CHAPTER 11.1 – BODY DEFENCE

Body defence

PATHOGENS

- ❑ The body defence system reacts when pathogens infect the body
- ❑ A pathogen is microorganism that causes diseases
- ❑ Examples of pathogens
    1. Bacteria (singular: bacterium)
    2. Viruses
    3. Parasites
- ❑ Pathogens can only cause diseases if they successfully infect body cells

ANTIGENS

- ⇗ The body defence system recognises pathogens as foreign particles known as antigens
- ⇗ Antigens are foreign particles that enter the body and subsequently stimulate the immune response

ANTIBODIES

- ◊ Antigens stimulate the lymphocytes to produce antibodies into the blood flow to destroy the antigens
- ◊ Antibodies are protein found on the lymphocyte surface or proteins released by lymphocytes into the blood plasm

IMMUNE RESPONSE

- → The interaction between antibodies and antigens that cause antigens to be destroyed is called the immune response

IMMUNITY

- ↘ Immunity is the body's ability to fight infections caused by pathogens or other foreign objects, though specific attacks on the pathogens
- ↘ When our body can fight a disease, we are said to be immune to that disease
- ↘ There are three lines of defence to fight against diseases in our body
    a. The first line of defence
    b. The second line of defence
    c. The third line of defence

The first line of defence

- ♥ The first line of defence consists of the physical and chemical line-up that prevent pathogens from entering the body
- ♥ The first line of defence is the defence line that is not specific and acts to prevent pathogens from entering the body

LYSOZYME

- Δ Lysozyme is an antimicrobial protein that can dissolve and destroy some types of bacteria
- Δ Lysozyme found in
    1. Tears
    2. Nasal mucus
    3. Saliva

MUCOUS MEMBRANE

- The mucous membrane that lines the respiratory tract secretes a sticky fluid called mucus
- Mucus contains lysozyme that destroys bacteria found in the air that enters the respiratory system

MECHANISM OF BLOOD CLOTTING

- The blood clotting mechanism prevents bacteria from entering through wounds

HYDROCHLORIC ACID

- Hydrochloric acid in the stomach destroys bacteria present in food and drinks

SKIN

- It is the physical defence that prevents the entry of pathogens because it is though and is difficult for microorganisms to penetrate
- The continuous shedding of dead cell layers on the skin surface makes it difficult for various types of microorganism to grow
- Acts as a chemical shield through the secretion of sebum
- Oil and acid in the sebum prevent the growth of various types of microorganisms
- Sweat secreted by the skin contains lysozyme, a type of enzyme that breaks down the cell wall of some bacteria

The second line of defence

- The second line of defence is
  1) Fever
  2) Phagocytosis
  3) Inflammation
- The mechanism of the second line of defence is also not specific

FEVER

- Fever is the second line of defence mechanism that fights infections
- Fever increases phagocytic activity and fights against microorganisms that infect the body

PHAGOCYTOSIS

- The phagocyte is a leucocyte that can carry out phagocytosis
- Neutrophils and monocytes are phagocytes
- Phagocytosis is the process by which microorganisms or other particles such as dead cells are trapped and digested by phagocytes
- When an infection occurs, the phagocytes move the infected area and enter the tissue fluid through the pores of the capillary wall
- When a phagocyte encounters a pathogen, the phagocyte will engulf the pathogen and the lysozyme in the phagocyte will digest the pathogen

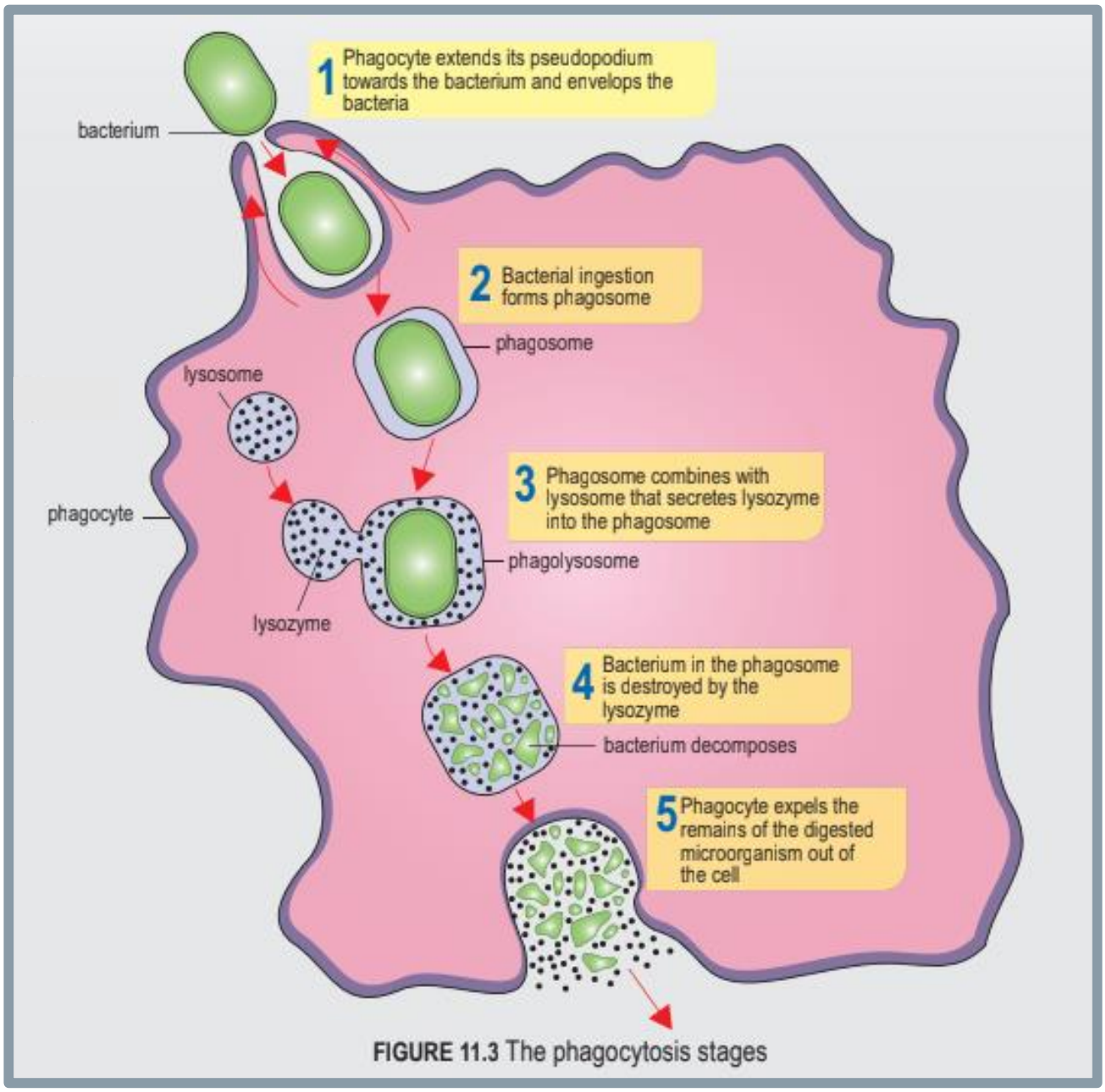
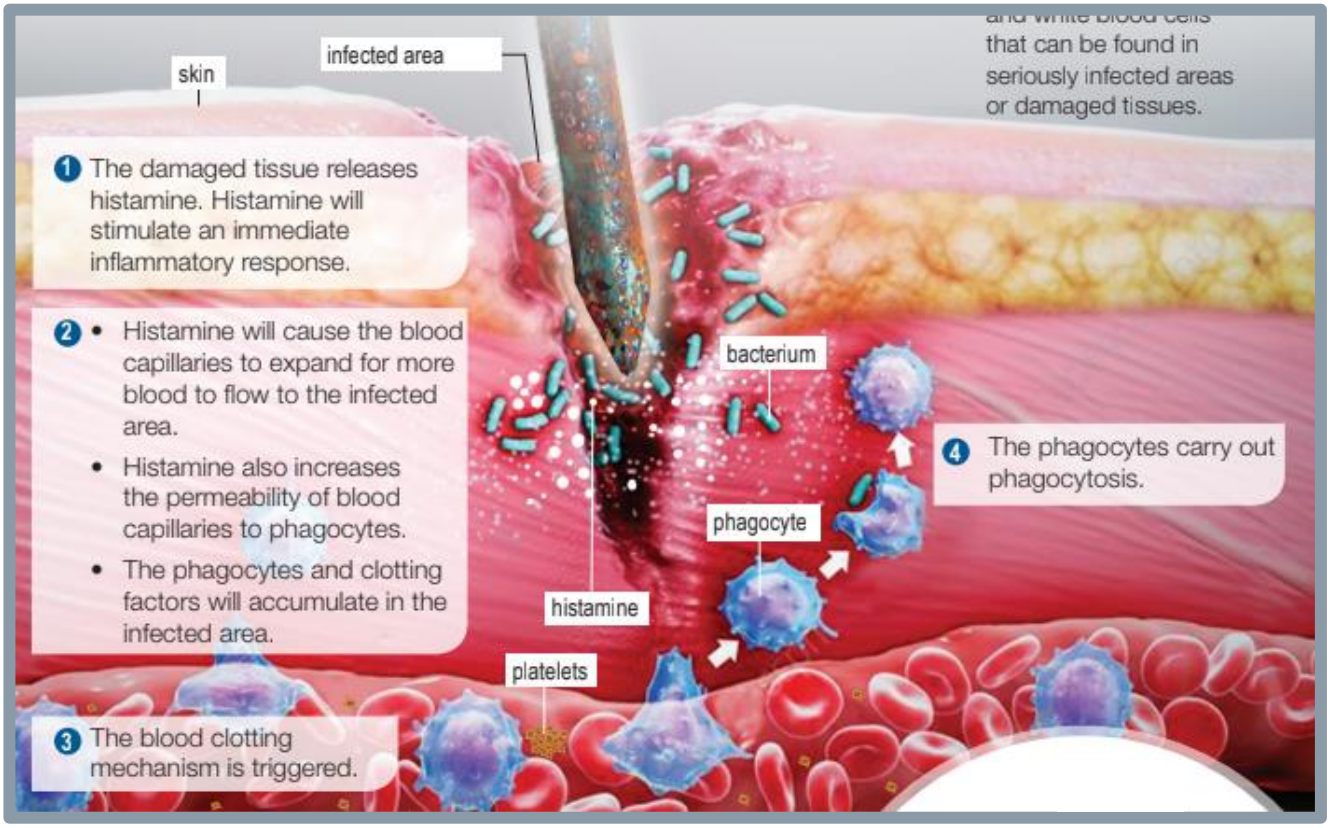


FIGURE 11.3 The phagocytosis stages

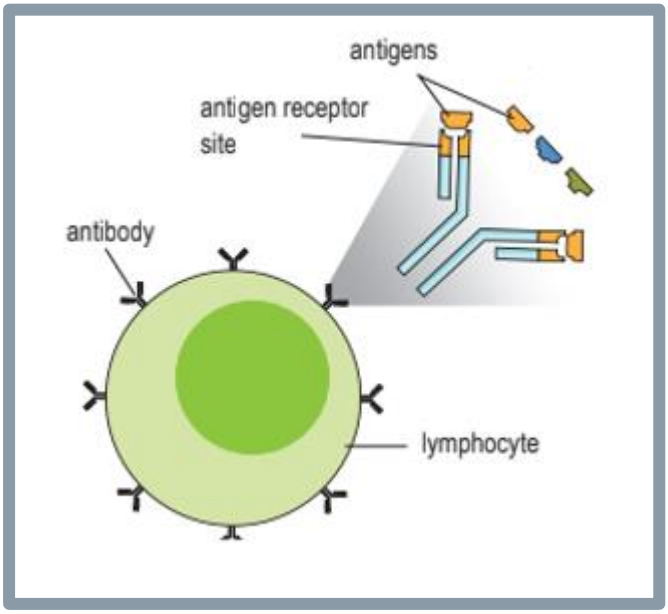
INFLAMMATION

- Inflammation is the immediate response that destroys and neutralises harmful actions of microorganisms and toxins at the early stages of infection



The third line of defence

- ◊ If pathogens overcome the second line of defence, the third line of defence will be activated
- ◊ The third line of defence is the immune response of the lymphocytes
  - » The lymphocytes formed in the lymph nodes produce antibodies
  - » The actions of antibodies are specific
  - » Each type of antibody can only combine with a certain type of antigen
  - » When a person is infected with pathogens, a large number of lymphocytes will accumulate in the lymph nodes to destroy the antigens and foreign particles
  - » This will cause the lymph nodes to swell
  - » The lymph nodes also contain macrophages that destroy bacteria, dead tissues and foreign particles through phagocytosis
  - » Lymphocytes are divided into two types,
    - a) T lymphocytes
      Attacks cells infected by pathogens
    - b) B lymphocytes
      T lymphocytes stimulate B lymphocytes to produce memory cells
  - » If the same pathogens attacks, the memory cells will be stimulated to produce antibodies immediately

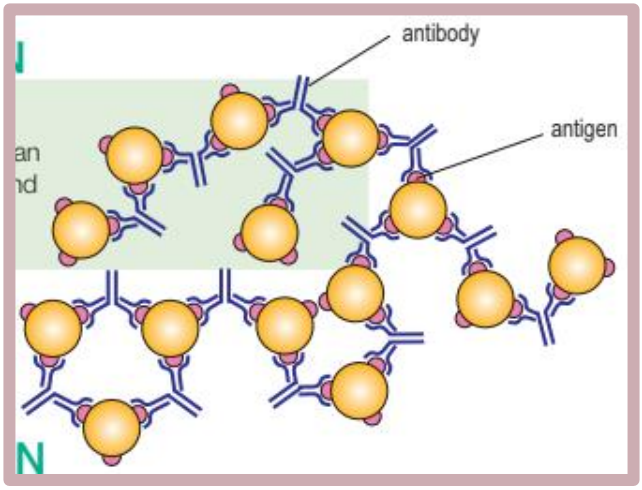

antigens
antigen receptor site
antibody
lymphocyte

CHAPTER 11.2 – ACTIONS OF ANTIBODIES

Actions of antibodies

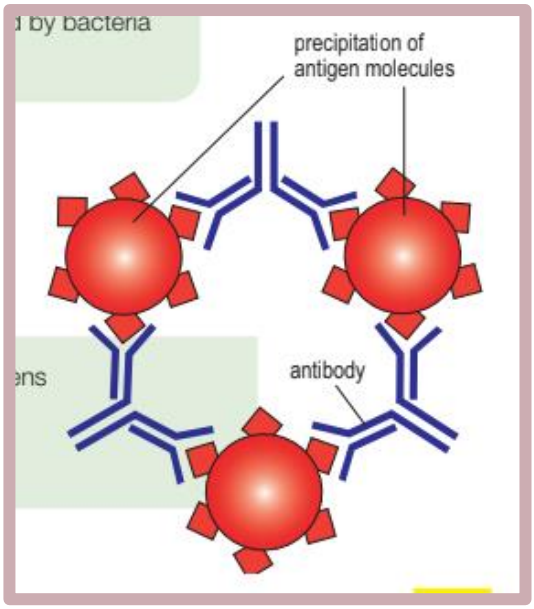
AGGLUTINATION

- Antibodies coagulate the pathogens and make them an easy target to be trapped and destroyed by phagocytes



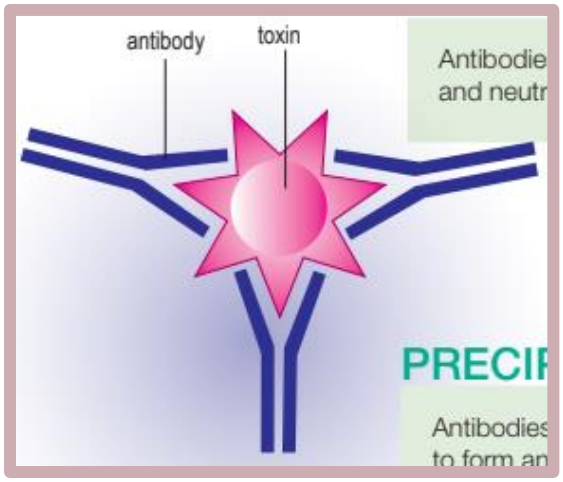
PRECIPITATION

- Antibodies react with dissolved antigens to form an insoluble complex (precipitate) that is easily destroyed by phagocytes



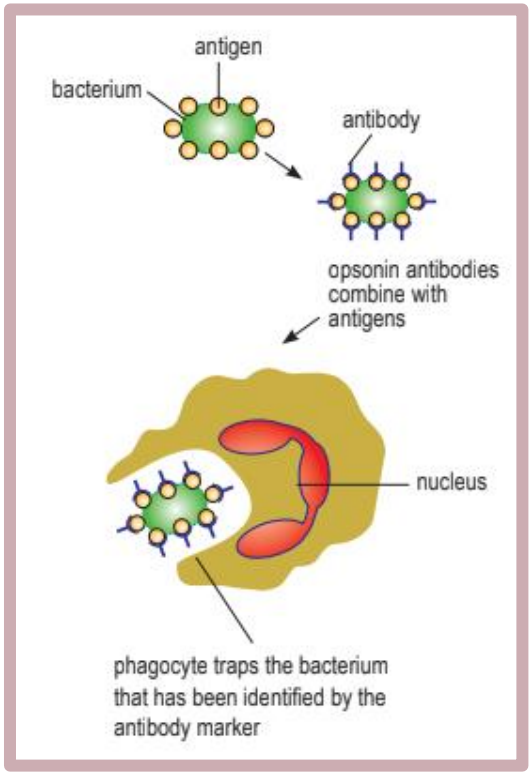
NEUTRALISATION

- Antibodies bind with toxins produced by bacteria and neutralise the toxin



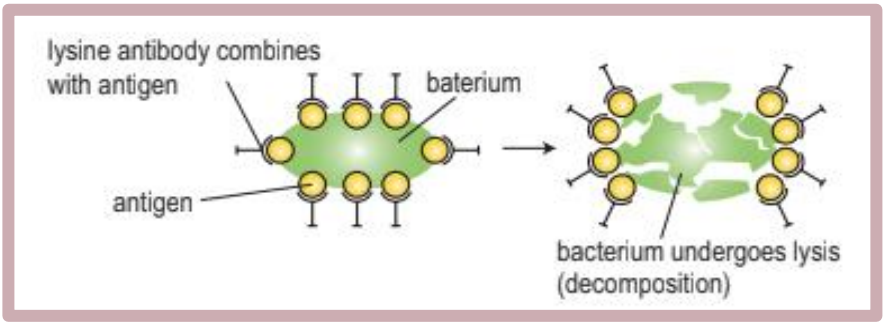
OPSONISATION

- Antibodies combine with antigens and act as a marker for phagocytes to recognise the antigens and destroy them



LYSIS

→ Antibodies combine with antigens and cause bacteria to be broken down and decomposed



CHAPTER 11.3 – TYPES OF IMMUNITY

Types of immunity

- There are two types of immunity
  - **Active immunity**
    Lymphocytes produce their own antibodies as a response to stimulation by the antigens
  - **Passive immunity**
    The body receives antibodies from an external source
- Both of these types of immunities can be naturally or artificially acquired

Active Immunity

- Antibodies are produced naturally by lymphocytes
- Active immunity remains for a long period of time
- There are two types of active immunity
  a. **Natural active immunity**
     Acquired after an individual recovers from an infection
  b. **Artificial active immunity**
     Acquired when an individual is given a vaccine injection

NATURAL ACTIVE IMMUNITY

- When someone is infected by pathogens, lymphocytes will produce antibodies as a response to these antigens
- When the individual recovers from an infection, that individual will gain a permanent immunity against the disease
- When the individual is attacked again by the same pathogen, the lymphocytes that stored memories of the pathogen (memory cells) will rapidly produce antibodies to react immediately against the antigens

ARTIFICIAL ACTIVE IMMUNITY

- To protect oneself from being infected by a highly infectious disease, an individual can be immunised against the disease
- Immunisation refers to the process that stimulates immunity against a specific disease through vaccine injections
- Vaccine is a suspension of pathogens that are weakened, dead or non-virulent
- When a vaccine is injected into the body, the vaccine will stimulate lymphocytes to produce antibodies to fight the pathogens
- The first vaccine injection will usually result in a low level of antibody production which is insufficient to protect an individual from the disease
- A booster dose must be administered to increase the antibody production to a level of immunity that can protect the individual from the disease
- If the individual is infected by actual pathogens, the lymphocytes will

produce enough antibodies and immediately destroy these pathogens

- Δ Examples:
  1. Salk for poliomyelitis
  2. BCG (Bacilli Calmette-Guerin) for tuberculosis (TB)
  3. HPV for cervical cancer

Passive Immunity

- The body does not produce its own antibodies
- Antibodies are obtained from an external source
- Passive immunity does not persist and can only give immediate, short-term and temporary protection
- There are two types of passive immunity
  1) **Natural passive immunity**
     Acquired through breastfeeding and from the mother to the foetus during pregnancy
  2) **Artificial passive immunity**
     Acquired through an antiserum injection

NATURAL PASSIVE IMMUNITY

- ⊕ This immunity is acquired by a foetus when the mother's antibodies diffuse through the placenta into the blood flow of the foetus
- ⊕ Antibodies also protect the baby for the first few months after birth through antibodies that are found in the mother's milk or colostrum when breastfeeding

ARTIFICIAL PASSIVE IMMUNITY

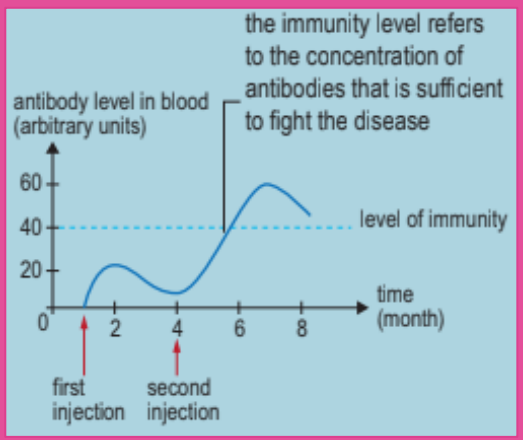
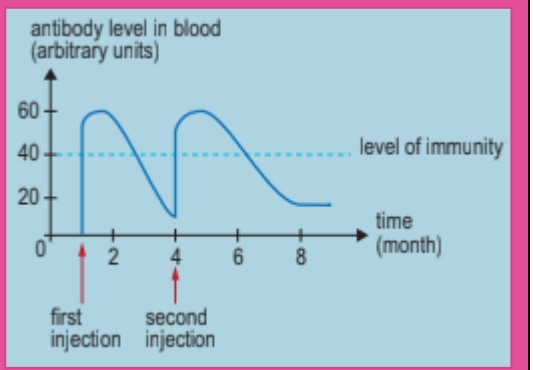
- ◊ This immunity is acquired through an antiserum injection or serum that contains specific antibodies to fight specific antigens
- ◊ The antiserum injection gives immediate protection but only for a short period of time
- ◊ Examples of antiserum
  i. Antitetanus
  ii. Anti-rabies and
  iii. Antiserum for poisonous snakes

Comparison between artificial active immunity and artificial passive immunity

SIMILARITIES

SIMILARITIES
○ Protects the body from infectious diseases ○ Involves interaction between antibodies and antigens

DIFFERENCES

ASPECT	ARTIFICIAL ACTIVE IMMUNITY	ARTIFICIAL PASSIVE IMMUNITY
Acquired through	Vaccine injection	Antiserum injection
Injected substance	Vaccine is a suspension of pathogens that are weakened, dead or non-virulent	Antiserum is a serum that contains specific antibodies
Purpose	Prevention	Treatment or when immediate protection is required
Effect	Does not give immediate protection	Gives immediate protection
Immunity period	Immunity lasts for a long period of time	Immunity is temporary and does not persist
When injection is given	Vaccine injection is administered before being infected	Antibody injection is given in advance if there is a high risk of infection or immediately after being infected by a disease
Antibody	Antibodies are produced by the lymphocytes	Antibodies are obtained from antiserums
The need to give a second injection (booster dose)	Must be given to boost the level of antibodies above the level of immunity as a protection against the disease 	Is only given when the antibody level in the blood drops below the level of immunity and the patient is still infected by the disease 

CHAPTER 11.4 – HEALTH ISSUES RELATED TO HUMAN IMMUNITY

Acquired Immunodeficiency Syndrome (AIDS)

HUMAN IMMUNODEFICIENCY VIRUS (HIV)

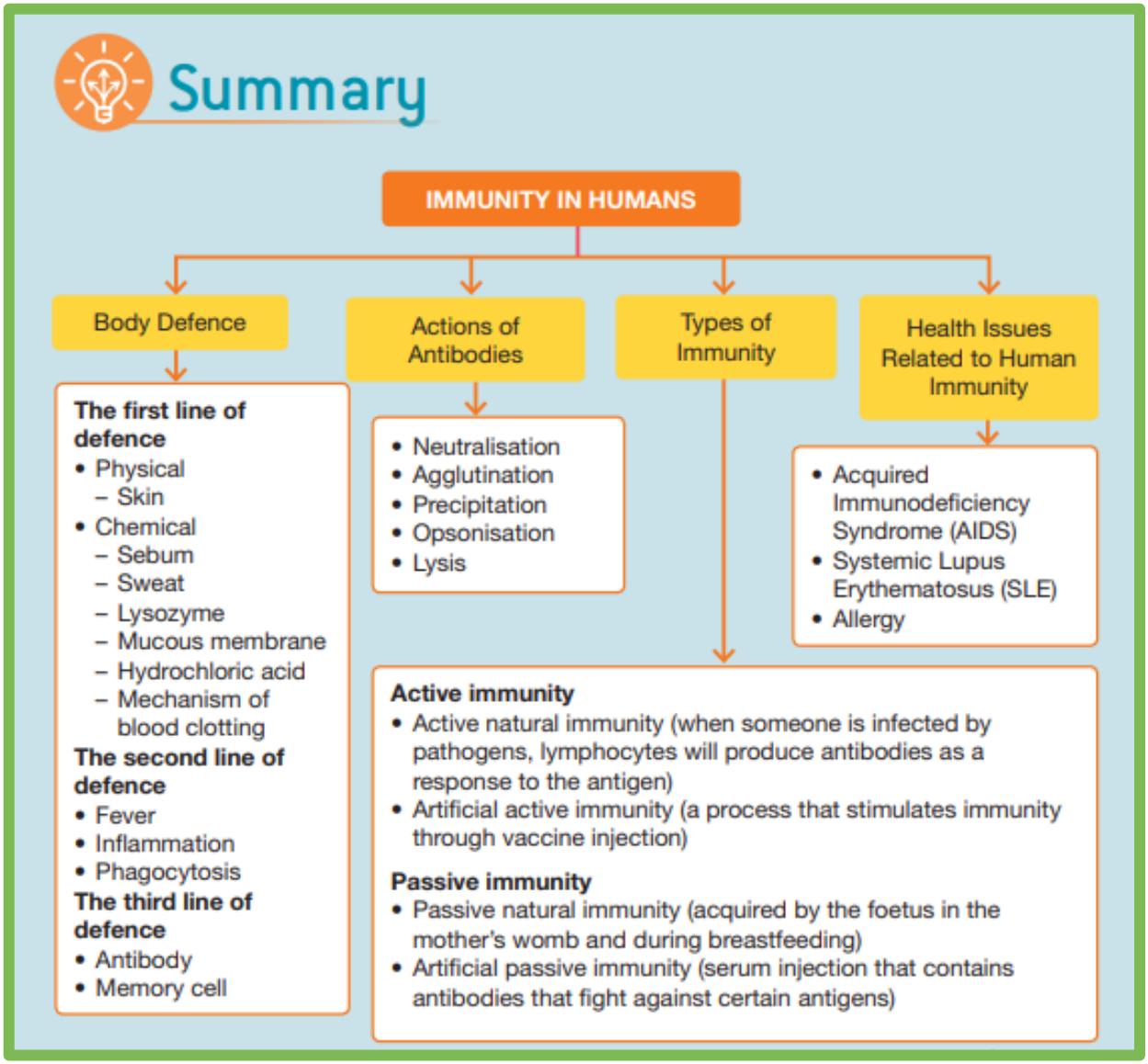
- » Human Immunodeficiency Virus (HIV) is a virus that attacks the human immune system
- » HIV infection causes Acquired Immunodeficiency Syndrome (AIDS)
- » An AIDS patient is easily infected by other diseases because of the progressive destruction of the individual's immune system
- » HIV spreads in the lymphocyte and destroys the lymphocyte

ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS)

- ❑ An individual infected with HIV does not show any symptoms for the first few years although HIV has been actively attacking the immune system
- ❑ Symptoms of the disease include chronic diarrhoea and fungi infection which are only visible after 8 to 10 years
- ❑ Since the immune system of the individual is already weakened, the body can be easily infected by diseases
- ❑ Finally, the immune system is paralysed and the patient will die from other infections

HIV TRANSMISSION

- ↘ HIV enters the body through the transfer of body fluids such as blood and semen or across the placenta
- ↘ Women infected with HIV can transfer the virus to the baby during pregnancy, birth or breastfeeding
- ↘ Nevertheless, HIV infection in the foetus and new born baby can be avoided with proper medical treatment when the mother is pregnant and during birth
- ↘ Individuals can be infected by HIV through when they share contaminated needless used to inject drugs or tattoo ink
- ↘ In addition, HIV is also spread through HIV-infected blood transfusion


Summary
IMMUNITY IN HUMANS
Body Defence
Actions of Antibodies
Types of Immunity
Health Issues Related to Human Immunity
The first line of defence
• Physical
– Skin
• Chemical
– Sebum
– Sweat
– Lysozyme
– Mucous membrane
– Hydrochloric acid
– Mechanism of blood clotting
The second line of defence
• Fever
• Inflammation
• Phagocytosis
The third line of defence
• Antibody
• Memory cell
• Neutralisation
• Agglutination
• Precipitation
• Opsonisation
• Lysis
• Acquired Immunodeficiency Syndrome (AIDS)
• Systemic Lupus Erythematosus (SLE)
• Allergy
Active immunity
• Active natural immunity (when someone is infected by pathogens, lymphocytes will produce antibodies as a response to the antigen)
• Artificial active immunity (a process that stimulates immunity through vaccine injection)
Passive immunity
• Passive natural immunity (acquired by the foetus in the mother's womb and during breastfeeding)
• Artificial passive immunity (serum injection that contains antibodies that fight against certain antigens)