

PHAGOCYTOSIS

A-LEVEL BIOLOGY

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Phagocytosis

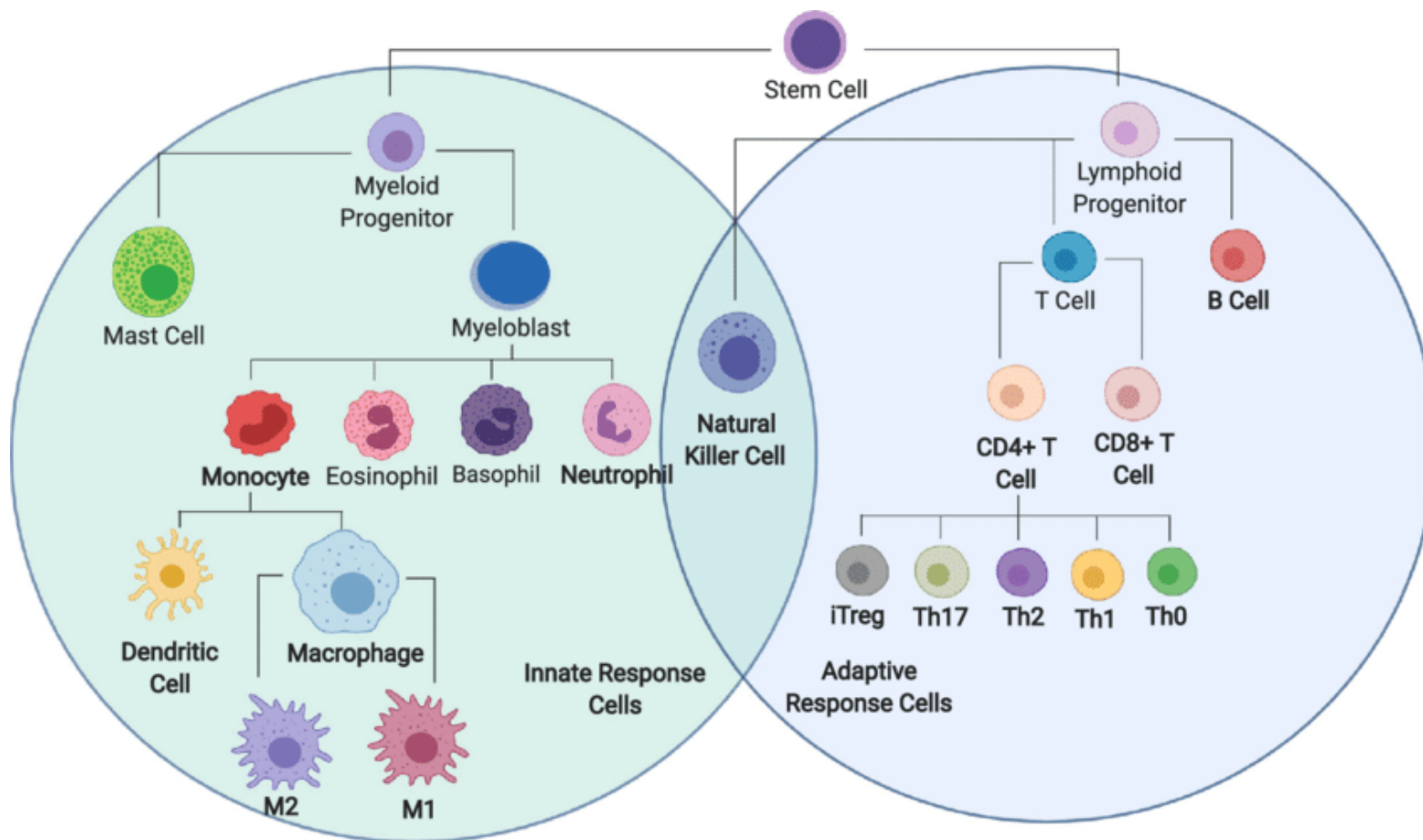
- Definition:
- It refers to the process by which certain living cells called phagocytes engulf other cells, particles , pathogens(bacteria or viruses), or infected cells.
- The phagocytes engulf cells, lyse them with lytic enzymes, and destruct them.
- It protects the body by ingesting harmful pathogens like bacteria or viruses or infected cells and killing them.

The phagocytic cells:

- Two types of the phagocytic cells:
- A. Either monocytes and its derivatives or
- B. The neutrophils.

The phagocytic cells

- **A.-Monocytes and their derivatives which are:**
 - 1. Monocytes in blood.
 - 2. Dendritic cells in skin, surrounding tissues, and lymph nodes.
 - 3. Kupfer cells in the liver.
 - 4. Alveolar macrophages in the lung.
 - 5 Microglial cells in the brain.
 - 6. Osteoclast in bones
 - 7. Synovial A cells in joints.
 - 8. Mesengial phagocytes in kidneys.
 - 9. Langerhan's cells in skin.
 - 10.. Macrophages in the peripheral tissues.
- **B. The neutrophils**

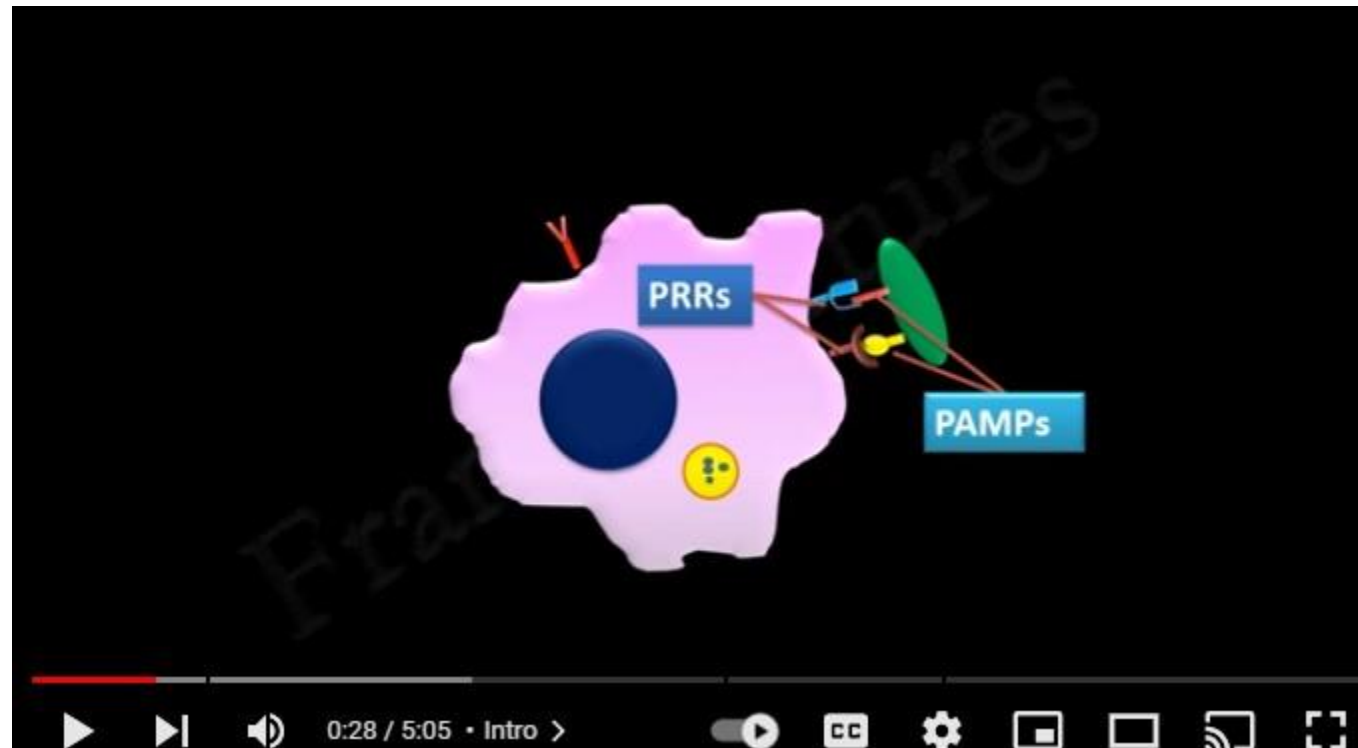


Steps of phagocytosis:

- 1. Recognition of the foreign body.
- 2. Inflammation.
- 3. Chemotaxis.
- 4. Adherence.
- 5. Engulfment.(Endocytosis or pinocytosis).
- 6. Formation of phagosome.
- 7. Formation of phagolysosome (fusion of phagosome with the lysosome).
- 8. killing and digesting of the microorganism.
- 9. Disposal and presentation.

Recognition:

- This can take place by interaction of :
- **The pattern recognition receptors (PRRs) and**
- **The pathogen associated molecular patterns(PAMPs).**



Inflammation:

- After recognition of the foreign body, the inflammatory process starting by **secretion of the inflammatory mediators by the mast cells and basophils:**
- **Mast cells** are resident in tissues near the site of infection.
- While the **basophils** are circulating in blood.
- The inflammatory mediators cause the following:
 - 1. Increase blood supply to the area of infection.
 - 2. Increase vascular permeability due to retraction of the endothelial cells.
 - 3. Migration of large molecules to reach the site of infection (**C5a,C3a**).
 - 4. Migration of the leukocytes: in early stage **the neutrophils** and in late stage **the macrophages**.
- **This process is controlled by the C5a mainly (the chemotaxin).**

Chemotaxis:

- Chemotaxis of the phagocytic cells can occur by secretion of:
 - **1. C5a .**
 - **2. C3a.**
 - **3. Acute phase proteins.**
- This process leads to the migration of the phagocytic cells (**the macrophages and the neutrophils**) to the site of infection.

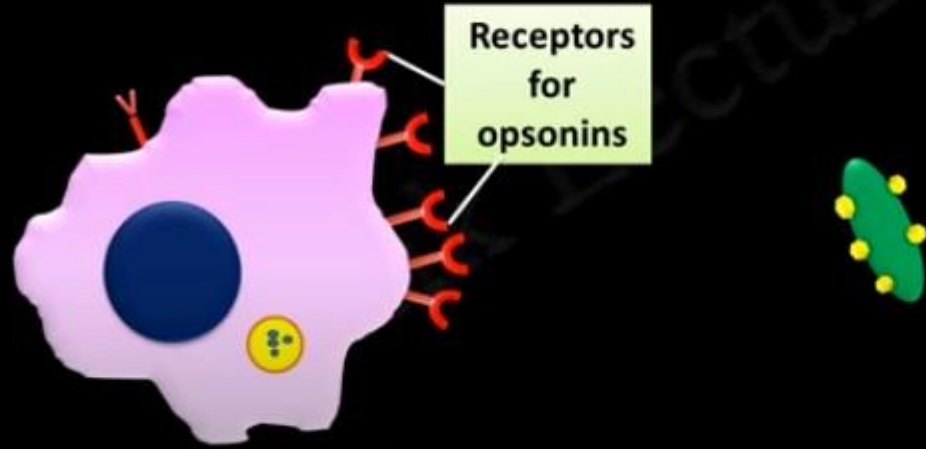
Adherence:

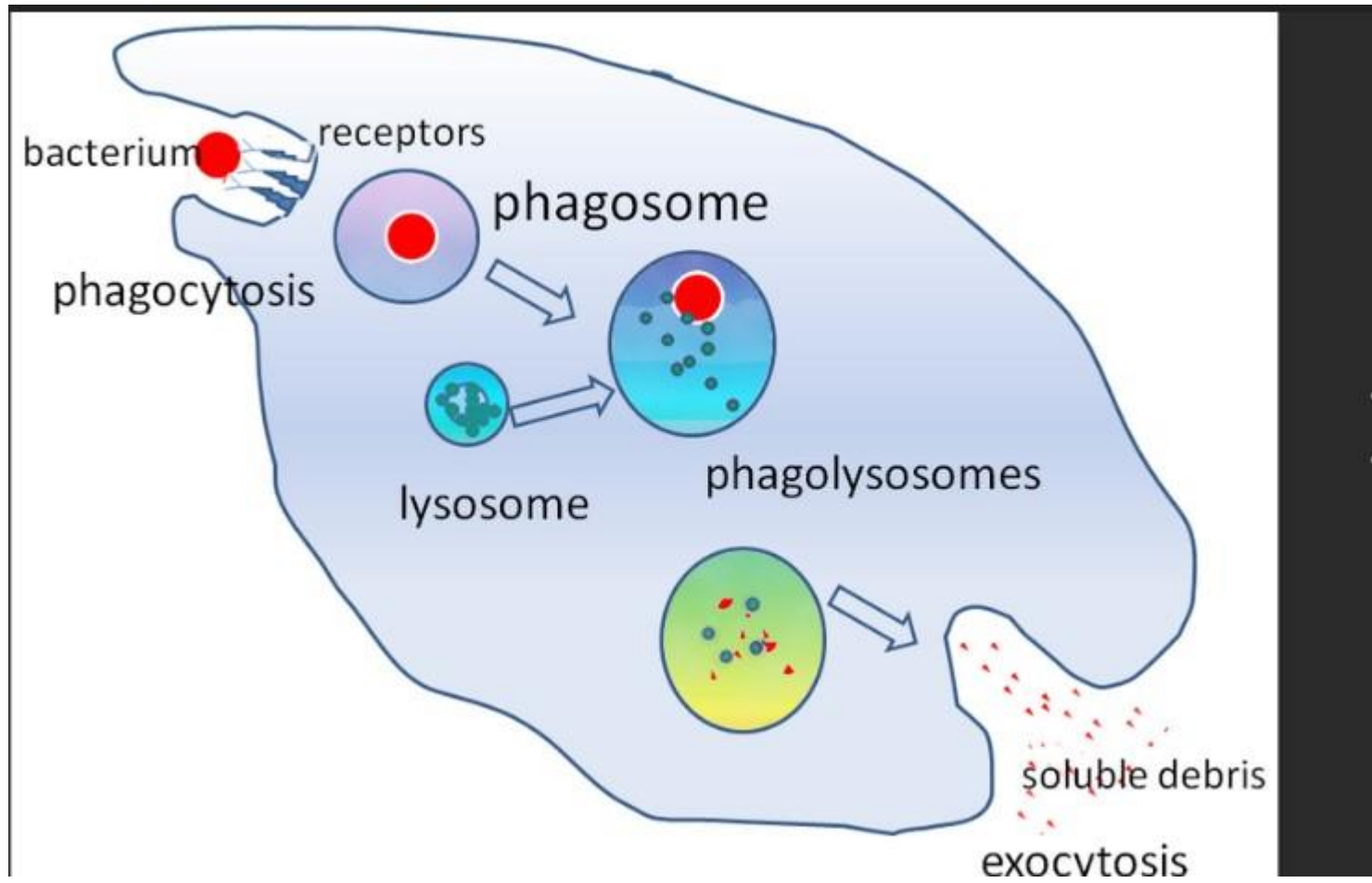
- Adherence means the adherence of the microorganism to the cell membrane of the phagocytic cells which leads to the engulfment of the microorganism by the phagocytic cells.
- The adherence takes place by one or more of the following opsonizing factors (**opsonization**):
 - **1. C-reactive protein.**
 - **2. C3b.**
 - **3. Fc-receptors.**
 - **4. Hydrophobic forces.**
 - **5. PRRs-PAMPs**

Opsonization

- *The process of coating pathogens to promote phagocytosis is called opsonisation. The proteins which perform this function are called opsonins.*

Opsonization





Engulfment:

- In this process engulfment of the foreign body happens by the bulging of the cell membrane of the phagocytic cells either by:
- **The Endocytosis or**
- **The Pinocytosis.**
- In this process **the phagosome** is formed which is a vacuole containing the ingested foreign body.
- Then fusion of the phagosome occurs with the **lysosome** to form:
- **The phagolysosome**

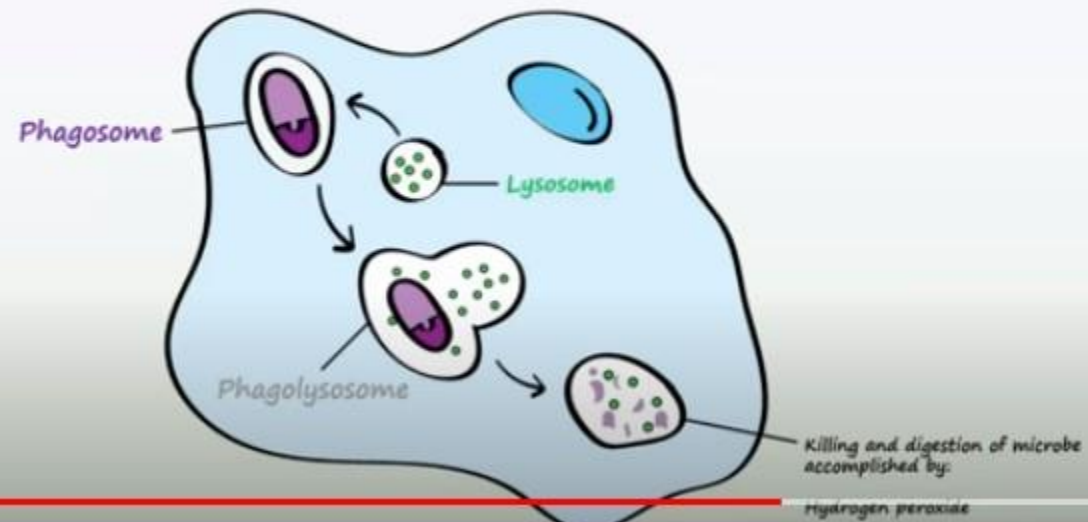
Killing, Digestion , Disposal, and Presentation of part of the foreign body

- After formation of the phagolysosome killing and lysis of the foreign body takes place. The killing process takes place by the effect of:
 - **1. The oxygen radicals like nitrous oxide and hydrogen peroxide.**
 - **2. The lysis by the lysosomal hydrolytic enzymes.**

Presentation and disposal of the antigens:

- The final stage of the phagocytosis is:
 - 1. The presentation of the antigen to the **T-lymphocytes** by the interaction between the antigen and **T-cell receptors** and **MHC molecules**.
 - 2. Also presentation of the **antigen to the B-cells** will occur
 - 3. Disposal of the undigested part of the foreign body will be later disposed out of the phagocytic cells.

Intracellular Killing



1:45 / 2:24



SUMMARY

- **Phagocytes** are white blood cells which do phagocytosis
- **Phagocytosis** is a **non-specific** mechanism to destroy ingested pathogens
- **Lysozyme** enzyme **hydrolyses** and **destroys** the pathogen

Phagocytosis - Summary

Recognition & Adherence



Engulfment



Intracellular Killing

