Fundamental Aspects of Immunology

Introduction to Immunology

Immunity

- **Immunity** is the ability of the body to recognize, resist, and remove harmful foreign substances or infectious organisms.
- The immune system must distinguish between the body's own components, called **self**, and foreign components, called **non-self**.

Purpose of the Immune System

- To recognize what belongs to the body (self) and what does not (non-self).
- To defend the body against infections and diseases.
- To remember past infections for faster response in the future.

Key Features of the Immune System

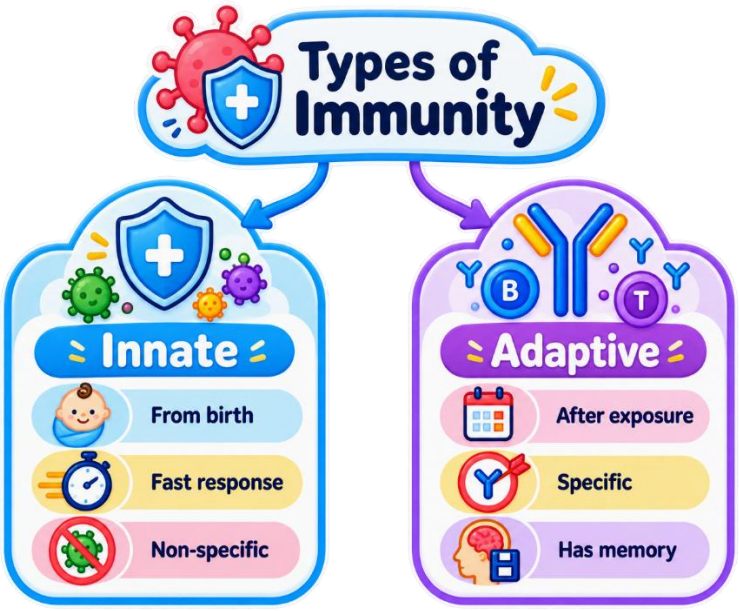
- **Specificity**: Ability to recognize specific antigens.
- **Diversity**: Can respond to millions of different antigens.
- **Memory**: Remembers previously encountered antigens.
- **Self vs non-self-recognition**: Avoids attacking its own tissues.

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Key Terms in Immunology

- **Antigen**: Any foreign substance that can trigger an immune response (e.g., bacteria, toxins).
- **Antibody**: A protein produced by the immune system to neutralize antigens.
- **Immunity**: The ability of the body to resist infections.

Types of Immunity (Basic Introduction)



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1. Innate Immunity

- Innate immunity is the natural defense system that is present from birth.
- It provides a rapid response against many different infectious agents.
- It does not normally require previous exposure to a particular microorganism.
- Important components include the skin, mucous membranes, phagocytic cells, natural killer cells, complement proteins, and inflammatory responses.

2. Adaptive Immunity

- Adaptive immunity develops after exposure to a particular antigen.
- It produces a highly specific response against that antigen.
- B lymphocytes and T lymphocytes are the major cells involved in adaptive immunity.
- Adaptive immunity produces **immunological memory**, which allows a faster and stronger response when the same antigen enters the body again.

Types of Adaptive Immune Response

1. Humoral Immunity

- Humoral immunity is mainly mediated by antibodies produced by B lymphocytes and plasma cells.
- It is especially important against extracellular microorganisms and toxins.

2. Cell-Mediated Immunity

- Cell-mediated immunity is mainly carried out by T lymphocytes.
- It is particularly important against infected cells, some intracellular microorganisms, and abnormal cells.

Importance of Immunology in Immunotechnology

- Helps in the development of vaccines.
- Used in diagnostic tests (like ELISA, rapid tests).
- Important for therapeutics such as monoclonal antibodies.
- Plays a role in organ transplantation and understanding rejection.

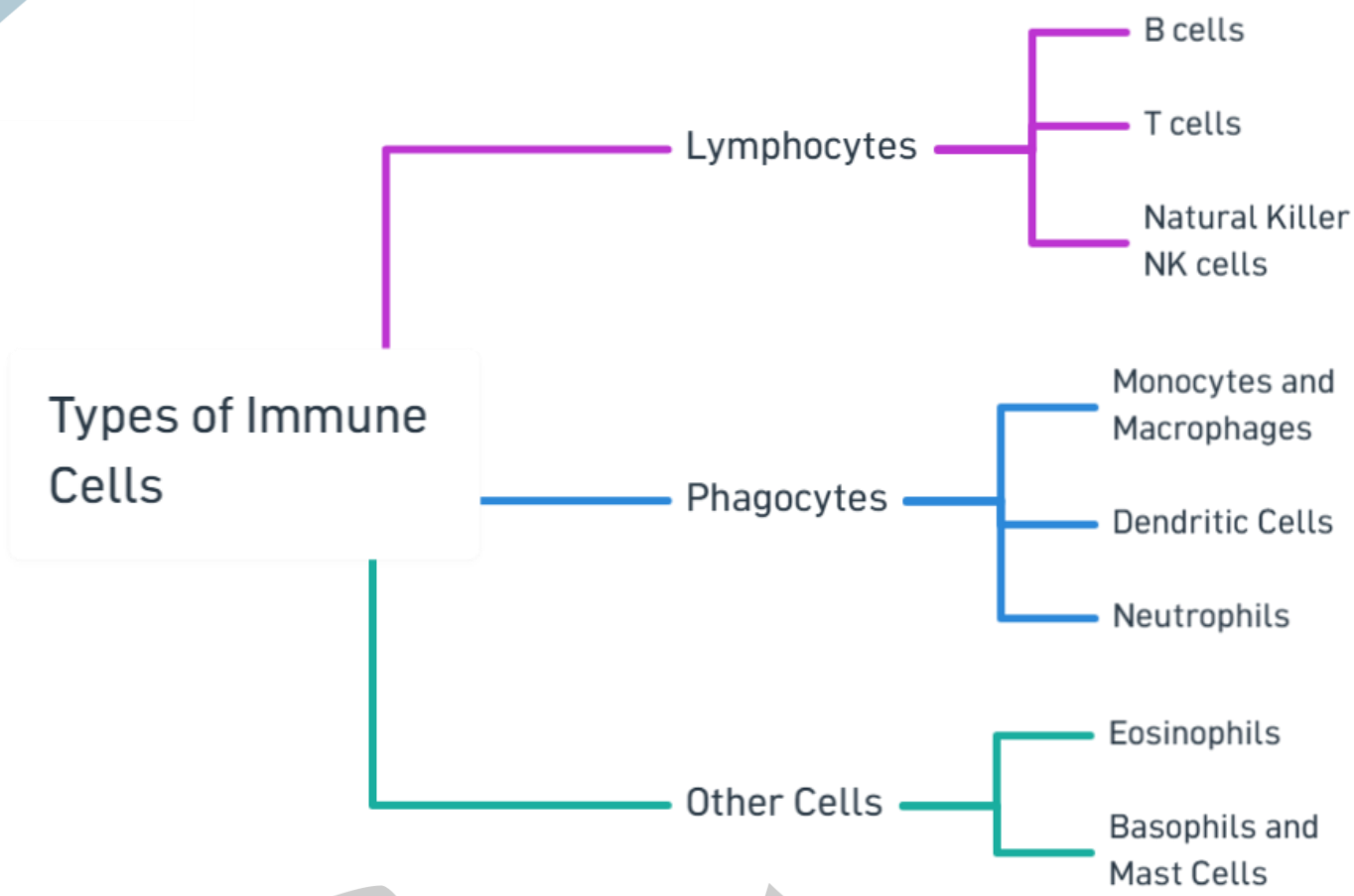
Cells of the Immune System

White Blood Cells (Leukocytes)

- Main functional cells of the immune system.
- Produced in the bone marrow.

Types of Immune Cells

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1. Lymphocytes

- Central cells in adaptive immunity.
- **Types:**

A. B cells

- Produce antibodies.
- Mature in bone marrow.

B. T cells

- Responsible for cell-mediated immunity.
- Mature in thymus.
- **Subtypes:**
  - Helper T cells (CD4+): activate other immune cells.
  - Cytotoxic T cells (CD8+): kill infected or cancerous cells.

C. Natural Killer (NK) cells

- Part of innate immunity.
- Destroy virus-infected and tumor cells.

2. Phagocytes

- Engulf and digest pathogens.

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- **Types:**
  - **A. Monocytes and Macrophages**
    - Monocytes circulate in blood; macrophages reside in tissues.
    - Engulf and digest pathogens (phagocytosis).
    - Act as antigen-presenting cells (APCs).
  - **B. Dendritic Cells**
    - Most powerful antigen-presenting cells.
    - Capture antigens and present them to T cells.
    - Link innate and adaptive immunity.
  - **C. Neutrophils**
    - First responders during infection.
    - Perform phagocytosis.
    - Most abundant white blood cells.

3. Other Cells

- **A. Eosinophils**
  - Fight parasitic infections.
  - Involved in allergic reactions.
- **B. Basophils and Mast Cells**
  - Release histamine and other chemicals.
  - Important in inflammation and allergic responses.

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Organs of the Immune System

Primary (Central) Lymphoid Organs

Sites where immune cells develop and mature.

1. Bone Marrow

- Produces all blood cells (hematopoiesis).
- B cells mature here.

2. Thymus

- Located above the heart.
- T cells mature and become functional here.
- Important in early life; shrinks with age.

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Secondary (Peripheral) Lymphoid Organs

Sites where immune responses are initiated.

1. Lymph Nodes

- Filter lymph fluid.
- Contain lymphocytes and APCs.
- Site of antigen presentation and lymphocyte activation.

2. Spleen

- Filters blood.
- Removes old red blood cells and pathogens.
- Initiates immune responses to blood-borne antigens.

3. Mucosa-Associated Lymphoid Tissue (MALT)

- Found in mucosal surfaces like gut, respiratory tract.
- **Includes:**
  - Tonsils
  - Peyer's patches (in intestine)
- Protects against pathogens entering through body openings.

Circulatory Components

- **Blood**: Transports immune cells throughout the body.
- **Lymphatic Sstem**: Network of vessels carrying lymph fluid, which contains immune cells.

Cellular Basis of Immune Response

Overview of Cellular Basis

- The immune response is carried out by interactions between different immune cells.
- These cells communicate using chemical signals (cytokines) and direct cell-to-cell contact.
- The response begins when a foreign substance (antigen) enters the body.

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