases of microbiological illness, it is difficult for consumers to prove the cause of illness and its food source.

The government allows what is considered to be "unavoidable filth" in food. This includes specified low levels of insect fragments in spices and in frozen and canned fruits and vegetables, and rodent and insect filth in peanut butter. This type of contamination can only be seen under a microscope, and it has not been shown to be a health hazard. If American consumers want moderately priced food, this practice of allowing some "unavoidable filth" in food will continue.

However, the presence of large particles and foreign objects (rocks, pieces of metal and plastic, bones, nut shells, stems from raisins, etc.) in food is a hazard. Whole bay leaves can also be a problem because they do not soften when cooked, and people can choke on them if they are left in food products. To prevent injury from foreign objects, objects in food should be kept smaller than 1/16 inch. Foods should be inspected for the presence of foreign objects by the food preparer. These objects can be removed by picking them out of food and/or by washing food items in flowing water, if this is applicable.

Microbiological Hazards

Appendix C (Pathogens in Food) is a list of pathogens in food. Truly, no raw, fresh food can be considered safe. Microbial contamination of food is not new. Food has been contaminated from the dawn of history. Microbiologically, raw food can be absolutely safe if it is handled correctly. Microorganisms on food can be reduced: by pasteurizing (heating) it, as for example, to 160°F for a few seconds; by acidifying food by a fermentation process or adding sufficient amount of acid (lemon juice or vinegar) to food; or by washing. Any one of these methods, or a combination, can be used to ensure food safety.

Especially on raw food such as fruits and vegetables, people eat millions of spoilage microorganism and some pathogens in a meal. Each individual's state of health affects his/her resistance to or tolerance of these pathogenic microorganisms. If you grew up on a farm, or in a contaminated environment, you probably developed a resistance to moderate levels of pathogenic microorganisms. Resistance to diseases is also gained from vaccinations, if not acquired naturally. If you take antacid medications, your body's first line of defense can be broken when the acid pH of the stomach is raised. Normal levels of acid in the stomach dissolve most pathogens before they can reach the small intestine. If you are taking antibiotic medications, you can reduce your body's second line of defense, good intestinal microflora. When there are few competitive microorganisms in the gut, pathogenic bacteria such as *Salmonella, Shigella, E. coli,* etc., if they survive the stomach, can easily multiply. The body's third defense is the immune system. Pregnant women,

elderly people, very young children, and other individuals with compromised immune systems must choose food carefully to avoid being made ill by low levels of pathogens that penetrate into the blood and can infect the body. The immune system is reduced in patients with organ transplants in order to prevent organ rejection. These patients are thus more susceptible to illness. In addition, there are auto-immune diseases such as AIDS that make one more susceptible to illness.

The longer raw, high-moisture foods are on display, the greater the amount of deterioration and spoilage. Most microorganisms grow best at high levels of moisture. Spoiled food does not necessarily mean hazardous food. It is merely unattractive and undesirable. In fact, there is no government standard for "spoiled". The American consumer who smells and tastes the food determines whether or not a food item is spoiled. Appearance and smell are indicators of freshness. Some foods are produced using spoilage organisms. This is called **fermentation**. Examples of fermented products include aged cheese, yogurt, cured salami, buttermilk, sour milk, sauerkraut, kimchi, wine and sourdough starter for bread. All of these foods are prepared from raw, contaminated ingredients, and proper fermentation creates distinctive flavor in these products and makes them safe to consume, because the fermentation process destroys the pathogens. It is common to consume 10,000,000 (10^7) spoilage microorganisms per gram (there are 28.35 grams per ounce) of a fermented food product. Foods such as fresh bean spouts and fresh mushrooms can contain from 100,000 to 20,000,000 spoilage microorganisms per gram because of the way they are grown. Non-pathogenic spoilage microorganisms do not cause illness or disease.

The presence of **pathogens in food usually cannot be detected by sight or smell**, nor can the presence of most chemicals and hard foreign objects. Food can make you very ill and yet may be the best-tasting food you have ever eaten. "If in doubt, throw it out" refers to indications that the food was not processed or stored correctly. Your senses can be used to judge the quality of food, but can never be used to accurately judge the safety of food.

The five classes of microbiological pathogens are as follows.

Bacteria. Bacteria are single-cell microorganisms that are so small they can only be seen with a microscope. Bacteria grow on and in soil, plants, animals and humans. They are killed (inactivated) by heat and some chemicals. Human bacterial infections are often cured when antibiotics are administered. In the United States, these same antibiotics are sometimes used to stimulate growth and prevent disease in animals and poultry. As a result of the extensive use of antibiotics, some antibiotic-resistant strains of bacteria have developed. Because of this, often the best treatment for foodborne illness bacterial infections in humans may be bed rest and allowing each individual's immune system time to combat the source of infection.

Viruses. Viruses are not true living cells and are much smaller than bacteria. Viruses are composed of a protein coating around genetic material (DNA or RNA) and are unable to reproduce unless they are inside a living cell. Viruses do not multiply in food. They do multiply in cells in various organs or tissues of the body. For example, Hepatitis A virus replicates in cells of the liver. It is quite difficult to isolate viruses on or in food. Normally, the best treatment for viral infections is allowing time (bed rest) for each individual's functioning immune system to combat the virus.

Yeasts. Yeasts are much larger than bacteria. Most yeasts are not pathogenic (do not cause foodborne illness or disease). However, *Candida albicans*, which causes thrush in infants, is the exception. The growth of some types of yeast is used to produce fermented food products. Undesired growth of some yeast in food products causes spoilage.

Molds. Molds are larger than bacteria. The presence of mold in food can be seen as a cottony, powdery or fuzzy patch on the surface of food that may be gray, white or highly colored. The presence of mold in products causes spoilage. When some types of mold grow on grains and nuts of high moisture content, aflatoxins may form. These toxins are thought to cause liver cancer and are not easily inactivated by heat achieved during baking. Extremely moldy food should be discarded. If mold growth is not extensive, it should be removed from the surface of the food in a way that assures complete removal of the mold-affected area without contamination of other parts of the food, such as cutting off the area and about 1/4 inch below it.

Parasites. Parasites are organisms that live at the expense of the hosts (humans, animals, fish and birds). Parasites in food generally refer to the presence of protozoa (microscopic single-celled animals) and helminths (small worms and their larvae). In the United States, there are far fewer documented cases of foodborne disease and illness due to parasites than due to bacteria. Parasites can be found in irrigation water, in cat feces in the farm yard, in the muscle tissue of improperly fed and maintained cattle and swine, and in fish muscle. Humans become infected when they eat undercooked meat, poultry, fish and vegetables. Parasites are hard to detect. Early symptoms of parasitic illness include loss of appetite and weight loss. Some parasitic illnesses may be treated with medication. The medication causes the parasites to die and they are excreted. In some cases, parasites may need to be removed surgically.

Types of Foodborne Illness

Two basic forms of foodborne illness result from the presence or growth of microorganisms in food: foodborne infection and foodborne intoxication.

Foodborne infection. Foodborne infection occurs when humans consume low numbers (1 to 100) of pathogenic pasteurization-sensitive microorganisms that then multiply in the body. Symptoms of illness can occur in no less than 8 hours, but usually 2 or 3 days to weeks are required for infectious microorganisms such as *Salmonella* and *Shigella* (bacteria), norovirus or hepatitis A virus, or *Giardia* and *Cryptosporidium* (parasites) to multiply in the body, causing the development of illness or disease.

Sometimes people complain that they became ill with diarrhea immediately after consuming a food. This type of immediate illness is not due to ingestion of infective microorganisms, but is more likely due to a food intolerance. For example, some people tolerate little or no fat in their diet and have a rapid onset of diarrhea (within 30 minutes to an hour) after they consume a food or meal high in fat.

Foodborne intoxication. The other type of illness, foodborne intoxication, is due to toxins formed by the multiplication of microorganisms in food. Examples of foodborne intoxication include ingestion of toxins produced by the growth of microorganisms in fish after they are caught; by *Staphylococcus aureus* in meat and dairy products; by the growth of *Bacillus cereus* in cooked cereal and dairy products; and by the growth of *Clostridium botulinum* in improperly processed, stored or packaged meat, fish, poultry and vegetables.

Toxins such as those produced by *Staphylococcus aureus* and *Bacillus cereus* are heat resistant and are not destroyed when food is reheated. Toxin produced by *Clostridium botulinum* is more easily destroyed by heat, and if food is boiled for 10 minutes, this very deadly toxin is inactivated. **Note:** If food is reheated only to 165°F, toxin formed by *Clostridium botulinum* will not be destroyed. In improperly preserved home-canned food, the hazard is the potential for toxin production from *Clostridium botulinum* in the food. Unless one is absolutely sure about one's canning process, one should **always boil home-canned food before it is eaten**.

A more complete description of foodborne illness onset times and illness symptoms is given in ***Appendix D (Illnesses and Diseases Attributed to Food)***. If you get sick, you can use this table to help you determine what might have made you ill.

Control. In order to control the microbiological hazards, they can be grouped into those that are vegetative and cause infection, and those that produce toxins. The infectious microorganisms are controlled by pasteurization with heat or acid, or by reducing the numbers of microorganisms to a safe level by washing foods such as fresh fruits and vegetables. ***VII. Preparation of Food***, beginning on page 14, describes methods of pasteurizing food.

Controlling toxin-producing microorganisms is not as simple. *Staphylococcus aureus* often gets into food after the food is cooked. During handling, when foods such as salads and casseroles become contaminated with *Staphylococcus aureus* and are given sufficient time at temperatures of 50 to 115°F, toxin will be produced. Regardless of how much the food is reheated, people will become ill after consuming these toxic foods.

Clostridium perfringens, Bacillus cereus and *Clostridium botulinum* are found in soil and are capable of forming heat- and chemical resistant spores that survive normal cooking procedures. When consumed in food in the spore form, these pathogens are not a safety problem. Healthy adults can eat food containing 1,000 spores per gram with no ill effects. These spores are only inactivated by canning procedures when food is heated under pressure to temperatures of 250°F for 2.4 minutes. This is called **commercial food sterilization**. Hermetically sealed food (in cans, jars and sometimes plastic containers) processed in this manner is shelf-stable at room temperature.

When food is **pasteurized** (heated to kill vegetative microorganisms), spores survive the heat process, become activated, and can grow out to form vegetative cells when the food cools. This outgrowth is especially fast between 120 and 70ºF. After food is cooked, it must be assumed that spores have survived, have been activated, and are ready to multiply. The USDA recommendations state that, if the food is cooled from 120 to 55ºF in 6 hours, followed by further continuous cooling to 40ºF, the food will be safe. This is about 14 hours from 120 to 40ºF. When cooling, the spore that turns into a vegetative cell first is *Clostridium perfringens* at about 125ºF. *Clostridium botulinum* and *Bacillus cereus* outgrow at about 122ºF. *Clostridium perfringens* has the fastest growth during cooling; so, cooling control can be based on preventing the outgrowth of *Clostridium perfringens*. *Clostridium perfringens* stops multiplying at 59ºF; *Clostridium botulinum* types A and B (vegetables and meat) stop at 50ºF; *Bacillus cereus* stops at 39.2ºF; and *Clostridium botulinum* type E (fish botulinum) stops at 38ºF.

In refrigerated storage of everything but cooked fish, the critical control is *Bacillus cereus*, which will grow down to 39.2ºF. To be absolutely safe, if cooked food is colder than 38ºF, only spoilage bacteria that survive cooking will grow, and the food will be safe for unlimited refrigerated storage life.

Keeping food at temperatures between 40 and 50ºF should keep pathogens sufficiently under control, and typical perishable food will be safe for at least 2.5 days at 50ºF in the refrigerator. Of course, there will probably be some spoilage.

Cooked food is potentially more hazardous than raw food. Spoilage microorganisms in food are reduced to low levels when food is cooked, and are not present in sufficient numbers to compete with the growth of pathogenic bacteria if cross-contamination occurs. The warning signs of spoilage (off-odors and slime) in cooked food often occur after the food became hazardous. Thus, **cooked food that is to be saved must be handled very carefully**, or it will make people ill and may even kill them. This food will probably show no signs of being hazardous if it is.

IV. Controls When Purchasing Food

What Precautions Must I Take When I Purchase Food?

It is now clear that **all raw food**, moist or dry, (spices, dried peas and beans, rice, etc.), **must be assumed to be contaminated with microorganisms, chemicals and hard foreign objects, and capable of causing illness, injury, or death** if not properly handled.

Choose fresh produce. Control begins when you select produce items that appear to be as fresh as possible. Avoid items that are too wet, have bruises and blemishes, and appear wilted, limp or slimy. Worms you may see on fruits and vegetables, while unappealing, will not hurt you. This type of contamination can be removed by washing, cutting out affected parts, and by cooking. Remember, just because food looks fresh, this is **no guarantee** of safety.

Check packaging. Choose packages that do not have obvious holes in them or show obvious signs of leakage. If a package of fresh meat or poultry is somewhat leaky, carefully wrap the package in another plastic bag to prevent drip or juices from cross-contaminating other raw food items in your shopping cart. Wiping your hands with a clean paper towel will reduce some of the pathogens that probably got on your hands, but it will not make your hands totally safe. Always shop for fruits and vegetables first, and place these items in plastic bags before going to the meat, poultry and fish counters. Customers who do not understand food safety sometimes open food such as salad dressing to smell and taste the food to determine if they like it. If you find a container that has been opened or the seal of which is broken, give it to one of the store personnel.

Observe display thermometers. The actual temperature of most fresh vegetables should be less than 50°F; dairy items less than 40°F; and meat, fish and poultry should be less than 35°F. Frozen foods should be maintained at a non-fluctuating temperature of 0°F. Be careful when reading thermometers in display cases. The sensing bulb is often placed on the refrigerator coil where the air is 10 to 15°F colder than the air around the food. Use your sense of touch. If you pick up food that is supposed to be cold and it is not as cold as the food in your refrigerator, do not buy it. Ask for food from the refrigerated storeroom in the back of the store. This may take time, but you have the right to ask for fresh food, and the food should not cost more.

Observe use-by-dates. Choose items that will be used within the period of time suggested by the use-by-date. Manufacturers set the sell-by / use-by dates assuming that the food is always less than 40°F, and sometimes less than 35°F. They can choose any sell-by / use-by date they wish because there are no government rules that they must follow. Sometimes they guess at the shelf life and do not actually do tests. It is always better to purchase items with an unexpired date. But, if the food has been even slightly temperature abused (kept above 40°F during distribution or selling), the sell-by / use-by-date has no meaning and the product can be spoiled when you get it home. Then, you have to waste your time exchanging the item. Sometimes food such as cheese and fruit is moldy when you open the package. Almost all cheese, raw fruits and vegetables, deli salads, etc. are contaminated with mold, but you cannot see it. Given time, it grows enough to be seen. The only control is to buy food as fresh as possible, store it correctly, and prepare and consume it promptly.

Check dates on dairy items. These products (milk in cartons, cottage cheese, sour cream, etc.) usually have use-by dates. Observe them and make your selections based on how soon you can use the product. Use-by dates on dairy food containers assume a constant temperature of 40°F. If the dairy items are at 50°F, the time in which you must use the item is reduced 3 times. In other words, 12 days storage at 40ºF becomes about 4 days at 50ºF. When milk is put in a refrigerator, it should not be stored on the refrigerator door. This area is especially warm, and the shelf life of the milk will be reduced. Place the most perishable food, such as fresh milk, fish, meat and poultry, against the back wall of the refrigerator where the refrigerator air temperature is 10 to 15°F colder than on the door. Food that is good for 10 days at 40ºF, is good for 20 days at 35ºF. When preparing food for a meal and you take refrigerated food (e.g., milk, meat for a sandwich) out, put it away immediately, because 30 minutes at room temperature can shorten quality shelf life considerably.

Check egg storage. Eggs in the grocery store should always be stored in a cooler at 40°F. Do not purchase eggs that have been sitting out at room temperature. Occasionally, chickens lay eggs containing *Salmonella enteritidis*, not only on the shell, which is quite common, but also inside the egg. Uncracked, perfectly fine-looking eggs that are washed still have low levels of chicken fecal bacteria such as *Salmonella* on the shell. Throughout the United States, it is estimated that 1 in 20,000 eggs contains *Salmonella* on the inside. If eggs are colder than 45°F, the *Salmonella enteritidis* will not multiply in the egg. (It will not multiply on the shell because there is not enough moisture. However, it can cross-contaminate other food or the egg itself when the shell is cracked to open it.) Check the eggs to make sure that there are no broken, cracked or dirty eggs, because these eggs can carry a high number of pathogens. Observe the sell-by / use-by dates if this information is printed on egg cartons. Eggs are usually graded for quality at the time they are packed. If grade AA eggs are temperature abused or old, they can have deteriorated to a grade B classification by the time they are used. You can judge the quality (not the safety) of the egg when you use it, by cracking it open and looking at how much it spreads when put into a frying pan, for example. The egg should have a white that does not spread beyond 3 inches in diameter, and the yolk should be 3/8 to 1/2 inch high. If the eggs are temperature abused in the store where you shop, shop at a store that controls temperature and stock rotation.

Selecting fresh meat, fish and poultry. The red color of meat is caused by a protein pigment called **myoglobin**. Red meats such as mutton and beef contain more myoglobin than do lamb, veal and pork. There is less myoglobin in turkey and chicken breasts than in the legs and thighs. Meat that has only a small amount of myoglobin is called "light" or "white" meat; "dark" or "red" meat is significantly higher in myoglobin. A bright, cherry-red color in meat such as beef is often used as an indication of freshness. Again, this has no relation to safety of the meat.

When red meats are cooked, myoglobin changes to a grayish-brown color. Because heat causes this change in color, the color of cooked meat, especially tender cuts of beef, is often used to indicate doneness. However, color is not a reliable indicator of microbiological safety because meat that is aged and has high lactic acid levels or is mixed with soy protein can turn brown at temperatures that are not adequate to destroy enough pathogenic microorganisms to make the food safe.

Another example of the unreliability of using meat color as an indication of doneness occurs occasionally when areas within meat or on the surface do not turn brown and remain a brownish red color, even when cooked to the well-done temperature range. This is most likely due to the myoglobin in meat becoming exposed to residual nitrates from fertilized root vegetables. The only way to know positively that the food is safe is to measure the temperature in the food.

A color change also occurs in myoglobin when meats are "cured". Sodium nitrite, salt and heat are used during the curing process. The nitrite combines with myoglobin to form the stable pink color of cured meats. This cured meat pigment is unstable in the presence of light and the color will fade. But, additional cooking has no effect on color. The addition of the correct amount of nitrites to cured meats (e.g., sausages and ham) also prevents the growth of *Clostridium botulinum.* Too much nitrite can cause death.

Sometimes the area around the bones of fried chicken or chicken cooked by other methods is quite dark. This often occurs in the drumsticks and thighs of young chickens, and particularly in those chicken carcasses that have been frozen. The hemoglobin in the blood from the chicken's porous bones leaks into the muscles near the bones, and it darkens when heated. There is no safety problem with this condition, if a proper, tip-sensitive thermometer is used during cooking to check the temperature of the chicken muscle near the bone to assure that an adequate pasteurization temperature was reached during cooking.

Selecting frozen and refrigerated food items. Select refrigerated and frozen items toward the end of your shopping time to prevent these items from getting too warm. Deli and cold display items should be cold (40°F). Always select only those foods that are below the load line. The load line is indicated on the inside wall of the storage unit. The load line is the point where the air flows across the top of the food. If the food is above the load line, you have no idea of the food's temperature. Do not trust the thermometers in the cold / frozen cases because they can be manipulated to indicate a colder temperature. If there are ice crystals in bags or boxes of frozen food, it is because the food has been held too long in freezer cases. Temperatures fluctuate ±15°F or more during automatic defrost cycles of freezer display cases. While the period of time for a defrost cycle is short, perhaps 30 minutes, it allows the surface of frozen food to warm up, and when the temperature decreases, the free water on the surface of the food forms ice crystals and the surface becomes dehydrated. This condition, called "freezer burn", is a quality problem, not a safety problem. Do not hesitate to complain to the store's management.

Selecting hot deli items. These items should be hot (above 150°F). Again, purchase them at the end of your shopping time. Pathogenic spores survive in

these foods. (Remember, spores are heat-resistant forms of some microorganisms that are activated by cooking and grow out to form colonies of microorganisms when food cools below 130°F.) These foods must be eaten within 4 hours if at warm temperatures, and leftovers thrown away. If you want to keep this food, refrigerate as soon as possible in containers less than 2 inches deep. Otherwise, the spores may grow out and multiply, and "perfectly safe-looking food" will cause vomiting, diarrhea and possibly, paralysis.

Selecting pasta, cereal products and other dry, shelf-stable food. These food products should be free of visible insects. **Note:** the eggs of insects are present in grain, pasta and cereal products. If flour and bakery mixes are stored in warm, moist storage areas, the eggs may hatch into *Tribolium* ("confused flour weevils") and other grain insects. Look for insects on store shelves. If the store does not rotate stock, you will see evidence of them. The presence of these insects is usually not a safety problem. It is a quality problem. All grains and cereal products, dried potatoes, rice and other dried foods such as dry milk solids are contaminated with spores. When water is added to these items and they are cooked and then allowed to remain at room temperature for 9 to 12 hours, it is almost assured that there has been spore outgrowth and toxin production. Reheating, which does not inactivate the toxin, will not make the food safe.

Selecting canned food. Check the cans you purchase for dents (along top, bottom and side seams). Use of defective canned food can cause death. Look for swelling or puffing, and bulging tops or bottoms. If you spot a bulging can of food, return it to a store manager. Usually, swollen cans of food are due to "hydrogen swell" (acid in food gets through the can liner and reacts with the metal in the can to release hydrogen gas). However, there is also the possibility that a swollen can of food indicates growth of *Clostridium botulinum* and production of its deadly toxin. If you have such a can, return it to the grocery store. NEVER open the can because the liquid could squirt up into your face.

Chemicals. Read food product labels to make sure they do not contain ingredients that cause allergic reactions.

The amount of monosodium glutamate (MSG) in commercial food is controlled and is used at a safe level. However, there are no FDA guidelines for amounts of MSG added to food in retail foodservice operations such as restaurants. Because some cooks or chefs have no education about using MSG, it may be used in excessive amounts that may make some people ill. The FDA has now stated that more than 3 grams of free glutamic acid in a meal may cause illness in some people. When you use MSG, never use more than 1/4 teaspoon per 4 pounds or 2 quarts of food.

When buying non-food items such as household cleaners, insecticides and laundry supplies, check to make sure that the lids are closed firmly to avoid leakage of the chemicals onto food items.

Bagging groceries. When bagging your groceries, pack cold and frozen items together to keep them as cold as possible (40°F). Keep hot foods away from cold items. Put raw meat and poultry items on the bottom of the bag. Remember, the outside of meat and poultry packages is contaminated. Chemicals should be packed in bags, separate from any food items. If someone packages the groceries for you, ask him/her to pack them as described above.

Keeping food cold on the way home. If you live an hour's drive or more from the food market, or if the chilled food will warm up to more than 50°F on the way home, you may want to bring a portable cooler with ice. Pack cold food in this ice chest in order to maintain its temperature when transporting cold food to your home or destination. Keeping food at 50°F for a short period of time, say 1 hour, is a spoilage problem, not a food safety problem.

V. What Precautions Must Be Taken When You Get the Food Home?

In order to prevent and control food safety hazards and minimize spoilage, do the following.

1. Store refrigerated and frozen food as soon as possible, preferably before refrigerated food warms to 45°F and frozen food to 10°F. Cover and place raw refrigerated food on bottom shelves in the refrigerator, below cooked food. Place refrigerated items near the back. The back of most refrigerators is 10 to 15°F colder than the door. Do not store any perishable items, such as milk, on the refrigerator door shelves. When storing food in the freezer or freezer compartment, move the older items to the front so that they will be used first. Date items before placing in the freezer.
2. Date products stored at room temperature before storage. This includes canned food items, spices, cereals and other dry, shelf-stable food items. While these products will be safe for years, the quality of the products slowly decreases. The dry storage area for canned goods should be at or below 70°F, 60% relative humidity. For highest quality, canned products should be eaten or used within 2 or 3 months after purchase.

3. Use food refrigerated at 40°F as soon as possible, normally within 6 days to preserve quality. If the food is at 50ºF, the times are 2 1/2 days. The government does have standards for processor-pasteurized food, and does do microbial testing. This is a major reason why these products are safe. Sliced luncheon meats contain preservatives that greatly slow or perhaps prevent the growth of pathogens in the refrigerator. These products may develop a slimy surface after being kept for a period of time. This slime is due to the growth of spoilage bacteria. However, the meat is probably safe to consume even though its quality characteristics make it objectionable.
4. Store household chemicals in a separate area, away from food. Lock these products, to prevent them being added to food accidentally or harming small children.
5. Do not store food on the floor. When foods are stored on the floor, insects and rodents are permitted easy entry.
6. Your refrigerator should operate at or below 40°F. (Remember, the food will never be colder than the air temperature in any part of the refrigerator). Your freezer should operate at or below 0°F for quality. When food is frozen, even at 29ºF, it is safe from pathogen multiplication.
7. To optimize the capability of your refrigerator or freezer, clean the compressor coil with a vacuum cleaner at least every 6 months. Keep the door gaskets clean and intact. If your refrigerator or freezer does not have an automatic defrost cycle, defrost the freezer unit when the visible signs of frost are more than 1/16 inch thick on the walls of the freezer compartment.

VI. Pre-preparation of Food

Getting Ready to Prepare Food for Consumption

It must assumed that up to 100% of raw, moist food is sufficiently contaminated to make you or someone else seriously ill if you touch your hands to your mouth after handling raw food. Raw food can cross-contaminate cooked-pasteurized food as well as fruits and vegetables that have already been washed. Dried food, as soon as water is added, becomes a potential hazard.

The table, ***MAXIMUM HOLDING TIMES AND TEMPERATURES*** indicates maximum times and temperatures for holding food.

MAXIMUM HOLDING TIMES AND TEMPERATURES
(Eat or Throw Out)

Temperature (°F)	Holding Time
<30	Safe
30	123.8 days
35	19.3 days
40	7.5 days
41	6.5 days
45	4.0 days
50	2.4 days
55	1.7 days
60	1.2 days
65	21.6 hours
70	16.9 hours
75	13.6 hours
80	11.2 hours
85	9.3 hours
90	7.9 hours
95	6.8 hours
100	5.9 hours
105	5.2 hours
110	4.7 hours
115	4.6 hours
120	5.6 hours
125	31.0 hours
>130	Safe

These times are derived from the growth of pathogenic microorganisms in food. They are based on the cold holding standard established in the FDA Food Code that food at 41°F can be held for 7 days. These times at specified temperatures are based on the assumption that the food is of average quality when obtained from the food market or supplier.

Hand Washing

Before preparing food, wash your fingertips and hands thoroughly using the double hand wash method. Since fingertips that hold the toilet paper are so difficult to clean, this method involves using a fingernail brush during the first wash to remove transient bacteria, such as fecal pathogens, from your fingertips. You can put soap on the fingernail brush, and this way, get the soap to the fingertips to remove the fecal pathogens. This procedure should be done in the bathroom, because you do not want to wash the possible high levels of fecal bacteria on your fingertips into the sink where you prepare food and wash dishes.

The steps for the double hand wash are:

1. Wet the hands and fingernail brush.
2. Apply about 1/2 teaspoon good lathering soap to the brush.
3. Work up a good lather on the fingertips. Add more water and soap, if necessary. Scrub the fingertips and under the fingernails with the fingernail brush. Do not use the brush except on the fingers, or you will

spread the fecal microorganisms on the fingertips all over the hands. As you wash and brush your fingertips, do so under the water. The microorganisms come off in the running water.

4. Rinse the soap and pathogenic microorganisms off of the brush and fingers. When the soap is rinsed off, so are the microorganisms. It is best not to use antibacterial soaps. They destroy the very important natural resident microflora in the skin of the hands. These resident microflora keep the hands healthy, and tend to destroy in 2 to 4 hours, any foreign microorganisms such as fecal pathogenic bacteria that get onto the skin. Set the brush down, with bristles up. Allow the brush to air dry. Do not worry about sanitizing the brush. Rinsing the brush in flowing water also removes the microorganisms from the brush, just as rinsing your hands in flowing water removes microorganisms.
5. Soap the hands up to the wrists a second time with enough soap to build a good lather.
6. Work up a good lather.
7. Thoroughly rinse soap off of the hands and wrists.
8. Dry hands using paper towels. Drying reduces the number of microorganisms even further. Do not use a common cloth towel that other people have used to dry their hands or to wipe up spills of meat juice, etc.

Use Clean Equipment

Make sure that your knives and cutting boards are clean before use. To clean dirty knives, serving utensils and cutting boards, first, **rinse** equipment and utensils in flowing warm water to remove excess food soil. This step is very important to reduce microorganisms as much as 1,000 to 1. If you put a dirty knife or cutting board into a dishpan or sink of detergent water, high levels of microorganisms are transferred to the water and simply recontaminate other items being washed. Actually, microorganisms begin to multiply in soapy warm water after a couple of hours. After utensils and cutting boards are rinsed, to further remove the microorganisms, **wash** them by placing them into a lot of fresh, hot sudsy water. Use a scrub brush to clean the cutting boards, knives and utensils or any other food contact surfaces that have been contaminated with raw food. (Do not use a sponge because they tend to harbor microorganisms and when not in use, permit microorganism growth due to retention of soil and moisture.) Once the surface is washed and rinsed, it is safe.

If you want to **sanitize** equipment and utensils, the best sanitizer for these items is very hot (171°F or above) water. If you want to sanitize a clean wood or plastic cutting board or a clean counter, use diluted vinegar. In a small container, mix 2 parts water and 1 part 5% vinegar (as purchased from the grocery store). Apply it to the washed and rinsed food contact surface, spreading it with a single-use paper towel. Discard the towel. Let the vinegar solution air dry on the surface to get the best reduction of surface microorganisms. Household bleach solutions have been used in the past for sanitizing purposes. However, bleach is slightly toxic and vinegar is a safer sanitizing solution. When a surface has less than 100 microorganisms per 8 square inches, it is considered to be sanitized. **Note:** It is the thorough washing that makes the difference, not the vinegar solution. Worldwide, cleaning practices are inconsistent, yet, if food contact surfaces are washed clean, there is no demonstrated food safety problem.

Slicing or grinding machines must also be cleaned before you use them to be sure that few microorganisms remain on the surface of the equipment.

When putting away clean equipment, the most important final step is to allow surfaces and equipment to **air dry**. Do not lay one wet cutting board on top of another. The water is trapped and there is always enough food left on food contact surfaces for the microorganisms to multiply. All utensils and dishes should be allowed to air dry before they are put away. When surfaces are dry, there is no moisture present to foster pathogen multiplication and numbers of pathogens are further decreased.

If you suspect that your equipment and utensils such as knives and cutting boards became contaminated during storage, it would be wise to wash them just prior to use, even though you already cleaned, perhaps sanitized, and put away these items.

Thawing Meat, Poultry and Fish

The best way to thaw meat, poultry and fish is to remove the frozen item from the freezer and place it in the refrigerator on the bottom shelf or lower rack (i.e., not above cooked-pasteurized or washed food to avoid drippings getting into the food). Make sure you allow enough thawing time. The food will begin to spoil during thawing because the spoilage bacteria begin to multiply slowly at 23°F and meat, fish, and poultry thaw at about 28°F. This is not a hazard. Spoilage will continue at a more rapid rate after thawing is completed. Many people thaw food on the kitchen counter during the day. Food can be thawed on the counter or in the sink if you make sure that no part of the food gets above 50ºF before it is returned to the refrigerator or cooked. Food can also be thawed in a microwave oven or in water. Food thawed by either of these methods should be cooked or used within an hour because it gets warm on the surface.

It is dangerous to cook partially thawed food because the middle might still be frozen or unpasteurized, even though the food looks cooked on the outside. Therefore, it is best to cook food that is completely thawed or still completely frozen. It is important to measure the interior temperature of food cooked in this manner, especially if it is a large cut of meat or a casserole. Food may be safely cooked from the frozen state without loss of quality, however, cooking time is usually doubled. Do not thaw frozen vegetables prior to cooking. It is not necessary and spoilage microorganisms will multiply during thawing.

If Raw Food Is Spoiled

High numbers of spoilage bacteria in raw food will NOT make you sick. When food spoils microbiologically, the spoilage microorganisms grow on the surface until they totally cover the surface, perhaps 2 to 3 layers deep. At this point, surfaces of foods such as meat, poultry or fish feel "slimy", and there can be 20,000,000 to 50,000,000 microorganisms per gram or per square inch of food. This is when hamburger smells sour and turns brown, and fish and chicken turn slimy and have very objectionable odors. The growth of spoilage bacteria on green onions harvested during a wet growing season causes the onions to become slimy, and yellow onions to become soft.

When spoiled food is cooked above 160°F to make it safe, it may have a foul odor. For this reason, **spices and herbs** have been added to food throughout the centuries to mask the off-flavors and off-odors of rotting or partially spoiled food.

Most people throughout the world do not have refrigeration units in their homes. They purchase food at the market in the morning, and cook it well done, seasoning the food with spices and herbs to mask off-flavors and off-odors. The food is eaten at midday. They eat food that does not require refrigeration for supper. These people do not have food safety problems as a result of this routine.

It is only in societies such as ours in the U.S., which have refrigeration and the practice of cooking ahead and serving days later, that we have complicated our lives with many more opportunities for foodborne illness. The household that cooks (especially using a thermometer) and serves fresh food and has no leftovers has fewer risks and has fewer spoilage problems than a household that cooks, stores and reheats food days to weeks later. Remember, the hazardous microorganisms that cause illness or death normally leave no evidence of their presence in the cooked food, such as off-flavors or off-odors.

Refreezing Food

Studies have shown that one can thaw food to 40ºF and refreeze it as many times as desired, and then pasteurize it with no safety problems. However, the quality of these refrozen foods will be reduced.

Washing Fruits and Vegetables

It is rare, but, raw fruits and vegetables can carry dangerous levels of chemicals (because of pesticides or herbicides applied at the wrong time). Normally, the hazard is contamination by microorganisms from human and animal fecal material. Always wash fruits and vegetables before eating them or using them to prepare other food items. Do not wash them with soap or chemicals. While some processors use a few chemicals as an aid, these chemicals only extend refrigerated shelf life. This is why vegetables can be prepared in California, for example, and sold up to 14 days later throughout the United States. There is no evidence that chemically washed food is any safer.

If you question whether or not your water is safe, heat it to 160ºF or above before washing the vegetables*. Do not wash and wet fruits and vegetables until just a few hours prior to use, or at most, a day before use. If the surface of fruits and vegetables is dry, the growth of slime bacteria and mold is reduced. Do not cut fruits and vegetables until shortly before serving them. Cutting fruits and vegetables 8 hours or longer prior to use allows microorganisms to multiply on cut surfaces, and as a result, spoilage occurs more rapidly.

Studies have shown that even double washing does not do much to reduce the microorganisms on the fruits and vegetables. They may be reduced 100 to 1. Nonetheless, this must be enough because there is no evidence that people become ill from eating washed fruits and vegetables.

To do a good job washing fresh fruits and vegetables, first soak them in a clean container with clean, cold water. To maintain freshness, use ice water. Using a clean container is preferable to placing fruits and vegetables directly into the kitchen sink because the sink may be contaminated. If necessary, a vegetable brush may be used to scrub the surfaces of fruits and vegetables. For the second wash, place the items in a colander and run flowing water over the surface to remove and dilute the microorganisms on the surface. Soaking without using flowing water is not recommended because microorganisms that float off of the surface into the water only contaminate the water, and may reattach on the surface of the food items.

* If you suspect that your water is unsafe, have it inspected by the proper agency in your area. If it is unsafe for washing vegetables, it is unsafe for drinking. Probably over 30% of the water in the U.S. has some microbiological risk, according to the American Water Works Association.

To control spoilage, remove as much water as possible from washed fruits and vegetables. The closer you can get to the natural condition of the fruit, the better. After washing, delicate fruit (fresh berries) can be placed on an uncovered tray in the refrigerator where the fruit will get cold, and the surface will dry, slowing down microbial multiplication. If the surface is wet, the microorganisms multiply quickly, even in the refrigerator. This breaks down the food's structure and it becomes mushy.

Always store raw meat, poultry and fish below fresh fruits and vegetables and any ready-to-eat items. This practice is essential to prevent drip from raw foods of animal, poultry or fish origin from contaminating any other food items.

Do not wash raw meat, fish or poultry. Studies have shown that only a few pathogens and spoilage microorganisms are removed by washing raw meat, fish and poultry. Because of drip or splash, there is also the danger of spreading illness-causing microorganisms around the kitchen. A way to almost double the refrigerated shelf life of fresh meat, fish or poultry is to blanch the surface for 10 to 15 seconds.

Some people do not have a normal functioning immune system. They are **immune compromised**. People with this condition include pregnant women, infants and young children, the elderly, people taking antibiotics or undergoing medical treatments such as chemotherapy and radiation, and people with AIDS. It is important that these people avoid foods that might contain even low levels of pathogens. Immune-compromised people must make sure that raw fruits and vegetables have been washed and are fresh, or they should not eat them.

VII. Preparation of Food

Cooking Food to Destroy Pathogens

There are a variety of familiar cooking methods that, when used correctly, will adequately destroy pathogens. These methods include oven cooking, frying, microwave cooking, wok cooking, grilling and pressure cooking. Microorganisms can multiply when food is heated too slowly. It is necessary for safety to cook food from cold to 130°F or hotter within 6 hours to prevent the multiplication of *Clostridium perfringens*. Covering food during cooking, as in a roasting pan, prevents what is called **evaporative cooling** and heat loss from the surface and ensures that the food is heated evenly. Cooking a whole pig or cow on a spit over a fire for 12 hours or more is highly risky. Food cooked in this manner may be cooked safely, if it is cooked well done (all parts above 160ºF).

Microwave Ovens

Microwave cooking has become a popular alternative to conventional cooking methods because it is convenient and fast. Small, tender pieces of meat, fish and poultry items can be cooked in a microwave, but they do not brown as they do when cooked by conventional methods. Less tender cuts of meat and poultry will not become tender when cooked in a microwave oven unless the microwave is turned to a low setting to increase the length of cooking time. These are quality considerations.

Because of the non-uniformity of food heating in a microwave oven, it should never be used to pasteurize raw food when you want to guarantee that the vegetative pathogens are dead. If you want to cook raw food in a microwave oven, cook the food in the microwave until it reaches about 100ºF and transfer it to the stove or conventional oven to complete the cooking, where you can be sure that all parts of the food get a uniform pasteurization. Food should always be cooked covered in a microwave oven to prevent surface cooling due to evaporation of water. If there is evaporative surface cooling, the microorganisms on the surface are not killed.

Cooked meat, fish, poultry products and other combination items can be reheated, covered, with microwave energy. The center temperature of reheated microwave items should reach 165ºF. Remember, make sure that your food is safe before you begin to reheat in the microwave because of the non-uniform heating and possible survival of vegetative pathogens.

Pasteurizing Food to Make It Safe

When you cook food, you are really pasteurizing it to make it safe. Our ancestors learned to cook food well done because they did not have thermometers, and if they did not cook their food well, they became ill. They cooked meat until evidence of the red color was gone, which is above 165ºF. As mentioned previously, it must be assumed that all raw food is contaminated. Pigs are carnivores and may eat rodents in the farmyard, and thus become infected. They can get into many other sources of pathogens. Both caged and free-range chickens eat anything on the ground or in the feed trough, including rodent and insect feces and other bacterially contaminated objects. Fish and seafood come from contaminated sources. Illness-producing, infective organisms that are on and in raw meat, poultry and fish must be inactivated (killed) to a safe level if the food is to become safe for consumption.

Destruction of *Salmonella* is used by the USDA as the pasteurization standard, and the FDA has copied this standard. When food is cooked, the pasteurization process is based on time-temperature relationships to reduce

Salmonella 100,000 to 1, to a safe level, about less than 1/25 grams. When preparing food, it is prudent to apply a sufficiently high temperature for a specified period of time so that *Salmonella* will be reduced by 5 decimal (5D) reductions, or 100,000 to 1 per gram of food (10^5 to 10^0). Since there are probably no more than 100 *Salmonella* per gram, this reduces the *Salmonella* to 1 organism per 1,000 grams of food. **Note:** Some pathogens will always survive (because there is no "zero" in microbiology). But, they will not be at a level that poses a real risk if the food has received a 5D destruction.

The table, ***INTERNAL TEMPERATURES AND TIMES FOR FOOD PASTEURIZATION***, shows recommended pasteurization times and temperatures.

INTERNAL TEMPERATURES AND TIMES FOR FOOD PASTEURIZATION

Center Temperature, ºF	Time, 5D kill (Hamburger)	Time, 6.5D kill (Roast Beef)
130	86.42 minutes	112.34 minutes
135	27.33 minutes	35.53 minutes
140	8.64 minutes	11.23 minutes
145	2.73 minutes	3.55 minutes
150	51.85 seconds	1.12 minutes
155	16.40 seconds	21.32 seconds
160	5.19 seconds	6.74 seconds
165	1.64 seconds	2.13 seconds

Each one of the times and temperatures is equivalent. For example, if you want your food very rare, you can cook it to 130°F and hold it at that temperature for approximately 112 minutes. The food will be exactly as safe as that food cooked to 160°F and held for approximately 5 seconds.

The temperatures and times listed in the table are also sufficient to also destroy *E. coli* O157:H7 in food (e.g., ground beef). The FDA recommends cooking all ground meat products, particularly ground beef, to a temperature of 155°F for 15 seconds. At this temperature, the interior of the ground beef patty is still slightly pink if the meat is fresh. Juices can be any color. If the ground beef patty is old, the color of the meat can be brown at 140°F. Visual characteristics should not be used to judge doneness of any product. Center food temperatures must be measured with a good electronic thermometer.

When foods thinner than 2 inches are cooked on a typical grill, broiler or griddle to less than medium rare (150°F), the data in the table, ***INTERNAL TEMPERATURES AND TIMES FOR FOOD PASTEURIZATION***, show that it will require holding the products a few minutes so that the center gets a proper pasteurization temperature and time. The question then becomes, how to hold hamburgers at 140°F for approximately 8.6 minutes to get a 5D destruction. This is very easy to accomplish in an oven, but it is difficult to accomplish with grilled foods.

If you cook a rare hamburger or a soft poached or sunnyside-up egg, your food item probably will not be adequately pasteurized. Only 1 or 2 grams of food need to be undercooked to have enough surviving pathogens to cause diarrhea one or two days later. Be aware of the risk involved in eating under-cooked foods. If you eat raw meat regularly, you might have built up a high tolerance for pathogens such as *Salmonella* and *E. coli*. But, do not serve it to anyone else.

Cook thin, fast-cooked food such as eggs to above 150°F, and hold at 150°F for about 52 seconds. Cooking food to over 160°F is not necessary for safety. These are quality issues. For example, cooking turkey dark meat to 185°F is necessary to tenderize the muscle and produce a characteristic odor and flavor. If poultry reaches a temperature of 160ºF for a few seconds, it becomes safe.

As discussed earlier, home-canned foods can be eaten safely if the food is boiled for 10 minutes before it is tasted. This procedure ensures the destruction of any *Clostridium botulinum* toxin that may have been produced in the home-canned food. One might still be made ill by an emetic toxin from a microorganism, but it is not the deadly *Clostridium botulinum* toxin.

Remember, immune-compromised people are a special case. However, food cooked to *RECOMMENDED TIME* temperatures will be safe. Food does not need to be cooked to a well-done stage of over 170°F to make it safe.

Measuring Food Temperature to Assure Adequate Pasteurization

If you use a standard non-electric **dial stem thermometer** to measure food temperature, be very careful. It **can give a very inaccurate temperature reading**. There is a 1- to 2-inch-long bimetallic spring in the stem. The thermometer must be immersed in the food more than 3 inches, and the temperature reading is only the **average temperature** across the bimetallic coil, or about 3 inches up the stem from the tip. This temperature measuring device is suitable for measuring the temperature of liquid products such as soup, where the temperature throughout the product varies only 1°F, and items that are more than 3 inches thick. This type of thermometer gives a very inaccurate reading for thin food items such hamburgers, chicken breasts, steak, fish, etc. It should never be used to verify the temperature and safety of thin items of food. If it is used in roasting turkey or beef, put the point 1 inch

beyond the center, not at the center, so that the middle of the coil will be at the center of the roast.

To measure food temperature, use a device that will measure the temperature of thin foods correctly. A device called a **thermistor thermometer** works adequately for this purpose. It can measure the center temperature of a thick item such as a roast or a large casserole. It is important to measure the center temperature of a thick food because the center will cook slower than the portions nearer the food's surface. A thermistor thermometer can also measure the center temperatures of thin foods such as a hamburgers, steaks, fish fillets or a breast of chicken. The temperature measuring zone at the tip extends about 1/2 inch up from the tip. The food should be about 1 inch thick and the thermistor thermometer must remain in the food for about 20 seconds in the food to get an accurate center temperature reading. The thermistor thermometer is not always practical when cooking food because waiting 20 seconds for the unit to accurately indicate temperature is usually too long to wait to get a reading and decide if cooking should or should not continue.

The best food temperature-measuring device is a thermocouple thermometer. Thermocouple thermometers can be used to give a very rapid and accurate temperature indication. These devices can measure the temperature of very thin foods such as a pea, surface temperatures of food and the center temperature of large items.

The sensing point on a thermocouple thermometer is at the tip, which is about 0.040 inch in diameter. It is quite possible to measure the center temperature of food, even food that is only 1/4 inch thick, accurately. Another major advantage of the thermocouple is that it gives an accurate temperature reading in less than 3 seconds. By using a thermocouple thermometer, it is possible to measure the temperature of a hamburger or chicken breast while these foods are cooking in a pan or on a griddle and decide if the products have been sufficiently pasteurized.

To get the correct temperature of thin foods like a hamburger being cooked, the hamburger should be turned over 3 or 4 times during cooking so that it heats from both top and bottom. When it appears that the hamburger is close to being at the desired degree of doneness (i.e., 150ºF center temperature), turn the hamburger over and immediately push the thermocouple into the food at a 45° angle. As you push the thermocouple in, take readings. For example, you will see the temperature go from 170°F to 160°F to 150°F to 140°F, and then start back up again as the tip goes through the center of the food. This is the correct way to judge the core temperature of food. Do not merely put a thermometer in food and hope that you have found the cold spot.

Note: Many people who sell food thermometers have no idea how they work and their limitations. We can provide you with a thermometer suitable to your needs and provide precise information how to use it. See ***Appendix E (Food Safety Products and Services)*** at the end of this booklet if you are interested in ordering either a thermistor thermometer or a thermocouple thermometer.

Acidifying foods. Organic acids present in vinegar and lemon juice are very effective preservatives. Commercial mayonnaise and salad dressings made in the U.S. are very safe products because of the amount of acid in these products. These products actually improve the safety of foods to which they are added. When home-prepared mayonnaise is made with raw ingredients such as eggs, the final pH (acidity) of the mixed product must be below 4.1. The acid (vinegar or lemon juice) is used to inactivate any *Salmonella* from raw eggs that may get into the mayonnaise. To be on the safe side, buy mayonnaise and salad dressing from commercial producers who have quality control departments to assure safety. If you make your own mayonnaise, make sure that the pH is always less than 4.1. The pH must be less than 4.1 because *Salmonella* will multiply down to this level of acidity. In order to allow destruction of *Salmonella*, the mayonnaise or other acidified food must be held for 2 days at room temperature before it is used. If the mayonnaise is held in the refrigerator, it can take from 2 to 3 weeks for the same destruction of *Salmonella*, because the acid does not work as quickly.

It is difficult to judge the effectiveness of acidifiers without the use of a pH meter or pH indicator strips. If you want to measure pH, see ***Appendix E (Food Safety Products and Services)*** at the end of this booklet for information on how to order inexpensive pH indicator strips.

Mixing foods. Once they are washed and cut, some food ingredients are ready to be mixed together to make a cold food item, or they are ready to be cooked or pasteurized. If cooked foods (e.g., macaroni or potatoes) are to be used in a cold recipe item, they should be cooled to 40ºF after pasteurization, before they are combined. If they are cooked and pasteurized and cut up while still warm, they will be slightly contaminated with *Staphylococcus aureus* from the food preparer's hands. If the ingredients are mixed while warm, the microorganisms will be able to grow as the food cools from, for instance, 95 to 50°F. The hazards associated with this process can be avoided, if first, the food is correctly cooled to 40°F. The food can then be taken from the refrigerator and mixed with other ingredients. If the temperature of the entire mixture remains below 50°F, *Staphylococcus aureus*, which may be present on the hands of the food preparer and get into the mixture, will not be a problem because it does not produce toxin below 50°F. Other pathogens

that might get into the food grow very slowly and are not considered to be a problem if the refrigerated food is consumed within specified times. This procedure should be used for meat, poultry, fish and vegetable salads. Salad dressings, because of their acidity, contribute to the safety of mixed salads. Salad dressings should be cool before being mixed into products in order to keep the product temperature as low as possible.

Marinades, salad dressings and sauces are often used on raw meat, fish, poultry or vegetables for flavor. In this process, the marinades will become contaminated with pathogens from the raw food. Cross-contamination can occur if this contaminated marinade is used on other food items that will not receive further cooking. If marinades used on raw foods are to be used as a sauce to flavor other food items, the marinades must be heated to 160°F to inactivate any potential pathogens before the marinades are added to any other cooked or raw food items.

When raw foods such as pieces of chicken or fish are dipped in a batter prior to frying, the batter should be discarded within 4 hours. Raw batters become contaminated and provide a good media for pathogen multiplication.

Take only small amounts of food out of the refrigerator at a time. Return these ingredients to the refrigerator to re-cool if you are not going to use them or cook them within an hour. Keep cold food ingredient temperatures below 50°F (as close to 40°F as possible), especially when you cut or mix ingredients several hours prior to serving and eating (e.g., salad ingredients). This is very important when you prepare large quantities of food.

VIII. The Seven Basic Food Recipe Processes

Food preparation methods can be grouped into one of seven basic food recipe processes in terms of cooking and preparation to assure safety:

1. Thick foods
2. Thin foods
3. Stocks, sauces and brews
4. Fruits, vegetables, starches, cereals, nuts and fungi (mushrooms)
5. Batters and doughs
6. Hot combination dishes
7. Cold combination dishes.

The key is to pasteurize the food to decrease the number of vegetative, infective microorganisms such as *Salmonella* to a safe level, and to prevent the spores of *Clostridium perfringens*, *Clostridium botulinum* and *Bacillus cereus* from growing out into the food.

Thick Foods

Raw protein items, more than 2 inches thick and at least 1 inch from center to surface. Examples of this type of food include prime rib of beef, turkey, whole poached salmon and a basket of crab. These foods must be cooked at lower temperatures (225 to 325°F) for longer times (1 to 8 hours) than thinner foods to prevent undesirable factors such as surface burning, unnecessary shrinkage and water loss before the center reaches a safe temperature. As a rule, the thicker the food, the lower the cooking temperature, because there is enough time for the food to brown. Examples are:

1. Tenderloin of beef (400°F)
2. Stuffed 4-lb. poultry (350°F)
3. Turkey, 12 to 18 lb. and beef, 10 lb. (325°F)
4. Turkey and roast beef, more than 18 lb. (275 to 300°F).

These long-time cooking temperatures are enough to ensure the destruction of the vegetative cells. Do not take more than 6 hours to go from 50 to 130°F. Otherwise, the bacteria may grow during the "come up" time.

Spores survive most cooking processes. Large roasts and turkeys are often not served immediately. If they are held for more than 4 hours below 130°F prior to serving, the spores of the pathogen *Clostridium perfringens* will have a chance to germinate and multiply, and can cause diarrhea about 8 hours after the food is ingested. If the food is held for more than 4 hours above 130ºF, the quality deteriorates. Leftovers of thick foods such as large roasts are difficult to cool and reheat later. Slice large cuts of cooked leftover meat less than 2 inches thick or 1-inch cubes, and chill the meat to 40°F in less than 14 hours. Be very careful of cross-contamination from hands, cutting boards or utensils after the food is cooled and while it is being converted into a leftover dish. There will be some contamination of the surface of the food, but if the food is correctly cooled, this inhibits pathogenic bacteria multiplication.

Stuffed meat, poultry and fish products must be prepared very carefully in order to prevent any foodborne illness due to growth of pathogenic bacteria (notably *Salmonella*) in the stuffing. If a raw meat, poultry or fish is to be stuffed for later cooking, the stuffing should be prepared from cold ingredients and be at a temperature of 40°F before it is placed in the meat, fish or poultry product. If the product (e.g., a turkey) is to be cooked immediately, it can be stuffed with warm stuffing. When cooking stuffed meat, poultry and fish products, both the internal temperature of the stuffing and the meat must reach pasteurization times and temperatures. For safety and quality, it has been recommended that stuffings be cooked in a separate casserole or

container and then served with meat, poultry, or fish. Unstuffed poultry cooks faster than stuffed poultry. The time required to cook whole, large poultry may also be reduced by removing the legs and thighs, and cooking them separately. Thus, the cavity of the bird is opened up and cooking time is cut in half because heat can get to the middle.

Thin Foods

Raw protein items, less than 2 inches thick. Examples of thin items include small fish and fish fillets, chicken pieces, steaks, shallow pans of casseroles, pancakes, eggs and grilled sandwiches. These items can be solid or a mix of ingredients. They can be heated quickly, and therefore are cooked at high temperatures (250 to 400°F) for short periods of time (2 to 40 minutes). The key to safety is to heat them to an adequate center temperature for sufficient time to achieve pasteurization and destruction of possibly high levels of vegetative pathogens. Some of these items require a lot of handling prior to cooking and can be contaminated with many pathogens. Pasteurize these foods according to the table, ***INTERNAL TEMPERATURES AND TIMES FOR FOOD PASTEURIZATION***, on page 15.

Because they may be contaminated with *Salmonella,* raw or unpasteurized eggs should not be used in food products where no cooking is involved after the addition of the eggs. If the yolks or whites are not solid after cooking, the eggs have not been sufficiently pasteurized. The risk of *Salmonella* in eggs is only 1 in 20,000 eggs. If an individual prefers soft-cooked or over-easy eggs, that is his/her choice. There is a very low risk of illness. However, as a basic safety rule, under-cooked eggs should never be eaten by immune-compromised people such as children less than 5 years of age and persons who are over 70. These people could become so sick that they could die. Hard-cooked eggs and scrambled eggs that are cooked to temperatures above 150°F for over 52 seconds are really the only safe eggs for consumption until farmers can raise *Salmonella*-free chicken and begin to certify the production of *Salmonella*-free poultry and eggs.

After cooking, thin food items should be held above 150°F or eaten within 30 minutes, for quality. (For safety, it is above 130ºF for as long as you want.) Otherwise, place the items in the refrigerator within 2 hours in layers less than 1 inch thick so the food will cool before spores within the food grow out and multiply.

Stocks, Sauces and Brews

This category includes hot items such as beef broth, gravies, soups, tomato sauce, stocks, jams, jellies and custards, and cold items such as icings, cold salad dressings, sauces, batters, eggnogs, ices and ice cream.

Hot items can be mixed and heated rapidly. The temperature reached should always be higher than 160°F simply for quality reasons. Heating to this temperature destroys the vegetative cells. However, the spores survive. If these types of foods are to be held for a long time after cooking, they should be held at 130°F or more to assure that pathogenic spores are controlled. Usually, this food is held at 165°F for quality considerations. This is the temperature preference of most people for hot soup and coffee. Hot soups and beverages should be kept covered to prevent surface cooling and moisture loss.

Egg and heavy cream sauces, however, do not tolerate long hot holding times. The quality of these products is best if they are kept hot in a double boiler. Again, the temperatures are 130ºF for safety and 165ºF for quality.

Do not thicken soup and sauce items until about 10 minutes before service because it is difficult to keep thickened sauces at a uniform temperature. Hot stew, stocks, soups, and sauces are difficult to cool, so the goal is to minimize leftovers. Any leftovers must be cooled from 135 to 41ºF in less than 6 hours (FDA recommendation). The USDA recommendations state that, if the food is cooled from 120 to 55ºF in 6 hours, followed by further continuous cooling to 40ºF, the food will be safe. This is about 14 hours from 120 to 40ºF. To accomplish either the FDA or USDA standard, food should be cooled in containers at a depth of less than 2 inches.

One way to assure the safety of Hollandaise or Béarnaise sauces is to acidify these products to a pH of less than 4.1. This can be done by adding either vinegar or lemon juice in a ratio of 1 tablespoon per 8 ounces of water and egg. (All classic recipes that the author has tested were even more acid.)

Fruits, Vegetables, Starches, Cereals, Nuts and Fungi (Mushrooms)

Fresh fruits and vegetables must be washed to remove dirt, chemicals and contamination from soil, irrigation water and human handling. Once washed, these food items should be cooked in 1 hour or dried and chilled if they are to be used raw in cold salads and fruit dishes. Most fruits are sufficiently acidic to prevent the survival and growth of most pathogens. Items to be cooked or served later and that do not contain much acid (i.e., some melons and many vegetables) need to be kept cold (less than 40°F) and/or dry, and packaged loosely so that they are not air tight. Cooked and uncooked vegetables that are stored air-tight, or more than 1 inch deep, above 50°F, can become hazardous due to the growth of *Clostridium botulinum* and subsequent toxin production (e.g., vacuum packaged cole slaw or chopped broccoli mix). Some packages of produce such as mushrooms have 2 1/8-inch holes in the plastic wrap. The holes allow oxygen in the air to get inside the package and prevent the growth

of *Clostridium botulinum*, which grows without air. After cooking fruits and vegetables and cereal items such as pasta, keep them above 150°F for quality, 130ºF for safety, if you need to hold them, or cool the food to 40°F in less than 14 hours (USDA) [to 41ºF in 6 hours (FDA)]. When most grains and cereals are cooked, the spores survive, and if the food is allowed to sit at 80 to 120°F for 9 to 12 hours, the food may cause foodborne illness resulting in diarrhea and vomiting. All cooked cereal products should be eaten within 2 hours after preparation to ensure safety. Be aware that nuts and seeds, although not typically washed, might contain shell fragments, low levels of pesticides, and mold toxins. Also, coconut can be contaminated with *Salmonella*.

Batters and Doughs

Unbaked batters and doughs can be hazardous if not handled properly. Most of the ingredients, particularly raw eggs, contain infective microorganisms and spores. Batters (i.e., pancake or dipping batters), if not acidified to a pH of less than 4.1, must be stored until used at less than 40°F to prevent multiplication of pathogens. **Do not eat raw batters.** They may contain high levels of *Salmonella*. Once baked, these items pose little threat because they lose moisture, and the center of the food reaches temperatures that decrease the number of pathogens to a safe level. Fillings containing milk, meat or other high-protein foods need to be cooled to 40°F in less than 14 hours before using them with baked goods. Egg white meringue on pies can be hazardous because of *Salmonella* in the eggs. During baking, the point where the meringue touches the pie surface must reach 160°F for more than 1 second. Both pie and meringue need to cool to 40°F within 14 hours (USDA) [to 41ºF in 6 hours (FDA)].

Hot Combination Dishes

These dishes are prepared with combinations of meat, fish, sauce, starch, vegetables and/or fruit. Examples include beef stew, chicken a la king, chili, lasagna meat pies, spaghetti sauce and meatballs. When preparing these items, follow the cold food temperature rules and keep ingredients at less than 40°F until they are ready to be cooked. When cooked, they must get over a center temperature of 130°F in less than 6 hours and then be heated to an adequate pasteurization time and temperature. When these items are created from multiple ingredients and handled for extended times in a warm kitchen environment, they can become hazardous if they are below 130°F. Once these items are prepared, they should be kept at 150°F. (A temperature of 130°F is safe, but the temperature is too cool to please most people.) Serve and eat food items within 2 hours for quality, or cover less than 2 inches thick and cool to 40°F in less than 14 hours. Food prepared for use later, or leftover foods, should be stored at 40°F and used within 5 days.

Cold Combination Dishes

These items are made of the same food items as hot combinations but are prepared with cold ingredients, are kept cold, and are mixed with an acidified dressing (pH less than 4.1). Examples include tuna salad, egg salad, macaroni and ham salad, cold meat and cheese sandwiches. Items that require cooking prior to mixing, such as pasta, potatoes or meat items, should be cooked separately and chilled separately to 40°F. Uncooked items such as fruits should be washed and kept at 40°F prior to mixing.

Cold combinations can become very hazardous if not handled and stored properly to limit the growth of pathogens. Prepare salads with ingredients that have been pre-cooled to 40°F. Many ingredients, such as pasta and potatoes, can be cooled in ice water. If warm ingredients are used, there is a high risk for growth of illness-producing and spoilage microorganisms when mixed ingredients cool because they are usually prepared in large amounts and in very large containers. Mixing should be done quickly so that the ingredients do not warm above 45°F. During preparation, use sanitized utensils and containers. Contaminated spices and herbs will not cause a problem if mixed into cold ingredients. Avoid having leftovers by making small batches. Once prepared, cold combination dishes should be refrigerated at 40°F. These items can be stored easily in zipper-type plastic bags, which will give maximum surface cooling.

When you prepare cold salads with pasteurized ingredients, it is quite easy to get a final pH of below 5.3. Add a little lemon juice, vinegar, or red or white wine. While this pH does not assure safety, microorganisms grow much slower at this pH range vs. a more neutral pH range of 6 to 7. Items that are acidified to less than pH 4.1 with vinegar, lemon juice and other additives can be stored for long periods of time. In fact, they are room-temperature safe. Since there is no safety threat, only quality problems will occur due to the multiplication of spoilage microorganisms.

Keeping Food Safe During Serving

Pathogenic spores will survive cooking or pasteurizing and must not be allowed to grow out and multiply. Ready-to-eat food must not be contaminated with infective organisms from raw animal and vegetable sources or from human sources (e.g., fecal contamination when people does not wash their hands after using the toilet).

Note: For safety, keep hot food above 130°F, in the device in which it was cooked. Turn the control to a low setting or an appropriate temperature. Keep

the food covered. Otherwise, evaporative cooling from the food will drop the food temperature about 10ºF below the heat source temperature. For quality, people like their hot food hot, so keep hot entrees above 150°F, and soups and gravies above 165°F. Food that is above 170°F can cause burn injury to the mouth. Warn people about hot food that is at or above this temperature.

Remember to prepare food progressively, that is, as you need it, to avoid long holding times. Holding hot food too long at high temperatures deteriorates the quality of the food and reduces the nutritional value. For example, holding broccoli and cauliflower for 30 minutes at 150°F can reduce the vitamin C content of these vegetables by as much as 50%. Hot food will maintain optimum quality and nutrient value if eaten within 30 minutes after preparation. It is always a good idea to keep hot food covered to prevent evaporative cooling and heat loss. Keep serving utensils in the hot food to maintain sanitation of the utensils.

Avoid touching hot, pasteurized or ready-to-eat food with your hands. If you must, be sure to first wash your hands, fingertips and under the fingernails to remove pathogens. **Note:** To avoid contamination when tasting or evaluating foods, use a clean spoon or fork to serve or dip into the product. Place the sample in a bowl or on a plate. Taste using a clean spoon or fork.

Serve cold foods cold, below 50°F (preferably at 40°F). To maintain a cold temperature as long as possible, use a cold or ice-lined container if you are serving cold foods in a warm, ambient temperature (i.e., on a warm summer day). Do not let cold foods remain out of the refrigerator too long. Use progressive service and serve only what will be eaten in the next hour.

Measuring surface temperatures of food is useful if you have a hot or cold food item that you are holding hot or cold, and if you want to find out if the surface is losing its heat or cold. You can do this with a thermocouple thermometer.

Because of the possibility of random contamination of raw animal food (i.e., raw chicken, beef, oysters, etc.) **serving and eating products containing raw animal food is not recommended.**

Cooling Food Safely

Many of these points have been covered, but let's review them because they are critical. After food is pasteurized, there is still the critical problem of spores that survive cooking. All cooked or pasteurized food (e.g., vegetables, pasta, rice, meat, poultry, fish, etc.) is contaminated with pathogenic spores that will outgrow and multiply if food is not cooled to 40°F in less than 14 hours (USDA) [to 41ºF in 6 hours (FDA)]. A very easy way to cool food is to put it in a zipper-type plastic bag and pack it so that it is less than 2 inches thick.

Do not put food to be cooled on a solid shelf in the refrigerator, or stack pans or packages of hot food in a pan; 75% of the heat comes from the bottom of the pan, and cooling time is almost doubled if cold air does not flow across the bottom of the pan.

You can start by cooling food on the counter until it reaches 130°F, the temperature at which spores begin to germinate and multiply. Food will cool to this temperature within a short time, usually 15 to 30 minutes. As soon as the food reaches 130°F, it should be placed into the refrigerator for cooling. Try to put the food to be cooled in a area of the refrigerator where there is maximum air flow. Glass, metal, paper (not thick cardboard) or plastic containers may be used. The thickness or depth of the food being cooled is the most important factor.

Cover the food if you can. If you leave the food uncovered, it cools faster, but the surface becomes contaminated with mold and bacteria, and will spoil more rapidly.

Ice can be used very effectively for cooling. If you are making a gravy or cream sauce that you want to use later, make it with half the amount of liquid. After it is cooked and thick, add the other half of the liquid as ice or frozen liquid such as milk. Stir. The sauce will come to a safe 40ºF temperature in 5 minutes as the frozen liquid melts. Then, it can be stored safely in any size container in the refrigerator. When cooling ingredients such as chicken breast, noodles, diced potatoes, etc. for salad, you can cool them in iced water very easily and effectively. After these items are cold in a few minutes, shake off the excess water and make the salad.

Sometimes, there is the temptation to put food in a freezer to cool it rapidly. If the food can be stirred about every 15 minutes and there is adequate space in the freezer, this is acceptable. However, avoid putting food in the freezer without stirring it, because the outside becomes frozen, and because of the energy wasted in the freezing process, the center does not get colder any faster than it would in a refrigerator at 35ºF with the same air flow.

How to Handle Leftovers

For both quality and safety, refrigerated leftovers at 40°F must be eaten within 7.5 days. If the food temperature is 45°F, then leftovers should be eaten within 4 days.

A very simple, effective way to cool and store hot leftovers, to include soup and gravy, is in zipper-type plastic bags. The closure needs to be absolutely

secure for liquids, but if you handle the bags carefully after filling and closing, the bags cool very well because they have such a large surface exposed to the refrigerated air when laid flat.

Never mix leftover food with fresh food in the same container because the bacteria in the leftovers can contaminate the fresh food. As a result, the combined food item spoils even faster. If there are even a few pathogenic bacteria in the leftover food, they have a chance to grow again.

IX. Cleaning Up

Use cleaning procedures previously described in ***Use Clean Equipment***, beginning on page 12. Remember to first rinse or flush all soiled or dirty surfaces with water so that major amounts of soil are removed. This practice keeps the detergent solution used to wash equipment and surfaces cleaner, with lower bacteria levels. Surfaces will be no cleaner than the detergent solution used to wash them.

X. Picnicking

If you are going to take cold food to a picnic, follow these food safety rules:

1. Make sure the food time and temperature have not exceeded the limits shown in the table, ***MAXIMUM HOLDING TIMES AND TEMPERATURES***, on page 11, when you begin to serve.
2. Eat it or throw away food within 4 hours after it is put out. This time is an estimated limit based on the time and temperature factors that can cause 10 multiplications of pathogenic microorganisms.

Pack the food in ice and transport it in a cooler to keep it at 40°F or below. A typical cooler with 1 pound of ice per pound of food should remain cold enough for about 24 hours. Raw meat, poultry and fish should be packed so that juices will not leak onto ready-to-eat food.

If you want to save leftover picnic food, put out as little as possible at one time and use it up before more is taken out of the cooler. Again, a zipper-type plastic bag is a good package to use for this food because it is thin.

You can check the temperature of what is left. Follow the guidelines for safe food shown in the table, ***MAXIMUM HOLDING TIMES AND TEMPERATURES***, on page 11. If the food is at 60ºF or less and there is ice in the cooler, you can safely repack it less than 1 inch thick, provided you can get it home and in the refrigerator in less than 1 hour. It should be eaten the next day at the latest, or frozen immediately. Remember, salad with mayonnaise (and acid) will be less of a problem than cold, sliced beef, chicken or turkey.

If the food will not be consumed within this period of time, it should be thrown out. Again, this is an estimation of when the pathogens could have multiplied 10 times.

Hot items will be more of a problem. If they are at more than 130ºF when they come from the hot picnic storage chest, the spores have not started to germinate and grow out. If the hot food is in the sun on a table, it may be between 105 and 115ºF, the fastest pathogen-multiplying temperatures. After 4 hours, the food should be thrown out. If the food is 75ºF, you have 11 hours. If you want to save hot leftover food that has been left out, handle it the best you can. Eating these leftovers is not recommended. Do NOT serve them to children or elderly people, or anyone who is immune compromised.

Dry items such as cookies, potato chips, etc. do not need to be kept cool. Their quality may deteriorate, but they will remain safe. Iced desserts, on the other hand, should be treated as perishable items.

XI. Eating at Someone Else's Home

If you have a normal immune system, you need not worry about eating at someone else's home, unless you have a reason to suspect that the food was not prepared according to the rules in this booklet, or if the food has been left at room temperature for more than 4 hours. The quality will have deteriorated during that time, and some foods could have become unsafe. Get your food the first time through a buffet line, and do not go back 4 hours later unless you know there is fresh food. Food that is intended to be hot should be HOT, 150ºF. If it is intended to be cold, it should be COLD, less than 45ºF. If in doubt about a food item, eat something else. Remember, the person preparing and serving the food is legally responsible for the safety of the food.

XII. Catered Food

If you like to have catered parties at your home, ask the caterer for his/her Hazard Analysis and Critical Control Points (HACCP)* program. If you prepare food ahead of time and cater for large functions, you should have such a program. Caterers should be able to tell you the following:

1. Their attitude toward food safety (i.e., all raw and dried food has pathogens that they must control). Safety must be their first concern.
2. They know and can describe how to control the hazards.
   a. They have a thermocouple and use it to assure safe food.
   b. How to wash fecal pathogens off of their fingers.
   c. How to clean cutting boards and knives.
   d. How to pasteurize food. How to keep food hot.
   e. How to cool food.
   f. How to make cold mixed recipes such as chicken salad.
   g. How to "clean as they go."
3. They have trained their employees to perform with zero food safety defects.
4. They coach, supervise and continually improve employee performance.

There is no government requirement stating that all caterers must have HACCP programs. You must be the one to check the food. Make sure that cold foods have been kept cold and hot foods have been kept hot prior to serving. Hot leftover food needs to be cooled as described in ***Cooling Food Safely***, beginning on page 20, and cold food refrigerated as soon as possible after eating. If there are leftovers that have been on the serving line for a while, and you are not sure about the temperature of the food, the food should be discarded (thrown out).

XIII. Take-out Food

Illness-producing spores and perhaps vegetative cells are present in hot take-out food. Hot food cools to the ideal bacterial growth temperature range of 80 to 110°F in a short time (usually less than 30 minutes), and the spores in food begin to germinate. If hot food is not kept above 130°F, it should be eaten within 4 hours. If you want to save it, it must be placed 1 inch deep in a covered container, and put into the refrigerator within one hour after you receive it. It should cool to 40ºF in about 14 hours (USDA) [to 41ºF in 6 hours (FDA)].

If you need a longer time period to get food home or before the food is consumed, choose cold food (less than 40°F) that you can eat cold or can reheat. If this is the case, keep the food as close to 40°F as possible and eat it within 7.5 days for quality.

XIV. Dining Out Safely

People usually do not think about food safety when they dine out, unless they have had a number of bad experiences. Certainly, they are less likely to return to a restaurant that they suspect caused them to become ill.

Most restaurants have no HACCP food safety programs. They follow the FDA Food Code and state and local food codes, and they look clean, but that has little to do with food safety. If the outside of the restaurant is not maintained, the toilet facilities are dirty, and the dining area is dirty, it is a risk to eat at that restaurant. While these factors have nothing to do with safety, they show that the owner and manager do not understand the basics of good foodservice management. If they do not know how to meet these basic requirements for customer satisfaction, there is a poor chance that they will serve safe food. Even when you go into a clean facility, if the hot food is cool and the cool food is warm, stop. Do not eat this food unless you really do not care about becoming ill.

Having completed this food safety booklet, you know as much about food safety as many restaurant managers. Ask the manager of your favorite restaurant if the restaurant has a HACCP food safety assurance program. Just as with the HACCP criteria listed in ***XII. Catered Food***, on page 22, the restaurant operator or manager on duty should tell you about the restaurant's employee training program. When you talk with employees, they should know the information in this booklet. If they say that management gave them no food safety training, dine elsewhere. Remember, the food employee, just as you are when you prepare food at home, is the critical control point for food safety.

If you ask to take your leftover food home in a "doggie bag," remember, the food is already somewhat cool. Eat it within 2 hours, or put it into the refrigerator in a thin layer less than 1 inch thick as soon as you get home. Remember, spores are outgrowing in this food.

Be aware of any allergies you may have. Ask the wait person about ingredients used to prepare food items that you may want to order. This includes food chemical ingredients such as monosodium glutamate or aspartame, or the presence of specific foods such as milk, eggs, wheat flour,

* A program whereby the manager, through employee training, support and enforcement, assures that the food produced by his/her organization is consistently safe and provides customer satisfaction.

fish or nuts, which can cause violent reactions and even death for some people. The wait person should not guess at ingredients. It would be wise for people with specific allergies to ask the cook, who should then look at the recipe or ingredient lists on the labels of the food used in the recipe.

If you are immune compromised, and the food establishment has no HACCP program, do not eat cold buffet food or from salad bars. Eat these foods as home, where you know how they are prepared. Eat hot food when you dine out, or cold food such as cheese and commercially prepared deli meat on a sandwich.

XV. Summary

This booklet has described in detail what you must do to control the pathogenic substances in food, and why. Below is a brief summary.

1. **At home**
   a. Make sure that you use tested, safe water, or get tested, safe water.
   b. If you use a septic system, be sure that it cannot leak into the water system.
2. **When shopping**
   a. Choose raw produce items that appear fresh. They should not be overripe, too limp, too wet, or bruised or injured.
   b. Choose raw meat, fish and poultry that appear fresh (good color, firm texture, absence of slime and strong odor). Observe sell-by / use-by-dates on these products. Place these items in a plastic bag to prevent drippings from getting on other purchases.
   c. Observe the use-by date on all products, including frozen items.
   d. Do not purchase unsealed, broken packages or cans with swollen or dented seams.
   e. Make certain that all chemical items (cleaners, soaps, air fresheners, etc.) are tightly sealed to avoid leakage. Pack chemical items separately from food items.
   f. Pack frozen and refrigerated items together in order to maintain their cold temperature.
   g. If you have a long ride home, you may want to bring a cooler in which to pack cold items in order to maintain their temperature.
3. **After shopping, unloading groceries in the home**
   a. Store items as soon as possible.
   b. Freeze or refrigerate cold items.
   c. Keep unwashed produce separate from washed produce.
   d. Do not wash fruits and vegetables until you are ready for them.
   e. Store raw meat, fish and poultry items in the refrigerator below washed, pasteurized and ready-to-eat items.
   f. Store chemicals in a separate area, away from food items.
   g. Look for hard foreign objects in the food.
4. **Preparation**
   a. Make sure that all food contact surfaces such as knives and cutting boards are washed before use.
   b. Wash your hands using the double hand wash method with a fingernail brush prior to handling food.
   c. Make sure that raw fruits and vegetable items are safe by double washing them in safe water prior to cutting, mixing, serving or eating them.
   d. Food items that require cooking must be cooked so that they reach pasteurization temperatures for a given period of time. The lower the pasteurization temperature, the longer the food must be held at that temperature. Use a thermistor or preferably a thermocouple thermometer to verify pasteurization temperatures.
   e. Food items that need to be cold must be no more than 2 inches thick and returned to the refrigerator as soon as possible after preparation.
   f. Make cold combination items such as tuna salad with ingredients pre-cooled to 40ºF. Immerse food such as hot macaroni or cubed potatoes for potato salad in water with ice for rapid cooling.
   g. Avoid cross-contamination of food products. Keep work surfaces and equipment clean by using the "clean-as-you-go" method. Use a scrub brush as much as possible. Avoid sponges. Always clean food contact surfaces when working with different food items, particularly between preparing raw and cooked food items. Keep your hands clean with a single hand wash, particularly after handling unwashed or unpasteurized raw food.
   h. For cooked foods, pasteurize to sufficient times and temperatures to ensure the destruction of pathogenic vegetative cells. Cover foods cooked in a microwave oven to ensure uniform heating of the surface.
5. **Serving**
   a. Serve food as soon as possible after cooking. Keep food above 130°F for safety and 150°F for quality. If the temperature is less than 130°F, in the 80 to 120°F temperature range, use it within 4 hours or throw it out. Follow the table, ***MAXIMUM HOLDING TIMES AND TEMPERATURES***, on page 11.
   b. Avoid cross-contamination of ready-to-eat food by using clean serving utensils and by keeping your hands clean.

c. Cover hot foods to keep the surface hot and to prevent surface evaporation.

6. Leftovers

a. Cool and store leftovers as soon as possible. Very hot items can be cooled at room temperature for approximately 30 minutes, to 130ºF, prior to being refrigerated. Frequent stirring accelerates the cooling at this stage.

b. Place hot items in a thin layer, no more than 2 inches (1 inch center to surface), in a shallow container so that they will cool safely in the refrigerator, preventing spore outgrowth. Place the container on wire refrigerator shelves to allow air to flow across the bottom of the container of cooling food. This practice allows food to cool twice as fast as sitting on a solid shelf. It is best to cover hot food to keep the surface clean. If the temperature on your porch or in your garage is 25 to 40ºF, and you have a fan, you have a "blast cooler." Put covered food about 4 inches away from the front of the fan in this cold spot, and food will cool 3 times faster than it would cool in your refrigerator.

c. Never add leftover food to fresh food.

d. Use ready-to-eat foods and leftovers if they have been handled carefully, within 7.5 days when stored at 40°F in a refrigerator.

e. If you reheat food, remember, if toxin was produced in the cooked food due to improper handling, reheating will not make it safe. "If in doubt, throw it out," if you are unsure about how it was handled. NEVER use your nose, eyes or taste buds to judge the safety of food. Use them to judge the taste, texture and overall quality.

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APPENDIX A

CHEMICAL HAZARDS

Poisonous Substances
- Toxic plant material
- Intentional (GRAS) food additives (added in excess)
- Chemicals created by the process
- Agricultural chemicals
- Antibiotic and other drug residues in meat, poultry, and dairy products
- Unintentional additives
- Sabotage
- Equipment material leaching
- Packaging material leaching
- Industrial pollutants
- Heavy metals
- Radioactive isotopes

Adverse Food Reactions (food sensitivity)
- Food allergies
- Food intolerances
  - Metabolic disorder-based reactions
  - Pharmacological food reactions
- Idiosyncratic reactions to food
- Anaphylactoid reactions

Nutrition
- Excessive addition of nutrients
- Nutritional deficiencies and/or inaccurate formulation of synthesized formulas
- Anti-nutritional factors
- Destruction and unnecessary loss of nutrients during processing and storage
- Inaccurate nutritional labeling

APPENDIX B

PHYSICAL MATERIAL HAZARDS

Material	Potential Injury	Sources
Buckshot	Choking, broken teeth	Wild game, ground beef
Screening	Lacerations in the mouth, choking, broken teeth	Grain and cereal processing
Pits	Choking, broken teeth	Fruits (e.g., cherries, plums, olives)
Stones and dirt	Choking, broken teeth, trauma	Vegetables, cereals (from harvesting areas)
Bones	Lacerations in the mouth, choking, broken teeth, may take surgery to remove	Meat, fish, and poultry (improper processing)
Whole spices and herbs	Choking and trauma	Bay leaves, peppercorns, whole all-spice left in products after preparation
Glass	Cuts, bleeding; may require surgery to find, remove, or repair	Bottles, glasses, light fixtures, glass bowls and covers, etc.
Metal pieces	Cuts, infection, choking; may require surgery to remove	Broken utensils; metal staples and nails from cardboard boxes; bolts, screws, and other equipment parts; metal shavings from cans caused by sharp can opener; bits of steel wool
Pieces of wood	Cuts, infection, choking; may require surgery to remove	Toothpicks, wooden skewers, pieces of building material, twigs
Insulation	Choking, long term effects if asbestos insulation	Construction material
Plastic	Choking, cuts, may require surgery to remove	Packaging material, construction material
Personal effects	Cuts, choking, broken teeth, may require surgery to remove	Stones or settings from rings, earrings, beads, or other jewelry; buttons, pins, safety pins; tie clips and tie tacks; gum, cigarettes and ashes; hair; Band-Aids; artificial fingernails, contact lens; pens, pencils; threads of cloth
Insects and rodents, their parts and excreta	Illness, trauma, choking.	Entrance of insects and rodents from surrounding environment or in packaging material; failure to keep facility clean

APPENDIX C

PATHOGENS IN FOOD

FOOD	PATHOGENS	
	Infective	**Toxin and/or spore producers**
Meat, poultry and eggs	*Salmonella* spp. *Campylobacter jejuni* *Escherichia coli* *Yersinia enterocolitica* *Listeria monocytogenes* *Trichinella spiralis*	*Staphylococcus aureus* *Clostridium botulinum* *Clostridium perfringens* *Bacillus cereus*
Fin fish	*Salmonella* spp. *Vibrio* spp. *Yersinia enterocolitica* Hepatitis A virus	*Staphylococcus aureus* *Clostridium botulinum* Microbial by-products (Histamine poisoning)
Shellfish	*Salmonella* spp. *Vibrio* spp. *Yersinia enterocolitica* *Shigella* spp. Hepatitis A virus Norovirus	*Staphylococcus aureus* *Clostridium botulinum* Microbial by-products (Paralytic shellfish poisoning)
Fruits and vegetables	*Salmonella* spp. *Listeria monocytogenes* *Shigella* spp. Hepatitis A virus Norovirus *Giardia lamblia*	*Clostridium botulinum* *Staphylococcus aureus* *Bacillus cereus*
Cereal, grains, legumes and nuts	*Salmonella* spp. Aflatoxins (mold) Hepatitis A virus Norovirus	*Clostridium botulinum* *Clostridium perfringens* *Bacillus cereus*
Spices	*Salmonella* spp.	*Clostridium botulinum* *Clostridium perfringens* *Bacillus cereus* *Staphylococcus aureus*
Milk and dairy products	*Salmonella* spp. *Campylobacter jejuni* *Escherichia coli* *Yersinia enterocolitica* *Listeria monocytogenes*	*Clostridium perfringens* *Bacillus cereus* *Staphylococcus aureus*

APPENDIX D

ILLNESSES OR DISEASES ATTRIBUTED TO FOOD

Cause of Illness or Disease, Symptoms and Onset Time	Median Duration (days)
Allergens, Metals, Chemicals and Poisons	
Allergens in food (sensitized individuals) Sensitized persons have life-threatening allergic reactions to nuts, eggs, fish, milk, wheat, etc. Reactions include respiratory failure, hives, rashes, nausea, vomiting, etc. Anaphylactic reactions are severe and require immediate medical attention. Onset time = a few minutes to hours	
Heavy metals (copper, tin, lead, zinc) Metallic taste, nausea, vomiting. Duration of illness dependent on retention of amount consumed. Onset time = a few minutes to hours	
Monosodium glutamate (MSG) Burning sensation in back of neck, forearms, chest; feeling of tightness; tingling; flushing; dizziness; headache; nausea. Onset time = a few minutes to hours	A day or less
Poisonous mushrooms Both gastrointestinal and neurologic symptoms, may be fatal. Onset time = a few minutes to hours	Days to weeks
Microbiological **Fish toxins** (PSP, ciguatera and others) Both gastrointestinal and neurologic symptoms, may be fatal. Onset time = a few minutes to hours	Days to years
Bacillus cereus (emetic toxin) Nausea, vomiting, occasionally diarrhea. May resemble *S. aureus* intoxication. Onset time = 1/2 hour to 5 hours	Less than 1 day
Staphylococcus aureus (toxin) Nausea, vomiting, retching, abdominal pain, diarrhea, prostration. Onset time = 2 to 7 hours	Less than 1 day
Clostridium perfringens Abdominal pain, watery diarrhea. Onset time = 8 to 22 hours	Less than 1 day
Bacillus cereus (diarrheal) (Simulates *C. perfringens* gastroenteritis). Abdominal pain, nausea, watery diarrhea. Onset time = 8 to 14 hours	Less than 1 day
***Salmonella* spp.** Abdominal pain, diarrhea, chills, fever, nausea, vomiting, feeling of ill health, loss of appetite. Onset time = 6 to 72 hours	Usually 2 to 5 days. Some 10 days or longer.
***Shigella* spp.** Abdominal pain, diarrhea, stools may contain mucous and blood. Onset time = 1 to 7 days	Less than a week
Escherichia coli (various types - general) (Simulates shigellosis or cholera.) Abdominal pain, diarrhea, stools may contain mucous and blood. Fever may or may not be present. Onset time = 1 to 7 days	Days to weeks
Streptococcus (Group A) Sore throat, fever, nausea, vomiting, rhinorrhea, tonsillitis, sometimes a rash. Onset time = 1 to 3 days	Days to months
Clostridium botulinum (toxin) Gastrointestinal symptoms precede initial neurologic symptoms of vertigo, double or blurred vision, difficulty in speech and swallowing, progressive nervous system involvement and paralysis. Onset time = 2 hours to 8 days	In those who survive, respiratory paralysis may last weeks to months
Listeria monocytogenes Fever, headache, nausea, vomiting, diarrhea precede complications of stillbirths, meningitis, encephalitis, sepsis. Onset time = 4 to 21 days	Days to a weeks
Vibrio cholerae Abdominal pain, nausea, vomiting, diarrhea, fever, chills, and headache. Onset time = 1 to 3 days	Days
Vibrio parahaemolyticus May cause profuse watery diarrhea and dehydration, fever. Onset time = 2 to 5 days	2 to 5 days
Yersinia enterocolitica Gastroenteritis with diarrhea, and/or vomiting; fever and abdominal pain are common symptoms. May mimic appendicitis. Onset time = 1 to 3 days	Days to weeks
Viruses **Hepatitis A virus** Fever, general feeling of ill health, loss of appetite, tiredness, nausea, abdominal pain, jaundice. Onset time = 10 to 50 days	Weeks to months
Norovirus Nausea, vomiting, abdominal pain, diarrhea, low grade fever, chills, general feeling of ill health, loss of appetite, headache. Onset time = 16 to 48 hours	48 hours

Cause of Illness or Disease, Symptoms and Onset Time	Median Duration (days)
Parasites	
Parasitic protozoa (*Cryptosporidium, Entamoeba histolytica, Giardia lamblia*) Diarrhea, abdominal pain, plus other symptoms characteristic of parasite. Onset time = 5 days to 2 weeks	Weeks to years
Parasitic protozoa (*Toxoplasma gondii*) Fever, headache, aching muscles, rash. Severe complications for pregnant women and fetuses, and infants. Fatalities occur in infants and adults. Onset time = 10 to 13 days	Weeks to years
Other parasites (tapeworms, pinworms, *Trichinella spirallis*) Some gastrointestinal symptoms, other symptoms are dependent on organs or tissue affected. Onset time = days to weeks	Weeks to years

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APPENDIX E

FOOD SAFETY PRODUCTS AND SERVICES

Prices are correct as of October 2008. Call the telephone number listed below for latest price and product information. Minnesota sales tax will be added to all items delivered in Minnesota. St. Paul sales tax will be added to all items delivered in St. Paul, Minnesota.

For home use, we recommend the following two devises to correctly measure food temperatures.

Thermistor pocket thermometer $23.50

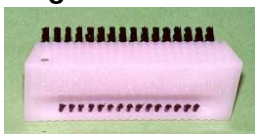
An inexpensive unit to provide a simple, method for measuring food temperature in the home. Has a thin tip (1.6 mm) for a quick response time. When placed in food, it takes about 6 seconds to give a reading. It can measure food that is 1 inch thick or more.

Thermocouple thermometer $160.00

You cannot pasteurize food if you cannot accurately measure food temperature. The bimetallic coil thermometer is totally inadequate. This thermocouple thermometer, which HITM currently sells, is also suitable for health inspectors and food service managers that test internal portion temperatures. Other pocket thermometers take at least 20 to 30 seconds to reach a full reading, while the thermocouple sensor on this unit has a 4-to-5 second total response time. The probe has a sharp, reduced-diameter sensing tip, which requires minimal immersion depth. This makes it usable even with thin portions, and it leaves a tiny, self-sealing hole. The probe swings open to switch on instrument and can be angled to suit usage.

We provide a professional fingernail brush to remove pathogens from fingertips and under fingernails.

Fingernail brush $3.50



This brush is a high-quality surgeon's scrub brush with added short bristles on one side to remove dirt and pathogens from under the fingernails.

To measure pH, use these pH indicator strips.

colorpHast® Indicator Strips, pH 0-14; 0-6; 2.5-4.5.... $24.00

We offer three different pH range measurements with these kits. A kit of 100 strips is used to measure pH within a range of 0 to 14 or 0 to 6 or 2.5-4.5 for increased accuracy when measuring acid foods.

For more detailed information, please request the following document.

*Please visit our website, **http://www.hi-tm.com**, for an updated list of our educational and product offerings as well as current information on a wide variety of food safety topics.*

To purchase these and other items sold by HITM, please contact:

Hospitality Institute of Technology and Management
670 Transfer Road, Suite 21A, St. Paul, MN 55114
TEL: (651) 646-7077; FAX: (651) 646-5984
info@hi-tm.com

	°F	
	250	**3 min. to kill 10^{12} *C. botulinum* spores/gram**
		Pasteurization Time for kill of wet *Salmonella*, 5D
		10^5 to 1
	165	1.6 sec.
	160	5.2 sec.
	155	16 sec.
	150	52 sec.
	145	2.7 min.
	140	8.6 min.
	135	27 min.
	130	86 min.
		Maximum Holding (1) (eat or throw out)
	115	4.6 hours
	110	4.7 hours
	105	5.2 hours
	100	5.9 hours
	95	6.8 hours
Heat <6 hrs.	**90**	7.9 hours
	85	9.3 hours
	80	11.2 hours
	75	13.6 hours
Cool <2 inches deep	**70**	16.9 hours
	65	21.6 hours
	60	1.2 days
	55	1.7 days
	50	2.4 days
	45	4.0 days
	41	6.5 days
	40	7.5 days
	35	19.3 days
	30	123.8 days
	<30	Safe chilled food holding
	28	Meat, poultry, fish thaw
	23	Spoilage bacteria begin to multiply
	14	Yeasts and molds begin to multiply

(1) 10 multiplications of pathogens

FOOD QUALITY	°F	FOOD SAFETY
Commercial food sterilization	←250→	Commercial sterilization of food *Clostridium botulinum* types A and B spores destroyed in 3 minutes
Coffee, soups, etc.	←170→	Skin instant burn
Milk pasteurization	←161→	15-second holding; 10-day shelf life 40°F
Beef well done Chicken rare	←160→	*Salmonella* 5D* pasteurization in 5.2 seconds
Hot food satisfaction	←150→	*Salmonella* 5D* pasteurization in 52 seconds
Beef rare	←140→	*Salmonella* 5D* pasteurization in 8.6 minutes
Very rare roast beef FDA mandatory minimum doneness temperature for beef	←130→	Food is safe *Salmonella* 5D* pasteurization in 86 minutes Cool food to 40ºF in 14 hours (USDA), 2 inches deep.
DANGER ZONE	127.5→	Highest growth temperature for a pathogen (*Clostridium perfringens*)
	115→	Highest growth temperature for *Salmonella* and most pathogens
	97→	*Salmonella* and *Staphylococcus aureus* multiply once every 20 minutes
	59→	*Clostridium perfringens* begins to multiply
	50→	*Clostridium botulinum* types A and B, and *Staphylococcus aureus* begin to make a toxin Cook food from this temperature to above 130ºF within 6 hours
	44→	*Staphylococcus aureus* begins to multiply
	41→	*Salmonella* begins to multiply
	38→	*Clostridium botulinum* type E begins to multiply
	30→	Some pathogenic bacteria begin to multiply.
Meat, fish and poultry thaw	←28	
	25→	Spoilage bacteria begin to multiply
	15→	Molds and yeasts begin to multiply
	0→	Food enzymes and chemical reactions cause slow deterioration in quality
	-40→	Food very stable for long-term storage

* Reduces *Salmonella* in wet food 100,000 to 1 (10^5 to 10^0)