CELLS OF SPECIFIC IMMUNE SYSTEM

LYMPHOCYTES

- Lymphocytes are the cells that recognize foreign antigen and mount immune response.
- Lymphocytes are small round cells (7-15µm in diameter) found in blood and in lymphoid organs suchas lymph nodes, thymus, spleen etc.
- Each lymphocyte contains a large round nucleus that stain intensely with dyes such as hematoxylin.
- They possess a thin rim of cytoplasm containing some mitochondria, free ribosomes and a small Golgiapparatus.
- Lymphocytes originate from bone marrow stem cells unlike other blood cells but they mature and differentiate into B and T cells in lymphoid organs.
- Lymphocytes are the most mobile cells in the body and travel a long distance from blood to tissues, tissues to lymphatic ducts and again into circulation.

B - LYMPHOCYTES

- B-lymphocytes originate from multipotent stem cells of bone marrow but maturation occurs in foetal liver before birth and in the bone marrow or payer's patches after birth in mammals where as in birds maturation takes place in bursa.
- The principal events during the maturation are rearrangements and expression of Ig (immunoglobulin) genes.
- The mature B cells are not antibody secreting cells but they can differentiate upon antigenic stimulation into antibody secreting plasma cells.
- Plasma cells are large cells (twice the size of a small lymphocytes) with eccentric nucleus and large cytoplasm containing more endoplasmic reticulum; they do not divide and have short life of 2-3 days.
- They are capable of secreting 300 molecules of immunoglobulin per second. Some B cells that do not develop into plasma cells become memory cells. Some of memory cells can survive more than 20 years in absence of antigen. Upon antigenic stimulation they become plasma cells and secrete antibody.

Surface molecules of B-lymphocytes and cluster of differentiation

- Very large numbers of B cell surface molecules have been characterized and it was found difficult todevise a rational nomenclature.
- Functionally distinct classes of lymphocytes express distinct types of cell surface proteins and thesehave been probed using monoclonal antibodies.
- The cell surface molecules recognized by monoclonal antibodies are called antigen (because antibodies can be raised against them) or markers and they identify or discriminate ('mark') between different cellpopulations.
- These markers can be grouped into several categories; some specifies for cells of a particular lineage ormaturational pathway or developed during activation and differentiation.
- Biochemical analyses of cell surface proteins recognized by monoclonal antibodies have been given auniform nomenclature.
- According to this system a surface marker that identifies a particular lineage or differentiation stage and that has a defined structure which is recognized by a group ('cluster') of monoclonal antibodies is called a member of a cluster of differentiation (CD). They have been given a CD designation e.g. CD_1, CD_2 etc.
- Newly recognized molecule is designated as 'workshop' candidates

CD_w and this is given to incompletely characterized molecules. Each CD molecule is characterized by certain function.

- B cell surface molecules which representing different receptors have been designated with different CDnumbers. More than 200 CD molecules have been defined so far.

Major B cell surface receptors

- B cells receptor (Ig molecules along with Igα and Igβ)
- Immunoglobulin receptors
- Complement receptors
- Cytokine receptors
- Histocompatibility MHC- ClassII molecules.
- CD19, CD 20, CD 21 ,CD40 etc.

T - LYMPHOCYTES

- Progenated T lymphocytes originate from bone marrow stem cells and attracted to thymus.
- They enter thymus at any time of embryonic or post- embryonic period.
- The microenvironment in thymus is essential for the maturation of T cells.
- T cells mature in thymus and hence the name (thymus derived).
- The immature T cells are initially found in the cortex, migrate to medulla and differentiate to mature Tcells.
- The mature T cells express its characteristic cell membrane glycoproteins.
- T cells have subpopulations and they express T cell receptors but can be differentiated by the presence or absence of two-membrane molecule i.e.CD4 and CD8.
- Helper T cells have CD4 and T cytotoxic / suppressor cells have CD8 molecules.
- The developing T cells within thymus are called thymocytes.
- They initially populate, proliferate and undergo rearrangements of TCR (T cell receptor) genes. There is surface expression of CD3, TCR, CD4 and CD 8 molecules in the cortex. After maturation they migrate to medulla.

Some of the surface molecules

- T cell receptors (α/β and γ/δ) along with CD3 complex.
- *CD 2:* Receptor of CD 58
- *CD 4:* Molecule on the surface of T helper cells
- *CD 8:* Molecule on the surface of T cytotoxic cells
- *CD 71:* Receptor for transferring (transport receptor).
- *CD 35:* complement receptor
- *CD 25:* Interleukin –2 receptor for T cell growth
- Adherence molecules (integrin family, selectin family etc.).

T CELL SUBSETS

- Several different subsets of T cells have been described, each with a distinct function.
- *Helper T cells* are the "middlemen" of the adaptive immune system which are $CD4^+$ T cells. The activated cells divide rapidly and secrete cytokines, which regulate or "help" in immune response.There are different subsets of Th cells:
    - Th1: Th1 cells secrete cytokines which help in the induction of the cell mediated immuneresponse.
    - Th2: Th2 cells secrete cytokines which help in the production of humoral immune response.
    - Th17: This subset of T helper cells are associated with inflammation in several autoimmuneand inflammatory diseases.
- *Cytotoxic T cells (T_c cells)* destroy virally infected cells and tumor cells,

and are also implicated intransplant rejection. These cells are $CD8^+$.

- *γ/δ T cells* constitute 5%-15% blood lymphocytes in human and mice but about 60% in young ruminants in the blood circulation. Many γ/δ T cells have nonpolymorphic TCRs that recognize microbial glycolipids presented by CD1 positive antigen-presenting cells and release cytokines and lyse target cells.
- *Memory T cells* are a subset of antigen-specific T cells that persist long-term after an infection has resolved. They quickly expand to large numbers of effector T cells on subsequent exposure to the sameantigen. Memory cells may either be $CD4^+$ or $CD8^+$.
- *Regulatory T cells* play a master role in regulating the immune system and maintaining the balancebetween peripheral tolerance and immunity.
- *Natural Killer T cells* (NK T cells) are a special kind of lymphocyte that bridges the adaptive immune system with the innate immune system. Unlike conventional T cells, NK T cells recognize glycolipid antigens presented by molecule called CD1s. Once activated, these cells can perform functions of both T_H and T_C cells (i.e. cytokine production and release of cytolytic/cell killing molecules).

DIFFERENCE BETWEEN B AND T CELLS

	Features	B cells	T cells
1.	Origin	Bone marrow	Bone marrow
2.	Mature with	Bursa , Bone marrow, Payer's patches	Thymus
3.	Distribution	Lymph node cortex, Splenic follicles	Lymph node -paracortex, Spleen -periarteriolar sheath
4.	Circulate	No	Yes
5.	Life span	Short (few days to few weeks)	Long (more than 1 year usually 6 months to 10 years)
6.	Surface immunoglobulin	Present (IgM, IgD, IgG)	Absent
7.	Immunity type	Humoral	Cell mediated
8.	Secreted products	Immunoglobulins	Cytokines
9.	Response to mitogens	Pokeweed, Lipopolysaccharides	Phytohaemagglutinin (PHA), Cconcavalin-A, BCG Vaccine, Pokeweed
10.	EAC Rosette formation	Yes [B cell bind to sheep RBC coated with antibody and complement due to (C3 receptor or CR2 on B cell surface)].	No
11.	E or SRBC rosette formation	No	Yes (T cell bind to sheep RBC due to CD2 antigen on T cell surface]

12.	Production pathway	Short	Long
13.	Antigen uptake	Can take up unprocessed antigen	Only processed antigen
14.	Diversity	No diversity in function	Diverse in function
15.	No. of subsets	No subset or very few	Subsets present