

Immunity

Microbiology

UNIT-3



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Objectives

At the end, the students will be able to:

- Define key terms
- Identify specific and non specific defenses
- Explain three lines of defenses
- Differentiate humoral and cell-mediated immunity
- Discuss phagocytosis process
- Discuss four types of acquired immunity
- Identify five classes of Igs and their functions

Key Terms

- **Immunity:** The ability of body to resist pathogens.
- **Antigen:** Any substance usually made up of protein that stimulate the immune responce
- **Antibody:** A protein produced in the body in response to an antigen.
- **Resistance:** The ability to fight off a pathogen through specific and non-specific defenses.
- **Specific Immunity or Resistance:**
The body's defensive response is specific against a specific pathogen.
- **Non-specific Immunity or Resistance:**
Body defense that provides protection against any kind of pathogen.





- **Innate Resistance:**

The non-specific defenses gifted by birth. e.g, Skin, phagocytic cells, or inflammatory response.

- **Susceptibility:** The lack of resistance to a disease is known as susceptibility.
- **Hapten:** A substance of low molecular weight that is not antigenic itself except when combined with a protein in the body. e.g, Penicillin drug, detergent.
- **Phagocytosis:** The process of engulfment and digesting of an antigen by a phagocytic cell.
- **Opsonization:** The coating or tagging of an antigen by complement proteins to enhance phagocytosis.



Immunity

Non specific

Specific

Physical
barrier

(skin, mucous
membrane)

Chemical
barrier

(lysozyme,
HCl,
interferon)

Inflammation
Phagocytes

(neutrophils,
macrophages),

Humoral
Immunity

Cell-mediate
Immunity

- **Nonspecific Defense/immunity**

Body defense that provides protection against any kind of pathogen. intact skin & healthy mucous membranes

- lysozyme (in saliva and tears) destroys bacteria
- stomach acid destroys ingested bacteria
- phagocytes engulf bacteria entering the body
- inflammatory response including fever
- Complement proteins in plasma

- **Specific Defense/immunity**

- The body's defensive response is specific against a specific pathogen. directed against antigens, or molecules recognized as foreign bodies.
- produces antibodies to destroy invader.
- memory cells develop and remain in circulation.
- Two main types of cells: **B cells** and **T cells**



Nonspecific cellular components

- **Natural killer cells (NK cells):**
Lymphocytes that can destroy other cells, especially tumor cells and other infected cells.
- **Macrophages** (phagocytes) often act as antigen presenting cells (APC's).
- This is then identified by the T cells





Three Lines of Defenses



First Line of Defense

It is nonspecific Defense:

- **Intact Skin:** Forms mechanical barrier that prevents entry of pathogens and other harmful substances into body.
- **Intact mucous membranes:** Form mechanical barrier that prevents entry of pathogens.
- **Mucous:** Traps pathogens in respiratory and digestive tracts.
- **Nasal hair:** Filter and trap microbes in nasal passage.



First Line cont...

- **Gastric juice:** Contains HCl that destroys pathogens in stomach.
- **Lysozyme:** Found in tears and saliva that kills microbes.
- **Urine:** Flushes out lower urinary tract; and, its lower PH also inhibits some microbial growth.



Second Line of defense

- **Nonspecific cellular and chemical defense**
- **Inflammatory response:** Prevents spread of harmful agents to adjacent tissues; promotes tissue repair; release chemical mediators to attract phagocytes and stimulate third line of immune response.
- **Fever:** It is systemic response initiated by pyrogens (i.e. prostaglandin); high body temperature inhibits microbial proliferation.



Second Line cont...

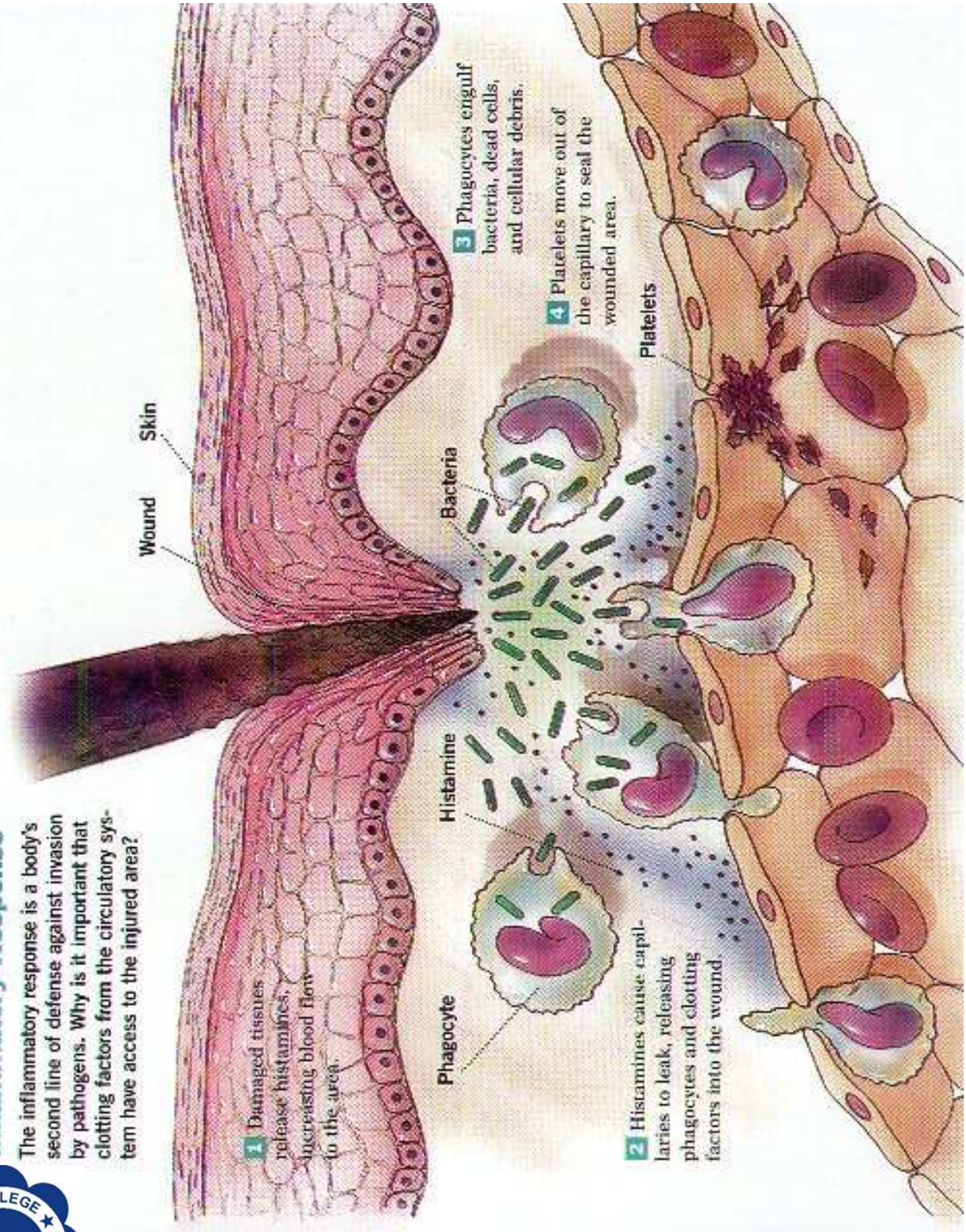
- **Phagocytes:** Engulf pathogens and contributes immune response.

Antimicrobial proteins:

- ▶ **Interferon:** Proteins released by virus infected cells that protect uninfected cells from viral overtake; mobilize immune system.
- ▶ **Complement:** Enhances phagocytosis by opsonization, Lyses microbes, and intensifies inflammatory and immune responses.

Steps of the Inflammatory Response

The inflammatory response is a body's second line of defense against invasion by pathogens. Why is it important that clotting factors from the circulatory system have access to the injured area?



1 Damaged tissues release histamines, increasing blood flow to the area.

2 Histamines cause capillaries to leak, releasing phagocytes and clotting factors into the wound.

3 Phagocytes engulf bacteria, dead cells, and cellular debris.

4 Platelets move out of the capillary to seal the wounded area.



Third Line of defense

- It's response is antigen specific, means differentiates pathogens.
- Third line of defense consists of humoral and cell mediated immune response.
- For each type of pathogen, the immune system produces cells and antibodies that are specific for that particular pathogen.
- They fight off pathogens and provide long term immunity by keeping record of the antigen into its memory.
- Secondary response is thus relatively rapid and stronger than the primary response.

Humoral and Cell-mediated

- **Humoral immunity (or antibody mediated):** involves the production of **antibodies**.
It is governed by B-lymphocytes.
- **Cell mediated immunity:** is governed by **T-lymphocytes** which involve different types of T-cells



Cell mediated Immunity

- Cell mediated immunity Involves T-lymphocytes that act against infected cell or foreign cell or tissue.
- T cells are produced in bone marrow but mature in **the thymus gland**.
- Also regulate the activation and proliferation of other immune system cells
- Cell mediated immune response is directed against bacteria and viruses inside phagocytic cells or infected host cells.
- This also causes rejection of implanted tissue.
- T lymphocytes proliferate into different types of cells





Types of T cells

- **Helper T-Cells:** which activate macrophages and help B cells
Helper T cell also produce chemicals called cytokines such as interleukin and interferon
- **Cytotoxic T-Cells:** destroy target cells on contact by producing toxin (**perforin**) that lyses infected cells
- **Suppressor T-Cells:** (also called regulatory T cells) are involved in stopping the reaction once the danger is finished.
- **Memory T-Cells:** are long-lived cells which give long term immunity against that pathogen.



Humoral immunity

- B cells or B lymphocytes are responsible for antibodies production.
- This provides resistance to bacteria and viruses and bacterial toxins
- Antibodies or immunoglobulins recognize different types of antigens.



B cells cont...

- B cells are produced and matured in stem cells of bone marrow.
- Mature B cells are found in lymphoid tissues like spleen and lymph nodes.
- B cells Recognize antigen by antigen receptors on cell surface.
- We make 100 million lymphocytes a day, so equal number must die. This death of cells is known as 'Apoptosis' or 'programmed cell death'



Activation of B cells

- Each B cell produces an antibody against a particular antigen.
- When antigen comes in contact with B cells they form **plasma cells** and **B memory cells**.
- **Plasma cells** start the production of antibodies while **Memory cells** give long term immunity against that pathogen by keeping its record.
- Antibodies start binding to antigen and thus inactivate the antigens.
- Secondary response of immune system is quick and stronger than the primary one.



Phagocytosis

Key Terms



- **Chemotaxin:**

A chemical produced by cells to attract macrophages towards antigens.

- **Chemotaxis:** is the process by which macrophages are attracted to microorganisms.

- **Opsonization:**

The labeling of antigen with serum protein to help phagocytes in ingestion.

- **Phagocytosis:**

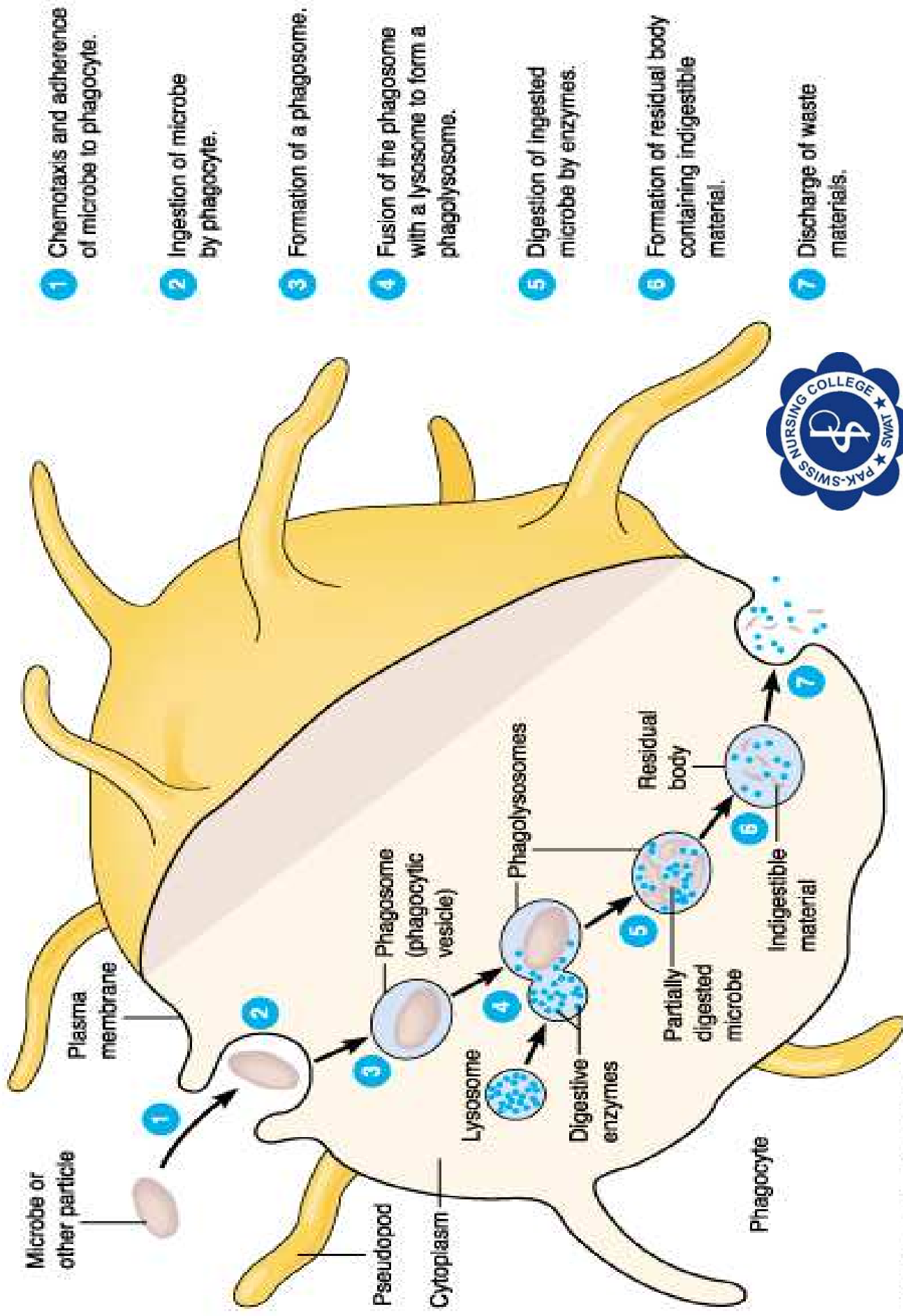
The process of digesting of an antigen by phagocytic cell is known as phagocytosis

The Process of Phagocytosis

The process or mechanism of phagocytosis involves the following steps:

- Chemotaxis attract and direct motility of phagocytic cells.
- Both Chemotaxis and opsonization help phagocytes to adhere to the microbial cells.
- Pseudopods of phagocytes engulf and ingest microbes.
- Inside macrophage, the microbes are killed by lysozymes and other oxidizing agents.





(a) Phases of phagocytosis

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1 Chemotaxis and adherence of microbe to phagocyte.

2 Ingestion of microbe by phagocyte.

3 Formation of a phagosome.

4 Fusion of the phagosome with a lysosome to form a phagolysosome.

5 Digestion of ingested microbe by enzymes.

6 Formation of residual body containing indigestible material.

7 Discharge of waste materials.

THE END



THANK YOU STUDENTS