UNDERSTANDING MICROORGANISMS

Microorganisms are found everywhere. They are not visible to the naked eye. Microorganisms can come from food, water, animals, humans, or objects. **Food contaminated with microorganisms may look, smell, and taste fine, even when it's not safe.** Because of this, it is important to know about microorganisms and how to control them.

Some microorganisms are beneficial to humans. We need them to make things like cheese, bread, yogurt, wine, and beer.

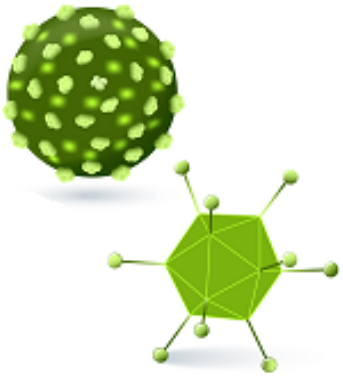


Other microorganisms can be harmful to humans and cause disease. **These harmful microorganisms are called pathogens.**

DIFFERENT TYPES OF MICROORGANISMS:

- Viruses
- Parasites (protozoa and helminths)
- Fungi (moulds and yeasts)
- Bacteria

<u>Viruses</u>



- Pathogens that multiply inside our own cells
- Not living, but can "survive" for a long time on surfaces
- Do not grow in food
- Very small, most cannot be seen with a regular microscope
- Illness occurs very quickly and usually lasts only a short time (1-2 days)
- Very contagious, often cannot be treated, dehydration in high-risk groups common
- Carrier state common
- Human hands commonly contaminate food so hand washing important
- Another common source is seafood and shellfish from contaminated water
- Examples of viruses carried in food: hepatitis A, norovirus, rotavirus

Parasites

- Feed off humans and animals, live in or on body, and often excreted in feces
- Range in size from tiny, microscopic single-celled organisms (**protozoa**) to multi-cellular worms (**helminths**) visible to the naked eye
- Illnesses they cause can range from mild discomfort to serious illness and possibly death
- Like viruses, parasites do not grow in food, they reproduce in the tissues of other organisms (hosts)
- Transferred through consumption of fecal-contaminated water and food
- Parasites live longer than bacteria and therefore symptoms persist longer
- Parasites, especially protozoa, are harder to remove from water than bacteria
- Cooking to proper temperatures and boiling untreated water for at least one minute is best way to control parasites

- Most parasites transferred to humans through:
  - Contaminated water or food washed with contaminated water
  - Eating undercooked meat from a contaminated animal
  - Cross-contamination
- Examples of common protozoa that cause food-borne illness: Giardia, Cyclospora, Cryptosporidium, Toxoplasmosis
- Examples of common helminths that cause food-borne illness: Trichinella, Taenia saginata/Taenia solium (tapeworms)

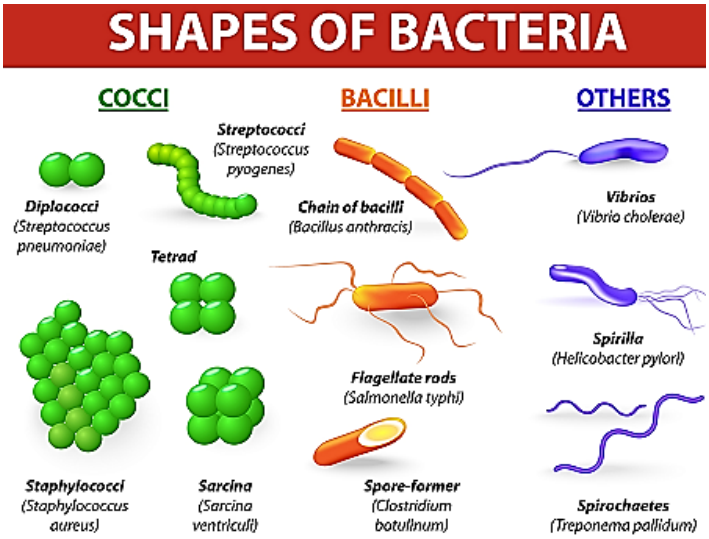
Fungi (Moulds and Yeasts)

- Can grow at refrigerator temperatures
- Yeasts don't usually cause food-borne illness, usually only spoil food
- Some moulds produce toxins called mycotoxins
- Toxin forms under the surface of the food, can't scrape off

- Hard cheese, salamis, and firm fruits and vegetables can be saved, but most mouldy food should be thrown away
- Transferred from place to place by air currents and carriers (people, equipment, food)
- Examples of moulds that make poisonous toxins:
  - Aflatoxin – often found in nuts, peanuts and peanut butter
  - Ochratoxin A – often found in grain, coffee and wine

Bacteria

- Bacteria can be beneficial or harmful for humans
- Example of good bacteria: probiotics in yogurt
- Examples of bad bacteria: Salmonella, E. coli, Campylobacter, Listeria, Botulism, Bacillus cereus, Staph aureus.
- Pathogenic bacteria cause food-borne illness in one of two ways:
    1) **Bacterial infection, or**
    2) **Bacterial intoxication**



1) Bacterial Infection:

- Caused by eating food contaminated with bacterial pathogens
- Bacteria multiply in food and multiply further inside intestine
- Start of symptoms slow (usually 1 to 3 days). Sometimes up to 10 days. Sometimes even up to 2 months
- Amount and type of bacteria eaten determines start of symptoms
- Usually results in (bloody) diarrhea, cramps, and fever
- Examples of bacteria that cause infection:
    - Salmonella (ex. chicken, eggs)
    - E-coli (ex. ground beef)
    - Campylobacter (ex. processed chicken, meat)
    - Shigella (ex. veggies)

2) Bacterial Intoxication:

- Sometimes it's not the bacteria itself that makes a person sick, but what the bacteria produces
- All bacteria produce a waste product, but some can be toxic to humans called **toxin**
- Toxin can come from bacteria growing in food or from bacteria on a food handler

- Illness is caused by eating food contaminated with toxin or toxin-producing bacteria
- Not all toxin is destroyed by cooking so temperature-abused food needs to be thrown away
- Start of symptoms is very quick (1-6 hours), illness can last up to 2 weeks
- These illnesses can be very serious.
- Vomiting and nausea are most common symptoms
- Other symptoms can include: paralysis, respiratory failure, and death

- Examples: botulism (home-canned veggies), Staph aureus (ex. ham), Bacillus cereus (ex. rice, gravy)

How Bacteria Grow

1. One bacteria **divide** to form 2 new bacteria
2. Divide as quick as **20 minutes** under right conditions
3. Some bacteria can enter a **spore** state where they **do not grow**, but are **still alive!**

Spores

- During stressful conditions, some bacteria can protect themselves by forming a protective outer shell called a spore
- A spore is the resting stage of some live bacteria
- Spores can survive for months in unfavourable conditions. When favourable conditions return, bacteria growth and dividing resumes. Favourable conditions consist of high protein and moisture levels, sufficient time within the temperature range of 4°C to 60°C (40°F to 140°F), a neutral pH, and sufficient oxygen or non-oxygen levels depending on the organism
- Bacterial spores are not destroyed by usual methods of cooking. High heat in excess of 120°C (248°F) is required to destroy spores
- Spores are also resistant to many disinfectants
- Botulism is an example of a spore-forming bacteria that produces extremely dangerous toxin

Carriers

- People can have an infection without showing any symptoms. These people can transfer germs they have into food they're preparing
- Frequent and proper hand washing is all the more important due to the lack of signs of illness in carriers

WHO GETS SICK?

There are a number of reasons that can make a person who eats contaminated food more or less likely to get sick. Some of these are:

1) Immune status

Groups at increased risk of food-borne illness:

- Young children
- The elderly
- People with weakened immune systems
- Pregnant women

2) How many organisms you ate

There has to be enough bacteria to make it through the stomach to the intestines for a person to get sick. This is called the 'infectious dose'. Different pathogens have different infectious doses. Usually the higher the infectious dose consumed, the faster and more severe the symptoms If a person's immune system is compromised, it'll take even less.

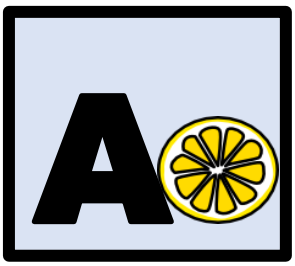
3) Type of organisms you ate

Some pathogens cause vomiting within ½ hour, others cause diarrhea after several days. There is much variation in the timing of symptoms depending on the organism eaten.

WHAT BACTERIAL PATHOGENS NEED TO GROW

FAT TOM!

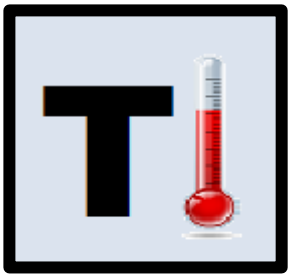
Food: Pathogens need nutrients in order to grow. These nutrients come from **water and protein** in food. Foods high in protein include animal products such as meat, chicken, diary, eggs, and cheese. Unprocessed, whole foods are also high in protein. Pathogens can also use carbohydrates as a source of energy. Foods high in carbohydrates include potatoes, rice, and pasta.



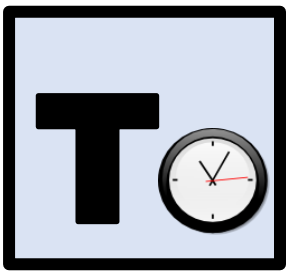
Acidity: Pathogens grow best in foods with little or no acidity. The pH scale ranges from 0 (acidic) to 14 (alkalinic). A pH of 7 is neutral. Each rise or fall in the pH scale by an interval of 1 is equal to 10 times (1 log). For example, a food with a pH of 5 is 10 times more acidic than a food with a pH of 6.

Foods with a pH between 4.5 and 7.5 is ideal for pathogens. Foods in this range include fish/seafood, meat, chicken, egg yolks, milk, and tofu. Sour or acidic foods have a pH below 4.5. This includes most fruits. Pathogens won't grow in foods in this range.

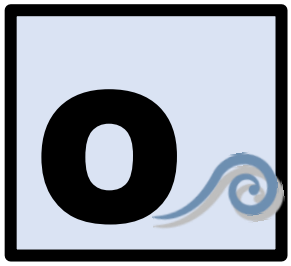
Be careful when home canning foods. A boiling-water canner does not kill bacterial spores during the canning process. Other protective measures should be taken to ensure spores do not grow in the canned food (e.g. Acidification).



Temperature: Pathogens grow very quickly in foods that are held in the Danger Zone between 4°C-60° (40°F-140°F). When working with hazardous foods at room temperature, work quickly and carefully. Keep hot foods hot and cold foods cold. **Freezing may not kill bacteria, but does prevent their growth.**



Time: Pathogens need time to grow. If foods are in the Danger Zone for **two hours** or longer, they will grow to levels high enough to potentially make someone sick. Time accumulates while food is held in the Danger Zone; the '2 Hour Rule' never resets. Hazardous food must be thrown out if held at room temperature longer than two hours.



Oxygen: Pathogens can grow with or without oxygen. Aerobic bacteria require oxygen to grow. Anaerobic bacteria require little to no oxygen to grow.

Moisture: Pathogens need water to grow. Water activity (Aw) measures the free water available in food for microorganisms to use. Foods with higher Aw (i.e. moist foods with low solutes) are at risk for rapid pathogen growth. Examples of foods that contain high Aw levels include meats, fish, dairy, eggs, cheese and cut vegetables. Foods with lower Aw are less at risk for rapid pathogen growth. Examples of low Aw foods include baked goods, crackers, peanut butter, jams, beef jerky, dried fruit and powdered milk.

Foods can be made safer if its free water available is lowered. For example, by:

- Adding salts, sugars, and spices
- Freezing
- Dehydrating
- Cooking

Low Aw does not kill pathogens; it only keeps them from growing. Some pathogens (e.g. Salmonella) can survive in dry foods and become potentially hazardous when the food becomes wet.

HAZARDOUS FOOD

It is important that food handlers are able to recognize hazardous foods as these foods have all the things that pathogenic bacteria need to multiply quickly and make someone sick. **When working with hazardous foods at room temperature, work quickly and carefully!**

Hazardous foods have all three of these characteristics:

1. High in Protein
2. High in Moisture
3. Neutral pH (between pH of 4.5 to 7.5)

Hazardous foods include meat, dairy, fish, eggs, cooked vegetables (ex. rice, baked potatoes), some raw vegetables (ex. bean sprouts, garlic in oil), and some raw fruits (ex. cut melons).

Shelf-stable products like commercially canned foods are not hazardous foods

Examples of Microorganisms Causing Food-borne Illness:

Pathogen	Signs and Symptoms	Incubation Period	Food Involved
Anisakis simplex (infection)	Abdominal cramps, pain, vomiting, coughing	12 hours to several days	Salt-water fish
Bacillus cereus (toxico-infection)	Nausea, abdominal pain, diarrhea, vomiting	Up to 24 hours	Cereal products, rice, custards and sauces, meatloaf
Campylobacter jejuni (infection)	Diarrhea (sometimes bloody), severe abdominal pain, fever, anorexia, headache, vomiting	2 to 5 days	Raw milk, poultry, beef liver, raw clams, contaminated water
Clostridium botulinum (intoxication)	Vertigo, double vision, difficulty swallowing, speaking and breathing, muscular weakness, respiratory paralysis. Gastrointestinal symptoms may precede neurological symptoms. **Frequently fatal.**	18 to 36 hours	Home-canned low-acid food, garlic and oil mixtures, vacuum-packed fish, fermented fish eggs, fish, marine mammals
Clostridium perfringens (toxico-infection)	Abdominal pain, diarrhea	8 to 22 hours	Cooked meat, poultry, gravy, sauces and soups
Cryptosporidium (infection)	Severe diarrhea, low-grade fever and severe intestinal distress	1 to 12 days	Any food product that was touched by a contaminated person or contaminated water
Escherichia coli O157:H7 (toxico-infection)	Severe abdominal pain, diarrhea (sometimes bloody), nausea, vomiting, fever, chills, headache, muscular pain, bloody urine	24 to 72 hours	Soft unpasteurized cheese, contaminated water and any undercooked animal-source foods, especially rare hamburger
Giardiasis lamblia (infection)	Abdominal pain, diarrhea, fever, cramps	1 week	Water, raw vegetables and fruits
Hepatitis A (infection)	Fever, anorexia, nausea, abdominal pain, jaundice	15 to 50 days	Shellfish, any food contaminated by hepatitis viruses, hepatitis virus A from feces, urine, blood, or infected humans and other primates, contaminated water
Listeria monocytogenes (infection)	Nausea, vomiting, stomach cramps, diarrhea, headache, constipation, fever	1 to 70 days	Unpasteurized milk, soft cheeses, undercooked poultry, prepared meats, unwashed raw vegetables
Norovirus (infection)	Nausea, vomiting, diarrhea, abdominal pain	24 to 72 hours	Contaminated water, food or food surface
Salmonella (infection)	Abdominal pain, diarrhea, chills, fever, nausea, vomiting	6 to 72 hours, usually 12 to 36 hours	Poultry, meat and their products, egg products, other contaminated food,

			feces of infected humans and other animals
Shigella (infection)	Diarrhea (sometimes bloody), abdominal cramps, chills, fever, dehydration	12 to 50 hours	Moist prepared foods, especially salads (potato, tuna, macaroni), raw fruits and vegetables, raw milk and dairy products, poultry
Staphylococcus (intoxication)	Nausea, vomiting, abdominal pain, diarrhea	2 to 4 hours	Ham, meat, poultry, cream-filled pastry, food mixtures, leftover foods
Trichinella (infection)	Abdominal pain, vomiting, nausea, fever, swelling around eyes, muscular pain, chills, laboured breathing	1 to 2 days for gastrointestinal illness; other symptoms occur within 2 to 4 weeks	Pork, bear meat, and walrus flesh
Yersinia (infection)	Watery diarrhea, vomiting, abdominal pain, fever, headache, sore throat; may mimic appendicitis	24 to 48 hours	Meats (especially pork, beef and lamb), tofu, oysters, fish, ice cream, fish, powdered milk and raw (unpasteurized) milk, raw vegetables, and soy products