FOODBORNE INFECTION, INTOXICATION AND PATHOGENS

NM 17/12/2020

CONTENT

Microorganisms

Beneficial microorganism

- Used in food fermentation. E.g. cheese, yogurt, kimchi, budu
- Microorganisms metabolise complex substrate to produce enzyme (*breakdown the indigestible compound*), flavour compound, and antimicrobial agents to inhibit pathogen growth, extend shelf life, provide product attribute.
- *E.g. Lactobacillus acidophilus, Lactobacillus thermophilus*

Spoilage microorganism

- Microorganism that grow in foods and cause spoilage. E.g. produce undesirable flavour, odour, texture, appearance (but not harmful).
- These organisms are often smelled, seen, or tasted but they won't make you sick.
- E.g. *Lactobacillus* spp., *Pseudomonas* spp., yeast and mould,.

Pathogenic microorganism

- Microorganisms that grow in foods and cause foodborne disease / illness to the consumer.
- Unfortunately these organisms cannot be seen, smelled, or tasted.

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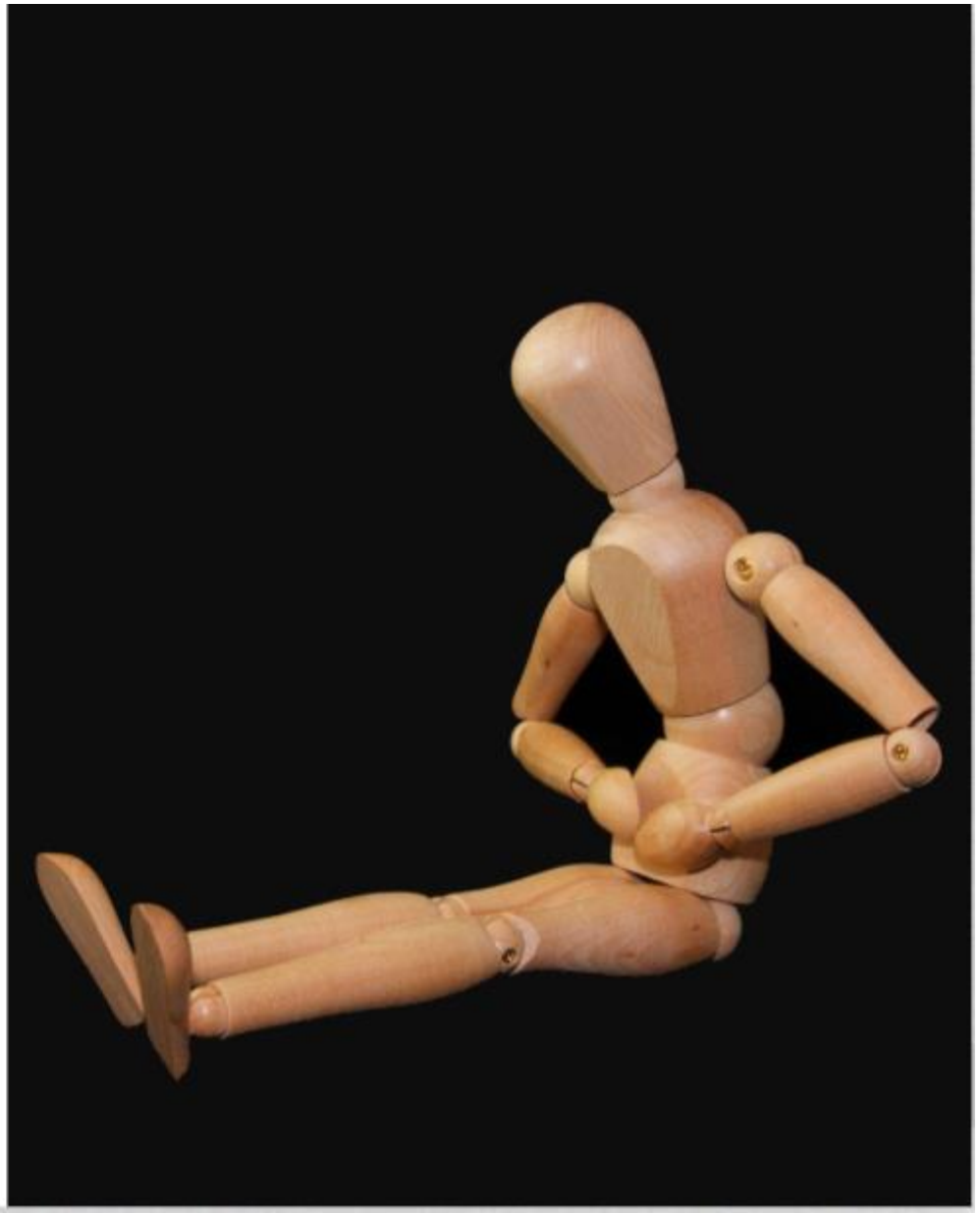
Foodborne Diseases

Foodborne disease is defined as a disease that is carried or transmitted to humans by food. The 3 types of foodborne diseases are:

- Foodborne infection
- Foodborne intoxication (food poisoning)
- Foodborne toxico-infection

+ READ MORE



Foodborne infection

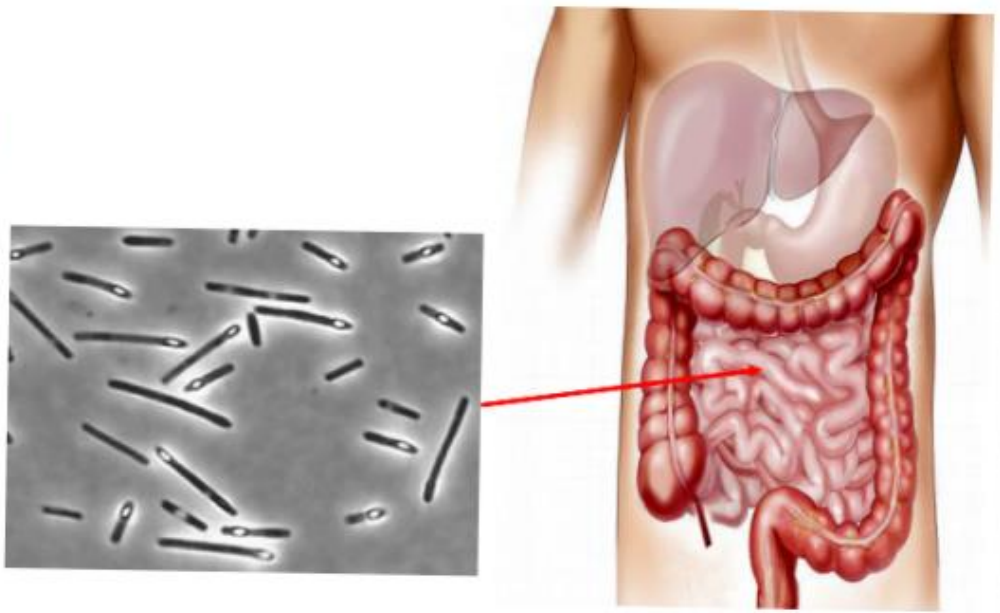
- Infection is caused by **ingestion of food that is contaminated with live pathogens** such as bacteria, viruses, or parasites and they act directly on the intestines.
- The pathogen multiplies in food until it reaches the **minimum infective dose (MID)** – (number of microorganisms needed to cause illness in human).
- MID: *Shigella* spp. 10 cells, *S. aureus* 10^5 cells, *C. perfringens* 10^8
- E.g. *Salmonella* spp., *Listeria monocytogenes*, *Vibrio parahaemolyticus, Campylobacter jejuni, Yersinia enterocolitica.*
- Symptoms may take longer time to appear and may also last longer than intoxication.

Foodborne intoxication

- Intoxication is caused by **ingestion of food which is already contaminated with toxins** produced by bacteria (pre-formed toxins)
- E.g. *Staphylococcus aureus, Clostridium botulinum*
- Symptoms may occur very soon and result in sudden/uncontrollable vomiting and/diarrhea.

Foodborne toxico-infection

- Toxico-infection is caused by **ingestion of food contaminated with live pathogens and they produce toxins inside the host.**
- The bacteria either sporulate (spore-formers) or die (cell lysis)(non spore-formers) and release toxins in the gastrointestinal tract (intestines).
- E.g. *E. coli* O157:H7, *Bacillius cereus, Clostridium perfringens.*



Causal factors related to food infection / poisoning

- Cross contamination
- Inadequate heat treatment/cooking
- Storage temperature
- Innfected food handler
- Unprocessed contaminated ingredient
- Poor personal hygiene
- Poor handwashing facilities

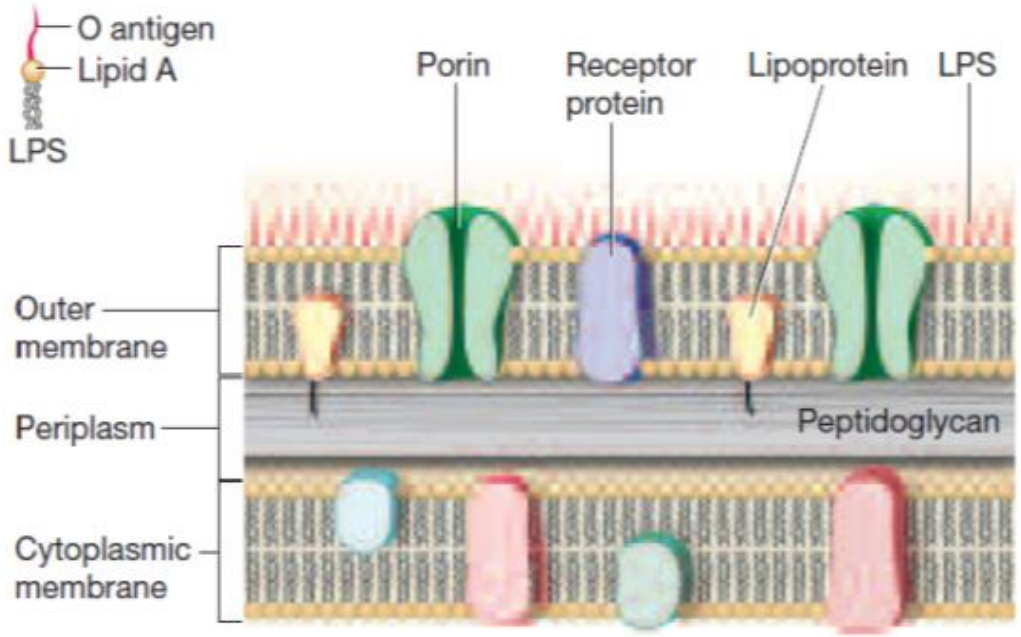
FOODBORNE PATHOGENS

Gram positive pathogens

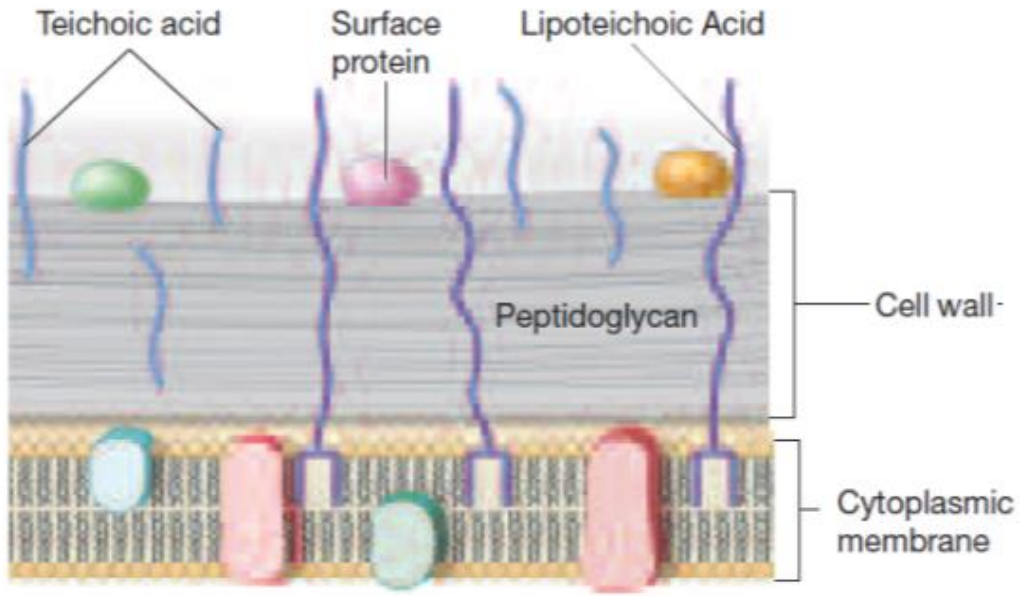
- *Clostridium botulinum*
- *Clostridium perfringens*
- *Bacillus cereus*
- *Staphylococcus aureus*
- *Listeria monocytogenes .*

Gram negative pathogens

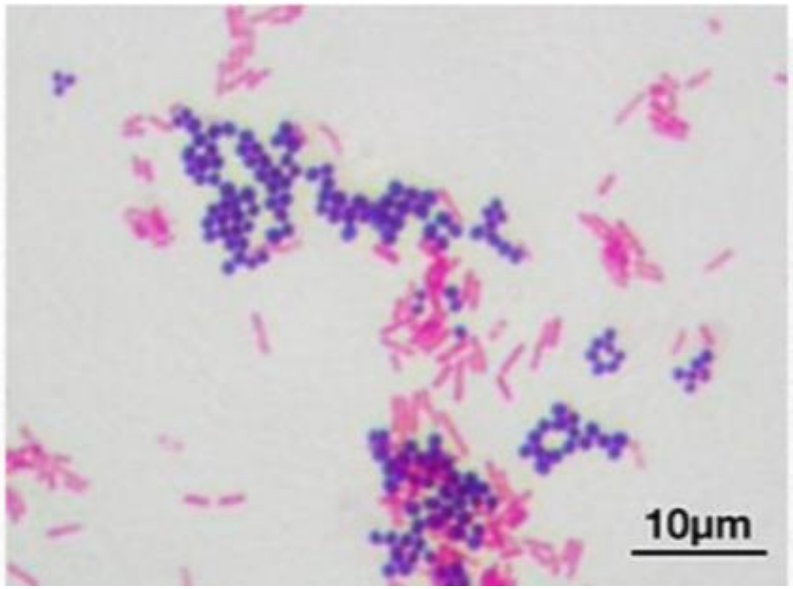
- *Salmonella*
- *Campylobacter*
- *Yersinia*
- *Vibrio cholera*
- *Vibrio parahaemolyticus*
- *Aeromonas hydrophila*
- *Escherichia coli*



Cell Wall of Gram Negative Organism



Cell Wall of Gram Positive Organism



GRAM-POSITIVE PATHOGENS

Clostridium botulinum

Characteristics

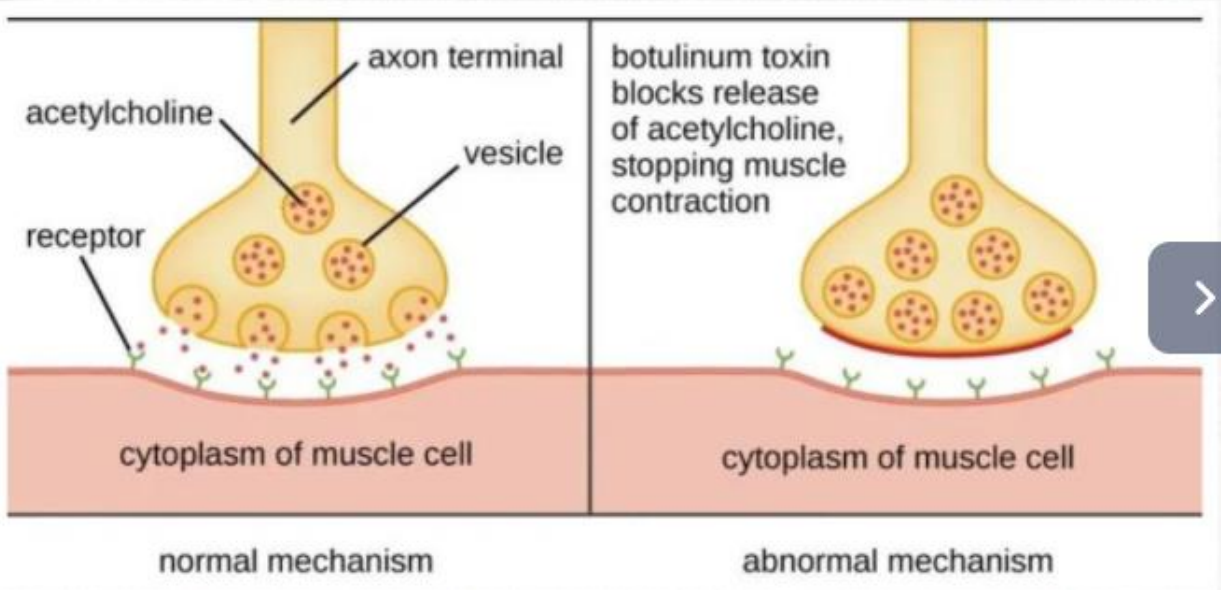
- Anaerobic
- Gram-positive
- Spore-forming rod
- Potent neurotoxin.
- Spores are heat-resistant
- Survive in foods that are incorrectly or minimally processed.
- 7 types of botulinum (A -G)
- Type A,B,E,F -botulism in human

Types of botulism

- Foodborne botulism - canned food
- Wound botulism - infected wound
- Infant botulism
  - spores get into infant's intestine and produce toxin (honey)
  - no honey to < 1 yo children

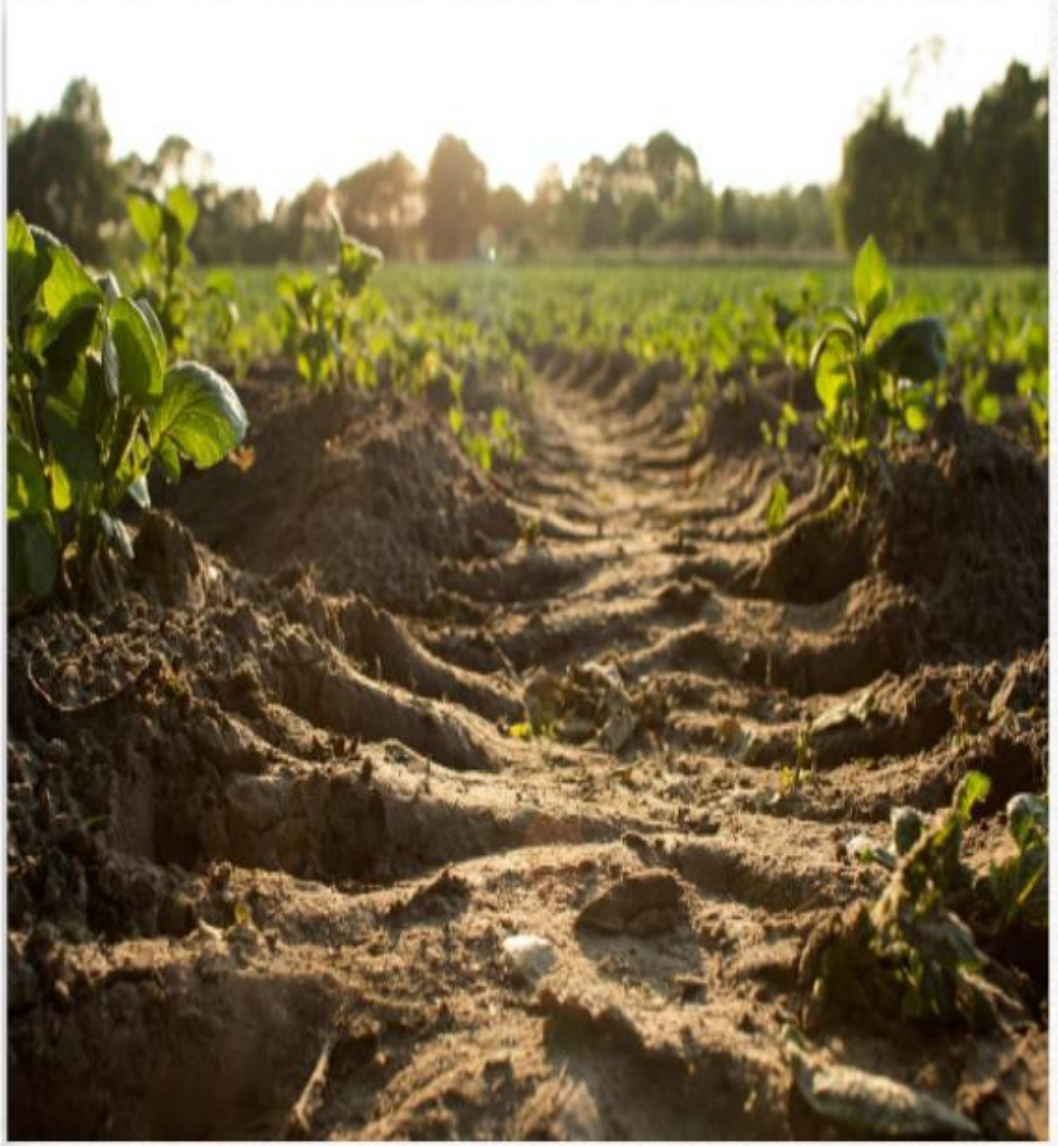
Foodborne botulism

- Severe type of food poisoning
- Ingestion of foods containing the potent neurotoxin formed during growth of the organism.
- The botulinum toxin is heat labile and can be destroyed if heated at 80°C for 10 minutes or longer.
- Incidence of the disease is low
- High mortality rate if not treated immediately and properly (5-10%)
- associated with inadequately processed, home-canned foods



Sources

- The organism and its spores are widely distributed in nature.
  - Cultivated and forest soils,
  - Bottom sediments of streams,
  - Lakes, and coastal waters,
  - The intestinal tracts of fish and mammals,
  - In the gills and viscera of crabs and other shellfish.



Symptoms

- Infective dose -- a very small amount (a few nanograms) of toxin can cause illness.
- Onset of symptoms usually 18 to 36 hours after ingestion of the food containing the toxin.
- Early signs:
  - Fatigue
  - Weakness and vertigo,
  - Double vision, dropping eyelid
  - Progressive difficulty in speaking and swallowing
  - Difficulty in breathing,
  - Weakness of other muscles - paralysis in the respiratory tract muscle
  - Accumulation of gas or fluid in abdomen
- Treatment - botulinum antitoxin, mechanical breathing assistance

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Botulism

Español (Spanish)

Botulism is a rare but serious illness caused by a toxin that attacks the body's nerves.

Symptoms of botulism usually start with weakness of the muscles that control the eyes, face, mouth, and throat. This weakness may spread to the neck, arms, torso, and legs. Botulism also can weaken the muscles involved in breathing, which can lead to difficulty breathing and even death.

Botulism in Infants

We don't know how most babies with infant botulism came into contact with *C. botulinum* spores, but we do know that these spores can be found in honey. Do not feed honey to children younger than 12 months because it has been linked to some cases of infant botulism.

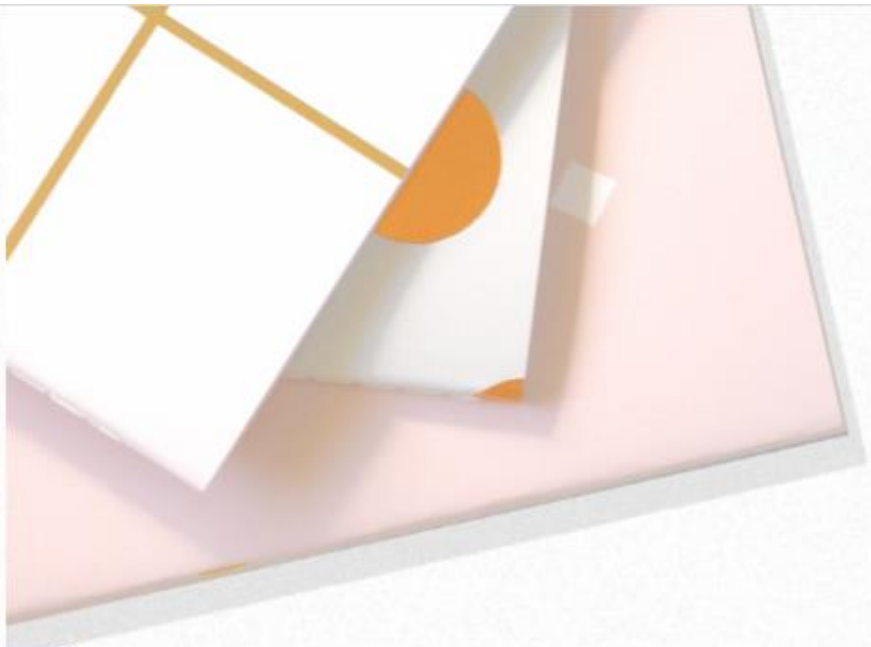
Protect Yourself from Botulism

Foodborne botulism is often caused by eating home-canned foods that have not been canned properly. Commercially canned foods are much less likely to be a source of botulism because modern commercial canning processes kill *C. botulinum* spores.

Clostridium perfringens

Characteristics

- very little or no oxygen (aerotolerant)
- spore forming rod
- cause toxico-infection
- Widely distributed in nature
- Spores persist in soil, sediments
- Food: raw meat and poultry, gravies, pre-cooked food
- *C. perfringens* type A contain enterotoxin genes - food poisoning
- Infective dose : > 10^6

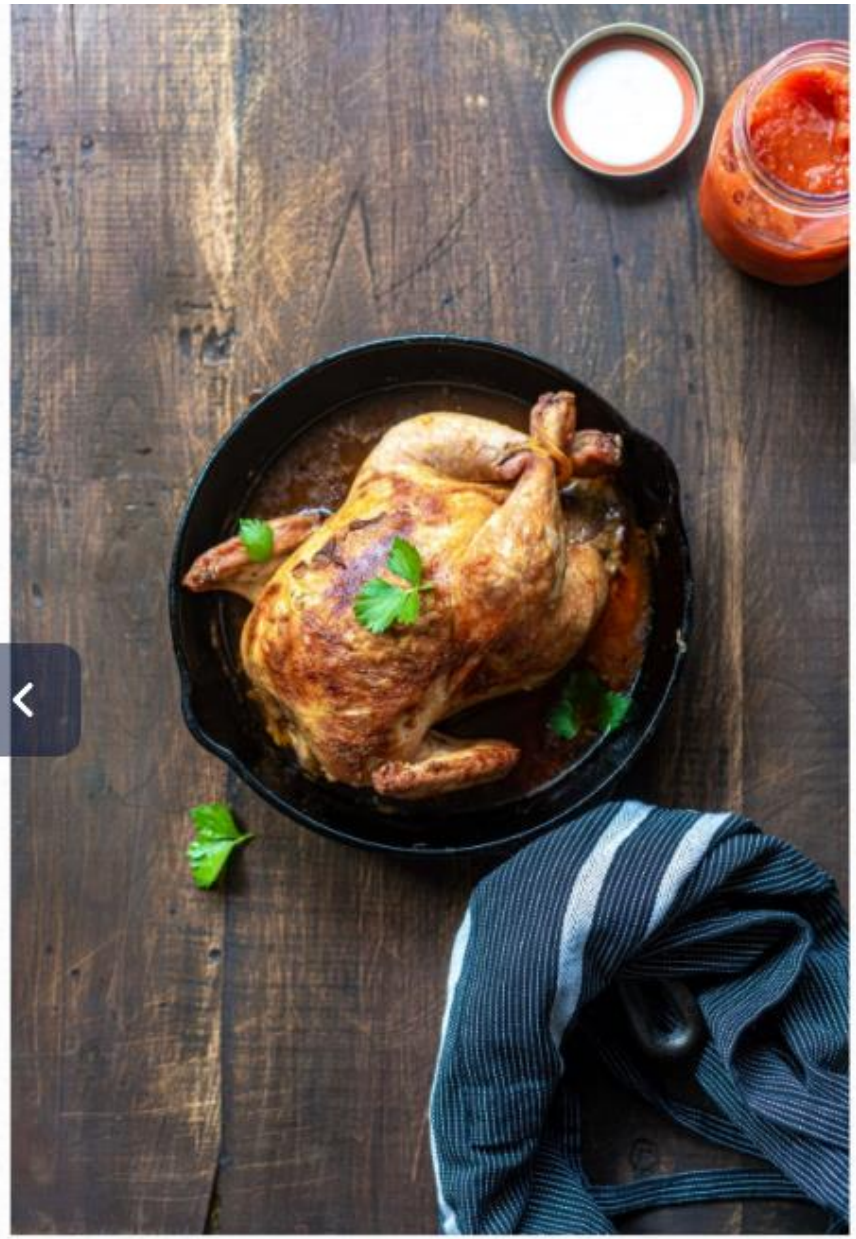


Clostridium perfringens

- Temperature abuse of prepared foods can cause food poisoning
- The spores survive cooking and it germinate into vegetative cells as the food cools
- Multiply faster than other bacteria to reach the infective dose: > 10^6
- Produce toxin inside the intestine
- It happens when foods are prepared in large quantities and kept warm for a long time before serving
  - (12°C–60°C) Temperature range
  - (43°C–47°C) Optimum

Symptoms

- Intense abdominal cramps and diarrhea
- 8-12 hours after consumption of foods
- usually no fever or vomiting
- Usually over within 24 hours
- But, less severe symptoms may persist in some individuals for 1 or 2 weeks.
- Oral rehydration (treatment)



Prevention

- Cook and keep food at the correct temperaturekeep food at >60C or < 4C
- Meat dishes should be served hot within 2 hours after cooking
- Refrigerate leftovers
- Reheat them properly (>74C) before serving

Bacillus cereus

Characteristics

- Facultatively anerobic
- Large rods
- Sporeformer - form spore at high temperature
- Can survive at low temperature
- Cause toxico-infection (enterotoxin) & intoxication (emetic toxin)
- Can tolerate 7.5% salt concentration
- *B. cereus* grows well after cooking and cooling (<48°C).
- Infective dose is > 10^6
- Generally mild and selft-limiting

Food implicated

- Two types of poisoning
  - Diarrheal-type : associated with meat, milk, vegetables, fish
  - Vomiting-type: associated with rice & starchy product
- Other foods: potatoes, pasta, cheese, sauces, puddings, soups, pastries, salads have been associated with food poisoning outbreak

Symptoms

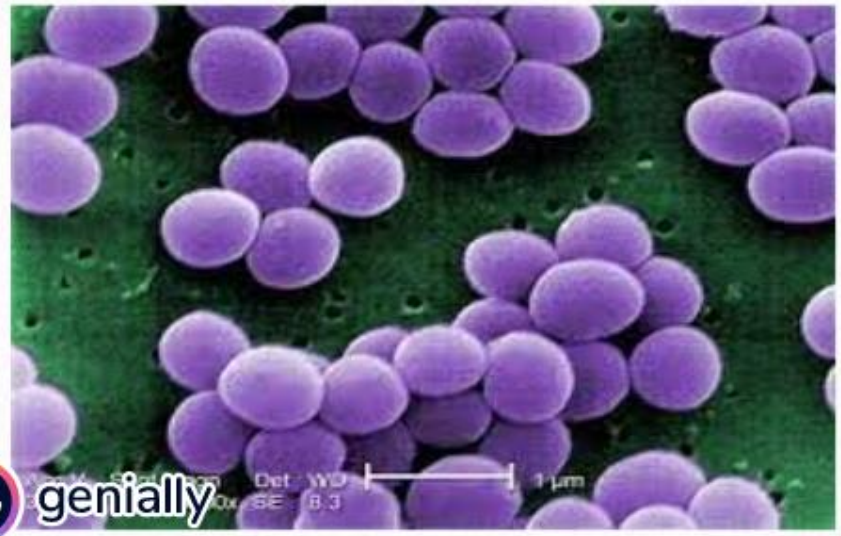
Diarrheal type poisoing

- Onset of watery diarrhea, abdominal cramps - mimic the *C. perfringens* poisoning
- pain occurs 6-15 hours after consumption of contaminated food
- Caused by enterotoxin produced in intestine
- Nausea may accompany diarrhea, but **vomiting rarely occurs.**
- Symptoms persist for 24 hours in most instances

Emetic type (vomiting) poisoning

- Characterised by **nausea and vomiting** within 0.5 - 6 hours after consumption of contaminated foods (rice & starchy food)
- caused by emetic toxin produced in food-heat stable
- Abdomial cramp & diarrhea may occur
- Duration of symptoms is < 24 hrs
- Symptoms similar to *S. aureus* intoxication

Staphylococcus aureus

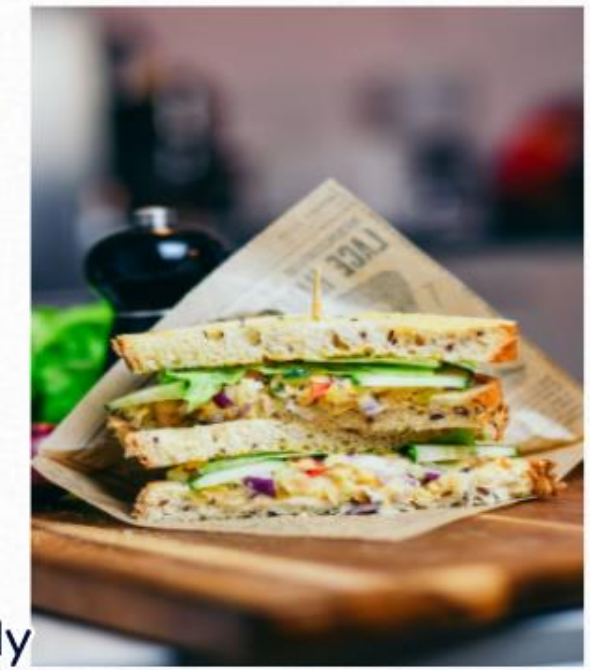


- small, spherical cocci
- appears in pair, short chains or bunched in grape-like clusters
- produce **heat-stable enterotoxin in food t**hat causes staphylococcal food poisoning - intoxication
- resistant non-spore forming pathogens
- can survive in a dry state (0.83 aw)
- highly tolerant to salts and sugar
- Intoxication dose is < 1 microgram which is reached when the population exceed 10^5 organisms /g

Symptoms

Staphylococcal intoxication

- Nausea, vomiting, abdominal cramping,diarrhea
- May cause temporary changes in blood pressure and pulse rate
- The illness is usually intense, but normally last within two days
- Infective dos: a toxin dose of less than 1.0 microgram in contaminated food will produce symptoms of **staphylococcal intoxication.**
- This toxin level is reached when **S. aureus** populations exceed 100,000 per gram.
- Outbreak often link to foods that require a lot of handling during preparation



Food implicated

- Meat and meat products
- Poultry and egg products
- Eegg, tuna, chicken, potato, and macaroni
- Bakery products such as cream-filled pastries, cream pies, and chocolate eclairs; sandwich fillings; and milk and dairy products.
- Foods that require considerable handling during preparation and that are kept at slightly elevated temperatures after preparation are frequently involved in staphylococcal food poisoning.

Sources

- Staphylococci exist in :
  - air, dust, sewage, water, and food
  - food equipment, environmental surfaces, humans, and animals.
- Humans and animals are the primary reservoirs.
  - *Staphylococci* are present in the nasal passages and throats and on the hair and skin of 50 percent or more of healthy individuals

- Food handlers are the main source of contamination in RTE foods
- Human intoxication is caused by ingesting enterotoxins produced in food by some strains of S. aureus, usually because the food has not been kept hot enough (60°C, 140°F, or above) or cold enough (7.2°C, 45°F, or below).
-

Listeria monocytogenes

- Rod=shaped, facultative anaerobes, motile
- Isolated from
  - soil
  - silage
  - other environmental sources (e.g. drain, wet floor, equipments)
- resists the deleterious effects of freezing, drying, and heat remarkably well for a bacterium that does not form spores.
- salt tolerant
- survive and can grow at low temperature (< 4C)

Symptoms of Listeriosis

- Mild to intense symptoms of nausea, vomiting, diarrrhea, fever - self limiting
- Deadly symptoms:
  - Infection in the bloodstream to the nervous system which results in meningitis
  - cervical infections in pregnant women, which may result in spontaneous abortion (2nd/3rd trimester) or stillbirth.
- Usually preceded by influenza-like symptoms including persistent fever.
- The onset time to gastrointestinal symptoms is unknown but is probably greater than 12 hours
- Infective dose: < 10^3 cells

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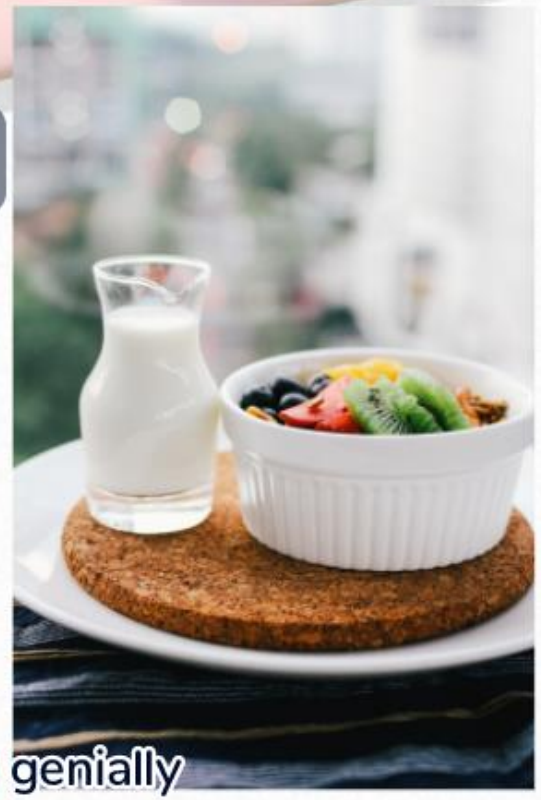
Food implicatied with L. monocytogenes

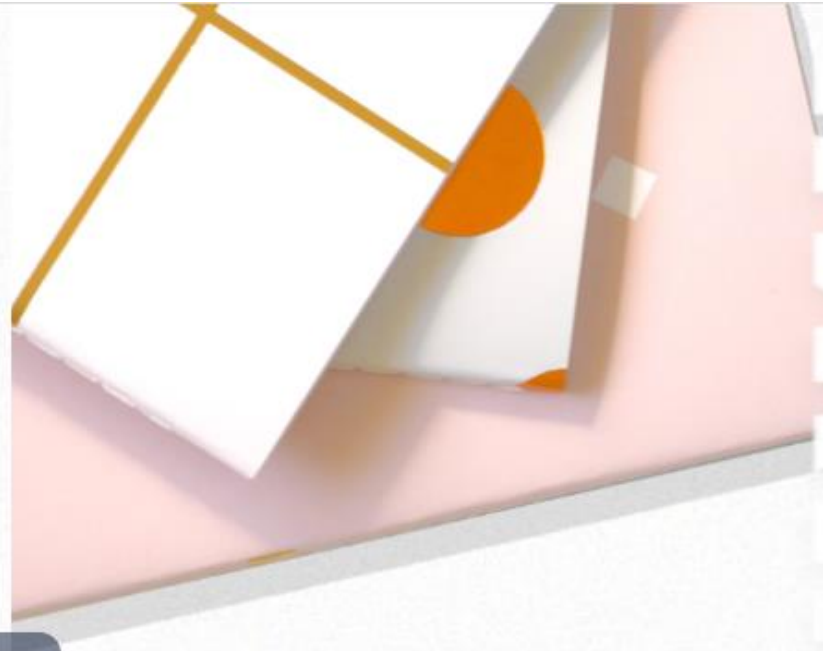


- Raw milk, cheese, ice-cream, raw vegetables and fruits, fermented raw meat sausages, raw nad cooked poultry, raw fish
- Psychrotrophs - can grow at temperature < 4C

GRAM-NEGATIVE PATHOGENS

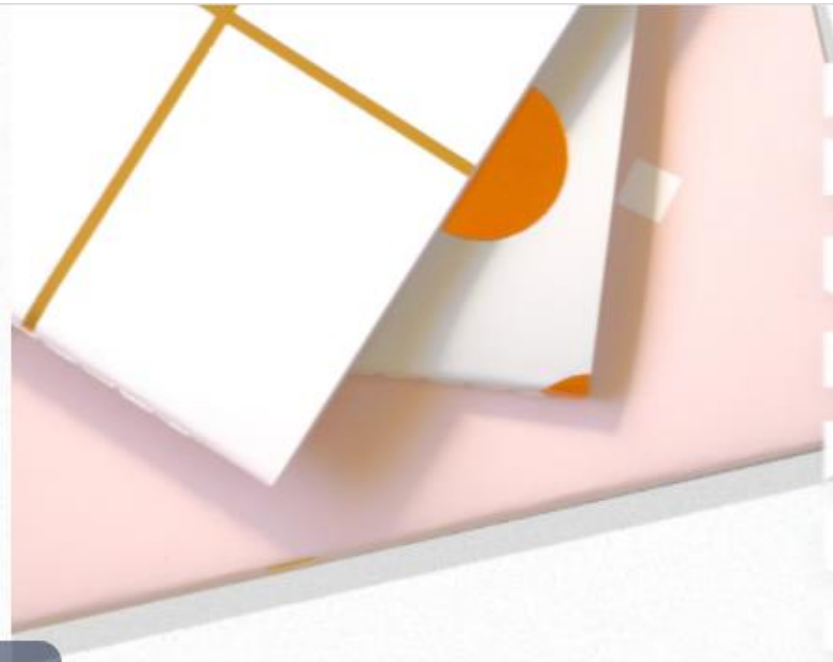
Salmonella

- Characteristics
  - rod-shaped, motile, non-sporeformer
- Abundant in animal esp. poultry and swine
- 2 species: *S. enterica, S. bongori*
- Commonly referred to their serotype name e.g. *Salmonella entrica* subsp. *enterica serotype* Thyphi - *S.* Thyphi
- Environmental sources include:
  - water, soil, insects, kitchen surfaces, human & animal feces
- Food: Raw meat and poultry, egg, milk and dairy product
- Other food: cream-filled desert & topping, peanut butter, chocolate



Symptoms

- 2 types of illnesses (salmonellosis)
- 1) **Non-thyphoidal:**
  - Symptoms: Nausea, vomiting, abdominal cramps, diarrhea, fever, and headache -self limiting
  - infective dose: as low as 1 cell
  - duration 4 - 7 days
  - dehydydration due to diarrhea and vomiting - may lead to death
  - arthritis may follow 3-4 weeks after onset of acute symptom (e.g. koint inflamation)
  - septicemia



Symptoms

- **2)Thyphoid fever:**
  - Caused by S. Thyphi & S. parathyphi
  - Symptoms: High fever, diarrhea, headache, drowsiness, abdominal pain, loss appetiate sometimes rashes - 10% mortality
  - *Salmonella* can spread to other organs and cause chronic infection - asymptomatic
  - Onset time:1-3 weeks
  - Duration: 2 - 4 weeks
  - Infective dose : < 10^3cells

Thyphoid & Parathyphoid fever

- Some other types of *Salmonella* cause typhoid fever or paratyphoid fever
  - life-threatening
  - need typhoid vaccine
- Common in the area with poor sanitation
- Can be symtomatic or asymptomatic
- Asymptomatic - Thyphoid Mary cases
  - people who have recovered from the illness but still shed the bacteria in their feces
  - chronic infection in the gallbladder

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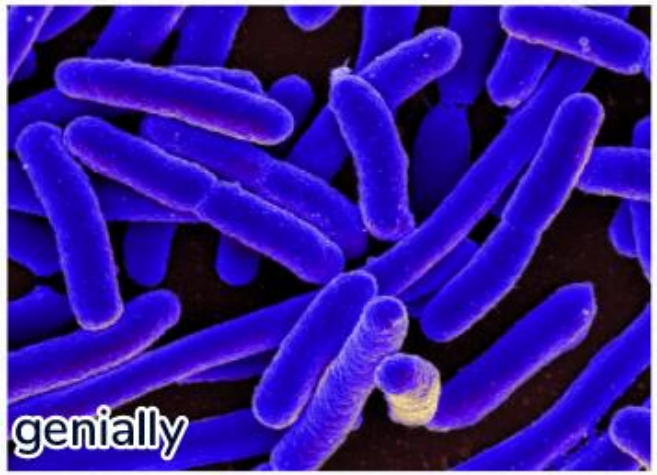
Escherichia coli



4 main groups of pathogenic *E. coli*

- *E*nterotoxigenic *E.coli (ETEC)*
- *Enteropathogenic E. coli (EPEC)*
- *Enterohaemorrhagic E. coli (EHEC)*
- *Enteroinvasive E. coli (EIEC)*

*So*urce of contamination:

- Undercooked or raw meat, raw milk, poultry, vegetables, unpasteurize juice,

Enterotoxigenic *E.coli* (ETEC)

- ETEC strains produce both heat -labile toxin and heat-stable toxin
- The organism frequently causes diarrhea in infants and travellers
  - **Traveller's diarrhea** (esp. those who travel to the country with poor sanitation)
- Infective dose is higher: 10^7 cells
- Symptoms: watery diarrhea without blood or mucus, abdominal cramps, low-grad fever, nausea - usually self limiting
- Source of contamination: water contaminated with human sewage, infected food handlers

Enteropatogenic *E.coli* (EPEC)

- EPEC cause either a **watery or bloody diarrhea, vomiting-**
- **high mortality rate : 20-50%**
- Infective dose - EPEC are highly infectious for infants and the dose is presumably very low to infant
- Normal dose is presumably similar to other colonizers (greater than 10^6 total dose).

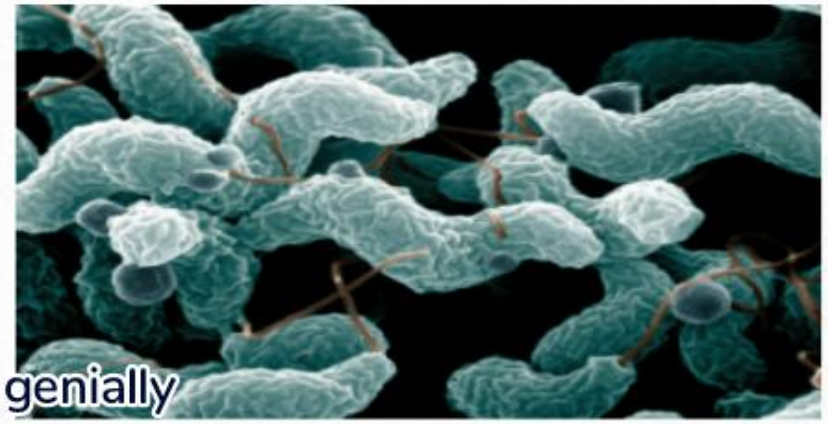
Enterohaemorrhagic *E.coli* (EHEC)

- *E. coli* O157:H7. E. coli is a normal inhabitant of the animal intestines
- Symptoms:
  - severe cramping (abdominal pain, diarrhea which is initially **watery but becomes grossly bloody.**
  - Occasionally vomiting occurs.
  - low-grade fever or absent.
  - produce shiga-like toxin (3-5% mortality)

Enteroinvasive *E.coli* (EIEC)

- Minority strain of *E. coli*
- The source of food is unknown but any food contaminated with human feces can cause disease.
- The illness is characterized by the appearance of blood and mucus in the stools of infected individuals

Campylobacter jejuni



- Characteristics
  - curved, motile
  - non-sporeformer
  - microaerophilic organism (require low level of oxygen ; 3-5% o2)
- Sensitive to envirenmental stress (high oxygen, drying, disinfections, acidic condition, etc)
- Often isolated from healthy cattle, chickens, bird, non-chlorinated water (pond, streams, etc)
- Food: raw milk, raw chicken - *C. jejuni* in the intestinal tract
- Proper cooking chicken, pasteurizing milk, and chlorinating water can kill the pathogens

Symptoms of campylobacteriosis

- *C. jejuni* infection causes diarrhea, which may be watery or sticky and can contain blood (usually occult) and fecal leukocytes (white cells).
- Other symptoms often present are fever, abdominal pain, nausea, headache and muscle pain.
- The illness usually occurs 2-5 days after ingestion of the contaminated food or water.
- Illness generally lasts 7-10 days
- Most infections are self-limiting and are not treated with antibiotics.

Yersinia enterocolitica

- Characteristics
  - small, rod-shaped
  - non spore former
- Non-pathogenic: Isolates from environmental and food sources, such as ponds, lakes, meats, ice cream, and milk.
- Pathogenic: *Y. enterocolitica* and *Y. pseudotuberculosis* cause gastroenteritis.
- Animal as reservoir: pigs, birds, cats, dogs
- Main source of food contamination: meat (pork, beef, lamb). fish, raw milk

Symptoms of yersiniosis

- Yersiniosis is frequently characterized by such symptoms as gastroenteritis with diarrhea and/or vomiting, fever, abdominal pain
- The infection **mimic appendicitis**
- The bacteria may also cause infections of other sites such as wounds, joints and the urinary tract
- Illness onset is usually between 24 and 48 hours after ingestion, which (with food or drink as vehicle) is the usual route of infection.

Vibrio cholerae

- Outbreak of chlolera is associated with the contaminated water, consumption of raw or undercooked shellfish
- Symptoms: watery diarrhea (rice water stool), abdominal cramps, nausea, vomiting, dehydration, and shock; after severe fluid and electrolyte loss, death may occur.
- Illness is caused by the ingestion of viable bacteria, which attach to the small intestine and produce cholera toxin - toxicoinfection
- Onset of the illness is generally sudden, with incubation periods varying from 6 hours to 5 days.

Vibrio parahaemolyticus

- Diarrhea, abdominal cramps, nausea, vomiting, headache, fever, and chills may be associated with infections caused by this organism.
- The illness is usually mild or moderate, although some cases may require hospitalization. The median duration of the illness is 2.5 days.
- The incubation period is 4-96 hours after the ingestion of the organism, with a mean of 15 hours.

THANK YOU