PATHOGENS AND DISEASE

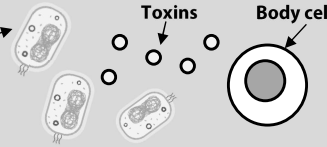
Communicable diseases

What are communicable diseases?
Infectious diseases that can be spread from one individual to another. This can happen through direct contact, or indirectly through water / air / a **vector** (an organism that doesn't cause disease itself but carries disease between organisms, spreading infection).

What are pathogens?
Microorganisms (viruses, bacteria, protists or fungi) that cause disease.

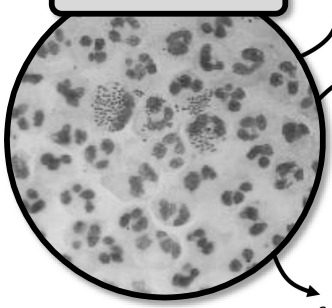
Bacterial diseases

Bacteria reproduce quickly inside the body



They can produce toxins that harm tissues to produce disease symptoms

Gonorrhoea



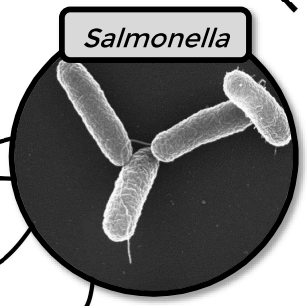
Microscope image of the bacterium that causes gonorrhoea

Symptoms
- Yellow/green discharge from genitals (vagina/penis)
- Painful urination

Prevention/treatment
1. Treatment by antibiotics (but some strains have become resistant to the penicillin antibiotic)
2. Prevention of spread by using barrier contraception, e.g. condoms

Transmission
Sexually transmitted

Salmonella



Microscope image of the bacterium that causes Salmonella

Symptoms
- Nausea, vomiting (which causes dehydration)
- Abdominal cramps
- Diarrhoea (causes dehydration)
- Fever

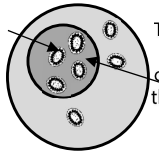
Transmission
The bacterium, *Salmonella*, enters a person's gut when they eat food that has *Salmonella* in or on it

Prevention
- Good food hygiene, e.g. handle raw poultry separately from other foods
- Vaccinating poultry against *Salmonella* bacterium

Treatment
- Drink fluids to restore hydration
- Antibiotics in severe cases

Viral diseases

Viruses are tiny so live inside the cells of hosts



They reproduce quickly inside cells, damaging them when they are released

HIV

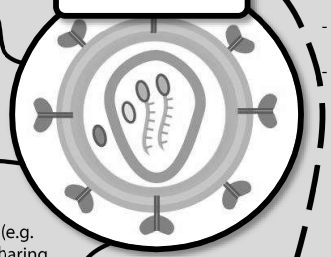


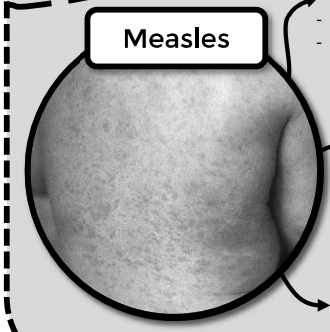
Diagram of the HIV virus

Symptoms
- Flu-like
- In late-stage HIV, known as AIDS, the immune system is too damaged to defend against infection/cancer. This is because the HIV virus attacks immune cells.

Transmission
Body fluid exchange (e.g. sexually transmitted, sharing needles, blood donation, and mother to fetus)

Prevention/treatment
- Prevented by barrier contraception, not sharing needles, screening blood donations
- Cannot be cured, but antiretroviral drugs delay the development of AIDS

Measles



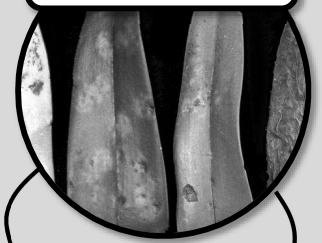
Measles rash on a patient's back

Symptoms
- Fever
- Red rash on skin

Transmission
- Highly contagious
- Breathing in droplets from coughs and sneezes

Prevention/treatment
Vaccinating children – successful in making measles uncommon in the UK

Tobacco mosaic virus



Mosaic pattern on leaves caused by a virus

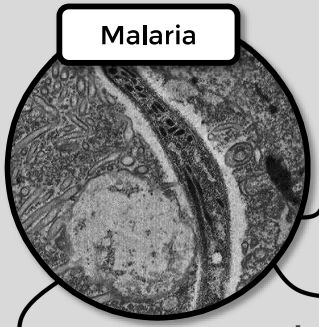
Symptoms
- Mosaic pattern of discoloration on leaves of plants
- This prevents plants from photosynthesising fully so reduces growth

Transmission
- Insect vectors
- Direct contact of infected plant material with healthy plants

Prevention
There is no treatment but it can be prevented through use of resistant varieties and pest control systems

Protist diseases

Malaria



Microscope image of the protist that causes malaria

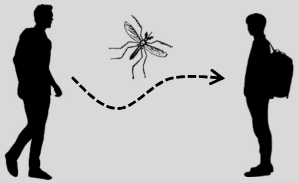
Protists are single-celled eukaryotic organisms that can cause disease if they enter the body of another organism.

Symptoms
- Recurring episodes of fever
- Vomiting
- Muscular pain

(If left untreated, malaria can be fatal)

Prevention/treatment
- Stop mosquitoes from breeding (e.g. by preventing waterlogging to reduce egg-laying source)
- Use mosquito nets to avoid being bitten

Transmission
Mosquitoes act as a **vector** (the protist that causes the disease lives inside the mosquito and is passed from one person to the next via the mosquito taking a blood meal)



Fungal diseases

Fungi are eukaryotic organisms. Most are harmless, but some can cause disease in animals and plants.

Rose black spot

Black spots on leaves caused by a fungus

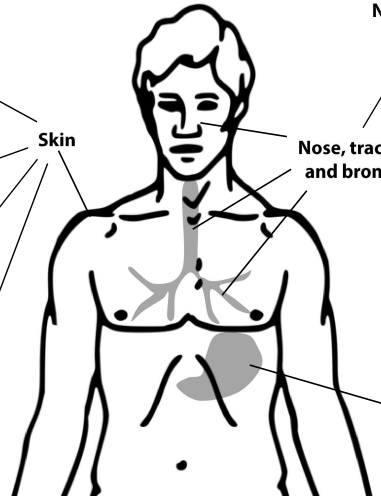
Symptoms
- Black/purple spots develop on leaves of plants
- Yellowing and premature drop of leaves
- Reduced growth because of decreased photosynthesis

Transmission
Water or wind spreads spores

Prevention/treatment
- Fungicides
- Removal and destruction of infected leaves

HUMAN DEFENCE AGAINST DISEASE

Non-specific immune system



Outer layer of dead cells that is difficult for microorganisms to break through

Secretes **antimicrobial oils** that kill microorganisms

Blood clotting at cuts forms scabs to prevent entry of microorganisms

'Good' microorganisms live on our skin and compete with, and kill, pathogens

Skin

Nose, trachea and bronchi

Nasal hairs prevent entry of some larger microorganisms

Mucus lining the nose, trachea and bronchi traps microorganisms

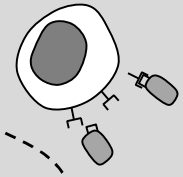
Hair-like cilia lining the nose, trachea and bronchi transport microorganisms to the back of the throat to be swallowed

Stomach contains hydrochloric acid that kills microorganisms that have been swallowed

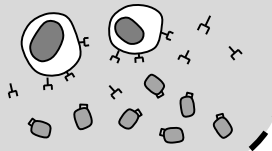
Vaccination

Expose the immune system to small amounts of harmless and inactive or dead forms of a pathogen

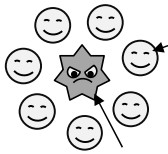
This triggers **production of antibodies** by white blood cells



If the harmful version of this pathogen infects the body at another time, white blood cells can **quickly produce antibodies** against it to defend the body against infection



Herd immunity

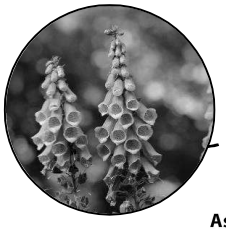


The majority of the population (herd) is made **immune** by vaccination.

Unvaccinated people become too thinly dispersed for the pathogen to **spread**, so it dies out.

Developing drugs

Traditional drug discovery



Digitalis, used to treat heart problems, comes from foxgloves.

Aspirin, a painkiller, originates from willow trees.

Penicillin, an antibiotic, comes from *Penicillium* mould.

Alexander Fleming discovered penicillin by accident!

Modern drug discovery

Synthesis of drug compounds by chemists in the **laboratory**

New drugs must be **tested** to check they are safe and effective before they can be used

Sometimes still use chemicals **extracted from plants** as a starting point

Preclinical testing: The drug is tested on cells, tissues and/or live animals in the laboratory

Clinical trials 1: Give healthy volunteers low doses of drug to test for safety

Clinical trials 2: Give patients larger doses to determine the optimum drug dosage, and see whether the drug is effective

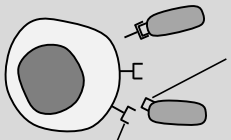
Peer review: Results from trials/testing reviewed by other scientists before publishing

Double-blind trials involve giving some patients a **placebo**. Neither the doctor nor the patients know who has been given the placebo.

Specific immune system

Some pathogens get past these non-specific defences. Fortunately, the **white blood cells of the immune system** have several methods of killing pathogens.

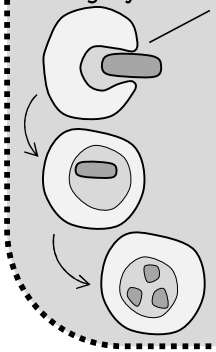
Antibody production



Microorganism has molecules called **antigens** on its surface

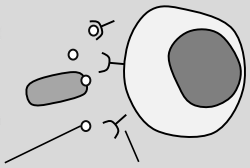
White blood cell produces **antibodies** that recognise and bind to molecules on microorganism's surface

Phagocytosis



White blood cells **take in and digest pathogens**, destroying them

Antitoxin production



Microorganism produces **toxins** that harm body tissues

White blood cell produces **antitoxins** that bind to toxins and stop them from working

Antibiotics

Antibiotics are drugs that kill or harm infective bacteria in the body to cure bacterial diseases. They are extremely useful, but have their limitations.

Advantages	Disadvantages
Kill pathogenic bacteria inside the body to stop them causing disease	**Cannot kill viruses** because they are acellular
Specific antibiotics can be used to **kill specific bacteria**	**Can also kill 'good' bacteria** that help our body function
Antibiotics were once thought to be **'miracle drugs'** and have helped save many lives from bacterial diseases	**Antibiotic resistance** is a growing problem – some bacteria can no longer be killed by certain antibiotics (e.g. some strains of the gonorrhoea bacterium are resistant to penicillin)

Painkillers

Painkillers can be used to **reduce the symptoms of disease**, including viral ones.

However, they **do not actually kill the pathogens** or cure the disease.

It is hard to make a drug that **targets viral pathogens without harming tissues of the body**, because they replicate inside host cells.