Introduction

Micro-organisms can cause disease

- Viruses
    - E.g. covid caused by coronavirus
- Bacteria
    - E.g. tuberculosis caused by mycobacterium tuberculosis
- Fungi
    - E.g. skin infections caused by tinea
- Protozoa
    - E.g. malaria caused by protozoa in the genus plasmodium

Microbes can spoil medicine

- Microbes may spoil and degrade medical products
- They can change the appearance, odour and taste of medicine
- We can prevent this by
    - Inhibiting microbial growth with preservatives
    - Producing products free of contamination to begin with, by using sterile production and Good Manufacturing Practice (GMP)

Major Infectious Diseases

- Top 10 infectious diseases by disability-adjusted life years (DALY)
- (the loss of the equivalent of one year of full health)
    - Diarrhoeal Disease
    - Tuberculosis
    - HIV/AIDS
    - Malaria
    - Covid
    - Hepatitis B
    - Meningitis
    - Hepatitis C
    - Measles
    - Whooping cough

Diarrhoeal Disease

- Third leading cause of death in children 1 to 5 years old
- It is preventable and treatable – by safe drinking water and adequate sanitation and hygiene
- Caused by bacterial, viral and parasitic organisms, found in faeces-contaminated water
- Bacterial pathogens include E coli and salmonella – most prevalent in kids 6-10
- Viral pathogens include rotavirus and norovirus
- Parasitic pathogens include cryptosporidium and giardia – most prevalent in kids 3-5
- Rotavirus and E coli are the most common diarrhoea causing pathogens overall

Tuberculosis

- Bacterial disease caused by mycobacterium tuberculosis
- A chronic infection, causing high morbidity and mortality worldwide
- It is transmitted in the air, after prolonged exposure to an infected person
- It usually affects the lungs, but can spread to other organs
- Tuberculosis can lay dormant within the body and avoid diagnosis, until symptoms appear
- Vaccinations/treatments exist but applying this globally has proven an issue
- HIV/AIDS sufferers are very susceptible to tuberculosis
- Tuberculosis has better outcomes than HIV/AIDS

HIV/AIDS

- Acquired Immune Deficiency Syndrome (AIDS) was the original name of this disease, but it was later discovered it was caused by a virus, Human Immunodeficiency Virus (HIV)
- The virus targets the body's T cells, supressing the immune system
- It is transmitted through bodily fluids, blood, saliva, semen and vaginal secretions
- The virus may lay dormant within the body and avoid diagnosis, until symptoms appear
- HIV/AIDS is near impossible to cure because a copy of the virus genome is present in the host genome

Malaria

- Caused by the parasite Plasmodium, a single-cell eukaryote microorganism
- A vector-borne infectious disease spread by mosquitoes; their bite introduces the parasite from its saliva into the bloodstream

- It is hard to treat in areas with poor health infrastructure where its ability to reinfect after a cure and its developing drug resistance make local elimination complicated and expensive
- In first world countries, malaria is hardly an issue and a vaccine is expected soon
- Malaria has better outcomes than HIV/AIDS

Medically Important Bacteria – Gram Negative

Bacteria

- Can be classified based on phenotype/phenetic or genotype/phylogenetic
- Gram-negative bacteria are more likely to be pathogenic
- All gram-negative bacteria can produce endotoxin
- Gram-negative bacteria have thinner peptidoglycan than gram-positive bacteria and an outer membrane
- Gram-negative bacteria are suited to surviving internally
- Types/phylums of bacteria include proteobacteria, bacteroidetes, spirochaetes etc.

Proteobacteria

- Escherichia/ E coli
    - Facultative anaerobic, gram-negative heterotrophic rods
    - Part of the *Enterobacteriaceae* family
    - Found in the gut of humans and animals
    - E Coli is used as a model organism in microbiology
    - Motile by peritrichous flagella (all over)

    - Most strains are normal flora and beneficial for the human body e.g. E coli K12 synthesises vitamin K in the human body
    - Some strains however are pathogenic, food or water borne pathogens
    - 0157 or 0111 is used to denote when E coli has infected something
    - Virulence factors; endotoxin, only some have enterotoxin (causes diarrhoea)
    - Symptoms; diarrhoea and fever
- Salmonella
    - Facultative anaerobic, gram-negative heterotrophic rods
    - Motile by peritrichous flagella (all over)
    - Very similar to E coli, however salmonella is only normal flora in animals not humans i.e. it is pathogenic to humans
    - Salmonella enterica – food-borne (raw eggs/chicken) and causes self-limiting diarrhoea
    - Salmonella typhi – water borne and causes potentially fatal typhoid fever
    - Virulence factors; endotoxin, enterotoxin, cytotoxin
- Vibrio
    - Facultative anaerobic, gram-negative heterotrophic curved rods
    - Motile by various flagella arrangements, often a single flagella
    - Generally found in the ocean, but can cause gut infection
    - Vibrio cholerae
        - The most pathogenic vibrio species
        - Causes cholera – severe diarrhoea
        - Transmission by faecal contamination of water (positive feedback loop with its symptom) OR by eating seafood
        - Virulence factors; cholera toxin

- Pseudomonas
    - Aerobic, gram-negative heterotrophic rods
    - Motile by a single flagella
    - Ubiquitous across the world in water, soil etc.
    - An opportunistic pathogen, its large genome means it is metabolically versatile and can colonise various parts of the body
    - Pseudomona aeruginosa

        - Often the cause of infection in hospital (nosocomial)
        - Virulence factors; innate antibiotic resistance due to its low membrane permeability, haemolysin, proteases

- Neisseria
    - Aerobic, gram-negative heterotrophic diplococci (two balls)
    - Is non-motile
    - Found in the mucus membranes, carried by the back of throat, nose
    - Virulence factors; capsule which helps evade immune response (no antigen exposed), fimbriae which helps adhesion to tissues/epithelial cells
    - Neisseria gonorrhoea – "hairy"
        - Causes gonorrhoea – STD - irritation around the genitals
        - Diagnosed by microscopic examination
        - Adheres to epithelial cells
    - Neisseria meningitis – "smooth"
        - Causes meningitis – the inflammation of the membrane around the brain
        - Fever, rash, headache, death
        - A serious, rapidly progressing disease which requires rapid treatment
        - Diagnosed by examination of cerebrospinal fluid
- Rickettsia
    - Aerobic, gram-negative heterotrophic coccobacilli
    - Is non-motile
    - Cannot be grown in vitro, only in tissue culture
    - Obligate bacteria, dependent on their host organism, they are intracellular parasites of arthropods e.g. fleas, ticks, lice
    - Very small "degenerate" genome which explains their dependency on the host
    - Transmitted via bites or faeces of arthropods, especially in overcrowded conditions
    - Rickettsia prowazekii
        - Causes epidemic typhus – headache, fever, rash, death
        - Virulence factors; adhesin, phospholipase

Bacteroidetes

- Bacteroides
    - Anaerobic, gram-negative heterotrophic <u>obligate</u> rods

- Normal flora of humans, but can be opportunistic pathogens if they escape the gut, causing abscesses, appendicitis
- Bacteroides are generally beneficial, digesting carbohydrates and competing and excluding other pathogens such as salmonella
- Virulence factors; capsule (no antigen exposed), antibiotic resistance

Spirochaetes

- Treponema
  - Anaerobic, gram-negative heterotrophic spirochaetes (spirals/corkscrews)
  - Obligate parasites, dependent on the host for nutrients/ to replicate
  - Very small "degenerate" genome
  - Motile by corkscrew motility, structure provided by axial filament – it is suited to move through viscous liquid i.e. moves through blood faster than water
  - Causes syphilis
    - STD
    - Chancres, rash, nervous system damage, facial disfigurement

Chlamydiota

- Chlamydia
  - Aerobic, gram-negative heterotrophic cocci
  - Non-motile
  - Obligate intracellular parasites dependent on its humans and animal hosts for energy
  - Has a small genome, hence it's dependency on its host
  - Causes urethritis (STD) and trachoma (eye infection)
  - Virulence factors; an unusual cell wall allowing for growth inside phagocytes, antibiotic resistance to antibiotics targeting peptidoglycan (it has no peptidoglycan)
  - The most prevalent STD in Australia
  - Most people with chlamydia are asymptomatic