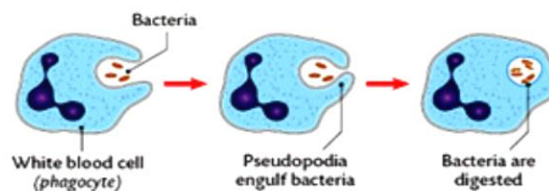


IMMUNE SYSTEM



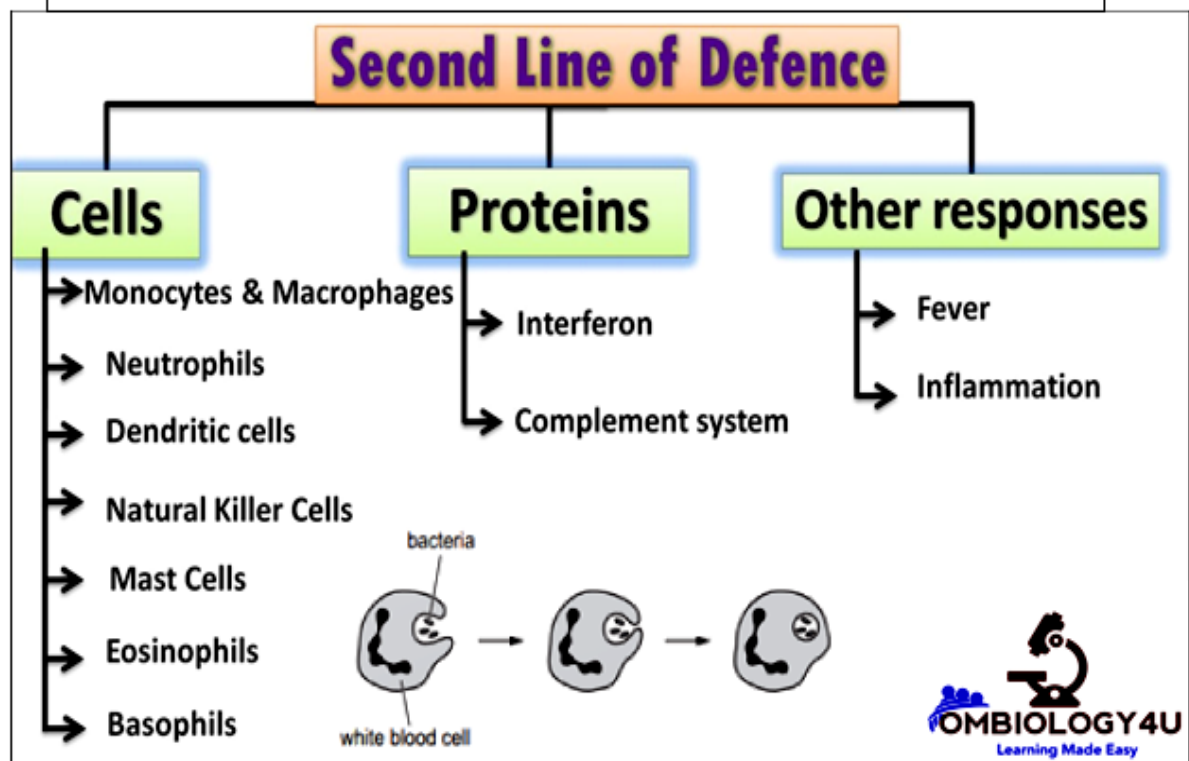
Second Line of Defense Mechanisms

Ombiology Summary Notes

with Exam Practices

⇒ When pathogens pass both **physical** and **chemical barriers** of the **skin** and **mucous membranes**, they encounter the **second line of defense**.

Components of Non-specific Immune Defense



♦ **What happens when pathogens pass through either the skin or mucous membranes of the first line of non-specific defense mechanisms?**

- ♦ If the pathogens such as bacteria, pass either skin or mucous membranes of first line, the below processes take place;
1. Inflammation (inflammatory response)
 2. Phagocytic attack
 3. Temperature response (increase of body temperature/ fever)

Inflammatory Response (Inflammation)

○ **What is inflammation (inflammatory response)?**

- Inflammation (inflammatory response) is the way in which the body reacts when pathogens damage tissue cells.
- Inflammation is a protective immune response against harmful substances such as pathogens, foreign cells and irritants.
- Inflammation (inflammatory response) is a localized nonspecific response to an infection or injury.

○ **What are the characteristics or signs of inflammation?**

- Characteristics or symptoms of inflammation are including;
 1. Warm/ fever (heat)
 2. Swelling
 3. Redness
 4. Pain

○ **Which chemicals initiate (start) inflammation?**

- Inflammatory chemicals are including **histamine** and **prostaglandins** which initiate the process of inflammation.

○ **Which white blood cells release histamine to initiate (start) inflammation?**

- Mast cells release **histamine** to initiate the process of inflammation.

(Note: - Mast cells and basophils are types of white blood cells which release **histamine** to start the mechanisms of inflammation).

○ **What are the mechanisms/ processes (steps) of inflammatory response (inflammation)?**

- The steps or processes of inflammation are
 1. Dilation of local blood vessels (**vasodilation**).
 2. .increased blood flow to the site of infection or injury.
 3. Increased vascular permeability (blood capillaries become more permeable).
 4. Phagocytic attack (Phagocytes move from blood vessels into the site of inflammation to engulf and destroy pathogen through phagocytosis).

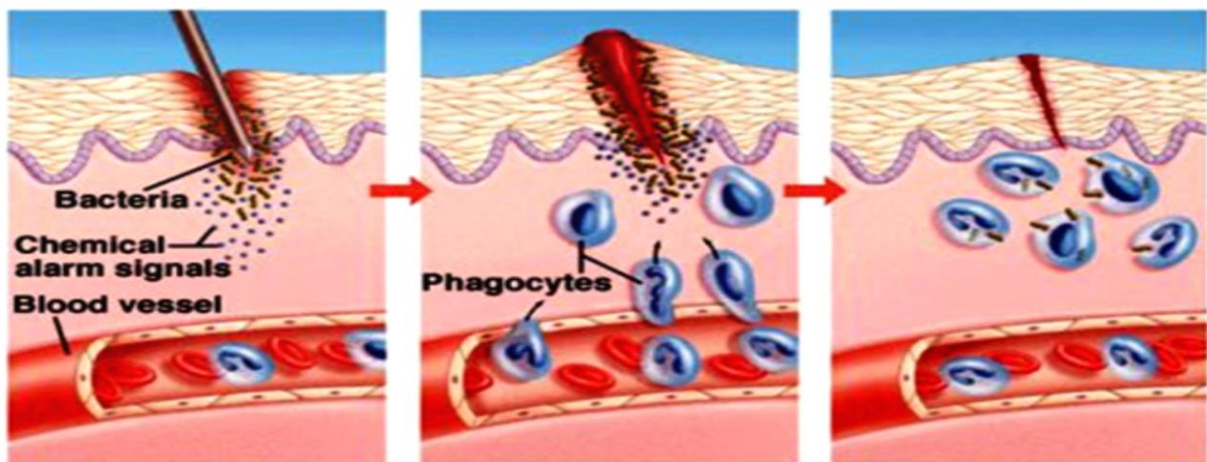
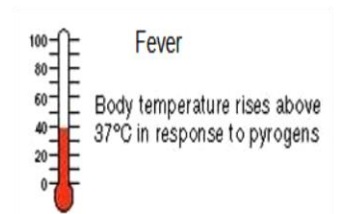


Figure: Events in the process of local inflammation

Temperature Response (Fever)

○ **What is fever?**

- Fever is the elevation of several degrees above normal body temperature.
- Fever is an abnormally elevated body temperature.
- Fever is an increase of body temperature above normal body temperature.



○ **Which chemical substance stimulates increase of body temperature (fever)?**

- **Interleukin-1** and also **pyrogen** stimulate the **hypothalamus** to increase the body temperature several degrees above the normal value of **37°C**.

- **Which type of white blood cells release interleukin-1?**
 - Macrophages that encounter the invading microbes release **interleukin-1**.
- **What are the roles of fever in immune system?**
 (What is the importance of fever in immune response?)
 (What are the advantages of fever in defense?)
 - Fever helps the body's defense by;
 1. Fever stimulates the process of phagocytosis. (Increases activity of phagocytosis).
 2. Fever causes the liver and spleen to store iron.
 (Note: - Fever causes the liver and spleen to store iron, reducing blood levels of iron, which many bacteria require in large amount to grow and reproduce).
 3. Fever speeds up repair of tissues.
- **What are the disadvantages of fever?**
 - The main disadvantages of fever are including;
 1. Very high fever can inactivate enzymes in the body.
 2. Very fever can lead dehydration
 3. Fever greater than 39°C is considered dangerous and those greater than 41°C can cause death (can be fatal).

Phagocytes

- Phagocytes are type of white blood cells (leucocytes) which are produced throughout life in the bone by **stem cells**.
- **What is the function of phagocytes?**
 - Phagocytes engulf and digest (destroy) microbes through phagocytosis.
- **What is phagocytosis?**
 - Phagocytosis is the process by which the invading microorganisms are engulfed and destroyed by **phagocytes**.

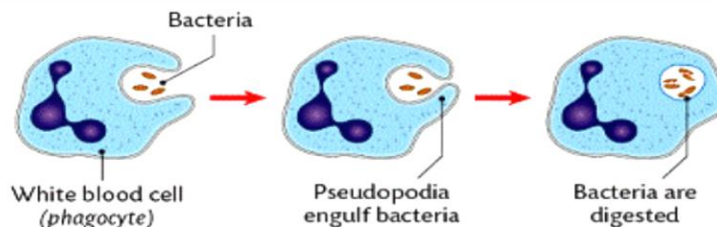


Figure: A **phagocyte** engulfing bacteria through **phagocytosis**.

- **What are the two common types of phagocytes?**
 - Neutrophils and Macrophages (Monocytes mature into macrophages).
- **What is the function of neutrophils?**
 - Neutrophils engulf (ingest) and destroy pathogen through **phagocytosis**.

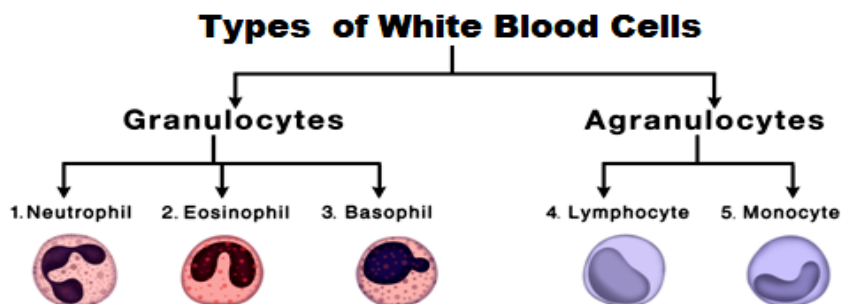
Note: -

- ✓ Neutrophils are type of phagocytes.
- ✓ Neutrophils form about 60% of white blood cells in the blood.
- ✓ Neutrophils mature in the bone marrow.
- ✓ Neutrophils travel throughout the body.
- ✓ Neutrophils can squeeze through the walls of blood capillaries to the body tissues.
- ✓ Neutrophils are short-lived cells.

**Neutrophils**

- **What is the difference between granulocytes and agranulocytes?**
 - Granulocytes and agranulocytes are two types of white blood cells found in the blood. White blood cells are also called leukocytes.
 - The main difference between granulocytes and agranulocytes are shown below;

Granulocytes	Agranulocytes
Granulocytes have granular cytoplasm. (Granulocytes have grains or particles in their cytoplasm).	Agranulocytes have smooth cytoplasm. (Agranulocytes have no grains or particles in their cytoplasm).
Granulocytes have <u>lobed</u> nucleus. (Note: <u>lobed</u> means parts/ sections)	Granulocytes have round nucleus.
Granulocytes have short life span.	Agranulocytes live longer than granulocytes.
Granulocytes are also known as polymorphonuclear cells because they have lobed nucleus.	Agranulocytes are also known as mononuclear cells because they have single large nucleus (no lobed nucleus)
Examples of granulocytes are neutrophils, basophils and Eosinophils.	Examples of agranulocytes are Monocytes and lymphocytes.



○ **What are the functions of macrophages?**

- Macrophages perform the below functions;
 1. Macrophages engulf (ingest) and destroy pathogen through phagocytosis.
 2. Macrophages destroy dead and worn out cells.
 3. Macrophages release **interleukin-1**.
 4. Macrophages destroy cancer cells.
 5. Macrophages present antigen of killed microbe to the T- lymphocytes (T-helper cells) to initiate adaptive immune response. (Macrophages are antigen presenting cells (APCs)).

(Note: - Macrophages have a molecule called **major histocompatibility complex class II (MHCII)** which antigen presenting cells use to present antigen of destroyed microbe to T-lymphocytes – (T-helper cells) for activation and initiation of immune response).

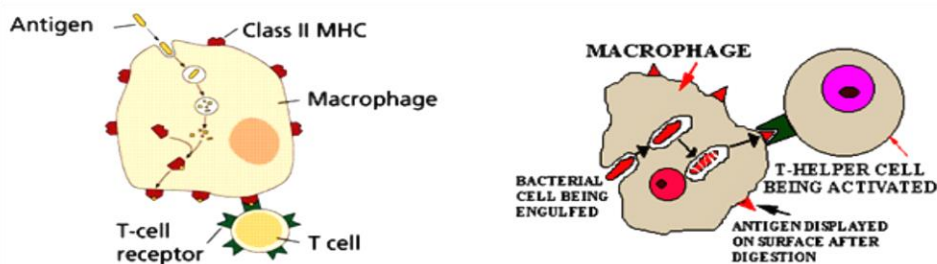
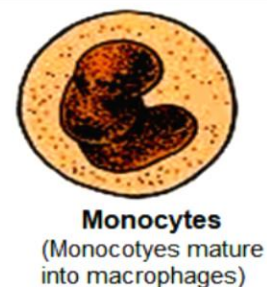


Figure: A macrophage presenting antigen of killed bacteria to T-lymphocytes (T-helper cells) for initiation of adaptive immune response.

Note: -

- ✓ **Monocytes** mature into macrophages in the bloodstream.
- ✓ Macrophages are known as '**big eaters**'.
- ✓ Macrophages are found and settle in organs such as lungs, liver, spleen, kidney and lymph nodes.
- ✓ Macrophages are larger than neutrophils.
- ✓ Macrophages are long lived cells.
- ✓ Macrophages play an important role in initiating immune response.



Phagocytosis

○ What is phagocytosis?

- Phagocytosis is the process by which the invading microorganisms are engulfed and destroyed by **phagocytes**.

○ What are the stages or mechanisms of phagocytosis?

(List the six phases of phagocytosis)

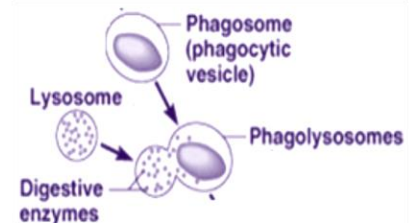
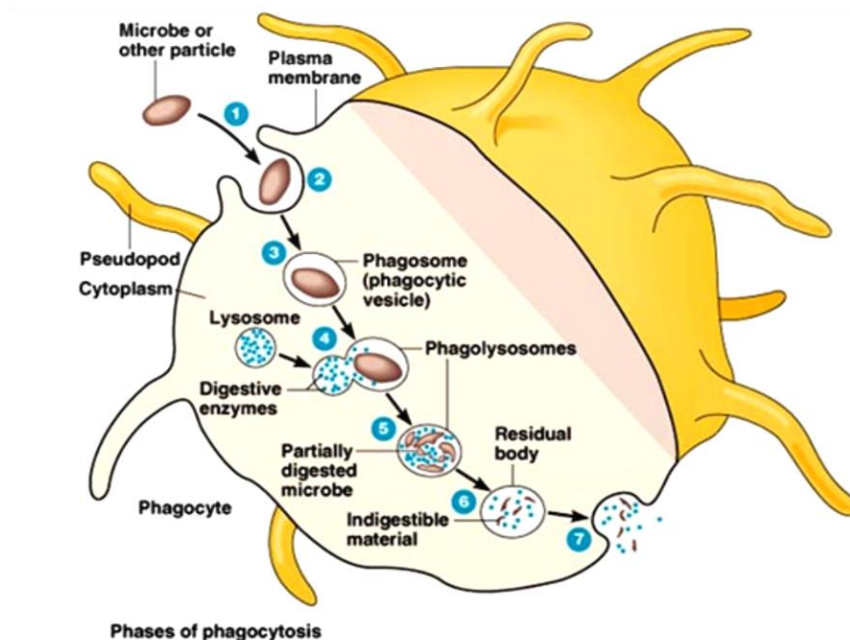
- Phagocytosis occurs in the following six phases;
 1. Chemotaxis
 2. Attachment (adherence)
 3. Endocytosis (ingestion)
 4. Vacuole formation
 5. Killing and digestion
 6. Exocytosis

○ What is Chemotaxis?

- Chemotaxis is the process of attracting phagocytes to the site of infection.

○ What is the difference between phagosome and phagolysosome?

- Phagosome** is a vacuole enclosed in a bacterium.
- Phagolysosome** is a **phagosome** that has fused with a **Lysosome** to destroy a bacterium.



○ **What are the functions of natural killer cells (NK cells)?**

- Natural killer cells are also called NK cells or killer cells are type of lymphocytes.
- Natural killer cells perform the below functions;
 1. Natural killer cells kill and destroy virus-infected body cells.
 2. Natural killer cells destroy cancer cells.

(**Note:** - Natural killer cells release a protein called **perforin** which they insert into the membrane of virus infected body cells by making pores which allow water to rush into the infected cell to burst (rupture).

○ **What is the function of basophils?**

1. Basophils release histamine which causes inflammation.
2. Basophils respond to allergic reactions.



Basophils

○ **What is the function Eosinophils?**

- Eosinophils kill parasitic worms and respond to allergic reactions.



Eosinophils

○ **What is the function of dendritic cells?**

- Dendritic cells present antigen of the killed microbe to T-lymphocytes (T-helper cells). They are antigen presenting cells (APCs).
- (**Note:** - Dendritic cells have a molecule called **major histocompatibility complex class II (MHCII)** which antigen presenting cells use to present antigen of destroyed microbe to T-lymphocytes – (T-helper cells) for activation and initiation of immune response).

○ **What is the function of interferons?**

- Interferons reduce the spread of virus in the body.
- (**Note:** - Virus infected body cells release a protein called **interferon** which stimulates the uninfected neighboring body cells to synthesize antiviral proteins that inhibit viral replication).

○ **What is the function of complement system?**

- Complement proteins make a hole on the membrane of the pathogen to rush in water and burst (rupture).

End of Second Line of Defense Mechanisms

Next parts

