# Diseases and Immunity

## Disease

- Pathogens are organisms that cause diseases (bacteria, viruses, fungi, protoctists and worms)
- Diseases caused by these pathogens are called transmissible diseases ad they can be passed/transmitted from one person to another. They are also called infectious diseases

| Method of transmission | Description | Examples of diseases |
|---|---|---|
| Through air | Pathogens in tiny droplets of liquid from the airways and lungs of infected people | Influenza, tuberculosis, common cold |
| Contaminated food and drink | People preparing food who do not wash their hands; foods that are not cooked properly; human faeces contaminating water supplies; flies transfer pathogens on their bodies | Cholera, typhoid |
| Direct contact | Uninfected people touch infected people, or items, that infected people have used | Athlete's foot |
| Insect vectors | Insects e.g. mosquitoes feed on the blood of an infected person and then feed on an uninfected person | Malaria, dengue fever |
| Body fluids | Blood from an infected person enters the blood of an uninfected person, e.g. an unsterilized needle shared between drug users | HIV/AIDs, hepatitis |
| Person activity | Pathogens pass from uninfected person to sexual partner in blood, semen or vaginal fluid | HIV/AIDs, nonspecific uteritis (NSU), chlamydia |

## Defences against diseases

1. The first line of defence prevents pathogens entering the body
2. The second line destroys any pathogens that beak through the first line of defence
3. The third line produces antibodies that defend us against specific pathogens

## Barriers to infection

### Mechanical barriers

- The dead outer layers of the skin form a barrier to entry
- The hairs in the nose trap large particles that are inhaled

### Chemical barriers

- The stomach makes hydrochloric acid that kills pathogens in food
- Cells that line the airways make mucus that traps dust particles and microorganisms. The mucus is moved away from the lungs and up in the throat by cilia. The mucus is swallowed and any pathogens are destroyed by stomach acid

If any pathogens get through these barriers and enter the blood, then there is a second line of defence.

### Blood defences

- White blood cells form a line of defence against pathogens
- Phagocytes engulf bacteria and viruses into vacuoles where they are digested and destroyed (phagocytosis)

- Lymphocytes produce antibodies
- When activated- antibodies have a variety of effects on pathogens
- Such as stopping pathogens from moving around the body and it easier for phagocytes to engulf them
- Vaccination is a way to make lymphocytes produce antibodies and give them long term protection against certain diseases

Defence against disease

- All pathogens have chemical proteins on their surface called antigens
- When you catch a disease lymphocytes respond by making antibodies, which can lock onto the surface of the pathogens

There are several ways in which antibodies attack pathogens:

i. They cause bacteria to stick together in a group, making it easier for phagocytes to find and engulf them
ii. Some bacteria have flagellum, antibodies can attach to flagella and stop them from moving
iii. Bacteria such as diphtheria and tetanus can release toxins into the blood, antitoxins ae a special group of antibodies which combine with toxins and neutralise them making them harmless
iv. Some antibodies kill bacteria directly by punching holes through cell walls. This weakens cell walls so water enters by osmosis causing the cells to burst

Immune response

- Each type of pathogen has its own antigens which have a specific shape. The antibodies are made against each type of antigen that have a shape that fits around the antigen. The antibody has a complimentary shape to the antigen
- When contracting an infection you will be ill and have a variety of symptoms, you will begin to feel better in a week or two and will be back to your normal healthy self
- If the virus attacks the system for the second time, you will not have the same symptoms or be ill. Lymphocytes are responsible for this and are activated during immune response
- You are born with a large number of different types of lymphocytes. These cells are specific to different antigens on the surface of different pathogens. When a pathogen invades, some lymphocytes respond and invade to make more cells of the same type
- Many of these lymphocytes become bigger and fill many ribosomes attached to a network of endoplasmic reticulum. The antibodies are secreted into the blood and lymph and distributed around the body. The antibodies lock on to the specific antigens on pathogens that have invaded the body
- Other lymphocytes are activated to patrol around the body looking for infected cells. When they find an infected cell they destroy it and stop it from producing more pathogens
- The reason HIV is such a serious infection is that it destroys the body's lymphocytes that are responsible for much of our defines against infectious disease
- The response to the first infection is slow
- The response to the second attack by the same pathogen is faster
- This process of defence against pathogens by antibody production is known as active immunity
- Becoming immune after catching a transmissible disease and being ill is a natural way to gain active immunity

- During immune response, many lymphocytes are produced- many develop into anti body producing cells but some do not
- They remain in blood and lymph circulating around the body
- These are memory cells which respond whenever there is another invasion by the same pathogen with the same antigens
- During each immune response to specific pathogens, more and more lymphocytes are produced to stay in the body
- Therefore when the pathogen invades the body there will be far more lymphocytes with the ability to produce the right antibodies
- The response to any subsequent infection is therefore much faster and much greater

Vaccination

- It is possible to promote active immunity without being ill
- This is done by injecting a vaccine that contains live pathogens, dead pathogens or antigens taken from the surface of proteins.
- Each vaccine stimulates immunity to a specific type of disease e.g. measles, mumps, rubella
- In some cases, the vaccine provides protection against a specific strain of that disease, in the cases if influenza diseases
- Vaccination is an artificial way to gain active immunity

Aspects of immunity

Passive immunity

- If protection is required in a hurry, antibodies may be given by injection. This provides only temporary immunity, but it should be sufficient to give protection. Immunity gained this way is passive immunity
- Antibodies pass across the placenta and are present in the break milk, so giving a baby protection against diseases which his/her mother will have immunity against
- This is also temporary as the baby's body treats the mother's antibodies as foreign and destroys them
- The immunity is gained without exposure to antigens so it is safer than active immunity
- Passive immunity is used in cases where people are at risk of tetanus entering the body through open wounds
- Health workers inject a vaccine that neutralise toxins produced by the bacteria which can cause muscle paralysis
- Venom from snakes, scorpions, spiders and other dangerous animals act far too quickly for active immunity to be of any use
- People who have been bitten by venomous animals need anti venom extremely quickly
- Anti-venom contains antibodies to the molecules in the venom
- Specialist companies collect venom from these animals and inject them in small quantities to horse and sheep
- This prompts an immune response and the antibodies are collected from the blood, processed and made available to hospitals in areas where people are at risk of being bitten by venomous animals
- No memory cells are produced in passive immunity, so this type of immunity is short term but instantaneous
- As soon as the antibodies enter the body they are available to be used

- There is no wait between the arrival of the antigens and the production of the antibodies as there is in active immunity

Malfunction of the immune system

- Sometimes the immune system does not work perfectly
- When this happens it detects our own antibodies as something foreign and this prompts an immune response
- As a result the immune system attacks and destroys healthy tissue by mistake
- Malfunctions of the immune system cause a variety of diseases collectively known as autoimmune diseases
- Examples are: rheumatoid arthritis, multiple sclerosis and type 1 diabetes

Type 1 diabetes

- This type of diabetes is caused when the immune system attacks and destroys the cells of the pancreas that make insulin
- This usually happens rapidly usually before the age of 20
- Insulin helps to control the concentration of glucose in the blood
- It is made in response to an increase in the glucose concentration in the blood usually while a meal is being absorbed
- Insulin stimulates the liver and muscles to store glucose as glycogen
- This means that glucose is not stored for times when it will be needed by cells to release energy in respiration

The symptoms of Type 1 diabetes are:

i. Weight loss- cells use protein and fat instead of glucose as sources of energy
ii. Thirst- this is due to the increased concentration of glucose in the blood that lowers its water potential
iii. Tiredness due to lack of glycogen that can be converted to glucose to provide energy between meals

One indicator of diabetes is the presence of glucose in urine

People with diabetes are treated with regular injections of insulin. The drug is manufactured using techniques of genetic engineering and many different types are available so that diabetics can control their blood glucose concentration efficiently

Controlling the spread of disease

Preventing infection

*Personal hygiene*

- People of all ages should wash their hands after urinating or defecating and also before handling or eating food
- Hair should be washed with shampoo to prevent dandruff and head lice
- Everyone should wash themselves frequently, especially in hot weather
- Brushing teeth regularly, and flossing to prevent dental cavities
- Cuts and bruises washed with an antiseptic and plasters placed on open wounds

*Hygienic Food Preparation*

- Food should be covered to keep flies away
- Kitchen surfaces should be cleaned with disinfectants to kill bacteria
- Food should be cooked thoroughly to make sure any bacteria (e.g. salmonella) are killed
- Cooked food should be separated from raw food
- Water used for cooking/drinking should be boiled or sterilised by adding water purification tablets if it comes from sources that might be contaminated

*Proper Waste Disposal*

- Household waste should be placed in covered bins and collected at regular intervals
- Collected rubbish should be disposed of correctly, recycled, incinerated or buried in properly regulated landfill sites
- If not regulated carefully will attract rats and flies who are diseases carriers
- Effluent from rubbish tips may contain harmful chemicals that cause pollution

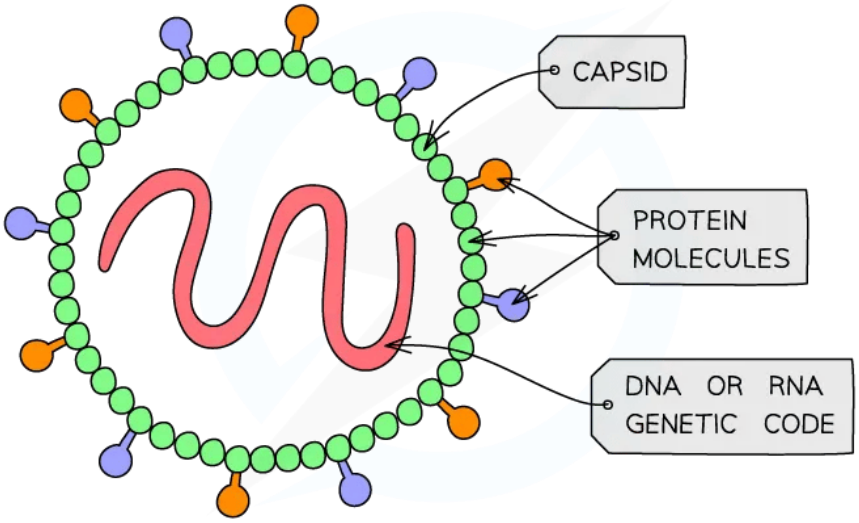
*Sewage Treatment*

- Toilet water is a serious health hazard if not disposed properly
- Human wastes are broken down by microorganisms in sewage treatment works
- The pathogens that cause typhoid and cholera are transmitted through faeces and transmit to people who drink water or eat food contaminated by raw sewage
- Thorough sewage treatment breaks down the transmission of typhoid and cholera so these diseases are unknown in countries with proper sanitation

The role of vaccination

- Vaccination programs are an important part of health
- Infants and children are vaccinated against diseases that used to be common and responsible for many deaths
- Many of these diseases are now very rare in many parts of the world
- During eradication programmes vaccination is used in two ways:
- Mass vaccination schemes attempt to give active immunity to everyone
- Some do not respond to vaccines but they can be protected because the chances of them coming into contact with the disease are small and most people around them have immunity and will not transmit the disease
- Careful surveillance by health officials identify people who have infectious diseases and the spread of the disease is limited or stopped by vaccinating all people who have come into contact with infected people
- For some diseases there are no cure, such as HIV, Ebola and dengue fever

Virus Diagrams





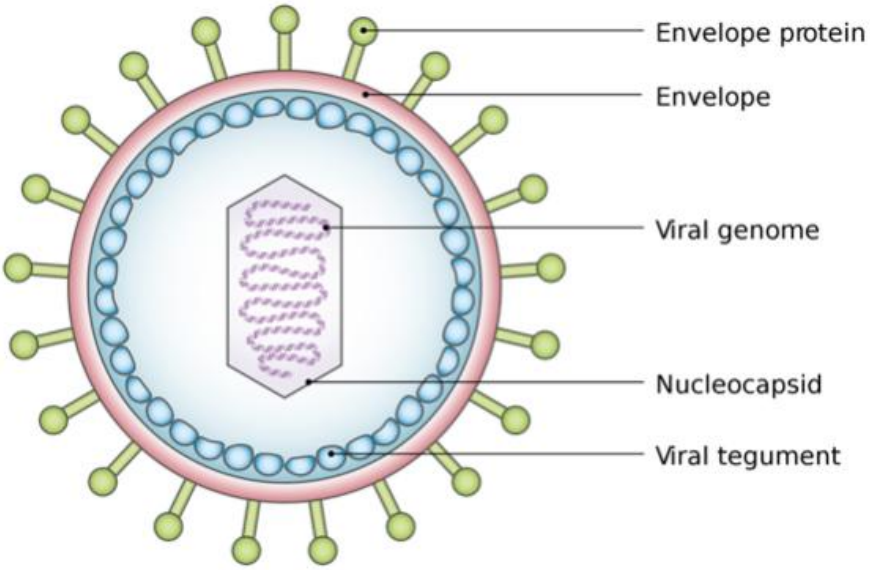
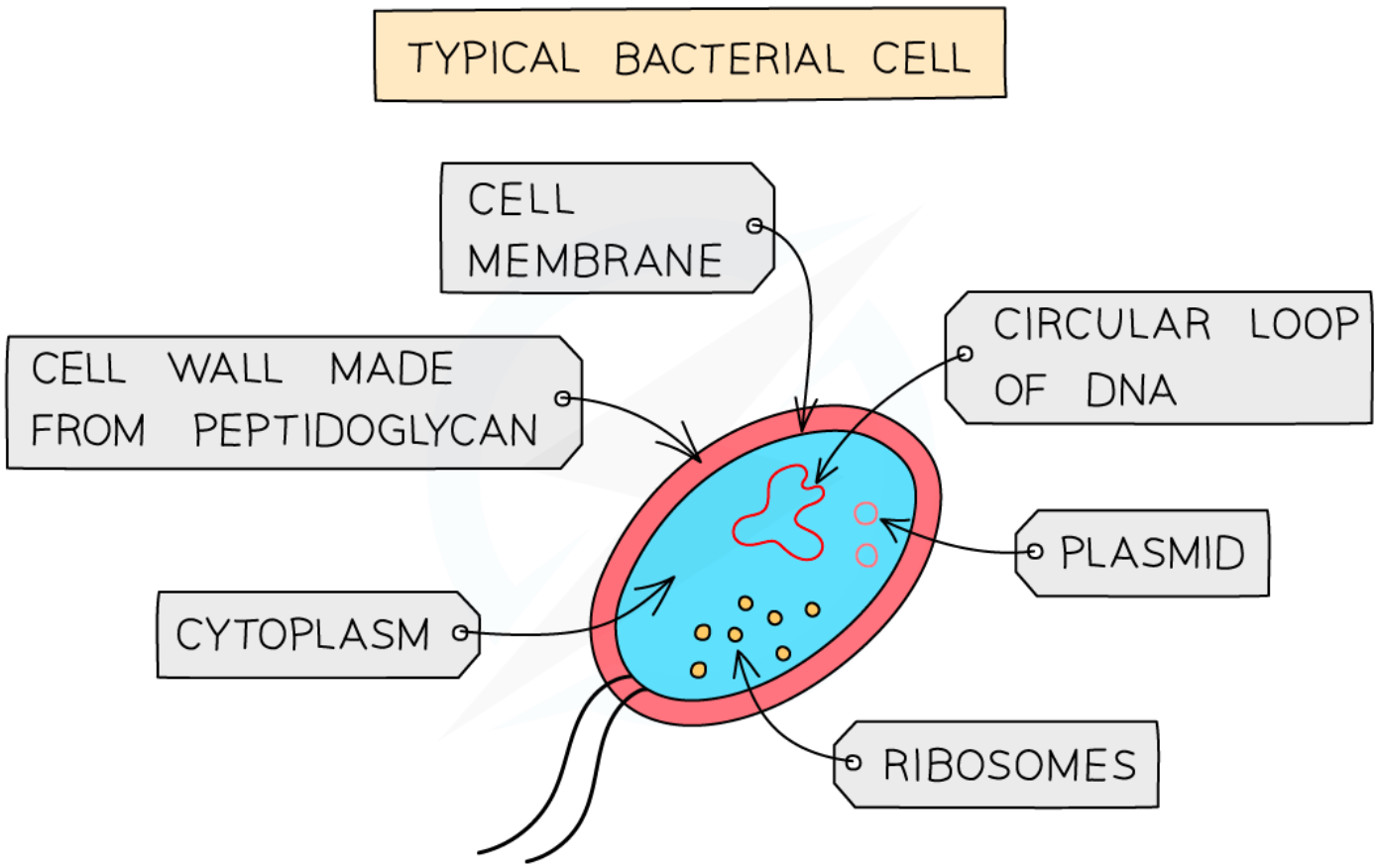



**Fig 1. Generalised Structure of a Virus.** The genetic material of the virus is surrounded by a protein capsid which protects it from the environment and host immune system. The capsid (envelope) has "spikes", which represent attachment (envelope) proteins, sticking out of it. These attachment proteins help the virus attach to and infect a host cell.

Bacteria Diagrams





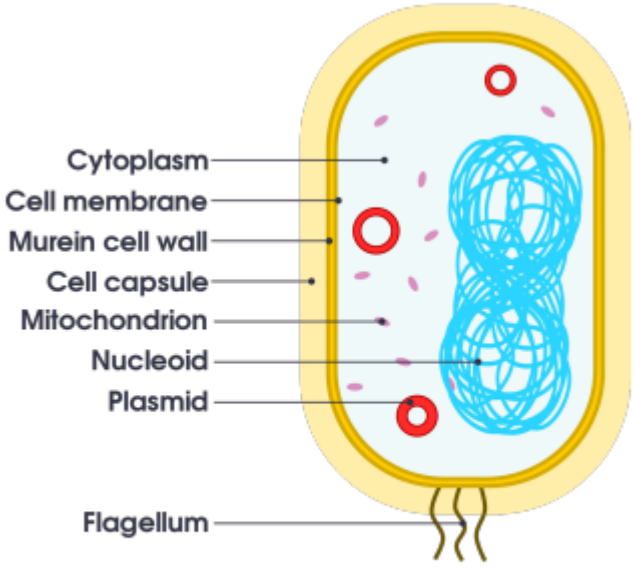
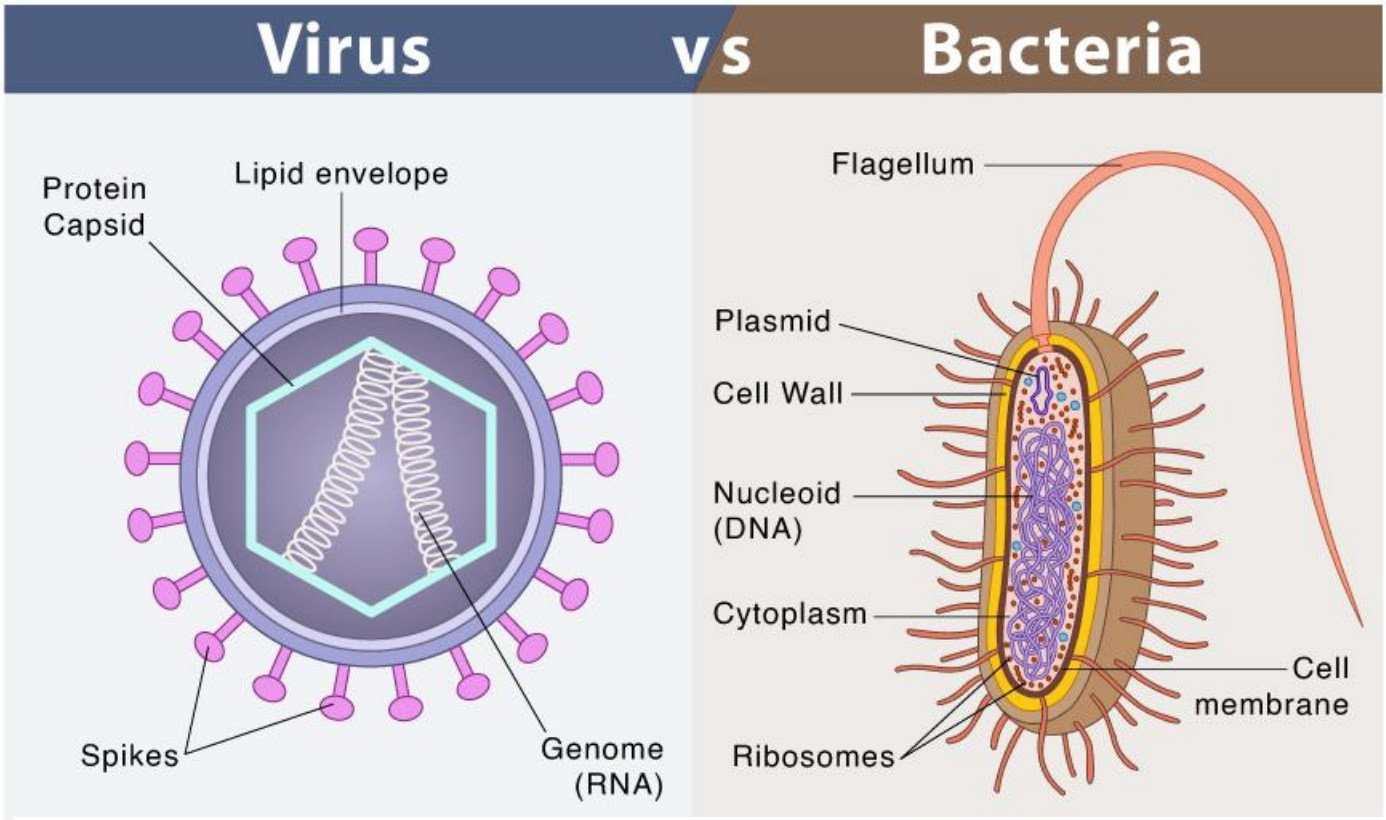




**Figure 1. Structure of a Bacterium.** Bacterial cells have some similarities to animal and plant cells.

Bacteria vs. Viruses




## Bacteria

- living organism, unicellular;one cell
- larger (1000nm)
- *fission- a form of asexual reproduction
- *localized
- usually treated with antibiotics
- in latin means little stick

## Both

- can cause disease
- spreads by routs of coughing,sneezing, coming into contact with cotaminated animals,people, iteams
- does not have a nuclei
- possibility to be vaccinated
- capable of killing humans and raging human health

## Viruses

- not living, no cells
- smaller (20-400nm)
- reproduction- invades a host cell, taking control and copies the DNA/RNA destroying the host cell
- *systemtic
- antibiotics will not effect the disease
- in latin means poison