

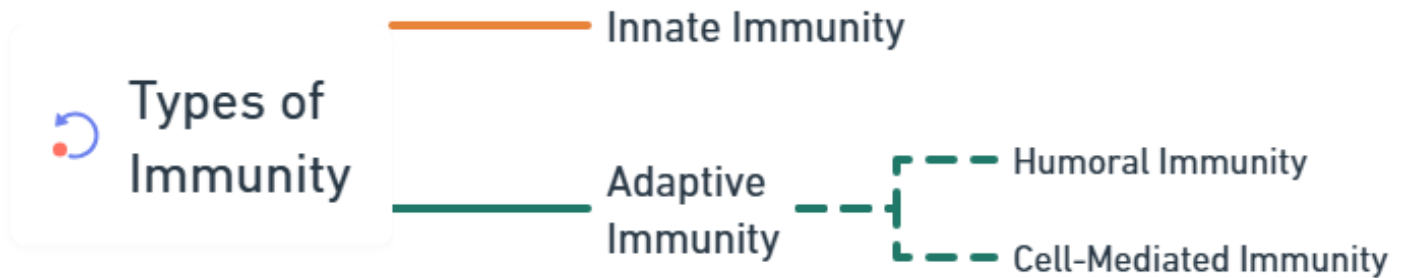
Immunity

Definition:

- Immunity refers to the body's ability to resist and fight off infections and diseases.
- It is the natural defense mechanism of the body that helps to keep us healthy and protects us from harmful invaders like viruses, bacteria, and parasites.

Types of Immunity

There are two main types of immunity: **innate immunity** and **adaptive immunity**.



1. Innate Immunity

- This is the first line of defense against pathogens and is present from birth.
- It includes:
 - **Physical barriers** such as the skin and mucous membranes.
 - **Immune cells** like neutrophils, natural killer cells, and macrophages.
- Innate immunity provides **immediate protection** against infections but is **non-specific** and does not provide long-term immunity.

2. Adaptive Immunity

- This type of immunity develops over time as the body is exposed to different pathogens.
- It is mediated by specialized immune cells called **T cells** and **B cells**, which can recognize and respond to specific pathogens.
- Adaptive immunity takes time to develop but provides **long-lasting protection** against specific pathogens through the production of antibodies and memory cells.
- There are two types of **adaptive immunity**:

A. Humoral Immunity

- Involves the production of **antibodies** by **B cells**.
- These antibodies recognize and neutralize pathogens in the bloodstream.

B. Cell-Mediated Immunity

- Involves the activation of **T cells**.
- T cells can directly **kill infected cells** and help regulate immune responses.

Humoral Immunity

Definition

- Humoral immunity is a branch of adaptive immunity mediated by antibodies secreted by activated B cells (plasma cells).
- It primarily targets extracellular pathogens, such as bacteria, viruses (before they enter cells), and toxins.

Key Players

1. **B Lymphocytes (B Cells)** – Produced in the bone marrow, these cells are responsible for antibody production.
2. **Plasma Cells** – Activated B cells that secrete large amounts of antibodies.
3. **Memory B Cells** – Persist after infection, providing long-term immunity.
4. **Antibodies (Immunoglobulins, Ig)** – Proteins that bind to antigens and neutralize them. Types include **IgG, IgA, IgM, IgE, and IgD**.

Mechanism of Humoral Immunity

1. Antigen Recognition

- A naïve B cell recognizes an antigen via its surface B-cell receptor (BCR).
- The antigen is processed and presented on MHC-II to T-helper cells (CD4⁺ cells).

2. T-Cell Help & B Cell Activation

- T-helper cells release cytokines (e.g., IL-4, IL-5, IL-6) that stimulate B cell differentiation.
- B cells differentiate into plasma cells and memory B cells.

3. Antibody Production

- Plasma cells produce antibodies specific to the antigen.
- Antibodies function by:
 - **Neutralization** – Blocking pathogen activity.
 - **Opsonization** – Marking pathogens for phagocytosis.
 - **Complement Activation** – Triggering a cascade that leads to pathogen destruction.

4. Memory Response

- Memory B cells persist in the body after infection.
- Upon re-exposure to the same antigen, memory B cells rapidly produce antibodies, leading to a faster and stronger immune response.

Advantages

- **Highly Specific** – Antibodies uniquely bind to specific antigens.
- **Long-Term Immunity** – Memory B cells ensure quicker future responses.

Cellular Immunity (Cell-Mediated Immunity)

Definition:

- Cellular immunity involves T lymphocytes (T cells) that target infected cells, tumor cells, or intracellular pathogens.
- Unlike humoral immunity, it does not rely on antibodies but instead directly attacks infected or abnormal cells.

Key Players:

1. **T lymphocytes (T cells)** – Produced in the bone marrow, mature in the thymus.
2. **T-helper cells (CD4⁺ cells)** – Regulate immune responses via cytokines.
3. **Cytotoxic T cells (CD8⁺ cells)** – Directly kill infected or abnormal cells.
4. **Memory T cells** – Provide long-term immunity.

Mechanism of Cellular Immunity

1. Antigen Recognition

- T cells recognize antigen fragments presented on MHC molecules on infected or abnormal cells.

2. Types of T Cells Involved

A. CD8⁺ Cytotoxic T Cells (CTLs)

- Recognize antigens presented on MHC-I.
- Kill infected or cancerous cells using:
 - **Perforins** – Create pores in target cells.
 - **Granzymes** – Induce apoptosis (cell death).

B. CD4⁺ Helper T Cells (Th Cells)

- Recognize antigens presented on MHC-II by antigen-presenting cells (APCs).
- Secrete cytokines that:
 - Activate **macrophages** for enhanced pathogen destruction.
 - Promote **inflammation**.
 - Enhance **B cell** antibody production.
 - Assist **CD8⁺ T cells** in activation.

Advantages of Cellular Immunity



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