

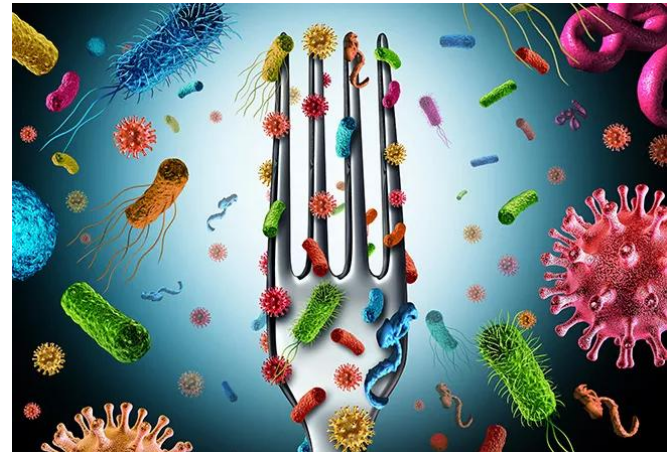
FE 305 FOOD MICROBIOLOGY

Foodborne Disease

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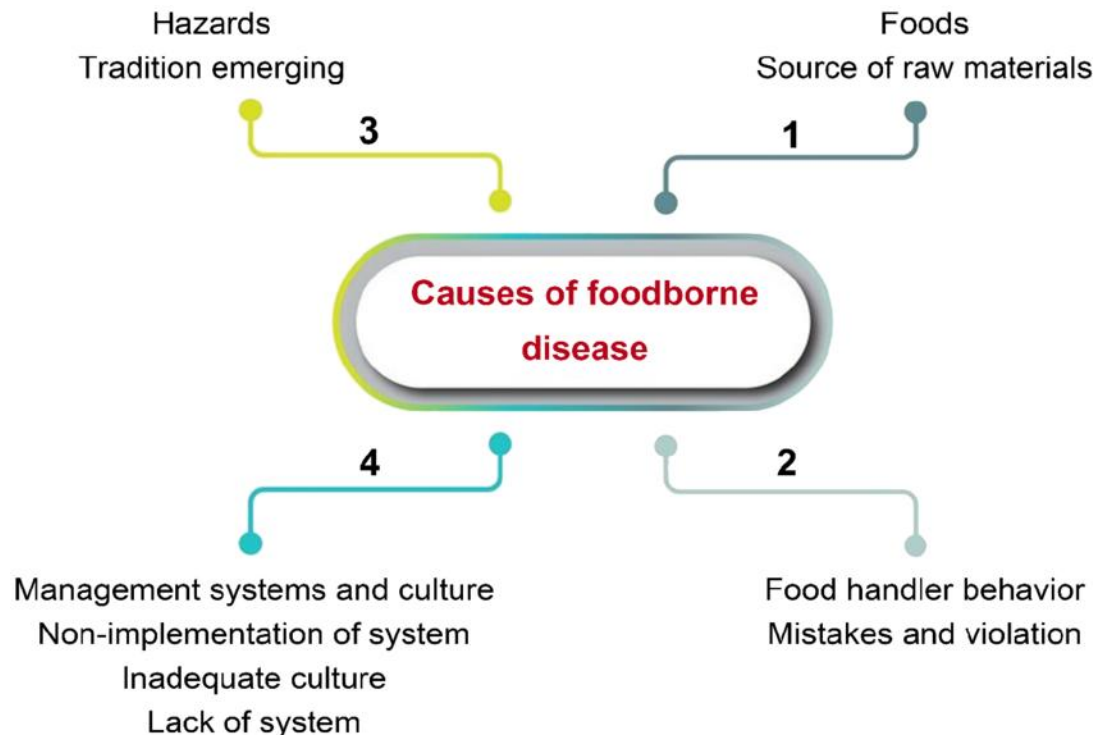
Foodborne Disease

- Foodborne disease is defined by the World Health Organization (WHO) as "disease of infectious or toxic character that can occur with the consumption of food or water".
- There are more than 250 known foodborne diseases and many different types of viruses, bacteria, parasites, toxins, metals and prions that cause these diseases.
- A foodborne disease is generally defined as the incidence of diseases on two or more individuals showing a similar illness after ingestion of the same food or water containing pathogenic bacteria or toxins.
- Foodborne diseases are the most widespread diseases on world.



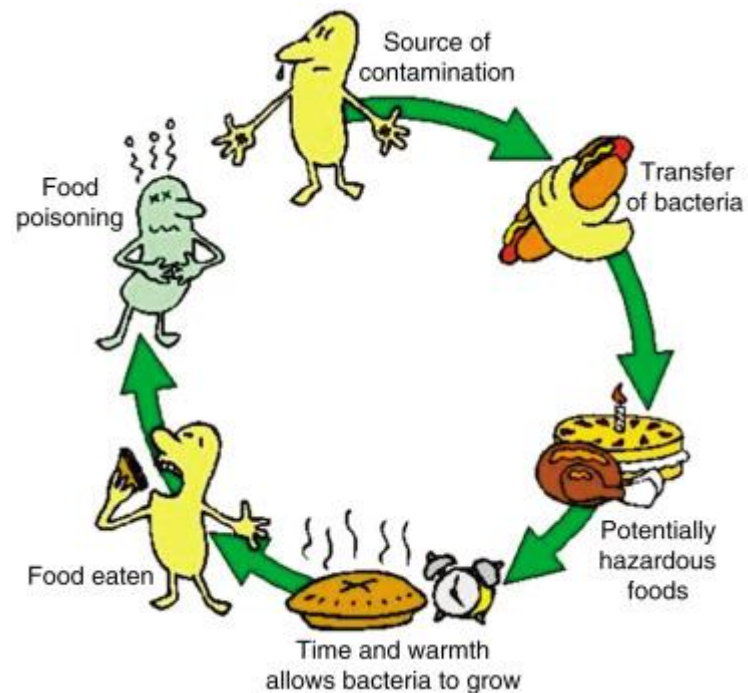
Foodborne Disease

- Foodborne diseases;
 - By ingestion of pathogenic bacteria, viruses, parasites and fungi or exo and endotoxins they create through foods, which are primarily present in foods or are secondarily contaminated,
 - They are diseases that occur as a result of the consumption of foods that contain certain substances with toxic effects or that are contaminated with toxic substances.



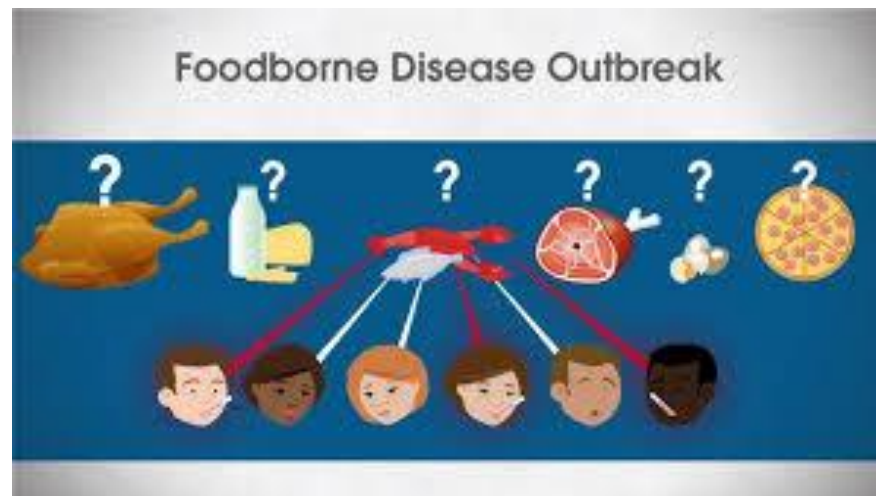
Foodborne Disease

- Although viruses are responsible for more than 50% of foodborne illnesses, hospitalizations and deaths are usually caused by bacterial agents.
- Each year, microbial pathogens cause an estimated 76 million cases of foodborne illness,
 - including 5200 deaths in USA according to the Centers for Disease Control (CDC).
- The total cost of five major bacterial pathogens is \$6.9 billion annually in USA.
- Diseases are caused by the toxin caused by bacteria or the reaction of the human body to the bacteria itself.
 - Life-threatening neurological from mild gastroenteritis,
 - It ranges from hepatic and renal syndromes.



Foodborne Disease

- WHO estimates that food- and water-borne diarrheal diseases are responsible for approximately 2 million deaths annually, of which 1.9 million are children.
- Food-borne diseases are a public health problem that causes significant economic losses and negatively affects people's quality of life in our country as well as all over the world.
- Since the reporting of foodborne diseases to official authorities is very low, it is not possible to know the global distribution rates of these diseases.



Foodborne Disease

Foodborne disease results from:

- transmission of microorganisms with foods that can cause diseases,
 - such as botulism, dysanteria, salmonellosis, campylobacteriosis, hepatitis, listeriosis and staphylococcal food poisoning.
- presence of toxic chemicals in foods either:
 - natural (e.g., cyanogenic glycosides in cassava), or
 - contaminated chemicals (e.g., toxic heavy metals, sanitizers, pesticides).
- presence of physical agents in foods, such as glass splinters.

Foodborne Disease

- Diseases caused by the consumption of a food containing a pathogenic microorganism or toxin are called food-borne microbial diseases.
- Foodborne microbial diseases;
 - Food infections
 - Food intoxications
 - Food toxico-infections are examined in three groups.

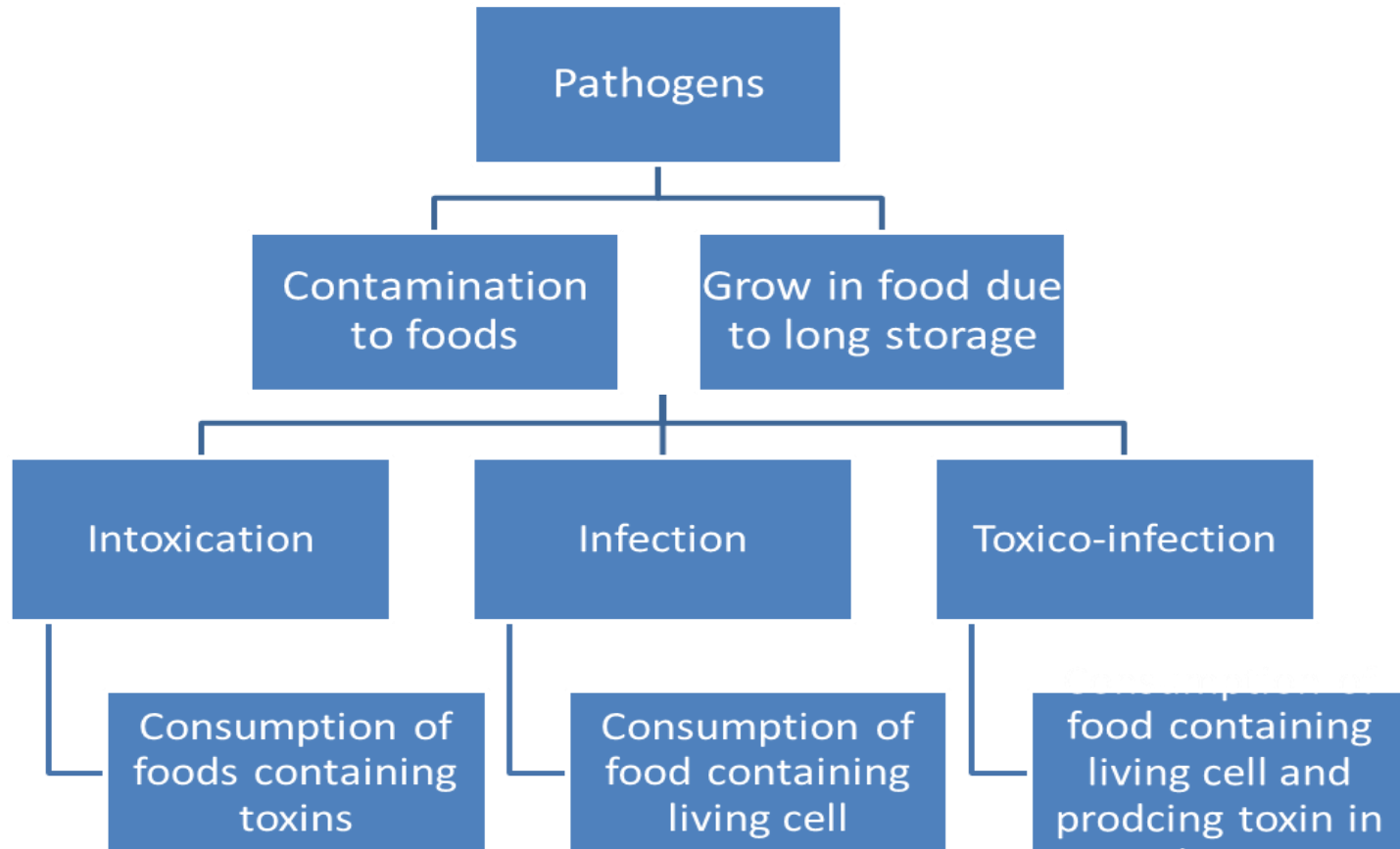
Foodborne Disease

- If the pathogen causing the disease is the cell itself, the disease is called a "**food-borne infection**".
- If the cause of the disease is the toxin secreted by the pathogen in the food, the resulting disease is called "**food-borne intoxication**".
- In foodborne infections, if the food is only the carrier and the microorganism cannot reproduce in the food, it is called "**foodborne passive infection**".
- If the disease occurs as a result of the growth of the pathogen in the food and the ingestion of a certain number of cells with the food, it is called "**food-borne active infection**".
- The "**intoxication type**" is formed by the ingestion of exo and endotoxins produced by pathogenic bacteria or molds.
 - Toxins must be present in food as active form.
 - In order for the disease to occur, it is sufficient to remove the toxin formed in the food, and it does not need to be a living cell.
 - *Staphylococcal* food poisoning is the most typical example for this group.

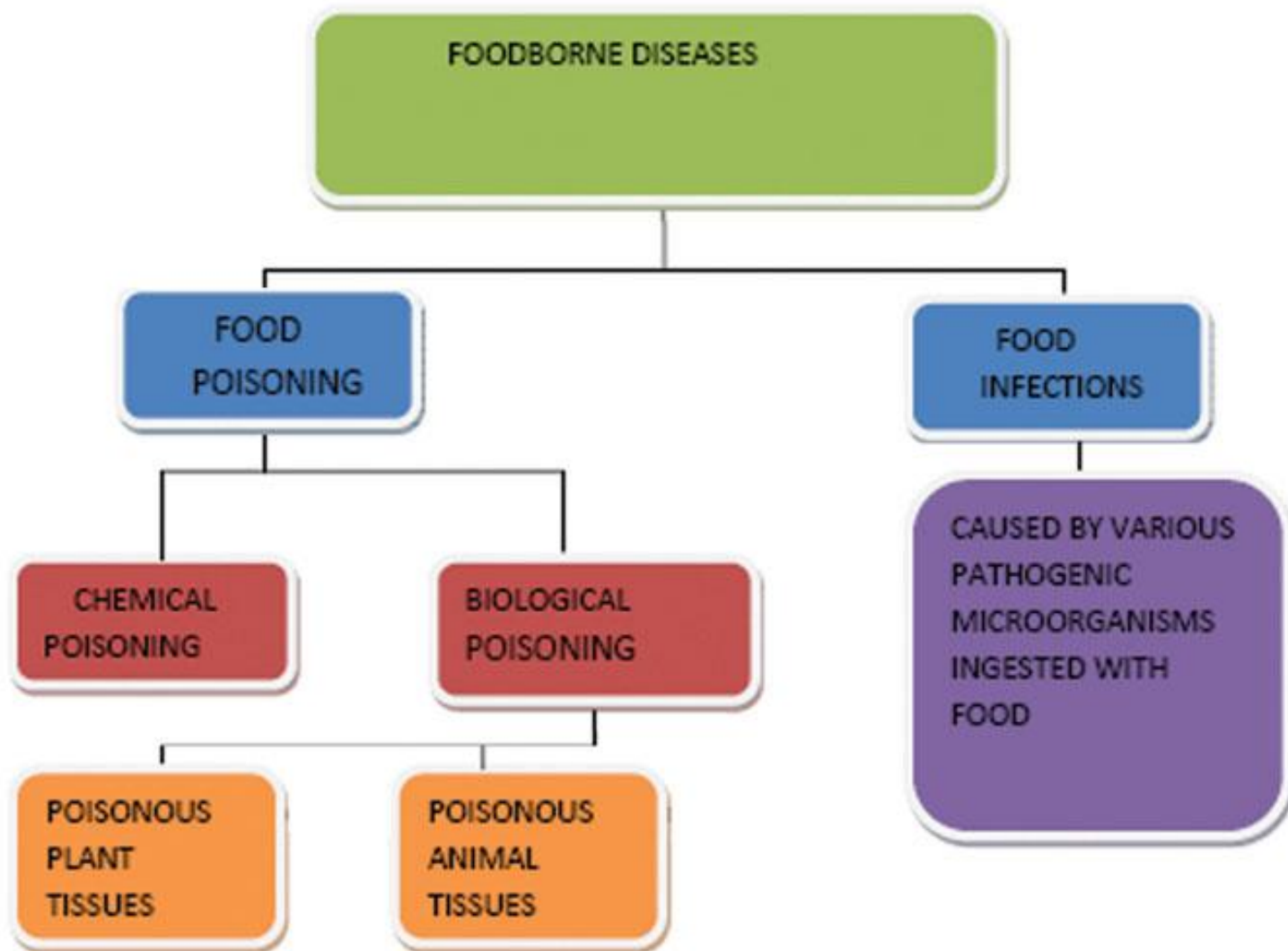
Foodborne Disease

- Food poisoning occurs in all countries of the world and causes health and economic problems.
- In general, the causes of these diseases are;
 - poor general hygiene
 - infected food handlers
 - storage at ambient temperature
 - consumption of raw foods
 - use of contaminated ingredients
 - contamination by infected persons
 - cross-contamination
 - use of contaminated equipment
 - failure in processing
 - undercooking
 - inadequate hot holding
 - too long storage time
 - contamination during final preparation
 - preparation extra-large quantities of food
 - use of left-overs
 - inadequate reheating before reuse
 - inadequate thawing.

Foodborne Disease



Foodborne Disease Classification



Common associations for foodborne pathogens

Epidemiology	Pathogens
Travel to a developing area	- Enterotoxigenic <i>E. coli</i> (ETEC) - <i>Salmonella</i> (e.g., <i>S. typhi</i>) - <i>Shigella</i> (e.g., <i>S. dysenteriae</i>) - <i>Campylobacter</i> - <i>Entamoeba histolytica</i>
Consumption of raw or undercooked foods of animal origin	- <i>Salmonella</i> (e.g., undercooked eggs, meat, chicken) - <i>Campylobacter</i> (e.g., undercooked chicken, milk) - <i>E. coli</i> O157:H7 (e.g., undercooked beef, hamburger) - <i>Toxoplasma gondii</i> (e.g., undercooked pork) - <i>Trichinella spiralis</i> (e.g., undercooked meat) - <i>Yersinia enterocolitica</i> (e.g., undercooked meat, milk)
Exposure to untreated water	- <i>Shigella</i> (e.g., lakes contaminated with human feces) - <i>E. coli</i> O157:H7 (e.g., lakes contaminated with feces) - <i>Cryptosporidium</i> (e.g., water contaminated with feces, including swimming pools, oocytes are resistant to chlorine) - <i>Giardia</i> (e.g., water contaminated with feces)

Types of food poisoning

Types of Food Poisoning

Food poisoning comes from many sources, including bacteria, viruses, and fungi.



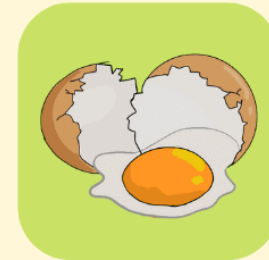
Listeria
fresh milk,
unwashed produce



E. coli
fecal
contamination



Campylobacter
undercooking,
unhygienic kitchen



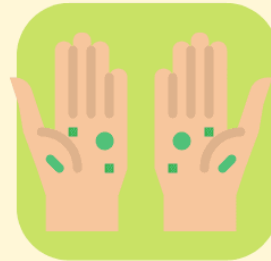
Salmonella
undercooking,
poor hygiene



Staphylococcus
unrefrigerated food



Ciguatera
coral algae toxin



Shigella
human waste
contamination



Botulism
damaged cans

Invasive (spreading) Infections

- This type of microbial foodborne disease results from
 - ingestion of viable bacterial cells in sufficient numbers together with food,
 - survive in stomach acidity and
 - in vivo multiplication of bacteria with colonization in the intestinal lumen.
- The pathogen attaches to and colonizes on the epithelial surface,
 - this prevents removal by the flushing action of the high flow rates of intestine.
- The attachment is provided by producing adhesions.
- The fimbriae on the bacterial cell surface recognize and attach to the specific receptor sites on the microvilli.

Invasive (spreading) Infections

- Intestinal inflammation, which is caused by the spread of pathogenic microorganisms in the intestinal tissue after ingestion with food, is called **invasive infections**.
- Live microorganisms taken with food, overcome the acid environment of the stomach, enter the intestinal epithelial cells, develop and produce toxins.
- The number of living microorganisms that will cause the disease varies according to the type and strain.
- Toxins from the microorganism cells, whose intestinal epithelium is lysed by the effect of microorganisms, are released into the intestinal cavity and live microorganisms spread to other epithelial cells.
- In some cases, bacteria cross the intestinal barrier and spread to the lymph nodes, liver, brain and other organs, causing non-enteric (systematic) disorders.

Invasive (spreading) Infections

- Loss of the ability to
 - adhere to the intestinal wall will
 - reduce a pathogen's virulens and
 - cause illness.
- Once attached, bacterial cells can multiply and produces a protein enterotoxin in the intestinal tract.
- Enterotoxin changes the flow of electrolytes and water across the mucous into intestinal lumen.
- *Vibrio parahaemolyticus*, *Vibrio vulnificus*, *Salmonella*, enteroinvasive *E. coli*, enterohemorrhagic *E. coli*, *Campylobacter*, *Yersinia*, *Listeria*, *Shigella*, *Brucella*, and viral infections are examples to invasive infection.

Invasive (spreading) Infections

- The dose of organisms required to initiate infection is usually large (10^6 or more per g of food);
 - this enables sufficient organisms to pass through the acid region of the stomach and reach the intestine.
- However, infections may result from a low dose of organisms
 - if the food has a protective effect on pathogen through the stomach,
 - e.g., if it is high in fat or has a high buffering capacity.
 - *Salmonella* infection have resulted from foods such as chocolate and cheese containing levels of **100 *Salmonella* cells** or less per gram of food.

Infection

- Infection type disease occurs as a result of ingestion of vegetative forms of pathogenic bacteria and viruses through food or water.
- During consumption, there must be living cells in the food.
- Even if living cells are present in low numbers, they can settle in the intestines, multiply under suitable conditions and cause disease.
 - *Salmonellosis, Shigellosis, Enterohemorrhagic E. coli* (EHEC), Hepatitis A virus infections are shown as an example for this group.

Toxico-infections

- In this type of infections, the disease factor is pathogenic microorganisms.
- Disease symptoms, unlike invasive infections,
 - Occurs as a result of the large number of spore bacteria consumed together with the food, depending on the microorganism that causes the disease, to form toxins by sporulating in the intestine, or as a result of the multiplication of microorganisms consumed with food in the intestine, the death of a large number of cells and the toxins released by cell lysis.

Toxico-infections

- This type of bacterial foodborne disease results from consumption of large number of viable bacteria ingestion together with food or water;
 - Cell should survive through stomach and reach the intestine.
 - In intestine, cells multiply and die, but do not spread through epithelial cells.
 - In intestine, sporeforming bacteria either sporulate and die;
 - They release toxin(s) to produce symptoms.
 - This causes fluid production and diarrhea.
- Common symptoms are diarrhea, fever and chills.
- Enterotoxigenic *E. coli*, *Bacillus cereus* (emetic syndrome), *Clostridium perfringens*, *Vibrio cholerae*, *Aeromonas hydrophilia* and *Plesiomonas shigelloides* can cause toxicoinfection.

Toxico-infections

- In toxico-infection, disease occurs as a result of the toxins formed in the digestive tract as a result of the ingestion of pathogenic bacteria, which contain a large number of living cells, through food or water and the sporulation of these bacteria, their colonization and death in the digestive tract.
 - As an example of this group; *Clostridium perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis, *Enterotoxigenic E. coli* gastroenteritis can be given.

Intoxication

- If the causative agent is a microbial toxin, this type of foodborne illness is called **intoxication**.
- In this case, the pathogenic microorganism multiplies in the food and creates a toxin in the food.
- If this toxin is consumed with food, symptoms of illness occur.
- In this type of diseases, the disease can occur without live microorganisms in the food. Because microorganisms can be inactivated for some reason after toxin production, while the toxin can remain in the food.

Intoxication

- Foodborne intoxication is caused by consumption of food containing toxins (previously produced).
- Toxigenic microorganisms
 - multiply in foods and
 - producing toxins under suitable conditions.
- Toxins cause the illness on living organisms as gastrointestinal or systemic disorders.
- Viable microorganisms need not to be present in the food at the point of consumption for foodborne intoxication.
- *S. aureus*, *B. cereus* (diarrheal poisoning), botulism, toxigenic molds, poisoning mushrooms and biogenic amines can cause intoxication.

Foodborne Diseases

Invasive Infections

- *Salmonella* (other than *S. thphi* ve *S. paratyhpi*)
- *Vibrio parahaemoliticus*
- Enteroinvasive *Escherichia coli* (EIEC)
- Enterohemorrhagic *E. coli* (EHEC)
- *Listeria monocytogenes*
- *Yersinia enterocolitica*
- *Brucella abartus* / *B. melitensis*
- *Shigella dysenteria*
- *Campylobacter*
- *Coxiella burnetii*
- Hepatitis A virus
- Poliovirus
- Enterovirus
- Parasides

Toxico-infections

- *Clostridium perfringens*
- *Bacillus cereus*
- *Vibrio cholerae*
- Enteropathogenic *E. coli* (EPEC)
- Enterotoxigenic *E. coli* (ETEC)
- *Plesiomonas shigelloides*
- *Clostridium difficile*
- *Aeromonas hydrophyla*

Intoxications

- *S. aureus*
- *Bacillus cereus*
- *C. botulinum*
- Micotoxins
- Plant toxins
- Alg toxins

Food Poisoning

FOOD POISONING



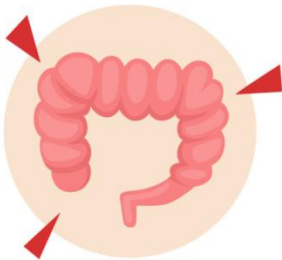
Overdue products



Medicine



Dizziness



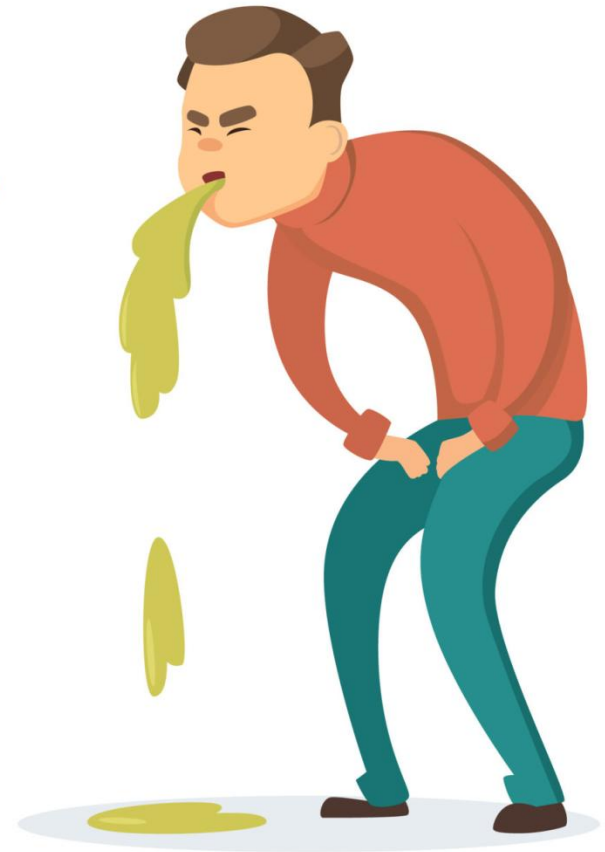
Intestinal colic



Diarrhea



Headache



Foodborne Disease

<i>Pathogen</i>	<i>Type</i>	<i>Foods Implicated</i>	<i>Causes</i>	<i>Symptoms</i>
Bacillus cereus	Bacteria	Cooked rice, corn, potatoes	Temperature abuse, improper cooking	Diarrhea, cramps
Botulism	Bacteria	Canned vegetables, baked potatoes in aluminum foil, herb or garlic infused oils	Foods held at warm temperatures	Double or blurred vision, slurred speech, difficulty swallowing, muscle weakness
Ciguatera	Bacterial Toxin	Large reef fish, barracuda, grouper, red snapper, eel, amberjack, sea bass, and Spanish mackerel	Toxin concentrated in the viscera and organs of fish	Nausea, vomiting, diarrhea, muscle pain, numbness, tingling, abdominal pain, dizziness, and vertigo
Clostridium perfringens	Bacteria	Meat, poultry, foods held in danger zone	Improper cooling of cooked foods, Foods held in danger zone	Diarrhea, cramps, headaches, chills
Campylobacter jejuni	Bacteria	Poultry, contaminated water	Improperly cooked foods, cross-contamination	Diarrhea, cramps, headache, nausea
Cryptosporidium parvum	Parasite	Contaminated water, fresh produce	Improper hand washing	Diarrhea, cramps, nausea
Escherichia coli	Bacteria	Raw/undercooked ground beef, raw milk, alfalfa sprouts, unpasteurized fruit juices, dry-cured salami, lettuce, game meat, cheese curds	Undercooked meats, cross-contamination, unpasteurized fruit juices, infected food handlers	Hemorrhagic colitis, hemolytic uremic syndrome
Hepatitis A	Virus	Ready-to-eat foods, shellfish, fresh green onions, contaminated water	Improper hand washing, Handling food with bare hands, Infected workers, Infected shellfish	Fever, physical weakness, nausea, abdominal pain, jaundice
Listeriosis	Bacteria	Vegetables, unpasteurized milk, raw meat, ready-to-eat foods, deli meats	Unpasteurized milk, improperly cooked foods, cross-contamination	Meningitis Septicemia , miscarriage
Norwalk Virus	Virus	Raw oysters and shellfish, contaminated water and ice, ready-to-eat foods	Inadequate treatment of sewage, infected food handlers	Nausea, vomiting, diarrhea, abdominal cramps
Salmonellosis (Salmonella)	Bacteria	Meat, poultry, egg or dairy products	Improper cooking, cross-contamination, infected food handlers	Nausea, diarrhea, abdominal pain, fever, headache, chills
Shigellosis	Bacteria	Contaminated food and water	Improper hand washing, infected workers,	Diarrhea, fever, abdominal pain
Staphylococcus	Bacterial Toxin	Custards, ham, poultry, eggs, potato salad, cream sauces, sandwich fillings	Improperly refrigerated foods, unsafe food handling practices, food handlers with open cuts and sores	Vomiting, diarrhea, abdominal cramps
Vibrio	Bacteria	Raw, partially cooked oysters	Undercooked oysters, infected oysters	Diarrhea, cramps, nausea, vomiting, fever, chills
Yersiniosis	Bacteria	Raw milk, chocolate milk, water, pork, raw meats	Unpasteurized milk, undercooked foods, cross-contamination	Enterocolitis (mimics acute appendicitis)

Some Causes for Foodborne Disease

- Not paying attention to the storage conditions of food For example; do not store in the cold,
- Insufficient cooking or insufficient heating
- Not cooling cooked food quickly
- Cross contamination,
- Insufficient or incorrect thawing of frozen foods
- Don't wait too long for food to be consumed
- Do not consume raw foods that should not be consumed raw
- Keeping the food to be served hot at a temperature lower than 63 °C
- Inadequate cleaning and hygiene
- Microorganism contamination of food after cooking
- Use of poor quality raw materials
- Raw food consumption (raw milk, raw fish, etc.)
- Preparing foods in large quantities
- Infections caused by personnel,
- Employment of carrier personnel,
- Using foods longer than their shelf life

Preventing of Foodborne Disease

- The symptoms of food poisoning vary greatly from country to country and from person to person. Differences in duration and severity of symptoms are due to:
 - The type of microorganism that causes the disease
 - Sensitivity, general resistance status of people
 - Concentration of bacteria or toxins in the food consumed
- Controlling microorganisms in food is for two main purposes. These;
 - Delaying or completely preventing microbiological spoilage in foods,
 - It is the prevention of diseases transmitted to humans by food.
- Four basic principles are applied in controlling microorganisms. Based on these basic Principles, different food preservation methods have been developed.

4 Basic Principles in Controlling Microorganisms in Food

1. Preventing contamination
2. Removal of microorganisms
 - i. Washing
 - ii. Cutting and weeding
 - iii. Centrifuge
 - iv. Filtration
3. Inhibition of microbial growth
 - i. Use of chemical food preservatives
 - ii. Low temperature storage
 - iii. Reducing water activity
 - iv. Storage in a controlled and modified atmosphere
 - v. Benefiting from the antagonistic relationship between microorganisms
4. Killing of microorganisms
 - i. Thermal treatments
 - ii. Radiation application
 - iii. Sterilant gases
 - iv. High pressure application
 - v. Combined methods

1. Preventing contamination

- Since microorganisms are widely found in nature, it is almost impossible to completely prevent the contamination of foods by microorganisms (except in some special cases).
- However, contamination can be minimized by controlling potential sources of contamination.
- Microorganisms in food
 - Number
 - Gender matters.
- Prevention / control of microbial contamination is carried out with sanitation practices.
- Sanitation → all the activities implemented to prevent / minimize microbial contamination in the chain starting from raw material production / harvesting to the consumer.

2. Removal of microorganisms

- One of the methods of controlling microorganisms in food is:
 - found in the normal flora of foods or
 - remove the microorganisms that are subsequently transmitted from the food.
 - For this purpose, washing, sorting, centrifugation and filtration methods can be applied.
- a. Washing: The washing process is especially applied to fruits and vegetables to be consumed fresh. With washing, most of the microorganisms and their spores are removed.
 - This method also increases the effect of thermal treatments to be applied later.
- b. Cutting and Sorting: It is a method used in fruit and vegetable processing. By removing moldy fruits and vegetables from the environment, contamination of healthy fruits and vegetables is prevented.

2. Removal of microorganisms

c. Centrifugation: This method is not very effective in removing microorganisms.

- This method is especially applied to milk and thus it is aimed to remove some of the foreign particles, bacteria and spores suspended in the milk from the environment.

d. Filtration: It is the most effective method in removing microorganisms.

- Depending on the pore diameter of the filter, microorganisms are retained in the filter.
 - For example: All microorganisms except viruses can be kept with filters with a pore diameter of $0.45\mu\text{m}$.

3. Inhibition of microbial growth

a) Preservation with chemical preservatives: Not in the structure of the food but into the food

- processing
- storage
- during packaging



Chemical substances added in stages are called additives.

b) Additives; They are substances that provide the appearance, taste, desired properties of foods, protect them and enrich their nutritional elements.

Some Chemical Food Preservatives

- ✓ (Na) or (Ca) propionic acid
- ✓ (Na) benzoate
- ✓ sorbic acid
- ✓ (SO₂) and Sulfites
- ✓ Formaldehyde
- ✓ Ethylene and Propylene oxides
- ✓ sodium nitrite

b) Low Temperature Storage

Cold storage:

- All chemical reactions slow down at low temperature,
- The activity of microorganisms in food (in its natural form) slows down and
- The formation of adverse changes that may occur in food also slows down.

Freeze preservation:

- Foods to be stored for a long time are frozen.
- With ice cream, the activity of enzymes and chemical reactions naturally found in the food structure slows down, while microbial development is completely stopped.
- Freezing and thawing can change the physical structure of some foods.

c) Reducing water activity

- In foods; The basic needs for microbial activity, enzymatic reaction and chemical reaction is the presence of free water.
- In foods, water is either physically removed or reactions can be limited by the addition of substances such as (salt sugar).
- Drying is one of the oldest methods used for this purpose.

4. Killing of microorganisms

There are many reasons for killing microorganisms, as well as benefits. These;

1. To destroy microorganisms that cause disease in humans, animals and plants and thus to prevent infections and their spread.
2. Foods, preserves, foodstuffs, etc. prevent deterioration.
3. To make the media and other environments free from microbes.
4. To ensure that pure cultures are obtained and to prevent their contamination.
5. To prevent contamination of materials and tools with microorganisms.
6. To prevent the spread and transmission of disease agents.