



## **Origin of cells of immune system**

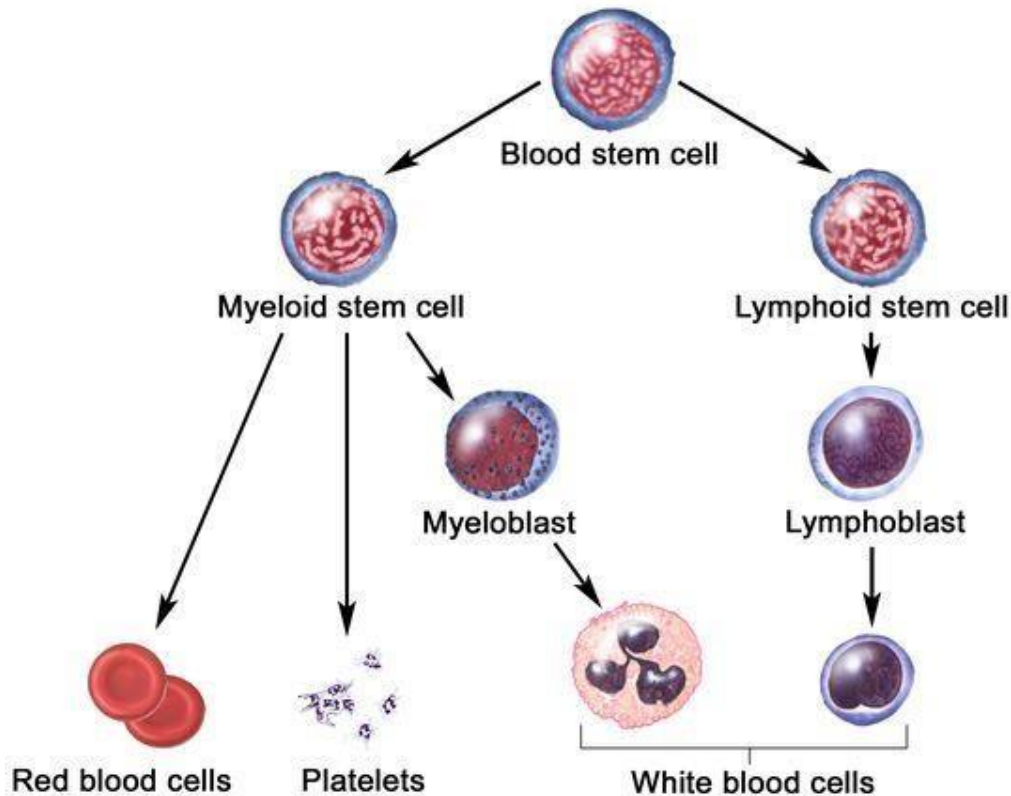
All components of the blood, including immune cells are originated from hematopoietic stem cells these cells are highly differentiated into progenitor cells to give different cells. The formation and development of hematopoietic stem cells begins in the early embryonic stages, lately these cells migration to liver, spleen, and differentiated in bone marrow in one of two pathways.

### **1- Myeloid progenitor cells can differentiate into:**

- a. Megakaryocytes, which are differentiated into platelets.
- b. Erythroblasts, which are multiply and differentiated into RBCs.
- c. Myeloblasts, which can differentiate into neutrophils, eosinophil, and basophil.
- d. Monoblasts, which can differentiate into monocyte and dendritic cells.

### **2- Lymphoid progenitor can be differentiating into:**

- T-lymphocytes, which are responsible for the cellular immune response.
- B-lymphocytes, which produce antibodies (humoral immune response).
- Natural killer cells (NKs).



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## Lymphoid system:

Some stem cells migrate to primary lymphoid organs which include the Thymus and Bone marrow to continue to proliferate and differentiate them.

- Thymus is the smallest gland situated in front of the heart and behind the sternum, it receives progenitor cells that leave the bone marrow for proliferation, differentiation, and form differentiated cells known as thymus-derived T cells.
- Bone marrow is the source of progenitor cells; it also plays a role in differentiating progenitor cells into B-lymphocytes.
- Mature T and B lymphocytes leave their differentiated site and migrate to peripheral or secondary lymphoid organs which include:



- 1- Lymph nodes: its act like lymphoid filters in the lymphatic system.
- 2- Spleen: its act like a lymphatic filter with in the blood vascular tree.
- 3- Mucosa-associated lymphoid tissue (MALT): is a collection cells in sub-mucosal of different tissue.
- 4- Gut-associated lymphoid tissues (GALT) which is lining the intestinal tract includes lymphoid tissue in the intestines (payer's patches), bronchus associated lymphoid tissue (BALT) lining the respiratory tract, and lymphoid tissue lining the genitourinary tract.
- 5- Tonsils: are nodular aggregates of lymphoid tissues, their function is to detect and respond to pathogens aero digestive tract.

## **The Lymphocytes cells**

Lymphocytes are one of white blood cells classes; derived from stems cells and maturate either in the bone marrow or thymus; comprise 20-40% of all leukocytes, distributed into blood, lymph and lymphoid organs.

Typically, it is a small, round cell with diameter of 5-10 $\mu$ m, spherical nucleus, densely compacted nuclear chromatin and scanty cytoplasm, divide in three major types of lymphocyte, **B lymphocyte, T lymphocyte and NK cells.**

Different lymphocytes are identified by protein markers on their surface called

"cluster of differentiation" or "CD" system like CD45 which is found in all leukocytes the most commone CD is CD4 and CD8 .



### **1-T- Lymphocyte:**

➤ Naming and maturation:

"T-cell" is an abbreviation of "thymus dependent lymphocyte". It arises in the bone marrow as T-cell precursors, then migrate and pass through the thymus as prethymocytes to complete their maturation which includes rearrangements and coding of the variable part of the TCR (T Cell Receptor) by enzymes and hormones activity (e.g. thymulin, thymosin, and thymopoietin). It requires to react with many receptors include antigens receptors, Fc fragment of antibodies, RBCs receptors, and Virus receptor.

➤ Distribution: T cell accounts for 70-80% of lymphocytes in peripheral blood, 5-10% in bone marrow, 70-80% in lymph node and 30-40% in spleen.

➤ Surface markers (TCR): they are two kinds of TCR, TCR 1 and 2 with other markers/receptors present on their surface.

➤ Subsets of T Cells: There are two major types of T cells:

#### **A- Helper T cells (TH):**

➤ Are identified by the presence of CD4 marker.

-They recognize antigen when presented along with Class II MHC molecules.

➤ They are subdivided into the TH1 and TH2 subsets on the basis of the kinds of cytokines they produce. TH1 cells produce interleukin-2 (IL-2), interferon-gamma (IFN $\gamma$ ), and tumor necrosis factor-beta (TNF- $\beta$ ) while TH2 cells produce IL-4, IL-5, IL-6, IL-10 and TGF- $\beta$  Transforming growth factor beta. They promote differentiation of B-cells and cytotoxic T-cells, activate macrophages, and secrete cytokines.



**B- Cytotoxic T cells (TC):**

- Are identified by the presence of CD8 marker.
- They recognize antigen when presented along with Class I MHC molecules.
- They have a role in down regulation of immune response, and Kill infected cells.

**2- B - Lymphocyte:**

- Naming and maturation:

They are called B cells they are developed and mature occurs in bone marrow. The early stages of B cell maturation occur in the fetal liver and continue in the bone marrow throughout life. The stages in B cell development in the bone marrow are: Stem cell → pro-B cell → pre-B cell → immature B cell → mature B cell.

- Distribution: They account for 5-15% of lymphocytes in circulation and 80-90% in bone marrow, 20-30% in lymph node and 50-60% in spleen.
- Surface markers: The most important surface markers on the surface of mature B cell are: CD32 (receptor of Immunoglobulin), CD35 (Receptor for complement component), and markers that distinguish B cells such as CD20, CD21 and CD22.
- Functions of B-cells:
  - Direct recognition and presentation of antigen.
  - Secrete large amounts of antibodies after differentiation into plasma cells.
  - It has memory can survive 20 years or more (Memory B cells). Subsets of B cells: There are two major types of B cells, T-independent cells and Tdependent cells.



**3- Natural Killer cells**

- Naming: Also called Large Granular Lymphocytes (LGLs), they are large lymphocyte which kill variety of target cells (such as tumor cells, bacteria / virus-infected cells, and transplanted cells) without participation of MHC molecules.
- Distribution: They account for 10-15% of blood lymphocytes. They are rare in lymphnodes and don't circulate through lymph.
- Surface markers: have CD16 (receptor of Immunoglobulin), CD8, CD56, also other receptors include IL-2R, CD2, ICAM-1 and LFA-1.
- Functions:
  - 1- Recognition of various target cells.
  - 2- Cytolysis of target substance and cytokines secretion as IFN- $\gamma$ .
  - 3- Kill antibody-coated target cells by antibody-dependent cell cytotoxicity (ADCC).
  - 4- Also participate in Graft in organs transplants as bone marrow.
  - 5- Enhanced of cytotoxic capacity after activated by IL-2.