Foods contaminated with pathogenic microorganisms (Salmonella, Campylobacter, and E. Coli, for example) have caused serious foodborne illness.

Although the US food supply is one of the safest in the world, every year 76 million people are infected by foodborne illness, 300,000 are hospitalized, and 5,000 die.
Foodborne illness, sometimes wrongly called "food poisoning," is caused from eating food that is contaminated with certain disease causing bacteria, viruses, parasites or toxins produced by microorganisms.

Foodborne illness is also caused by eating foods contaminated with poisonous chemicals, such as heavy metals or pesticides.

Also, some consider food allergies a form of foodborne illness.

The vast majority of foodborne illness is caused by bacteria, viruses, and parasites.
Foodborne transmission of pathogenic and toxigenic microorganisms has been a recognized hazard for decades.

Half a century ago we knew about the dangers of *botulism* from under-processed canned foods; *staphylococcal* poisoning from unrefrigerated cream-filled pastries, sliced ham, meat, and poultry salads; and *salmonellosis* from infected animal products.

Changes in preservation techniques and failure to follow recognized procedures have created new dangers.

- We now recognize new organisms that can cause foodborne illness—*Listeria monocytogenes*, *Escherichia coli O157:H7*, *Campylobacter jejuni*, *Vibrio parahaemolyticus*, *Yersinia enterocolitica*, and others.
- Controlling these organisms will require widespread education and possibly new regulatory initiatives.
Causes of Foodborne Illness

- There are nearly 250 different types of bacteria, viruses and parasites that are known to cause foodborne illness.
- A few of these are very common and account for the majority of cases of illness.
- Some cause serious diseases or death, but most cause only a mild illness ranging from slight discomfort to more serious symptoms such as diarrhea, fever, vomiting, abdominal cramps and dehydration.
Preventing Foodborne Illness

- Education
  - It is true that much can be done by farmers, ranchers, meat packers, food manufacturers and government food safety inspectors to make food safer
  - Until everything else in the food supply chain works as it should, YOU are your best protection against foodborne illness
  - The vast majority (85% to 95%) of reported cases of foodborne illness are caused by food handling errors in the home or by workers in a restaurant or commercial kitchen
  - Foodborne illness could be reduced by 90% if everyone learned simple safe food handling and preparation procedures.
Food Preservation methods

- Drying
- Freezing
- Thermal Processing
- Non-thermal processing
Drying

- Food dehydration is interpreted as the removal of moisture from a food product.
- To distinguish this process from evaporation, additional specifications related to characteristics of the final product are usually required.
- There are many objectives of dehydration as applied to food products, probably the most important being to preserve the product during prolonged storage.
Preservation of food by freezing occurs by several mechanisms.

The reduction of the product temperature to levels below 0°C causes a significant reduction in growth rates for microorganisms and the corresponding deterioration of the product due to microbial activity.

The same temperature influence will apply to most other reactions that might normally occur in the product, such as enzymatic and oxidation reactions.
In the food industry, thermal processing refers to the heating, holding, and cooling process required to eliminate the potential for foodborne illness.

Pasteurization is one type of thermal processing designed to treat a specific pathogenic microorganism, but it requires refrigeration to result in a shelf-stable product.

Commercial sterilization is the process that leads to a shelf-stable product in cans and other containers.
Canning
Pasteurization
Sterilization
Aseptic
Canning

- Heat sufficient to destroy microorganisms is applied to foods packed into sealed, or "airtight" containers.
- The canned foods are then heated under steam pressure at temperatures of 240–250°F (116–121°C).
- The amount of time needed for processing is different for each food, depending on the food's acidity, density and ability to transfer heat.
- For example, tomatoes require less time than green beans, while corn and pumpkin require far more time
The heating of every particle of milk or milk product to a specific temperature for a specified period of time without allowing recontamination of that milk or milk product during the heat treatment process.

There are two distinct purposes for the process of milk pasteurization:

1. **Public Health Aspect** – to make milk and milk products safe for human consumption by destroying all bacteria that may be harmful to health (pathogens).

2. **Keeping Quality Aspect** – to improve the keeping quality of milk and milk products. Pasteurization can destroy some undesirable enzymes and many spoilage bacteria. Shelf life can be 7, 10, 14 or up to 16 days.
Sterilization

- Pasteurization conditions effectively eliminate potential pathogenic microorganisms,
- But it is not sufficient to inactivate the thermoresistant spores in milk.
- The term sterilization refers to the complete elimination of all microorganisms.
- The food industry uses the more realistic term "commercial sterilization"; a product is not necessarily free of all microorganisms, but those that survive the sterilization process are unlikely to grow during storage and cause product spoilage.
Milk can be made commercially sterile by subjecting it to temperatures in excess of 100° C, and packaging it in air-tight containers.

The milk may be packaged either before or after sterilization.

The basis of UHT, or ultra-high temperature, is the sterilization of food before packaging, then filling into pre-sterilized containers in a sterile atmosphere.

Milk that is processed in this way using temperatures exceeding 135° C, permits a decrease in the necessary holding time (to 2–5 s) enabling a continuous flow operation.
Aseptic processing is a high-temperature, short-time process which results in products with improved texture, color, flavor, and nutritional value, compared to conventional canning.

This technology involves the filling of pre-sterilized containers with a commercially sterile cooled product, followed by aseptic hermetic sealing with a pre-sterilized closure in an atmosphere free of microorganisms.
Non-thermal processing

- High hydrostatic pressure
- Oscillating magnetic field
- High intensity pulsed electric fields
- Intense light pulses
- Irradiation
- Hurdle technology
Foods "pasteurized" by HHP undergo pressures of up to 80,000 psi at or near ambient temperatures (under 45°C). Under these conditions, HHP is effective in inactivating most vegetative pathogens commonly found in the foods. Commercially available HHP-processed products in Europe and Asia include juices, jams, jellies, meat and yogurts. Consumers in this country can buy HPP-processed guacamole and oysters. Food processed by HHP reportedly has better retention of flavor, texture, color, and nutrients.
This 35-liter high-pressure batch unit from Flow International can process up to 700 lbs. an hour and is designed for prepackaged products such as bottled juices. Units with capacities up to 300 liters are available. Food scientists are optimistic about hydrostatic pressure's ability to extend shelf life and produce safe food.
Microorganisms are typically found in many foods. Some microorganisms are harmless and will only spoil food. But other microorganisms such as *E. coli* 0157–H7 in fresh juice or *listeria Monocytogenes* in ready to eat meats can make some people very ill.
HHP processing

- High Pressure can kill microorganisms by interrupting with their cellular function without the use of heat that can damage the taste, texture, and nutritional value of the food.
HHP processing

- Hydrostatic pressure creates no shear force to distort food particles.
- Thus, any moist food such as a whole grape can be exposed to ultrahigh-pressures without being crushed.
- You can create a hydrostatic pressure by squeezing on a water filled plastic bottle.
- No matter how hard you squeeze, you can not crush a grape placed inside.
One of the unique advantages of ultrahigh-pressure processing is that pressure transmission is instantaneous and uniform.

Pressure transmission is not controlled by product size and no edge or thickness effect takes place.

The "mechanism" of high-pressure based bacteria kill is low energy and does not promote the formation of new chemical compounds, "radiolytic" by-products, or free-radicals.

Vitamins, texture and flavor are basically unchanged.

For example, enzymes can remain active in high pressure produced orange juice.
Fruit Juice treated with HHP

- Juice tests have shown that food pathogens such as salmonella and E.coli 0157:H7 can be effectively destroyed without changing the fruit juice's fresh, natural characteristics.

- A pressure exposure of 80,000 psi for 30 seconds can achieve a 3–5 log reduction of all of the pathogens of concern in fresh juice.
Another example of food safety is the destruction of *Vibrio* bacteria in raw oysters without destroying the raw feel and taste of the oyster.

A pressure of 200 to 300 MPa for 5 to 15 minutes at 25C inactivated a variety of raw oysters.
High Intensity Pulsed Electric Field

- HIPEF processing involves the application of pulses of high voltage (typically 20 – 80 kV/cm) to foods placed between 2 electrodes.
- HIPEF treatment is conducted at ambient, sub-ambient, or slightly above ambient temperature for less than 1 s, and energy loss due to heating of foods is minimized.
- For food quality attributes, HIPEF technology is considered superior to traditional heat treatment of foods because it avoids or greatly reduces the detrimental changes of the sensory and physical properties of foods.
- Although some studies have concluded that PEF preserves the nutritional components of the food, effects of PEF on the chemical and nutritional aspects of foods must be better understood before it is used in food processing.
Static (SMF) and oscillating (OMF) magnetic fields have been explored for their potential as microbial inactivation methods.

For SMF, the magnetic field intensity is constant with time, while an OMF is applied in the form of constant amplitude or decaying amplitude sinusoidal waves.

The magnetic field may be homogeneous or heterogeneous – in a homogeneous magnetic field, the field intensity B is uniform in the area enclosed by the magnetic field coil, while in a heterogeneous field, B is nonuniform, with the intensities decreasing as distances from the center of the coil increases.

OMF applied in the form of pulses reverses the charge for each pulse, and the intensity of each pulse decreases with time to about 10% of the initial intensity.
A local high-tech manufacturer is offering a potential first line of defense against bioterrorist postal attacks.

A prominent former politician is heading up the firm's efforts to market the technology.
Food Irradiation

- Identified by the FDA and World Health Organization (WHO) as having significant strategic importance for the future of food safety worldwide
- Non-thermal technology for pasteurization of solid food
- Improves food Safety and shelf-life economically
- Can kill *Salmonella* and *E. coli*
Food Irradiation

- Destroys insects and parasites
- Inhibits sprouting in crops
- Eliminates disease causing microorganisms in food
- Extends the shelf life of perishable products
- Delays ripening and spoilage of fresh fruits and vegetables
- Sterilizes herbs, spices
# Use of Irradiation in Food Products

<table>
<thead>
<tr>
<th>Dose Level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low doses up to 1 kGy (1 Gy = 1 Joule/Kg)</td>
<td>Inhibit Sprouting and delay fruit ripening</td>
</tr>
<tr>
<td>Medium doses (1-10 kGy)</td>
<td>Reduce the risk of food pathogens and increase shelf life</td>
</tr>
<tr>
<td>High doses (&gt; 10 kGy)</td>
<td>Achieve sterility</td>
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Ionizing Radiation

- Emission and propagation of energy through space or through a material medium
- Radiation must carry kinetic energy or quantum energies in excess of 4–25 eV to be called ionizing
- High energy absorbed by nuclear structures can kill a cell directly or by the formation of highly reactive chemical species such as free radicals
- Consists of exposing the food product to a source of either gamma rays, X-rays, or an electron accelerator
Types of Radiation

- Gamma rays
  - Electromagnetic radiation emitted from Co-60 and Cs-137
  - Deep and uniform penetration in all directions
  - Exponentially attenuated by shielding
  - Higher penetration
Types of radiation

- Electron beams
  - Lower penetration power
  - Switch on and off capability
  - Higher efficiency: direct deposit of energy
  - Higher throughput