6.3. DEFENCE AGAINST INFECTIOUS DISEASE

Pathogen

Pathogen is an organism or a virus that enters a body (host), reproduces and causes disease.

- Many types of organism can act as pathogens in humans

Examples of diseases caused by pathogens

DISEASE	TYPE OF PATHOGEN
Influenza	Viruses
Tuberculosis	Bacteria
Thrush (oral or vaginal)	Fungi
Malaria	Protozoa
Schistostomiasis (bilharzias)	Flatworms
Hookworm	Roundworms

Antibiotics are effective against bacteria but not viruses

→ There are many differences between human cells and bacterial cells. There are many antibiotics that can block metabolic processes found only in bacterial cells and not in eukaryotic cells. Hence, there is no damage caused to human cells.

- Most bacterial diseases can be treated successfully with antibiotics. Tuberculosis can be treated with streptomycin.

← Viruses rely on host cells, such as human cells to carry out the metabolic processes for them. Hence, it is not possible to block these processes without harming human cells at the same time.

- For this reason, viral diseases cannot be treated with antibiotics.

Antibiotics are chemicals produced by microorganisms, to kill or inhibit the growth of microorganisms.

Penicillium fungus produces penicillin (Florey and Chain 1930's) to kill bacteria.

It was initially tested on 8 mice infected with a bacterium that causes pneumonia. The 4 treated mice survived, while the rest died. They continued the trials on humans all of which were cured!

Major barriers against pathogens

a) Skin

- The outer layers of the skin are tough and form a physical barrier
- **Sebaceous** glands in the skin secrete lactic acid and fatty acids, which make the surface of the skin acidic. This prevents the growth of most pathogenic bacteria
- Additional support: blood clotting factors to prevent pathogen entrance as well as blood loss

b) Mucous membranes

- These are soft areas of skin that are kept moist with mucus
- They are found in the nose, trachea, vagina and urethra

→ **Lysozyme**, an enzyme in the mucus is responsible for killing many bacteria.

Other barriers

- Hairs in ears and nostrils
- Eye tears
- Mouth saliva

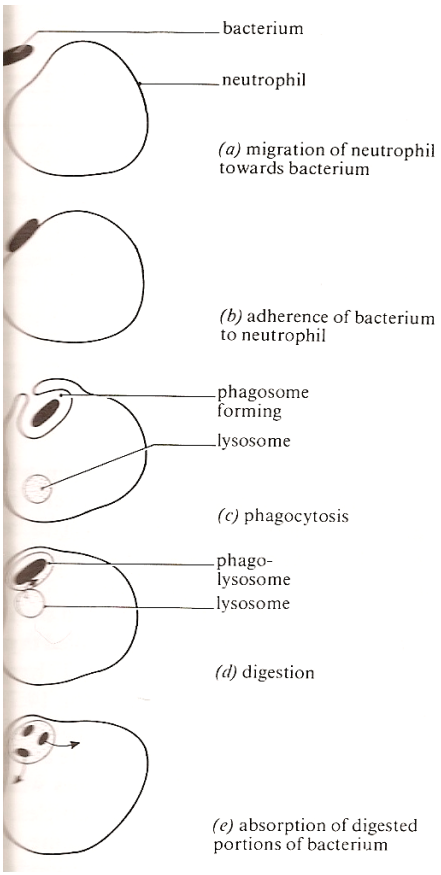
Antibody is a protein synthesised by an animal, in response to the presence of foreign substances (**antigens**).

- Antibodies usually only bind to one specific antigen.
- Antigens can be pathogenic bacteria, fungi or pathogenic viruses

(a) Non – specific Immunity

Ingestion of pathogens in the blood and body tissues by phagocytic leucocytes

- Some of the leukocytes in the blood are phagocytes. These cells can identify pathogens and ingest them by endocytosis.



- However, some pathogens are able to avoid being killed by phagocytes so another defence mechanism is needed (i.e B- and T- lymphocytes).

(b) Specific Immunity

Antibody Production

- ***Stages of antibody production***

1) Antibodies are made of lymphocytes

2) A lymphocyte can only make <u>one</u> antibody, so a huge number of different lymphocyte types is needed.

   Each lymphocyte puts some of the antibody that it produces into its cell surface membrane with the antigen combining site facing outwards.

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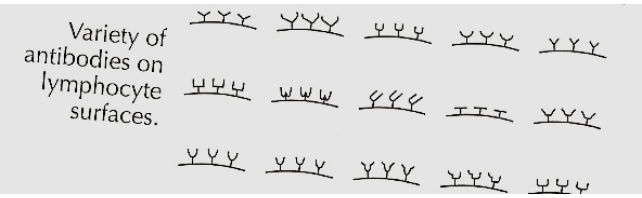
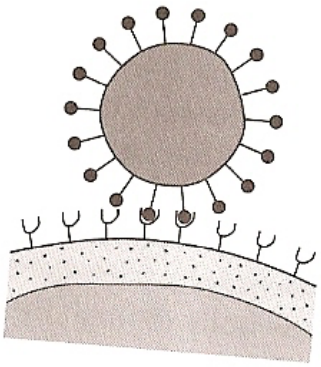
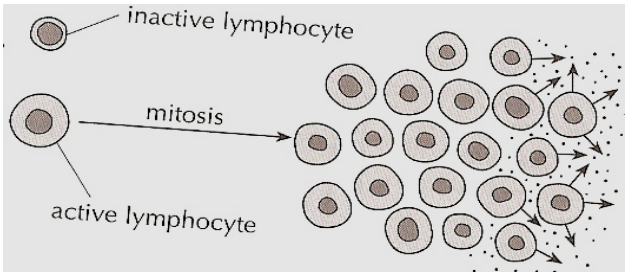


3) When a pathogen enters the body, its antigens bind to the antibodies in the cell surface membrane of one type of lymphocyte.



4) When antigens bind to the antibodies on the surface of a lymphocyte, this lymphocyte becomes active and divides by mitosis to produce a clone of many identical cells.



5) The clone of cells starts to produce large quantities of the same antibody – the antibody needed to defend the body against the pathogen.

!!! In a nutshell:

Many different types of lymphocytes exist. Each type recognizes one specific antigen and responds by dividing to form a clone. This clone then secretes a specific antibody against the antigen.

Blood clotting

- A tissue is wounded and blood flows from it
  → Blood coagulates to form a **blood clot**
  → Blood clot prevents further blood loss and entry of pathogens

- The whole clotting process depends on at least twelve (12) **clotting factors** working in harmony with each other.

- Clotting factors are released from
  → platelets or
  →damaged (wounded) cells
  initiating the clotting process

Clotting factors set off a **series of reactions** in which the product of each reaction is the catalyst of the next reaction thus ensuring that clotting occurs rapidly only when needed.

- Thromboplastin (lipoprotein) is released from injured tissues
- Thromboplastin together with clotting factors VII and X (plasma enzymes) and calcium ions catalyses the conversion of inactive plasma protein prothrombin to **thrombin** (proteolytic enzyme)
- Thrombin hydrolyses the conversion of the soluble protein molecule fibrinogen into the fibrous protein **fibrin** (a mesh of fibres)
- Blood cells from the wound are caught in the mesh of fibrin and become a semi solid clot. When this clot is exposed to the air it dries and forms a protective scab, which remains until the wound has healed.

- The absence or low concentration of any of the essential clotting factors could produce excessive bleeding, a condition known as ***haemophilia***.

A Viral Disease: AIDS (acquired immunodeficiency syndrome)

- AIDS is an example of a syndrome where the immune system fails.
- As a result the number of active lymphocytes (T) is reduced.
- The patient loses the ability to produce antibodies. Therefore, the immune system is destroyed and the patient subsequently dies.

Cause

A virus called HIV (human immunodeficiency virus) causes AIDS.

- The virus infects a type of lymphocyte that plays a vital role in antibody production
- Over a period of years these lymphocytes are destroyed hence, antibodies can no longer be produced
- Without a functioning immune system, the organism is vulnerable to any pathogen that would normally be easily controlled

Transmission

HIV does not survive for long outside the body and cannot easily pass through the skin. It involves the transfer of body fluids from an infected person to an uninfected one.

How?

- Through small cuts in the vagina, penis, mouth or intestine through sexual intercourse
- Through traces of blood on a hypodermic needle that is shared by drug users
- Across the placenta from a mother to a baby, through cuts during childbirth or in milk during breastfeeding
- In transfused blood or blood products such as Factor VIII used to treat hemophiliacs.

Effect

- Gradual reduction of one type of lymphocytes, together with weight loss and a variety of diseases caused by viruses, fungi, bacteria, protozoa.
- Diseases weaken the patients body and eventually cause death.

Social Implications

- Individuals infected with HIV may become stigmatized and not be able to find partners, housing or employment

- Sexual activity in a population may be reduced because of the AIDS fear

Stages of antibody production (HL)