science

biology

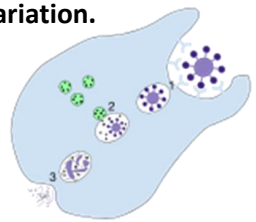
A-Level Transport Cell recognition and the Immune System

Our body has defences against invading **pathogens,** these include physical barriers such as skin and chemical barriers such as saliva or stomach acid. Types of white blood cells interact to protect us from pathogens.

Pathogens are micro-organisms that cause disease. Pathogens, as well as other cells in the body, have **antigens** on their cell surfaces**.**

Antigens are protein molecules that **initiate an immune response.** The immune response can also be triggered by toxins. Many pathogens change their surface antigens frequently, this is known as **antigenic variation.**

First Line of Defence: Phagocytosis



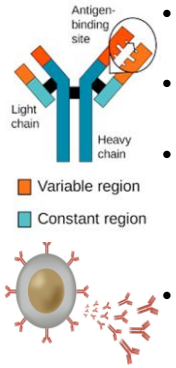
- The **phagocyte** recognises a foreign **antigen** on a pathogen
- The phagocyte surrounds the pathogen **engulfing** it.
- The pathogen is encased in a **vesicle.**
- **Lysosomes** fuse with the vesicle releasing digestive enzymes known as lysozymes into the vesicle.
- The pathogen is destroyed.
- The phagocyte then places the pathogens antigens on its surface, becoming an **antigen-presenting cell**.

T-cells

- Respond to the **antigens** that are presented on the **antigen-presenting cells**.
- **Helper T-cells (T_H)** release chemical signals that activate and stimulate phagocytes.
- **Cytotoxic T-cells (T_C)** kill abnormal and foreign cells.
- T-cells undergo many mitotic divisions to form **clones** of T-cells.
- T-cells activate B-cells.

Cell		Function
Phagocytes	Macrophages	Engulfs and digests pathogens by fusion of the phagosome with lysosomes
	Neutrophils	
T cells	T helper cells	Stimulates B cells to divide and secrete antibodies
	Cytotoxic T cells	kill abnormal cells and infected body cells via perforin
	T memory cell	Remain in the blood for years and provide long term protection
B cells	Plasma cell	Secrete antibodies
	B memory cell	Remain in the blood for years and provide long term protection

The Humoral Immune Response B Cells



- B-cells are covered in **antibodies** which are specific to particular antigens.
- When an antibody on a B-cell meets a complementary antigen it binds to it.
- Together, with chemicals released from T-cells, the B-cells are activated in a process known as **clonal selection** and divide to form **plasma cells (clones of B-cells)**.
- They secrete the complementary antibody to the antigen.
- Antibodies have binding sites for antigens, after forming an **antibody antigen complex**, the pathogens are clumped together - a process known as **agglutination.**
- This clump is then engulfed by a phagocyte.

Immunity

- **Passive immunity (natural)** gained by receiving antibodies from either the mother through the placenta or breast milk.
- **Active immunity** when the body responds to antigens and produces antibodies.

Primary response

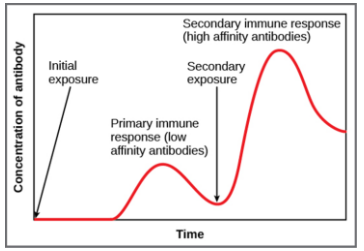
- When an antigen activates the immune response.
- It's **slow** as there are few B-cells to make the correct antibody. During this time a person will show symptoms of the disease.
- The immune system destroys the pathogen and **memory cells** are produced.

Secondary response

- When the same pathogen enters again
- Faster response with more antibodies.
- **Memory B-cells** are activated to produce **plasma cells** which produce the correct antibody.
- Memory T-cells are activated to produce more T-cells to kill the cell carrying the antigen. This is known as the **secondary response.**
- **Vaccines** work by this process.

Vaccines

- Contain antigens that might be free from a pathogen or still attached to a weakened form of the pathogen.
- Booster vaccines ensure more memory cells are produced.
- If the real pathogen enters the body, the concentration of antibodies in the blood will rise much faster and be higher than in the case of primary infection.



- The pathogen is destroyed before the symptoms can show. The more vaccines are given the fewer people are likely to be infected. This is known as **herd immunity.**

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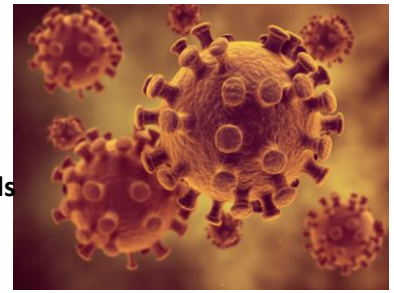
HIV (human immunodeficiency virus) and AIDS (acquired immune deficiency syndrome)

HIV is a virus that affects the immune system. It leads to AIDS which causes the immune system to deteriorate and eventually it will fail to control invasion by relatively harmless pathogens.



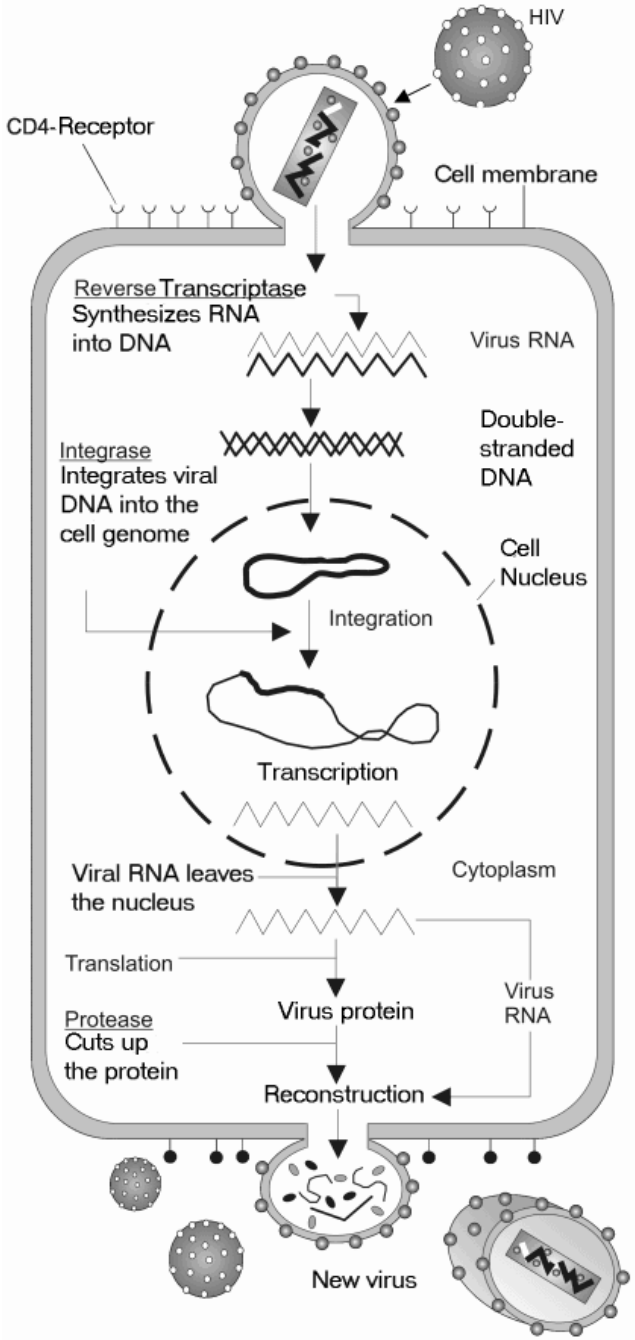
Helper-T-cells are the host cells for HIV.
Without helper-T-cells, chemical messages that stimulate **phagocytes, B-cells and other T-cells** will not be sent. A normal immune response cannot be carried out.

Symptoms of aids: infections of the **nose** and **respiratory system. F**ollowed by bacterial infections such as **TB.**
Patients usually die as a result of **secondary infections** rather than the HIV itself.

HIV is spherical, contains **RNA** and has an enzyme called **reverse transcriptase**

Replication of HIV:

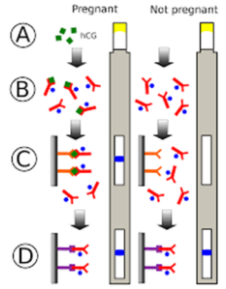
- the HIV attachment proteins attach to receptor molecules on the membrane of the helper-T-cell
- the capsid is released into the helper-T-cell and the RNA is released
- reverse transcriptase makes a strand of DNA from the viral RNA template.
- the DNA is copied and becomes double stranded
- the viral DNA is inserted into the host cell DNA
- viral proteins assemble new viruses which then burst out of the cell and infect other helper-T-cells.



Monoclonal antibodies

Produced from a single clone of **B-cells**.
Made in laboratories to bind with antigens or any other molecule.

Cancer cells have **tumour markers** on the outside of their membranes. These are not found on healthy body cells.
Monoclonal antibodies can bind to these markers. If the monoclonal antibody has cancer drugs attached to it, these drugs can be delivered straight to the cancer cell.
They can be used in **pregnancy tests** where they bind to hCG, a hormone found in pregnant women



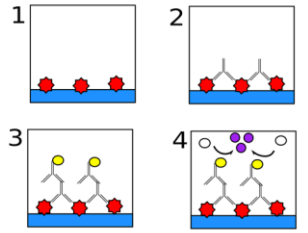
ELISA test

(enzyme-linked immunosorbent assay)
Monoclonal antibodies are also useful in **diagnosis** of disease such as prostate cancer.
ELISA tests allow doctors to see if patients have antibodies to certain antigens, or antigens to a certain antibody.

In an ELISA test the antibody has an **enzyme** attached to it. This enzyme reacts with substrate to produce a **coloured product**.
This causes a colour change in a reaction vessel demonstrating the presence of the antigen.

Direct ELISA uses a single antibody.

Indirect ELISA uses two different antibodies



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