

# 10 Infectious diseases

## 10.1 Infectious diseases

- > **Disease** – abnormal condition affecting an organism that reduces the effectiveness of the function of the organism
- > **Infectious disease** – a disease caused by a pathogen, is transmissible and reduces the effectiveness of functions of the organism e.g., tuberculosis, cholera, etc.
- > **Non-infectious disease** – long-term, degenerative diseases not caused by pathogens and not transmissible e.g., lung cancer, sickle cell anaemia, etc.

- **Transmission cycle** – the way in which a pathogen transfers from one host to another
- **Endemic** – diseases that are always present in populations e.g., malaria is endemic in tropical and sub-tropical regions
- **Incidence** – the number of people who are diagnosed over a certain period of time
- **Prevalence** – the number of people who have that disease at any given time
- **Epidemic** – sudden increase in the number of people with a disease
- **Pandemic** – increase in the number of cases worldwide
- **Mortality** – death rate from different diseases
- **Incubation period** – time a disease takes to infect someone

### Summary of diseases and their causative agent

DISEASE	CAUSATIVE AGENT	TYPE OF ORGANISM
cholera	<i>Vibrio cholerae</i>	bacterium
malaria	<i>Plasmodium falciparum</i> , <i>P. malariae</i> , <i>P. vivax</i> , <i>P. ovale</i>	protocist
tuberculosis (TB)	<i>Mycobacterium tuberculosis</i> (airborne), <i>M. bovis</i> (infected milk/cattle)	bacterium
HIV/AIDS	human immunodeficiency virus (HIV)	virus
smallpox (eradicated)	<i>Variola virus</i>	virus
measles	a species of <i>Morbillivirus</i>	virus

### How diseases are transmitted

#### a) Cholera

**Transmission** – via the faecal oral route or when raw human sewage of an infected person is used to irrigate vegetables

- infected people pass out the pathogen (*Vibrio cholerae*) in faeces which contaminates water supply and food whilst handling (due to lack of hygiene)
- the bacteria pass through the stomach acid to reach the small intestine – their site of action
- they multiply and secrete a toxin called **cholera toxin**
- it disrupts the functions of the epithelium lining in the small intestine
- salts and water leave the blood causing severe diarrhoea which may be referred to as 'rice water'

#### Prevention and control

- treatment is via oral rehydration therapy (a mixture of glucose and salts)
- drink bottled water or chlorinated water
- wash utensils and vegetables properly
- raise awareness
- improve sanitation services and sewage treatment plants

#### Global patterns of distribution

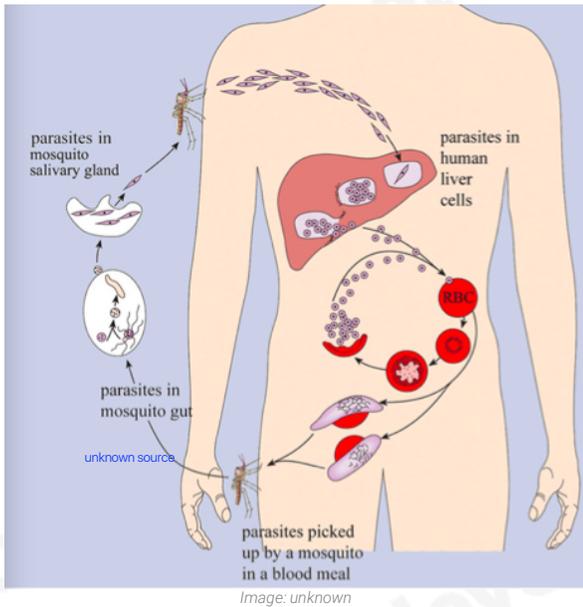
- prevalent in large cities in developing countries that don't have adequate sewage systems or clean water supply
- global distribution – Asia, Africa, Latin America

#### b) Malaria

> **Vector** – organism which carries a disease from one person to another or from an animal to a human e.g., female anopheles mosquito for plasmodium

#### Transmission

- 1) blood transfusion
- 2) when unsterilised needles are used
- 3) plasmodium can pass across placenta from mother to foetus



### How infection of malaria occurs

- 1) female anopheles mosquito feeds on human blood to obtain the protein they need to develop eggs
- 2) if an infected person is bitten, the mosquito takes up the pathogen's gametes with the blood meal
- 3) male and female gametes fuse in the mosquito's gut and develop into infective stages that move to the salivary glands
- 4) when the mosquito feeds again, an anticoagulant is injected from the salivary glands causing the infective stages to pass out as well
- 5) the anticoagulant is injected to prevent blood from clotting
- 6) parasites enter the blood stream, then enter liver cells and finally infect red blood cells

### 2. Prevention and control

- 1) control of breeding of mosquitoes (e.g., drainage of stagnant water, aerial spraying of insecticide, oil on water, stocking ponds)
- 2) reduction of contact between vector and humans (e.g., bed nets impregnated with insecticide / insect repellents)
- 3) earlier identification of cases (introduction of dip stick tests ensuring diagnosis can be done quickly)
- 4) use of new drugs to prevent transmission or using drugs in combination to reduce chances of drug resistance arising
- 5) better awareness
- 6) better screening of blood before transfusion

### Why malaria is very difficult to control

- 1) no vaccine as plasmodium is eukaryotic and antigens differ in the different life stages
- 2) drug resistance in Plasmodium
- 3) insecticide resistance in Plasmodium

- 4) cost of drugs
- 5) problems with funding research
- 6) lack of knowledge
- 7) infected people not identified
- 8) inaccessibility of some regions to healthcare

### Why is it difficult to create a vaccine for malaria?

- 1) plasmodium is eukaryotic
- 2) antigens differ in different life stages
- 3) intracellular parasite
- 4) antigenic concealment

### c) HIV/AIDS (acquired immune deficiency syndrome)

#### Transmission

- 1) semen and vaginal fluids during intercourse
- 2) infected blood (via donation, etc)
- 3) sharing needles
- 4) mother to foetus across placenta
- 5) mother to infant in breast milk

#### Epidemic caused by:

- 1) anal intercourse (*mucous lining of rectum not as thick as a vagina's + less natural lubrication; rectal lining is easily damaged during intercourse and virus passes from semen to blood*)
- 2) many sexual partners
- 3) lack of awareness

#### How HIV affects the body

- 1) genetic material of HIV is RNA
- 2) viral RNA is converted to DNA inside host cells to be incorporated into human chromosomes
- 3) infects and destroys T<sub>helper</sub> cells (cells that control the immune system's response to infection)
- 4) when the number of T<sub>helper</sub> cells are low, the body is unable to defend against infection allowing pathogens to cause opportunistic infections
- 5) AIDS isn't a disease – it's a collection of opportunistic diseases associated with the immunodeficiency caused by HIV infection

#### Treatment

- 1) drug therapy (e.g., zidovudine)
- 2) it binds to viral enzyme reverse transcriptase and blocks its action
- 3) this stops the replication of viral genetic material and blocks its action and leads to an increase in the body's lymphocytes
- 4) combination therapies are however difficult to follow

- 5) people are unable to keep up with the regimen are susceptible to strains of HIV that have developed resistance to drugs

> **reverse transcriptase** – an enzyme encoded by certain viruses (retroviruses) that uses RNA as a template for DNA synthesis

#### Prevention and control

- 1) spread awareness
- 2) use condoms, femidoms and dental dams
- 3) don't have many sexual partners
- 4) don't share needles
- 5) contact tracing
- 6) blood collected by donors screened and heat treated
- 7) reduce mother to child transmission by using formula milk

#### d) Tuberculosis (TB)

##### Transmission

- 1) infected person coughs
- 2) aerosol droplet carrying the pathogen
- 3) inhaled by uninfected person
- 4) or consumption of meat/milk of an organism carrying TB

##### Treatment

- when TB is confirmed, patients are isolated
- Several drugs such as the antibiotic streptomycin are used to ensure bacteria are killed

##### Prevention

- contact tracing
- cattle are routinely tested for TB

##### Global distribution

- TB is endemic however most common in poor and crowded living conditions
- also present where a large number of people have HIV/AIDs

#### e) Measles

**Transmission** – inhalation of droplets of moisture containing the virus

##### Prevention and control

- vaccination
- treatment – bed rest and medicines to lower fever

#### f) Smallpox (eradicated)

**Factors that led to the successful eradication of smallpox**

- 1) smallpox virus was stable/did not mutate

- 2) same vaccine was used for whole programme/vaccine did not need to be changed
- 3) vaccine was live/gave strong immune response
- 4) one dose was enough to give life-long immunity/no boosters required
- 5) heat stable/freeze-dried vaccine
- 6) suitable for hot countries/isolated areas/rural areas
- 7) few/no symptomless carriers
- 8) no animal reservoir/only in humans
- 9) infected people easy to identify

## 10.2 Antibiotics

An antibiotic is a drug that kills or stops the growth of bacteria without harming the cells of the infected organism

#### Antibiotics may interfere with

- synthesis of bacterial cell walls
- activity of proteins in the cell surface membrane
- enzyme action
- DNA synthesis
- protein synthesis

#### How penicillin acts on bacteria

- 1) penicillin prevents the synthesis of cross links which hold together a bacterium's peptidoglycan walls (so penicillin is only effective when bacteria are growing)
- 2) enzymes autolysins secreted create small holes that allow the wall to stretch so new peptidoglycan chains can link
- 3) penicillin prevents linking but holes continue to appear making the cell wall weaker
- 4) when bacteria take up water via osmosis, it cannot withstand the pressure potential exerted due to the weakened cell wall and bursts

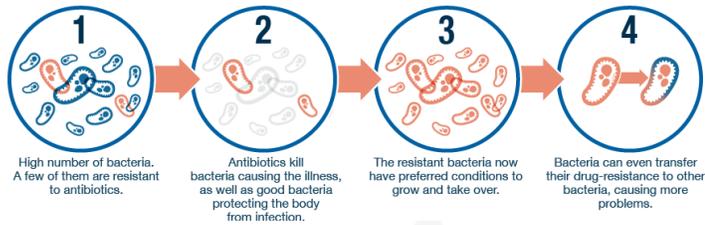
#### Why antibiotics do not affect viruses

Antibiotics target areas of the bacterium such as its cell wall or other organelles. Viruses do not possess such organelles and therefore are immune to the effects of antibiotics.

#### How bacteria become resistant to antibiotics

- 1) people not completing course of antibiotics causing a reservoir of bacteria to remain
- 2) remaining bacteria mutate to become resistant bacteria with resistance survive
- 3) when they reproduce they pass on the allele for resistance to their offspring

## How does antibiotic resistance occur?



Bacteria transfer their drug-resistance by vertical or horizontal transmission. Some mutated bacteria may have plasmids carrying several resistance genes leading to multiple resistance.

## Consequences of antibiotic resistance

- 1) decreased ability to treat infections
- 2) increased human illness and mortality
- 3) increased cost and length of treatments
- 4) adverse effects from alternate treatments
- 5) lack of availability of clinically effective antibiotics

## Steps that can be taken to reduce the impact of antibiotic resistance

- 1) don't use antibiotics for trivial reasons or to treat viral infections
- 2) complete the course
- 3) use a combination of antibiotics
- 4) don't use as preventative medicine
- 5) only use wide-spectrum antibiotics when the pathogen is not known
- 6) rotate antibiotics so the same ones aren't used all the time
- 7) don't use the same antibiotics for animals and humans
- 8) don't sell antibiotics without a doctor's prescription