CHAPTER 2 : BIOLOGICAL HAZARDS

Bacteria

- Most of the bacteria that are part of food's natural bacterial ecology cause no ill effects when eaten
  - They are beneficial in preventing other pathogenic bacteria to grow in food

- bacteria are without doubt the major cause of food-borne illness worldwide
- There are many species of pathogenic bacteria associated with food, and each has its own preferences with respect to :
  - the food it infects,
  - the conditions it prefers to grow in,
  - its geographical distribution
  - and the severity of the diseases it causes

Bacterial ecology of food

- Some food-borne pathogenic bacteria can be fatal (e.g. botulism caused by *Clostridium botulinum*)
- others can cause severe diseases (e.g. campylobacteriosis caused by *Campylobacter jejuni*)
- others simply result in a few days of severe discomfort (e.g. *Staphylococcus aureus*).

Foodborne illness can contaminate foods in many ways

- Infection
- Intoxication
- Toxin- mediated infection

Infection

Disease causing MO → eaten along with food → cause **infection** → MO ingested with food → burrow into the lining of the victim's digestive tract → grow in number → lead to the common symptoms

Sometimes MO can spread to other part of the body through blood stream

Examples

- Bacteria : salmonella (in poultry and eggs)
- Viruses
- Parasites

Intoxication (food poisoning)

- Living MO multiplies → produces chemical waste or toxins in the food → the toxin causes illness

- When consuming food that contain man-made chemicals (such as cleaning agents and pesticides)

Examples

- Clostridium botulinum
- Staphylococcus aureus

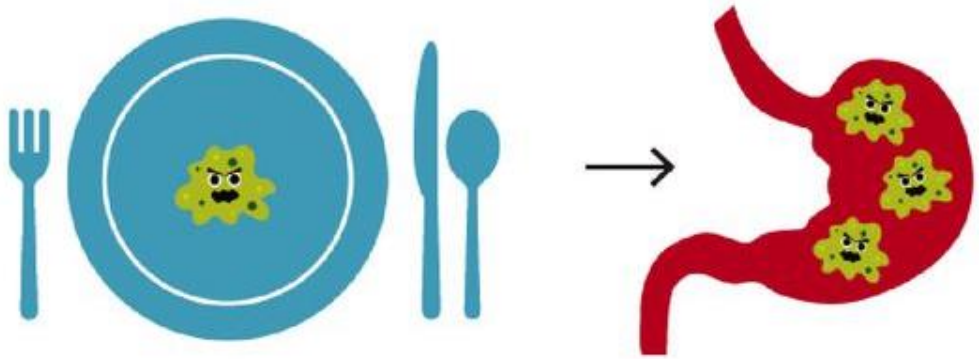
Toxin- mediated infection

- Living MO consumed with food (like infection) → the MO produces toxins inside the human body → cause illness

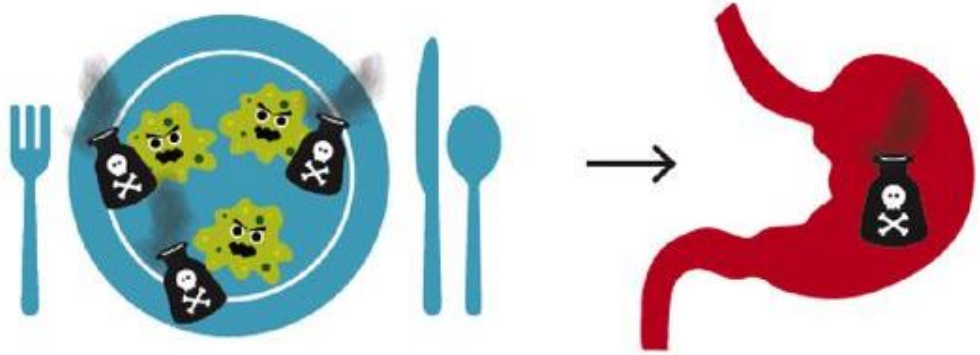
- Toxin mediated vs. intoxication ???

- Clostridium perfringens

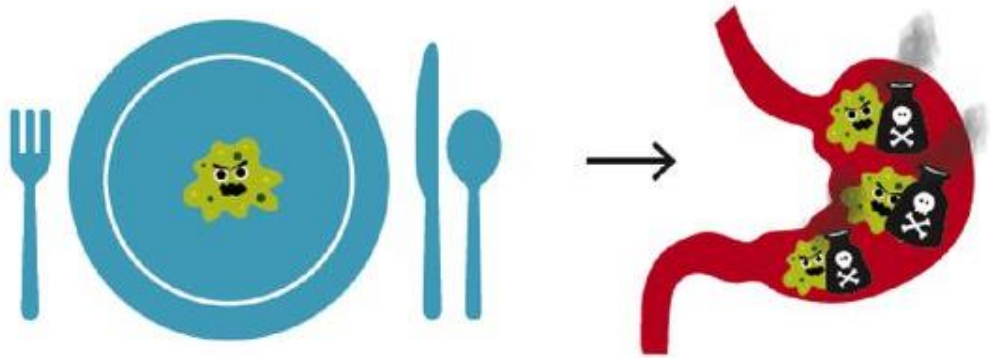
Foodborne Infection



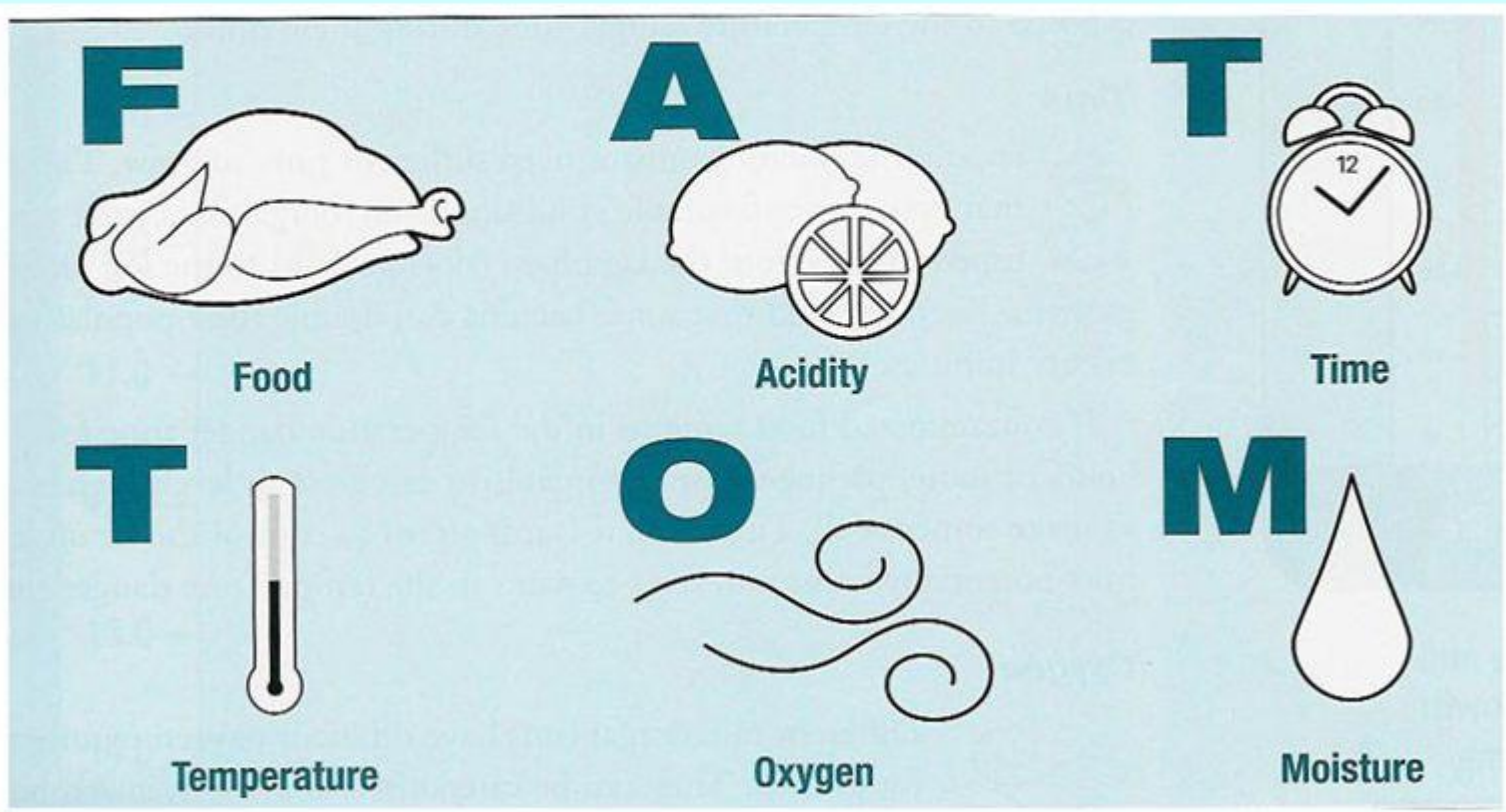
Foodborne Intoxication



Toxin-mediated Infection



Bacterial Growth Conditions-Fat Tom



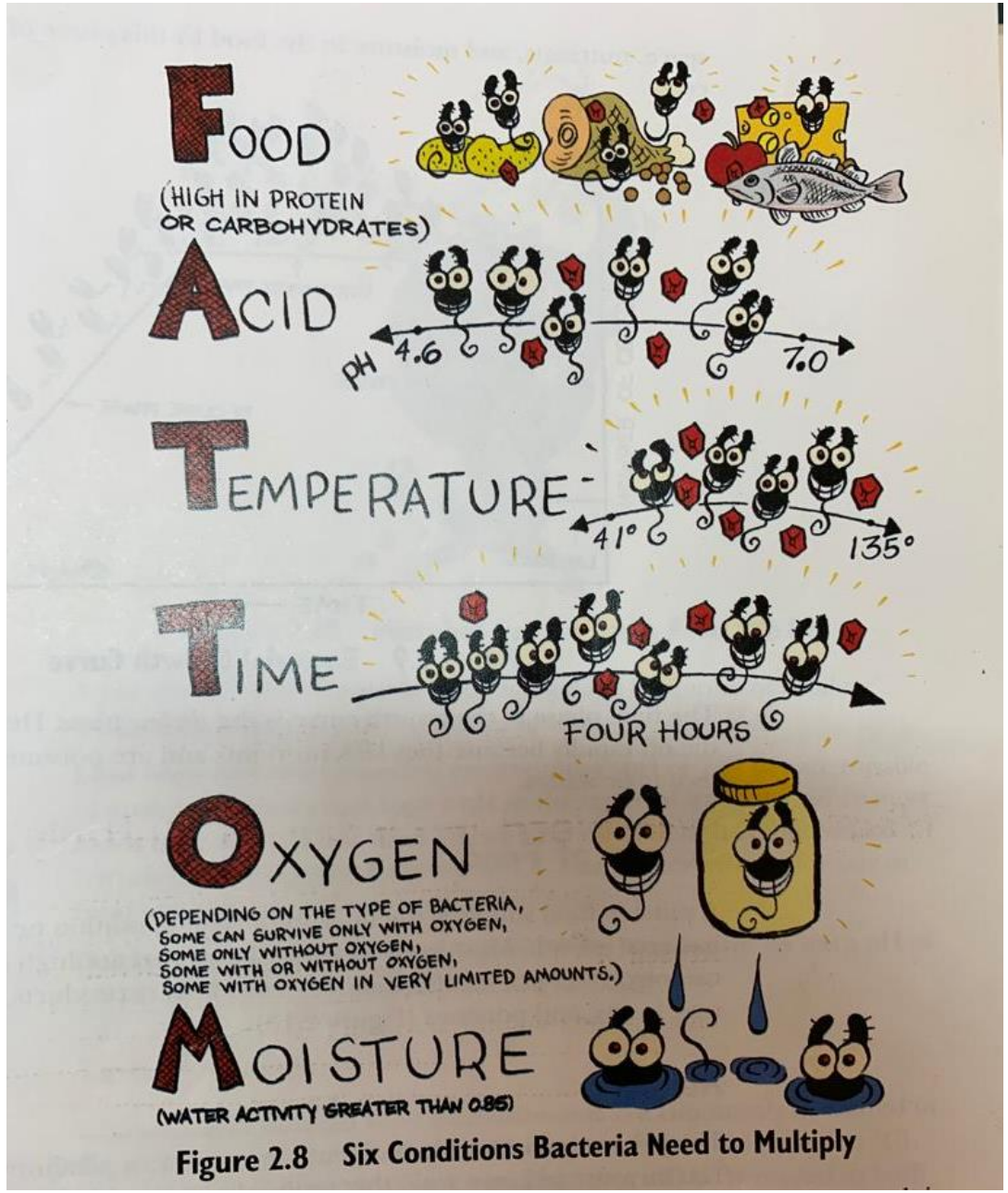


Figure 2.8 Six Conditions Bacteria Need to Multiply

Bacteria	Some characteristics	Food borne illness causes	where we can find it
Bacillus cereus Emetic : vomiting	Spore forming	2 types of diseases: 1. Emetic gastroenteritis causes by emetic toxin 2. Diarrheagenic gastroenteritis causes by Diarrheagenic toxin Both are not very severe, resolve within 24 hrs	- Naturally on many foods - Naturally in soil and soil contaminated foods *linked to alkaline carbohydrate foods (e.g. rice) that have been cooked, stored and reheated **TOXIN IS HEAT STABLE**

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Brucella	None spore forming	Brucellosis: fever associated with muscular pain and sweating Humans develop septicemia → bacteria enter the blood stream Others → enter the intestine	raw (unpasteurized) milk, cream and milk products (e.g. cheese) - Killed by pasteurization

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Campylobacter *C. jejuni* *C. coli*.	When animals are slaughtered, contamination of their flesh with intestinal contents can lead to food-borne *Campylobacter*, particularly in poultry	Campylobacteriosis (symptoms appear within 3-5 days of consuming contaminated food) - severe diarrhea (often bloody) - abdominal pain - cramps and fever (temperature can reach 40°C);	- meat from different animal species (since it is found in intestines of animals) - 89 % of cases in chicken - Heating to 55 C can kill them - Even freezing

Campylobacter incidence

Table 3.2 The incidence of *Campylobacter* (*C. jejuni* + *C. coli*) contamination in meat in New Zealand from a national retail survey carried out in 2003 and 2004. (Data from Lake *et al*. (2007) *Risk Profile: Campylobacter jejuni/coli in Red Meat*. Institute of Environmental Science & Research, Christchurch, New Zealand, www.nzfsa.govt.nz.)

Meat	Percentage positive for *Campylobacter* (number tested)
Beef	3.5 (230)
Veal	10 (90)
Lamb/mutton	6.9 (231)
Pork	9.1 (230)
Chicken	89.1 (230)

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Clostridium 1. *C. botulinum →* 2. *C. perfringins* 3. *C. diffcile (can grow during antibiotic therapy) → colitis*	Endospore forming Toxin producing	*C. botulinum → botulism* *C. diffcile → colitis*	

- Botulinum toxin : prevent the presynaptic neurotransmitter vesicles being released into the synapse and so stop the nerve impulse crossing the synapse.

Bacteria	Some characteristics	Food borne illness causes	where we can find it
C. botulinum *Most serious of all food borne bacteria*	Live in high sodium concentration, and low acidity Botulinum toxin : the most toxic chemical known	Botulism → fatal Muscle weakness , difficulty breathing, poor oxygenation of blood, respiratory failure , coma , death All if this are due to inhibition of neurotransmission at the synapse by the toxin Death rate: 33%	

Botox

- interesting application of a very toxic molecule.
- Botulinum toxin A (BTX-A) is used under the trade name Botox for cosmetic purposes.
- It is injected at very low concentrations usually into the muscles of the face.
- The BTX-A inhibits neurotransmission to the muscles and causes relaxation which removes lines and wrinkles and apparently makes people look younger

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
C. perfringins	Produces spores that survive high temperature (100 C) Produces heat stable toxins	Diarrhea Abdominal pain Nausea Higher levels of bacterial cells – sooner sypmtoms	soil Feces Easy to contaminate food if hygiene is not observed **Foods that have been cooked, cooled slowly and reheated

Bacteria	Some characteristics	Food borne illness causes	where we can find it
Escherichia ***Escherichia coli*** is by far the most common bacterial species 1. *E.coli O157:H7 is the pathogenic one*	- non-spore forming - Most common bacterial species - Important member of the normal gut flora - **Synthesizes Vitamin K which is absorbed by the human host** **- it accounts for about 50% of the dry weight of feces.**	*E. coli* O157:H7 lives in the intestines of farm animals (e.g. cattle) When slaughtering, and cooking → no risk Bloody diarrhea, severe abdominal pain , but with no fever	- Meat - Unpasteurized milk (during milking) - Some vegetables like lettuce (from fertilizers)

Foods associated with *E. coli* O157:H7

- When meat is contaminated by *E. coli* O157:H7 the bacteria are only present **on the outer surface of the meat** and therefore providing it is cooked well on both sides the bacteria will be killed
  - Rare steak can be eaten safely

- if minced meat is contaminated,the *E. coli* O157:H7 that was on the outside of the original piece of meat
- is distributed onto the multiple surfaces of the minced meat.
- If the meat is used to make hamburgers **the risk of consuming a rare hamburger is great** because the *E. coli* O157:H7 will not be killed in the 'pink' middle of the hamburger during cooking

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Listeria *Listeria monocytigenes*	- **Can live 4-37 C (which means at the refrigerator!!)**	Listeriosis Fever, muscles aches, vomiting, nausea , diarrhea **invasive listeriosis** which has more severe neurological effects	- Soil , waterways , intestines of animals meat (particularly cold cut cooked meats, e.g. boiled ham), dairy products (particularly soft cheeses, e.g. Brie), seafood, milk (usually unpasteurized), pâté and vegetables (e.g. salads stored in a refrigerator)

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Salmonella	- None spore forming - Not killed by freezing - Destroyed by cooking (≥60°C for 2–6 minutes)	Salmonellosis diarrhea, vomiting and fever most people recover completely In rare cases the *Salmonellae* can spread from the intestinal epithelial cells to the blood stream resulting in a severe septicemia which can be fatal	infect egg whites and as the egg ages the yolk membrane breaks down which allows the *Salmonella* to infect the egg yolk Mayonnaise , and runny(uncooked) yolks common component of the gut microflora of most warm-blooded animals **Chicken is the highest risk** **50% of cases from poultry and eggs**

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Shigella	- **None spore forming** - **Naturally in intestines of humans and animals** - **Only 100 bacteria are needed to cause the disease**	Shigellosis or dysentery by *shigella dysenteriae* from mild abdominal discomfort to severe cramps, diarrhea, fever, vomiting, bloody feces The death rate from shigellosis is very high (10–15% of cases) Causes dehydration → death	- Contaminated water rather than contaminated food - And feces does not matter which food an infected handler contaminates Cooking kills *Shigellae* so many cases are traced back to foods that are eaten raw

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Staphylococcus : most of the series are naturally occurring in flora of skin and mucus ***S. aureus* is a food-borne pathogen**	heat-stable protein Toxin is produced by S. aureus not destroyed by cooking or the acids and proteases in the stomach	food can easily get contaminated by handling nausea, vomiting, retching, stomach cramps and diarrhoea The severity of the symptoms depends on the amount of toxin (i.e. the dose) in the food	Any food that is handled during its preparation and is a good culture medium for *S. aureus* •• Cooked meats, poultry and egg products (e.g. mayonnaise) •• Salads – egg, tuna, chicken, potato, macaroni •• Cream-filled pastries, chocolate éclairs •• Sandwich fillings •• Milk and dairy products

Bacteria	**Some characteristics**	**Food borne illness causes**	**where we can find it**
Streptococcus/Enterococcus *Some species produces acid → tooth decay* *Some species help in making yogurt*	Large number of bacterial cells 10^7 are needed to cause infection when ingesting contaminated foods	Diahrea Abdominal cramps Nausea Vomiting Fever Chills Dizziness Most people do not go the doctors	They are found naturally on and in humans (mouth, tongue Highly processed or handled foods during manufacturing or preparation Sausages Evaporated milk Cheese Meatballs Meat pies ,

Bacteria	Some characteristics	Food borne illness causes	where we can find it
Streptococcus pyogenes		Sore throat Pain when swallowing Other symptoms associated with strep throat	Strep bacteria are spread through direct contact with mucus from the nose or throat of infected persons or through the air by sneezing or coughing. **Rarely, people catch** Strep throat eating contaminated food or milk