

Ministry of Higher Education
and Scientific Research
Tishk International University
Faculty of education
Department of Biology



Phagocytosis

Lecture-4-

By

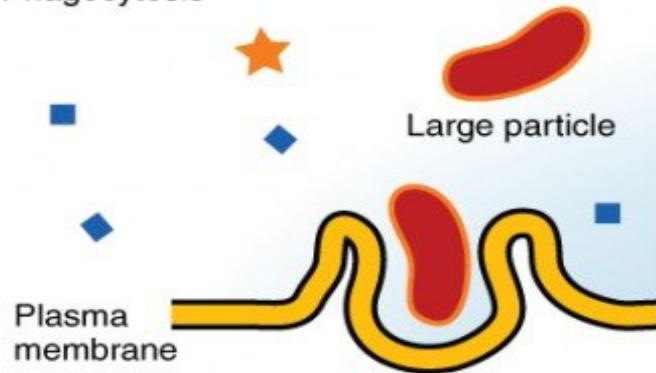
Harmand Ali

Objectives:

- To figure out what phagocytosis is? And what are the cells whose performing it?
- To clarify steps of phagocytosis.



Phagocytosis



Large particle

Plasma membrane



Vacuole

(a)

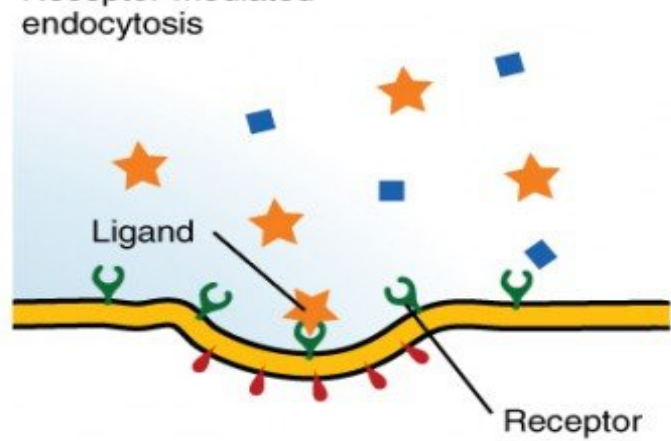
Pinocytosis



Vesicle

(b)

Receptor-mediated endocytosis



Ligand

Receptor

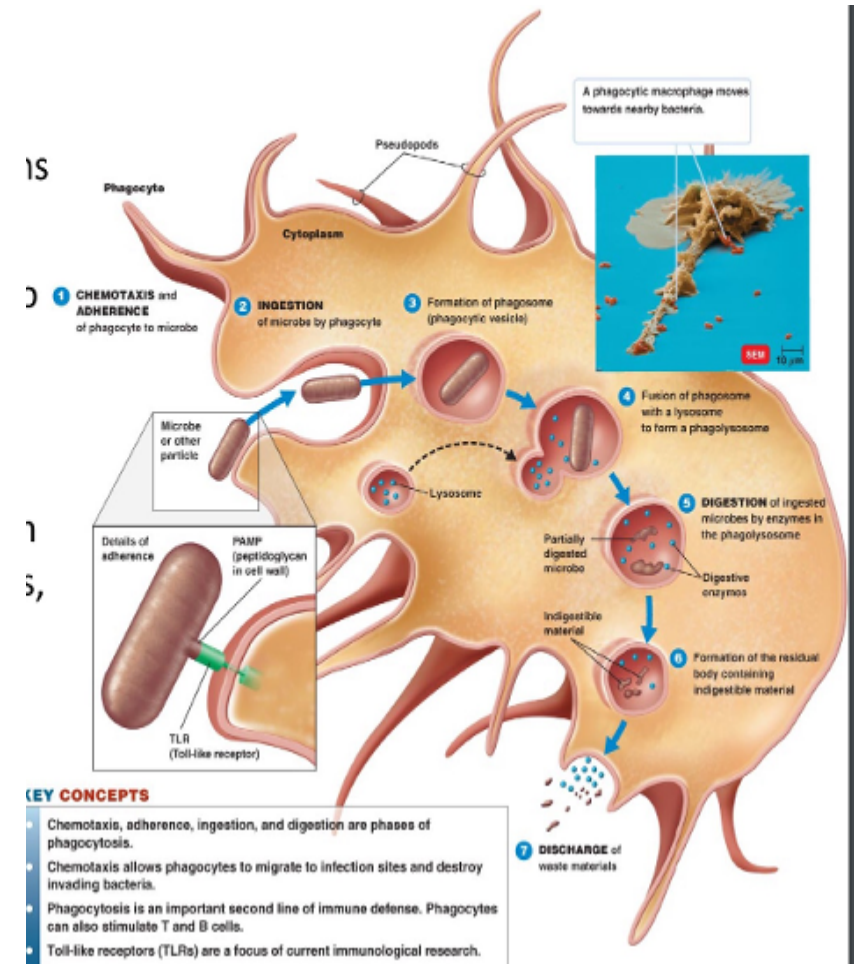


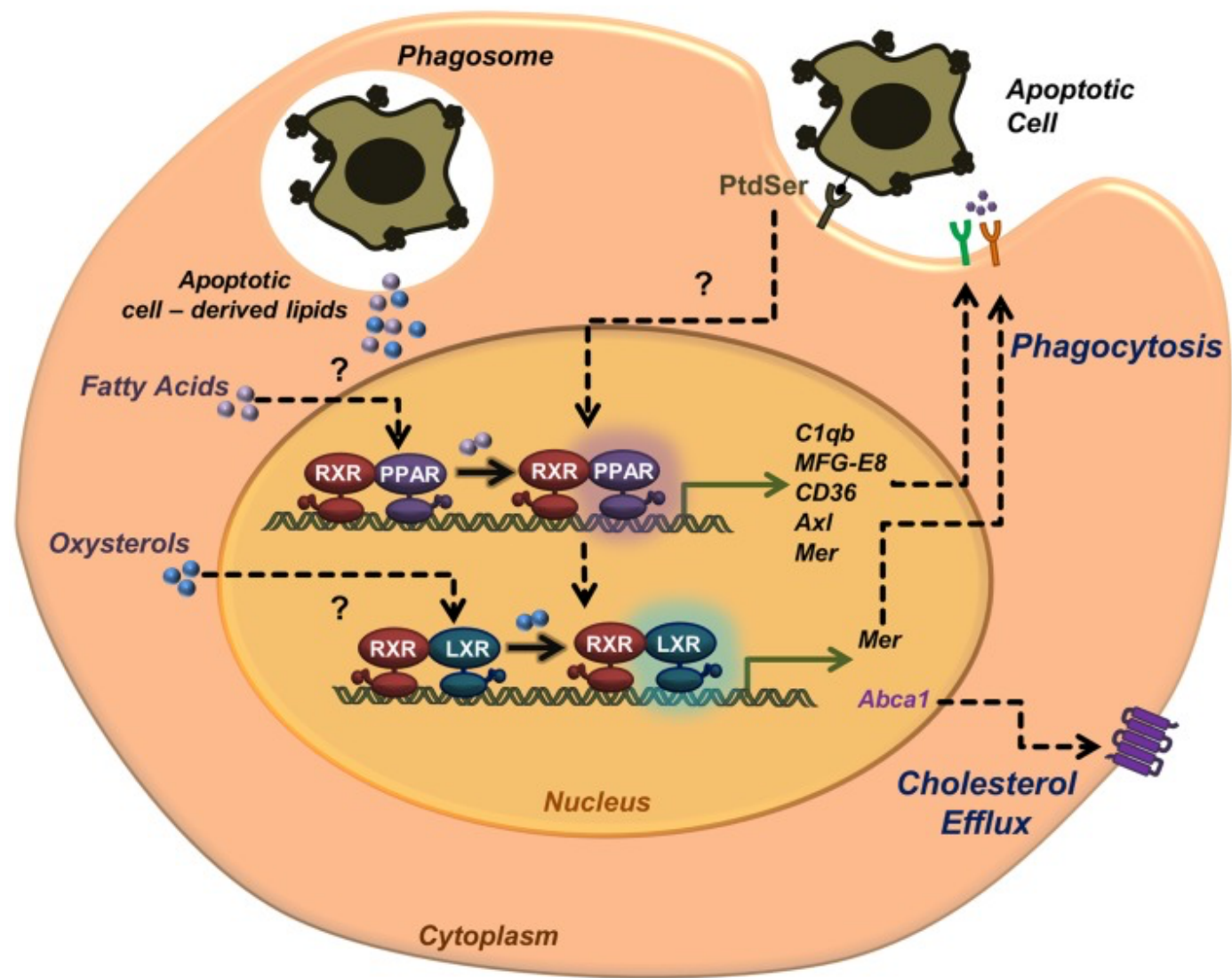
Coated vesicle

(c)

Phagocytosis

- Is the process of Engulfment harmful agents that comes to contact with the immune system mediated by specific cells known as phagocytic cells
- This important Biological process involves the ingestion and digestion of the following:
 - Microorganisms
 - Insoluble particles
 - Damaged or dead host cells
 - Cell debris
 - Activated clotting factors
- Phagocytic cells are; Macrophages, dendritic cells and neutrophils.

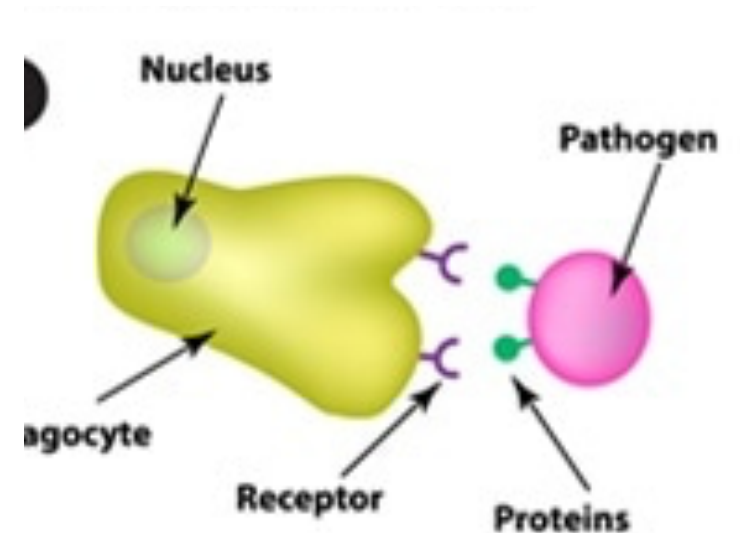




Steps of Phagocytosis

1. Activation

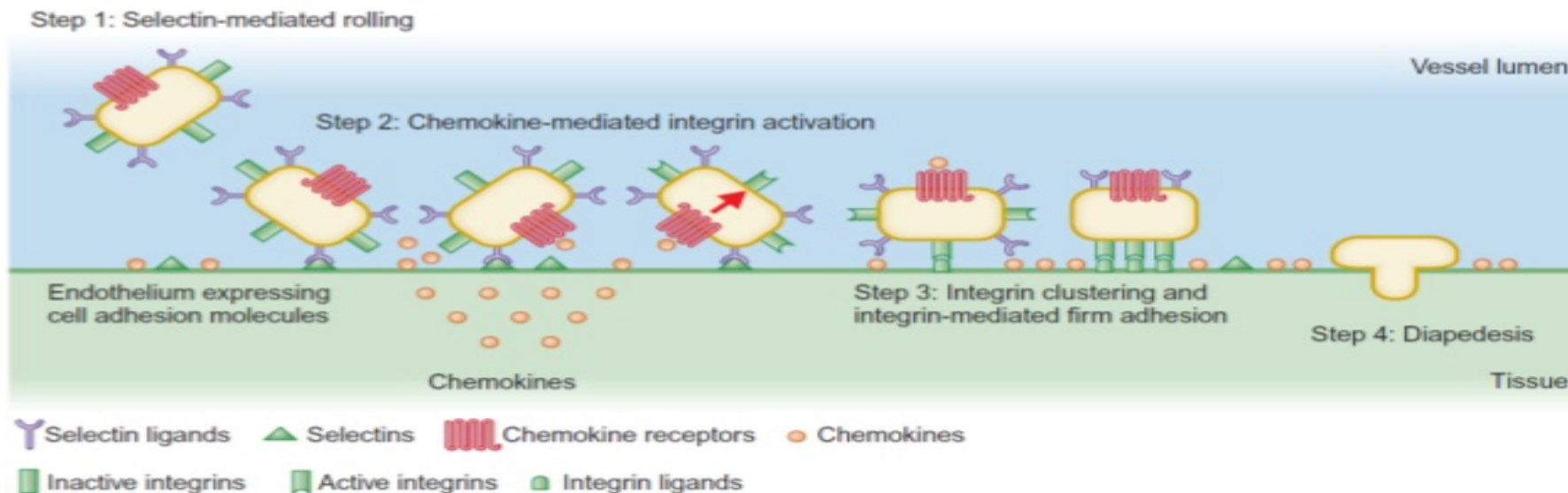
- Resting phagocytes are activated by inflammatory mediators including bacterial products, complement proteins, cytokines, and prostaglandins.
- As a result, the phagocytes produce surface glycoprotein receptors that increase their ability to adhere to surfaces and recognize microbes. These glycoprotein molecules, known as **endocytic pattern-recognition receptors**, because they recognize and bind to pathogen-associated molecules (such as peptidoglycan, teichoic acids, lipopolysaccharide, and mannose that are not found in human cells).



2. Chemotaxis:

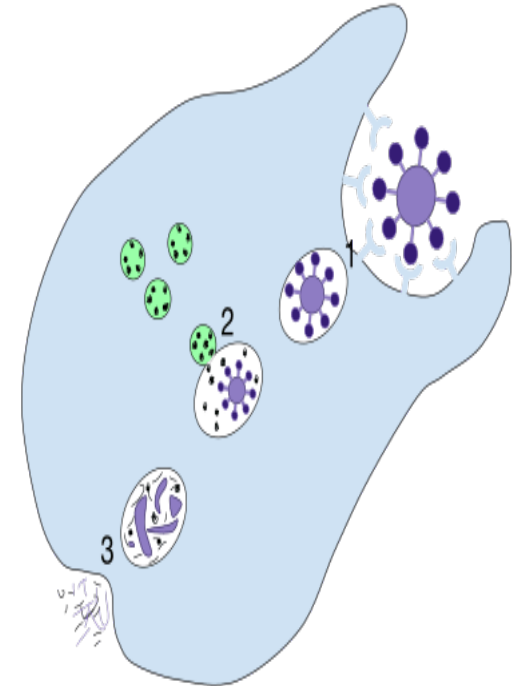
- This is the movement of cells up a gradient of chemotactic factors, which may be directly induced by a substance such as C5a, or indirectly induced as a consequence of release of preformed mediators within mast cells by the action of C3a or C5a e.g. eosinophil chemotactic factor, or neutrophil chemotactic factor. Leukotrienes.

Chemotaxis



3. Adherence

This works reasonably well for whole bacteria or viruses, but less so for proteins or encapsulated bacteria. In order to deal more effectively with encapsulated bacteria, antibodies directed against the capsule enable the phagocytic cells to ingest the organisms, using their Fc receptors.



4. Pseudopodium formation

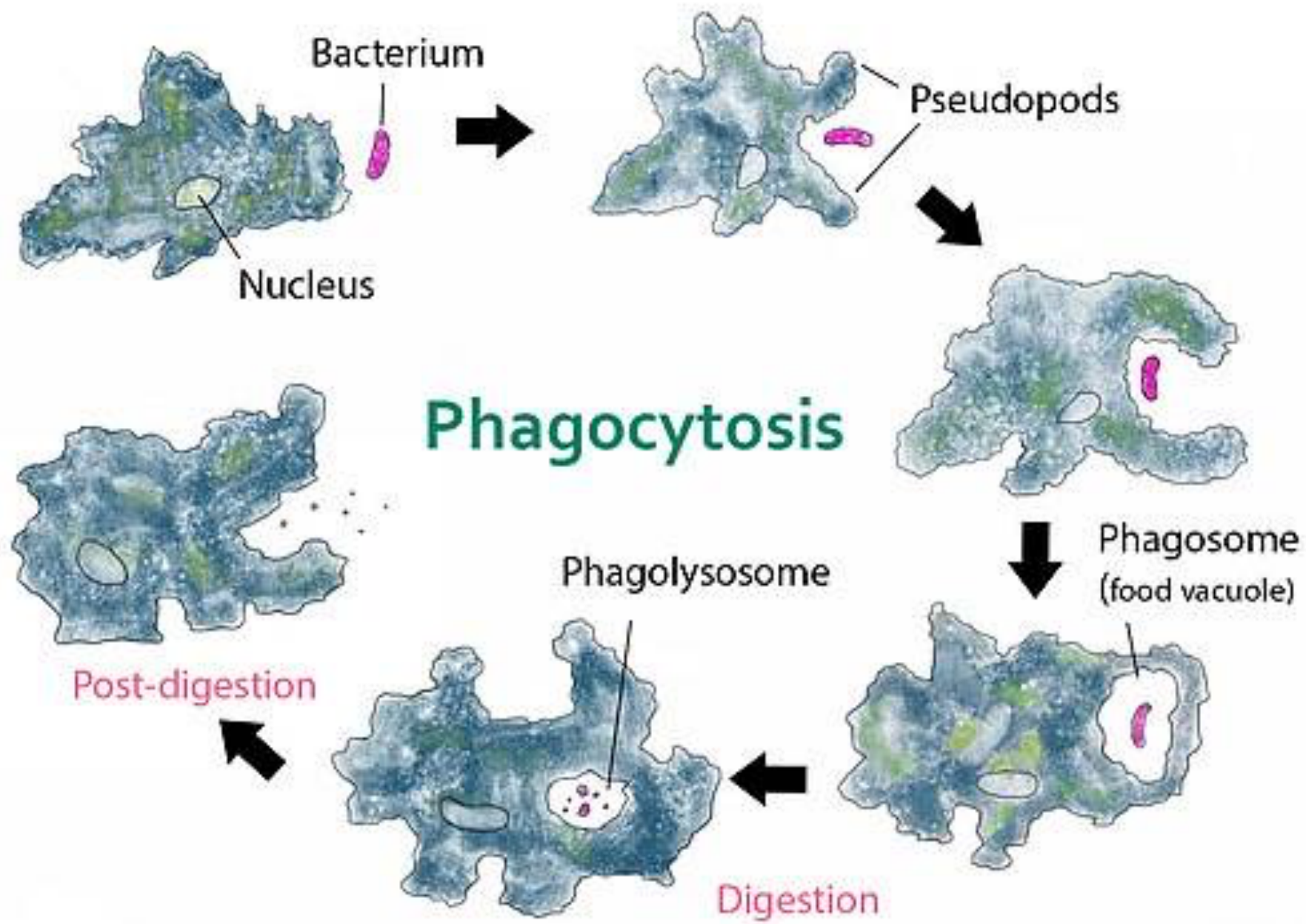
- This is the protrusion of membranes to flow round the "prey".

5. Phagosome formation

- Fusion of the **pseudopodium** with a membrane enclosing the "prey" leads to the formation of a structure termed a **phagosome**.

6. Phago-lysosome formation

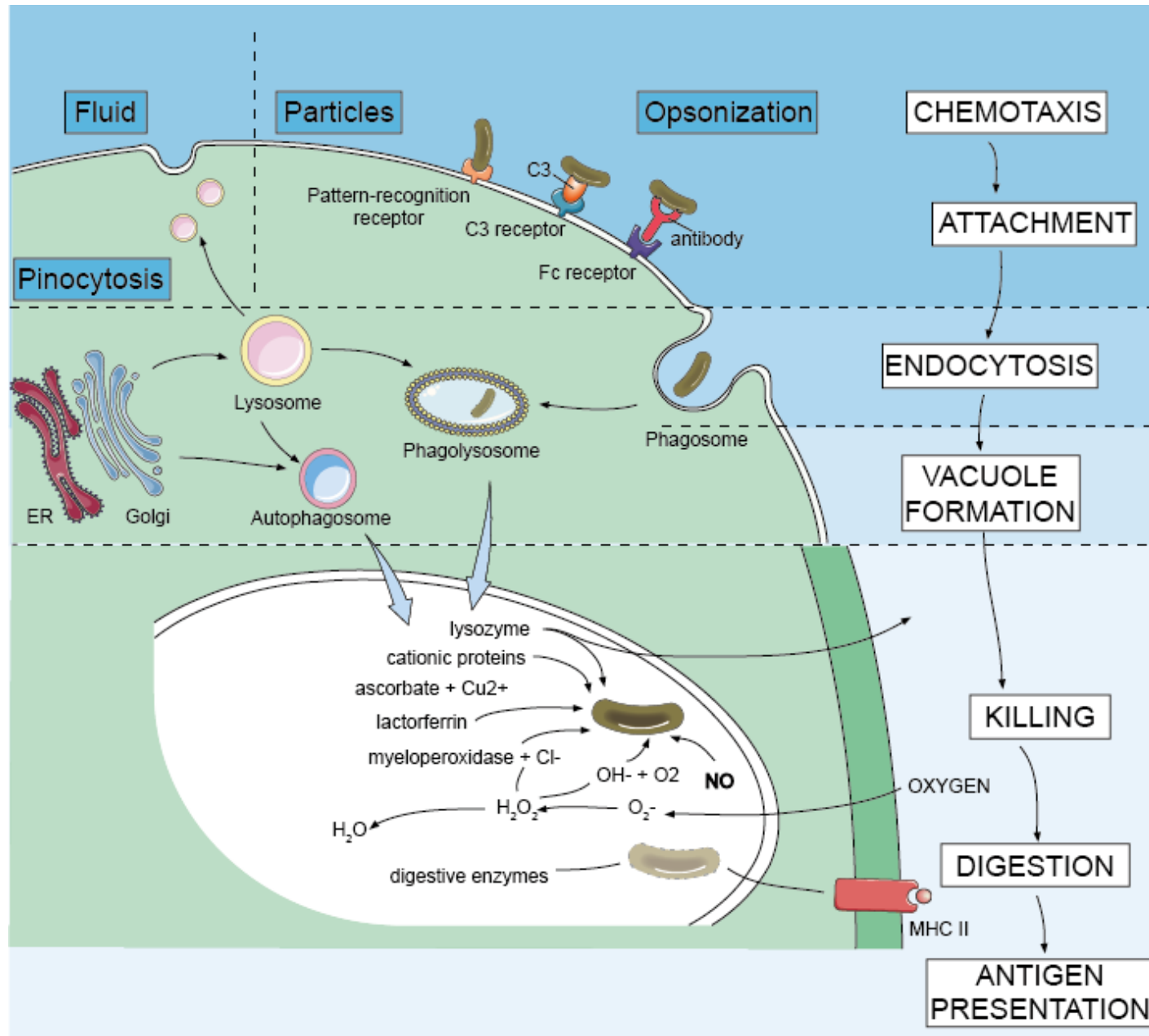
- Integration of phagosome with lysozyme (its enzyme contents)



7. Destruction of the agents:

- The following are important factors that help destroy microorganisms within a phagolysosome:
- **Hydrogen Ion Transport.** Transporters for hydrogen ions acidify the phagolysosome, which kills various microorganisms.
- **Oxygen Radicals.** A complex of proteins called NADPH oxidase in the membrane of a phagolysosome generates oxygen radicals in the phagosome. These highly reactive molecules react with proteins, lipids and other biological molecules

- **Nitric Oxide.** Nitric oxide synthase synthesizes nitric oxide, a reactive molecule that damages various biological molecules.
- **Anti-Microbial Proteins.** Such as lysozyme, an enzyme that attacks the cell walls of certain (gram positive) bacteria, and special proteases which break down protein when in an acid environment.
- **Anti-Microbial Peptides.** Defensins and certain other peptides attack bacterial cell membranes. Similar molecules are found throughout much of the animal kingdom.
- **Binding Proteins.** Lactoferrin binds iron ions, which are necessary for growth of bacteria. Another protein binds vitamin B12.



References:

- Abbas, A.K., Lichtman, A.H. and Pillai, S., 2014. *Cellular and molecular immunology E-book*. Elsevier Health Sciences.
- Goldman, A.S. and Prabhakar, B.S., 1996. *Immunology overview*. University of Texas Medical Branch at Galveston, Galveston (TX).
- Abbas, A.K., Lichtman, A.H. and Pillai, S., 2015. *Basic Immunology E-Book: Functions and Disorders of the Immune System*. Elsevier Health Sciences.