

Serology Lec.1 Introduction

Innate and Acquired Immunity

Immune (Lymphatic) System

- Consists of a complex network of specialized cells and organs that defend the body against invaders such as bacteria and viruses.
- Immune System can be broadly divided into: Innate immune system (Born with it) and Adaptive Immune system (Acquired during life).
- Components of Immune System: consists of a number of organs and several different cell types. Cells are originated from precursor cells in the bone marrow. The lymphoid lineage produces T lymphocytes and B lymphocytes and Natural killer (NK) cells. The myeloid pathway gives rise to mononuclear phagocytes, monocytes and macrophages, and granulocytes, basophils, eosinophils and neutrophils, as well as platelets and mast cells.

Lymphocytes –2 major types:

1) B cells-differentiate in the bone marrow of mammals (or the cloacal bursa of birds), give rise to plasma cells that secrete antibodies into the extracellular fluid, which bind to antigens. This antibody/antigen complex is more easily recognized by phagocytes.

2) T Cells-differentiate in the thymus, 70-80% of blood lymphocytes; 3 subtypes:

T helper cells (CD4+)-act through secretion of soluble short-range effector molecules, called cytokines that will stimulate B cells and macrophages

T cytotoxic cells (CD8+)-attach directly to target cells to kill them

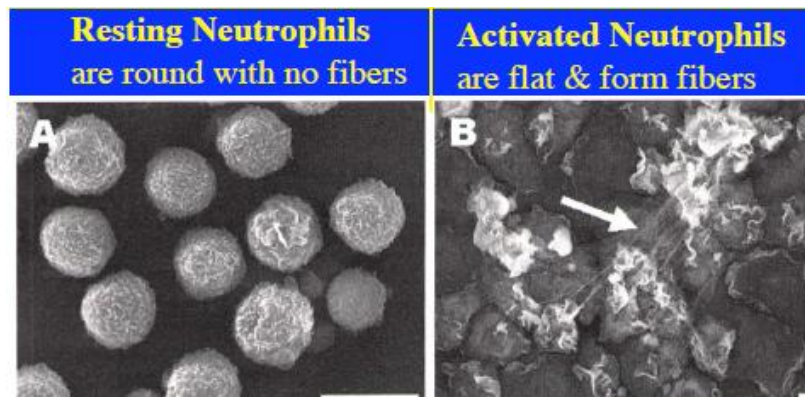
3) Natural Killer Cells-lacks antigen specific receptors that are typical of B and T cells, play an important role in:

innate immunity; mechanism similar to T cytotoxic cells,

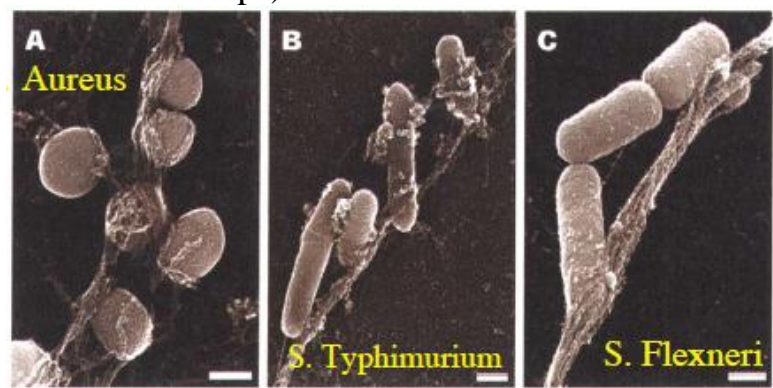
important in elimination of tumors and virus-infected cells

Phagocytes - provide innate cellular immunity in tissues and initiate host-defense responses (they provide the first line of defense against MO).


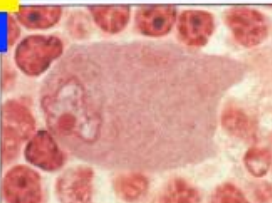



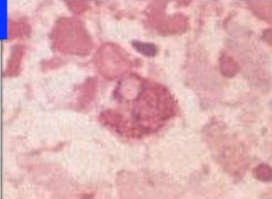
Three types:



Neutrophils generate extracellular fibers called NETs (neutrophil extracellular traps) that kill bacteria without need for phagocytosis.



Gram positive and negative bacteria associate with neutrophil fiber-NETs appear to be a form of innate response that binds micro-organisms, preventing them from spreading and have bactericidal activity.

Cell Type		Activated function
Macrophage 		Phagocytosis and activation of bactericidal mechanisms Antigen presentation
Dendritic cell 		Antigen uptake in peripheral sites Antigen presentation in lymph nodes
Mast Cell 		Release of granules containing histamine and other active agents

Organs/tissues of the Immune System: Specialized organs and collections of tissue where lymphocytes interact with non-lymphoid cells,

which are important either to their maturation or to the initiation of adaptive immune responses.

Lymphatic (Immune) tissues are characterized by having numerous lymphocytes and significant numbers of reticular fibers. They are classified as follows:

a. Primary (Central) Immune Organs--where stem cells develop and differentiate into mature B-cells and T-cells:

1) Bone Marrow—B-cells mature in the bone marrow (cloacal bursa in birds)

2) Thymus—a large organ in the cranial chest in which T-cells mature

b. Secondary (Peripheral) Immune Organs—these organs trap cells or pathogens arriving from sites of infection and antigen is presented to lymphocytes to stimulate adaptive immune responses.

1) Lymph Node—situated along the extensive drainage system of lymph vessels, they serve to filter the lymph fluid before returning it to the bloodstream (B cells found in follicles, T-cells located in paracortical areas). Lymph nodes provide an environment in which lymphocytes are able to respond to lymph-borne antigens.

2) Spleen—serves as a filter for the blood, it is involved in clearance and mounting of immune responses against blood-borne antigens

3) Immune tissue associated with various organs:

GALT—gut-associated lymphatic tissue; comprised of lymphoid tissue (lymph nodules) in the intestinal wall containing lymphocytes, plasma cells and macrophages.

MALT—mucosa-associated lymphatic tissue; lymphoid tissue associated with the mucosa of the female reproductive tract, respiratory tract, etc.

SALT—skin-associated lymphatic tissue; lymphatic tissue associated with the dermis of the skin.

Nonspecific Defenses

- The body has a variety of **nonspecific defenses** that help protect the body from infection.

- Barriers to entry

- The inflammatory response

- Natural killer cells

The Inflammatory Response

- Any damage to the body's tissues trigger events of the **inflammatory response**.

- Reddening, An increase in temperature, Swelling, Pain

The Complement System

- The **complement system** consists of a variety of blood plasma proteins.

- When activated by the presence of pathogens, these proteins amplify the immune response.
- Complement proteins also form a membrane attack complex that contributes to the lysis of pathogens.

Features of Adaptive Immunity

- ✓ **Specificity**
Lymphocytes (B and T cells) bind and respond to foreign molecules (antigens) via antigen receptors: each to a specific antigen
- ✓ **Diversity**
The body possesses millions of lymphocytes that can recognize and respond to millions of antigens (one each)
- ✓ **Memory**
1st exposure to an antigen generates lymphocytes & long-lived memory cells – next exposure to the same antigen, memory cells react more quickly & stronger response (‘acquired immunity’)
- ✓ **Self-Tolerance**
Lymphocytes can distinguish ‘self’ (our normal antigens) from ‘nonself’ (antigens from foreign material).

Innate immunity	Acquired immunity
Broad specificity No change with repeat exposure Mechanical barriers Bactericidal substances Natural flora	Specific Memory
Humoral Acute-phase proteins Interferons Lysozyme Complement	Antibody
Cell-mediated Natural killer cells Phagocytes	T lymphocytes

B Cells and the Antibody Response

- The **B-cell receptor (BCR)** on the surface of B cells allows for the recognition of and binding to specific antigens.

- The binding of the BCR to an antigen activates the B cell.
- Activated B cells undergo cell division to produce two special types of B cells.
 - Plasma B cells
 - Memory B cells
- Plasma cells are responsible for the mass production of antibodies for the antigen.
- The antibodies are released into the bloodstream to help the body identify the antigen within the body.
- Memory B cells are retained within the body for an extended period of time.
- The memory B cells allow the body to mount an immune response more quickly if the antigen is perceived again.

T Cells and the Cellular Response

- The mature T cells that leave the thymus gland have unique T-cell receptors (TCR).
- These receptors only recognize an antigen when an antigen presenting cell (APC) of a macrophage presents the antigen to the TCR.
- The presentation of the antigen by the APC activates the T cell.
- An activated T cell undergoes cell division to produce two types of T cells.
 - Cytotoxic T cells
 - Helper T cells
- Cytotoxic T cells release a protein called perforin to create a pore in the surface of infected cells.
- Cytotoxic T cells also release granzymes that then trigger the infected cell to undergo apoptosis (self-destruct).
- Cytotoxic T cells are responsible for the response to virus-infected and cancerous cells.
- Helper T cells contribute to immunity by secreting cytokines.
- Cytokines are chemicals that stimulate the immunocells, particularly the B cells.

Antigenic Determinants or Epitopes: is the smallest part of an antigen that is "seen" by somatically generated B and T cell receptors.

Immunogenicity is determined, in part, by four properties of the immunogen:

1. Foreignness:
2. Molecular size:
3. Chemical composition and heterogeneity
4. Susceptibility to antigen processing and presentation

5 major classes of secreted antibody

