

TYPES AND GRADES OF IMMUNITY

Adaptive or acquired or specific immunity

INTRODUCTION- ADAPTIVE IMMUNITY

- Adaptive immunity is specific for different microbial and non-microbial antigens and increased by repeated exposures to antigen.
- Adaptive immunity when mediated by B-lymphocytes is called *humoral immunity* and when mediated by T lymphocytes is called *cell mediated immunity*.
- The T lymphocytes circulate throughout the body, passing continuously from vascular to lymphoid circulation and through the lymphoid organs and tissues. B-lymphocytes do not re-circulate and mainly concentrated in spleen and lymphoid organs.
- In contrast to innate immunity, when immunity develops as a response to infection and adapts to the infection, it is called *adaptive immunity*.
- Adaptive immunity has an extraordinary capacity to distinguish among different closely related microorganisms or molecules and hence it is called *specific immunity* and provides defense activity with higher magnitude.
- *Cardinal signs of immunity* are *specificity, diversity, memory and recognition of self and non-self*. Innate immunity is phylogenetically the oldest system of host defense and adaptive immune system evolved later.

FEATURES OF INNATE AND ADAPTIVE IMMUNITY

Characteristics	Innate immunity	Adaptive immunity
Specificity	Common structures shared by groups of related microbes and vital for survival of organisms.	Recognize particular antigen and develop specific immune response.
Diversity	Limited and germ line encoded	Very large: large variety of receptors is produced by somatic recombination of gene segments to recognize antigens.
Memory	No	Yes

Non reactivity to self	Yes	Yes
------------------------	-----	-----

TYPES OF ADAPTIVE IMMUNE RESPONSE

- There are two types of adaptive immune responses:
 - **Humoral immunity:** Produced by B-lymphocytes and mediated by the production of antibodies, which neutralize the target microbes and eliminates from the body by several effector mechanisms.
 - **Cellular immunity:** Produced by T- lymphocytes and mediated by production of effector cytokines which activate macrophages to kill microbes residing in phagocytes and cytotoxic T cells kill the infected cell to eliminate infection.
- Adaptive immunity can be acquired by two ways
 - Active immunity
 - Passive immunity.
- **Active immunity:** When the host's body in response to foreign antigen produces antibody, the immunity develops slowly and persists for a long time. Active immunity may be
 - **Natural:** When produced due to natural infection by infectious organisms.
 - **Artificial:** This is produced by the host's body in response to inoculation of an antigen e.g., vaccination
- **Passive immunity :** The antibody is prepared elsewhere and subsequently introduced into host's body. The immunity is rapidly established but persists for short duration. Passive immunity may be of two types
 - **Natural**
 - Maternal antibody from mother to foetus (Trans placental transfer)
 - Colostrum antibody through milk from mother to neonates.
 - **Artificial**
 - By injection of immune serum in case of tetanus
 - Transfer of lymphocyte or immune cells.

CARDINAL FEATURES OF ADAPTIVE IMMUNE RESPONSES

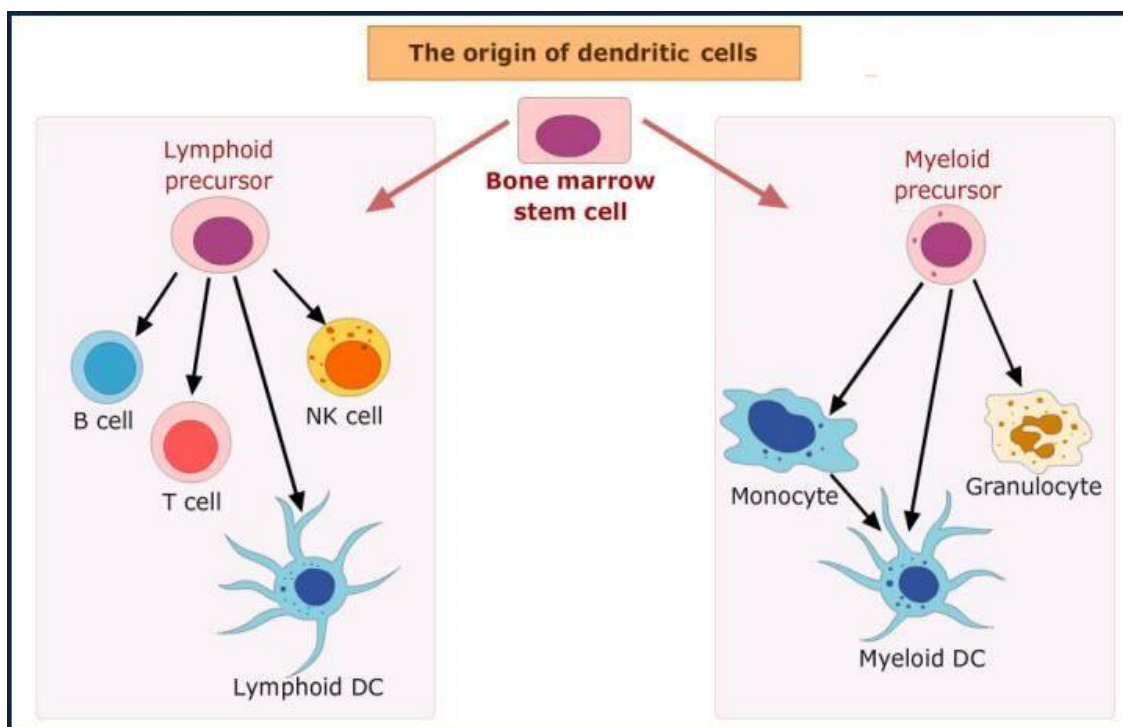
- Both humoral and cell mediated immune responses to antigens have a number of fundamental properties
 - Specificity
 - Diversity
 - Memory
 - Specialization
 - Self limitation
 - Non reactivity to self
- **Specificity**
 - Specific immune response is highly specific for distinct antigens or even different parts of a single antigenic complex (protein, polysaccharide or other macromolecules).
 - Antigenic specificity is determined by epitopes,

which are some specific areas or chemical groupings on the surface of antigen molecules. Epitopes are also called antigenic determinants.

- **Diversity**
 - The total number of antigenic specificities of the lymphocytes in an individual is called lymphocyte repertoire, which is extremely large.
 - Immune system can discriminate at least 10^7 to 10^9 distinct antigenic determinants because of variability in the structure of the antigen binding sites of lymphocyte receptors for antigens. This property of the lymphocyte repertoire is called diversity.
- **Memory**
 - Memory is the capacity of the sensitized lymphocytes to respond more efficiently to the subsequent exposure to the antigen.
 - Memory cells produce secondary immune response. Plasma cells and B-lymphocytes are short lived and die because of apoptosis. But some B-lymphocytes become long-lived memory cells. On exposure to antigen, they proliferate and differentiate into plasma cells without undergoing further maturation.
 - The second type of memory cells consists of large dividing IgM producing cells. These cells exist in the germinal centers where presences of IL-2 and antigen or follicular dendritic cells are required for the survival of memory cells.
 - When a second dose of antigen is given the sensitized (previously exposed) memory cells respond promptly, the lag period is shorter and more antibody is produced (secondary immune response). IgG is produced more than IgM where as in *primary immune* response IgM is produced more than IgG.
 - Similarly, memory T cells are better able to home to the sites of infection than the naïve T cells.
- **Specialization**
 - It is the capacity of immune system to respond in distinct and special ways to different microbes. Thus, maximizing the anti-microbial defense mechanisms.
- **Self-limitation**
 - All normal immune responses wane with time after antigen stimulation and immune system return to its resting basal state in a process called homeostasis.
 - Immune response eliminate antigen, which provide stimulus for lymphocyte activation.
 - The activated lymphocyte also may die or differentiate into functionally quiescent memory cells.
- **Non-reactivity to self**
 - The specific immune system discriminates between 'self' and 'non-self' (foreign) and responds to only foreign materials to the host, which is antigenic.
 - Abnormalities in the induction of immune response against self -antigen (autogenous antigen) results in disorder called autoimmune disorder.

CELLULAR COMPONENTS OF ADAPTIVE IMMUNE SYSTEM

- The principal cells of the immune systems are lymphocytes, antigen presenting cells (APCs) and effector cells.
Lymphocytes specially recognize foreign antigen and respond in two different ways
 - Humoral immunity
 - Cell mediated immunity
- B lymphocytes when recognize antigens (extra cellular), they are differentiated in to antibody secreting cells and function as the mediators of humoral immunity.
- T- lymphocytes recognize, intracellular antigen and destroy the microbes or infected cells. They do not produce antibody. T lymphocytes do not respond to soluble antigens but they recognize peptide antigen attached to host proteins and produce different lymphokines to eliminate the antigen.
- The third class of lymphocytes, natural killer (NK) cell is also involved in innate immunity to remove intracellular organisms.
- For specific immune response, the antigen must be captured and presented to specific lymphocytes. The cells, which perform this function, are called **antigen-presenting cells (APCs)**. They are mostly **dendritic cells**.



- Effector cells perform numerous functions to eliminate the antigen. Activated T lymphocytes, mononuclear phagocytes and other leukocytes function as effector cells in different immune responses.

COMPONENTS OF IMMUNE RESPONSE

- Recognition of antigen
- Processing
- Production of antibody or cytokines
- Antigen – antibody reaction or CMI response
- Elimination of antigen or succumb to infection

DIFFERENCE BETWEEN HUMORAL AND CELL MEDIATED IMMUNITY

Characteristics	Humoral immunity	Cell mediated immunity
Antigen	Extra cellular antigen	Intracellular antigen
Responding lymphocytes	B-lymphocytes	T-lymphocytes
Effector function	Antibody mediated elimination	Lymphokines mediated elimination or lysis of infected cells
		or antigen
Passive transfer	Through serum	Through T-cells