Immunity – Definition

What is Immunity?

- Immunity is the body's defense mechanism against foreign harmful substances (known as antigens), such as pathogens (bacteria, viruses, fungi, parasites), toxins, or even abnormal body cells (like cancer).
- It represents the body's ability to recognize, fight, and eliminate these threats.
- In essence, immunity is a protective biological response that allows an organism to resist infection or disease.
- This involves a complex interplay between cells, molecules, and tissues that detect and neutralize harmful agents.

Immune Response Process Overview:

1. **Recognition** – Immune system detects antigens (foreign invaders).
2. **Activation** – Mobilization of immune components to respond to the threat.
3. **Effector Phase** – Destruction and elimination of the pathogen.
4. **Memory Formation** – Development of long-lasting protection (in adaptive immunity).

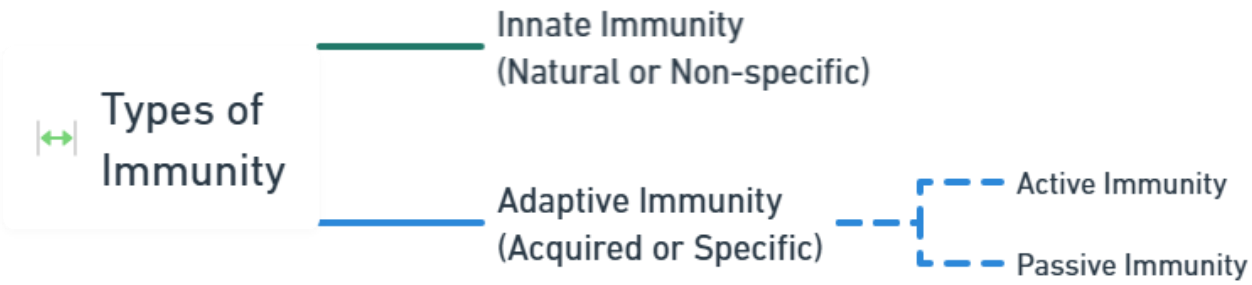
Key Components of the Immune System:

- **White blood cells (leukocytes)**: Include lymphocytes (B and T cells), neutrophils, monocytes, etc.
- **Organs and tissues**: Bone marrow, thymus, spleen, lymph nodes.
- **Molecules**: Antibodies, cytokines, complement proteins.

Classification of Immunity

- Immunity is broadly classified based on its **mode of acquisition** and **response mechanism**.

The major types include:



A. Innate Immunity (Natural or Non-specific Immunity)

Characteristics:

- Present from birth.

- Provides **immediate defense**.
- **Non-specific**: Responds the same way to all pathogens.
- No immunological memory.

Main Components:

1. **Physical Barriers**: Skin, mucous membranes, cilia.
2. **Chemical Barriers**: Stomach acid, lysozyme in tears and saliva, antimicrobial peptides.
3. **Cellular Defenses**:
    - **Phagocytes**: Neutrophils and macrophages engulf pathogens.
    - **Natural Killer (NK) cells**: Destroy virus-infected and tumor cells.
4. **Soluble Factors**:
    - **Complement system**: A group of proteins that enhances pathogen destruction.
    - **Cytokines**: Small proteins that modulate immune responses.

B. Adaptive Immunity (Acquired or Specific Immunity)

Characteristics:

- Develops after exposure to specific antigens.
- **Highly specific** response to individual pathogens.
- Has **memory**: faster and stronger upon repeated exposure.
- Delayed onset (days to develop).

Subtypes:

1. Active Immunity:

- Produced when the body makes its own antibodies.
- Can be natural (after infection) or artificial (after vaccination).
- Long-lasting or permanent.

2. Passive Immunity:

- Results from the transfer of antibodies from another source.
- Can be natural (maternal antibodies via placenta or milk) or artificial (antibody injections like antivenom).
- Provides immediate but short-lived protection.

General Principles of Natural Immunity (Innate Immunity)

- Natural immunity, also called innate immunity, is the first line of defense that the body has against invading pathogens.

- It is non-specific, meaning it does not differentiate between different types of pathogens.
- It provides a general defense mechanism that works the same way each time, regardless of the pathogen involved.

Below are the general principles and components of natural immunity:

1. Anatomical (Physical) Barriers

- These are the first defenses that prevent pathogens from entering the body.
  - **Skin:** Acts as a physical barrier. The outer layer (stratum corneum) contains keratin, which is impermeable to most microbes.
  - **Mucous membranes:** Line the respiratory, gastrointestinal, and genitourinary tracts. They trap microbes in mucus.
  - **Cilia** in the respiratory tract help sweep out mucus with trapped particles.

2. Physiological and Chemical Barriers

- **pH:** The acidic environment of the stomach (pH ~2) kills many ingested microbes.
- **Lysozyme:** An enzyme present in tears, saliva, and mucus that breaks down bacterial cell walls.
- **Fatty acids and lactic acid:** Present on the skin surface; they inhibit microbial growth.

3. Cellular Components

- These include white blood cells involved in immediate defense:

A. Phagocytes:

- **Neutrophils:** First responders, short-lived, engulf pathogens.
- **Monocytes/Macrophages:** Arrive after neutrophils; live longer; process antigens for presentation.

B. Natural Killer (NK) Cells:

- Kill virus-infected and tumor cells.
- Act without prior sensitization (non-specific).

C. Dendritic Cells:

- Present in epithelial tissues.
- Capture antigens and initiate adaptive immune responses.

4. Inflammatory Response

- **Vasodilation:** Increases blood flow to the affected area.
- **Increased vascular permeability:** Allows immune cells and proteins to reach the infection site.
- **Recruitment of immune cells:** Especially neutrophils and macrophages.

- **Purpose:** To isolate and eliminate the pathogen and repair tissue.

5. Soluble Mediators

- **Complement System:** A group of plasma proteins that help in:
  - Opsonization (coating pathogens for phagocytosis),
  - Lysis of pathogens,
  - Chemotaxis (attracting immune cells).
- **Cytokines:** Small proteins (e.g., interferons, interleukins) that:
  - Modulate immune response,
  - Help communication between immune cells.

6. Genetic Factors

- Some individuals or species are naturally resistant to certain infections due to:
  - Lack of specific receptors,
  - Innate cellular resistance,
  - Host genetic variations.

Phagocytosis

- Phagocytosis is a fundamental process of the innate immune system where certain immune cells, called **phagocytes**, engulf and destroy pathogens and foreign particles.

Main Phagocytic Cells:

1. Neutrophils:

- Most abundant white blood cells.
- First responders during infection.
- Short life span.

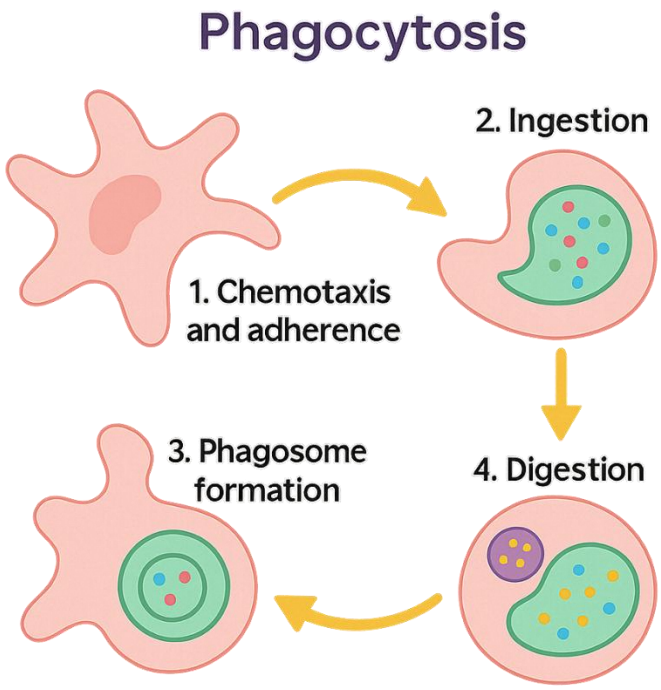
2. Monocytes/Macrophages:

- Monocytes circulate in the blood and differentiate into macrophages when they enter tissues.
- Long-lived.
- Also play a role in antigen presentation to the adaptive immune system.

3. Dendritic Cells:

- Specialized antigen-presenting cells.
- Efficient in capturing and processing antigens.

Steps of Phagocytosis:



1. Chemotaxis:

- Movement of phagocytes toward the site of infection.
- Guided by chemical signals such as cytokines or bacterial products.

2. Recognition and Attachment:

- Phagocytes recognize PAMPs (Pathogen-Associated Molecular Patterns) on microbes using PRRs (Pattern Recognition Receptors) such as Toll-like receptors (TLRs).
- Opsonins (e.g., antibodies or complement proteins like C3b) can coat pathogens to enhance recognition.
- Opsonization increases phagocytic efficiency.

3. Engulfment (Ingestion):

- The phagocyte's membrane extends around the pathogen forming a **phagosome** (a membrane-bound vesicle containing the ingested particle).

4. Phagolysosome Formation:

- The **phagosome** fuses with a **lysosome**, forming a **phagolysosome**.
- Lysosomes contain digestive enzymes and reactive oxygen/nitrogen species.

5. Killing and Digestion:

- Inside the phagolysosome, the pathogen is killed and broken down.
- Mechanisms include:
  - **Oxygen-dependent killing**: Production of reactive oxygen species (ROS) like hydrogen peroxide, superoxide.

First Hope

FREE PREVIEW

Click here to visit our website

PHARMACY PREMIUM NOTES

Complete subject and semesters are available on FirstHope app only.

Scan or click here

Click here to get the app >

Available on Google Play

JOIN THE FIRSTHOPE COMMUNITY

Join our Telegram channel

Click here to join Telegram >

Scan or click here

@FirstHopeNotes

Instagram

@firsthope.official

Click here to follow >

YouTube channel

FirstHope-Pharmacy / Live streams

Click here to watch >

WhatsApp channel

Follow FirstHope on WhatsApp

Click here to join >

FirstHope website

firsthope.co.in

Click here to visit >

B.Pharm / D.Pharm / M.Pharm / Pharm.D

Preview notes. Complete subjects and semesters in the FirstHope app.