Introduction

The immune system is the system of specialized cells and organs that protect an organism from outside biological influences. It protects the body against:

- Bacterial and viral infections
- Cancer cells
- Foreign substances.

Host defenses include:

- Non-specific immunological responses.
- Specific immunological responses.

Non-Specific Immune Response (innate immunity)

- A. Skin and mucous membranes provide the first line of defense through:
  - Mechanical factors: barrier to penetration.
  - Chemical factors: gastric acidity, lysozyme.
  - Microbial factors: antagonism by normal flora.
- Phagocytic cells provide a secondary line of defense by consuming invaders and secreting substances that produce immune responses.
Specific Immune Response (adaptive immunity)

A) Humoral immunity: antibody-mediated defenses

- Antitoxins: specific antibodies that bind certain exotoxins.
- Bacteriolytic antibodies: antibodies plus complement can directly lyse Gram-negative cells.
- Opsonizing antibodies: coat cell surface and enhance phagocytosis (Fc receptors).

B) Cell-mediated immunity: CD-mediated immunity

- Cytotoxic T-lymphocytes: specific cells capable of destroying altered host cells.
- Killer and natural killer cells: Ye altered or transplanted host cells.
- Activated macrophages: for intracellular destruction of ingested microorganisms.

Phagocytosis

Mediated by macrophages and polymorphonuclear leukocytes

Stages of phagocytosis:
1. Chemotaxis
2. Adherence
3. Pseudopodium formation
4. Phagosome formation
5. Digestion of ingested microorganisms

Mediated by macrophages and polymorphonuclear leukocytes

Phagocytosis (Fc receptors):
- Opsonizing antibodies: coat cell surface and enhance destruction of ingested microorganisms.
- Bacteriolytic antibodies: antibodies plus complement can directly lyse Gram-negative cells.
- Exotoxins: specific antibodies that bind certain antigens.
1) Chemotaxis: the movement of phagocytic cells towards the foreign agent.

2) Adherence: antibodies directed against the capsule enable the phagocytic cells to ingest the organisms, using their Fc receptors. This coating of the organisms by molecules that speed up phagocytosis is termed 'opsonization'. Also, complement proteins C3b and C4b serve as opsonins. The coating of the organisms by molecules that speed up phagocytosis is termed 'opsonization'. The movement of phagocytic cells towards the organisms is termed 'chemotaxis'.

3) Pseudopodium formation: This is the protrusion of membranes to flow round the microorganism.

4) Phagosome formation: Fusion of the pseudopodium with a membrane enclosing the microorganism leads to the formation of the phagosome. The phagosome is a structure formed by the fusion of the pseudopodium with a membrane enclosing the microorganism. This is the protrusion of membranes to flow round the microorganism.

5) Killing: a- Oxygen dependent (reactive oxygen and nitrogen species) b- Oxygen independent (lysozyme and lactoferrin)
Immunity

a) Passive immunity:
acquired without the immune system being exposed to an antigen.
Done by transfer of already formed serum or gamma-globulins from an immune donor to a non-immune individual.

b) Active immunity:
The body makes its own immunity when stimulated by immunogenic agents.

Types:
1. Natural: After infection.

Passive immunity

Advantages:
- Provides rapid protection.
- Effective for only a short duration.

Disadvantages:
- Carry the risk of transmitting Hepatitis viruses and HIV.
- May result in pathological complications: serum sickness, direct for only a short duration.

Types:
1. Natural: Lymphoid tissues of immune system
2. Artificial: Injection (colloidal transfer of IgG), through placental transfer of IgG. 3. Passive: Through plasma transfer of IgG.

Lymphoid Tissues of Immune System

1) Primary: Responsible for maturation of immune cells.
   - Bone marrow: B-cell maturation.
   - Thymus gland: T-cell maturation.

2) Secondary: Sites for antigen contact and response.
   - Lymph nodes:
   - Lymph glands:

Active Immunity

The body makes its own immunity when stimulated by immunogenic agents.

Types:
- p) Acute immunity:
- 1) Non-immune individual: Gamma-globulins from an immune donor to a non-immune individual.
- 2) Acute: Exposed to an antigen.
- 3) Passive immunity: acquires without the immune system being exposed to an antigen.
Cells involved in the immune responses

1) B lymphocytes
- Functions
  - Differentiation into Ab-producing plasma cells
  - Antigen presentation within Class I MHC
  - Direct antigen recognition
  - Memory

2) T lymphocytes
- Functions
  - Constitute the "cellular" arm of adaptive/specific immunity
  - Recognizes and differentiates antigen presented within Class II MHC
  - Regulates the activities of other cells
  - Includes the "helper" T-cell subset which promotes differentiation of B-cells and cytotoxic T-cells
  - Cytotoxic T-cells (Tc): Recognizes and differentiates antigen presented within Class I MHC, kills cells expressing appropriate antigen
  - Memory T-cells: Persist in the blood stream to protect against future infection

Other cells:
- Macrophages
- Dendritic cells
- Natural killer (NK) cells

Autoimmune: Involves the cellular arm of adaptive/specific immunity.
3- Macrophages and dendritic cells:
- Enhances phagocytosis.
- Antigen presentation within Class II MHC.
- Secrete IL-1: T-cell differentiation and proliferation.

4- Killer cells:
- Direct cell lysis.
- Natural Killer (NK) cells:
  - Kills variety of target cells (e.g., tumor cells or virus-infected cells).
- Killer (K) cells:
  - Bind Fc portion of immunoglobulin. Kills immune cells or virus-infected cells (ADCC).

5- Mast cells:
- Initiate some allergic responses by release of histamine.
Differences between B-cell and T-cell

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<thead>
<tr>
<th></th>
<th>B-cell</th>
<th>T-cell</th>
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<tbody>
<tr>
<td><strong>Humoral immune response</strong></td>
<td>Produces antibodies</td>
<td>Secretes lymphokines</td>
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<tr>
<td><strong>Cell mediated immune response</strong></td>
<td>Produced in bone marrow</td>
<td>Developed in bone marrow</td>
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<td><strong>Produced in bone marrow</strong></td>
<td>Produced in bone marrow</td>
<td>Produced in bone marrow</td>
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<tr>
<td><strong>Secondary lymphoid organs</strong></td>
<td>Splenic white pulp</td>
<td>Thymus</td>
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<tr>
<td><strong>Location in lymph node</strong></td>
<td>Location in superficial cortex of lymph node</td>
<td>Location in deep cortex of lymph node</td>
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<td><strong>Developed in the thymus</strong></td>
<td>Developed in bone marrow</td>
<td>Developed in bone marrow</td>
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<tr>
<td><strong>Location in spleen</strong></td>
<td>Location in spleen (++)</td>
<td>Location in spleen (++)</td>
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<tr>
<td><strong>Location in thoracic duct</strong></td>
<td>Location in thoracic duct (+)</td>
<td>Location in thoracic duct (+++)</td>
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