Cells of the Immune system

Introduction

- WBCs are the principle cells of immune system formed from **Hematopoietic stem cell (HSC)** by the process of hematopoiesis. Hematopoiesis occurs in yolk sac during 1st week of gestation. After 3rd month of gestation, hematopoiesis occurs in liver and spleen of fetus and after birth, it occurs in bone marrow.
- **The cells of immune system are:**

1. **Lymphocytes**
2. **Phagocytic cells**
3. **Granulocytic cells**
4. **Dendritic cells**

The cells of immune system

1. Lymphocytes

- **T-lymphocytes**
- **B- lymphocytes**
- **NK cell**

2. Phagocytic cells

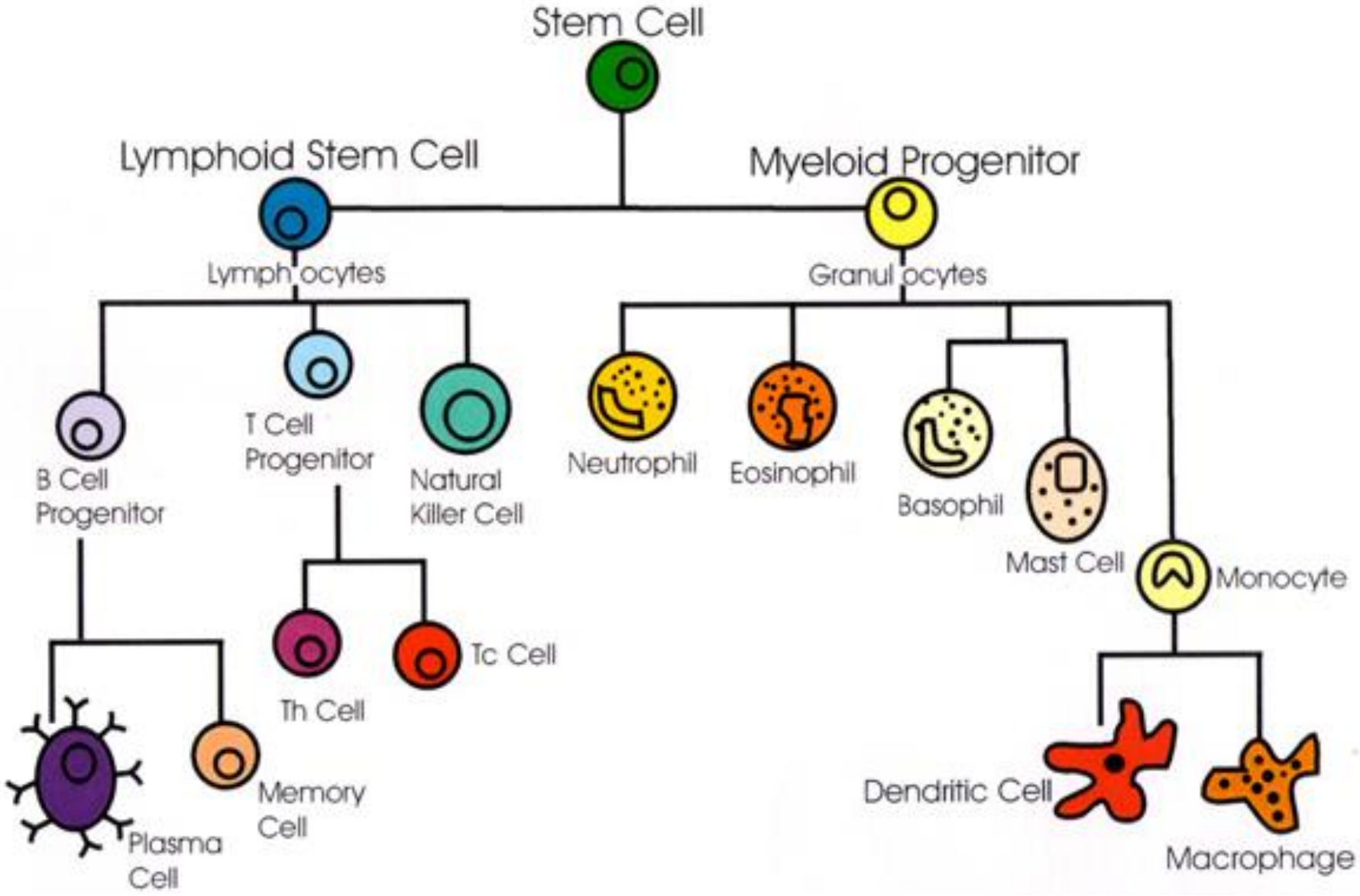
- **Monocytes**
- **Macrophages**

3. Granulocytic cells

- **Neutrophils**
- **Basophils**
- **Eosinophils**

4. Dendritic cells

Cells of the Immune System



Lymphocytes

- Lymphocytes are **small, round cells found in peripheral blood, lymph, lymph nodes, lymphoid organs and in tissues.**
- Lymphocytes represent 20-45% of total cells in peripheral blood and 99% of total cells in lymph and lymph node.
- Depending on life span lymphocytes are classified into short lived (2 weeks) and long lived (3 years or more or even lifelong).
- Broadly lymphocytes are divided into three sub-populations, **on the basis of function and cell membrane components.**
- **T-lymphocytes**
- **B- lymphocytes**
- **NK cell**

T-lymphocytes

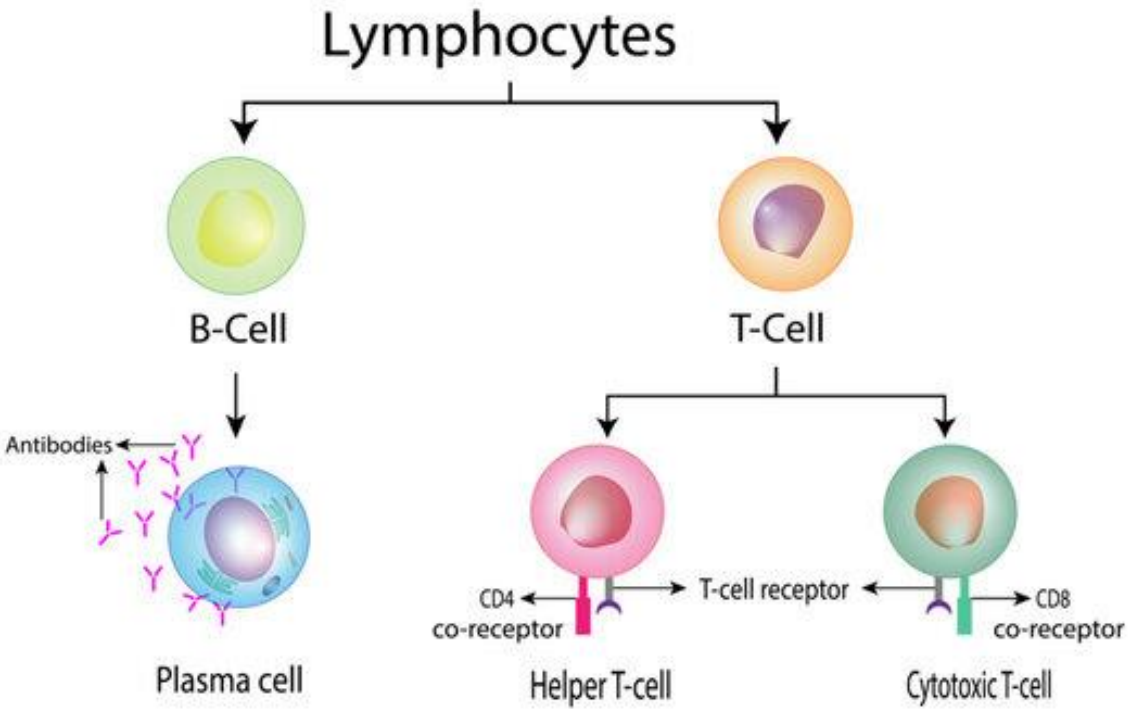
- T-cells **originate in bone marrow** and **mature and differentiate in thymus.** The name T- cells is derived from its **site of maturation**.
- All T-cells contains **T- cell receptor (TCR)** on its surface. TCR is **specific** and **recognize MHC bound antigen**.
- Most of the T-cells are distinguished on the basis of **CD4** and **CD8** glycoprotein receptor on their cell membrane.
- None of the T- cells contains both CD4 and CD8.

Functional sub-population of T-cells:

Helper T-cells (TH) or CD4+ T –cells- MHC-II restricted.

Cytotoxic T-cells (Tc) or CD8+ T –cells- They are MHC-I restricted.

Supressor cells (Ts-cells)- to suppress humoral and cell mediated immunity.



Natural Killer
(NK) cell

i. Helper T-cells (TH) or CD4+ T –cells:

- TH cells are activated by recognition of antigen on MHC-II on APCs. Ie. **MHC-II restricted.**
- When antigen binds on TCR of CD+ T –cells, it is activated and divides into memory cell and effector cells. Effector **TH cells secretes various cytokines which helps in B-cell activation for production of antibodies**.

ii. Cytotoxic T-cells (Tc) or CD8+ T –cells: Tc cells are activated by recognition of antigen on MHC-I on altered self cell such as tumor cell or virus infected cells.. i.e. **They are MHC-I restricted.**

- When antigen binds on TCR of CD8+ cells, it is activated and divides into clones of **memory cell** and **effectors cells**. Effector Tc cells is known as **cytotoxic T-lymphocytes (CTL)** which kills **virus infected cell or tumor cells**.

iii. Supressor cells (Ts-cells): Ts-cells **helps to suppress humoral and cell mediated immunity.**

B- Lymphocytes

- The name B-cell is derived from its site of maturation and differentiation in **Bursa of fabricius in Birds.** In adult human B- cell originates and mature in **Bone marrow.**
- Morphologically B- cells are indistinguishable from T-cells. B-cells are identified by their **surface protein ie**. **Immunoglobulin** or **antibody** which serves as receptor for antigen.

Immunological functions of B-cells:

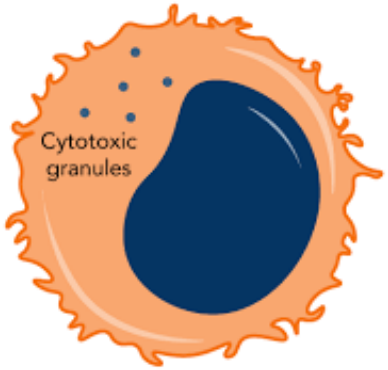
- **Antibody production** against specific target antigen
- Acts as **APC** and Present antigen to T-lymphocytes
- Provides **signal for T – cell activation**

Natural killer (NK) cell

- Natural Killer (NK) cells are **large granular lymphocytes (LGL)** present in small proportion in **spleen** and **peripheral blood**.
- Unlike T-cell and B-cell, NK cell **lacks specific antigen receptor**.
- **They are called as natural killer cell because they do not require activation in order to kill tumor cells or virus infected cells.**
- Although NK cells have no TCR or immunoglobulin in their cell membrane, they can recognize potential target cell by two ways:

i. NK :cell receptor mediated

ii. ADCC (antibody dependent cell mediated cytotoxicity



Natural Killer (NK) cell

Phagocytic cells

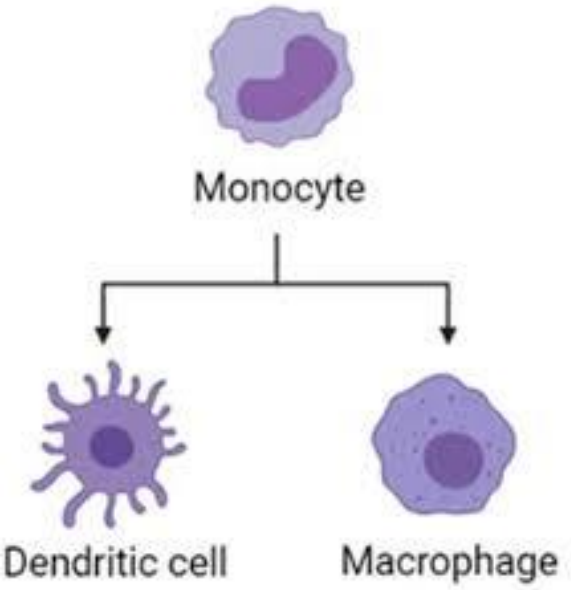
- **Monocytes** and **macrophages** are mononuclear phagocytic cells.
- **Granulocyte-monocyte progenitor cell** differentiates into promonocytes and neutrophil.
- Promonocytes leaves the bone marrow and enter into blood stream where they differentiate into mature monocytes.
- Monocytes circulates in blood for about 8 hours, during which they enlarges and then enter into tissues and **differentiates into specific macrophages and dendritic cells.**

1. Monocytes:

- Helps in antigen processing and presentation
- Releases cytokines
- Specialized function in tissues
- Cytotoxicity

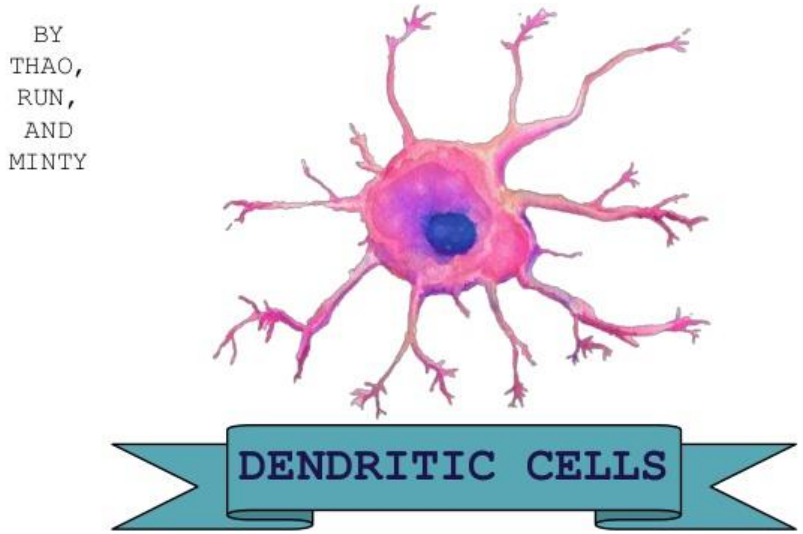
2. Macrophages

- **Monocyte migrates to tissue and differentiates into macrophages.**
- Differentiation of monocytes into macrophages involves **following changes:**
- Cell enlarges 5-10 folds
- Intracellular granules increases in number and complexity
- Increase phagocytic ability
- Produces higher level of hydrolytic enzymes and cytokines
- Macrophages serve different functions in different tissues.
- **Alveolar macrophages** : in lungs
- **Histiocyte:** connective tissue
- **Kuffer cell**: liver
- **Messangial cell:** kidney
- **Microglial cell:** brain
- **Osteoclast:** bone



3. Dendritic cells

- Dendritic cells have **long cytoplasmic extensions** that resembles to **dendrites of nerve cell.** They have highly pleomorphic with a small central body and many long needle like processes. Dendritic cells are **antigen presenting cell (APC)** because they possess MHC class.
- **Immunological functions:**
- Involved in antigen presentation to T-cells during primary immune response.



Granulocytic cells

Neutrophils

- Neutrophils are (11-14µm) in diameter with **multilobed nucleus** with granules in cytoplasm.
- It constitutes **50-70 % of total circulating WBC** and remains for **7-8 hours in blood and then migrates to tissues**
- Life span is 3-4 days.
- Also known as polymorphonuclear (PMN) leucocyte.
- Neutrophils is stained by both acidic and basic dye.

Immunological functions of Neutrophil:

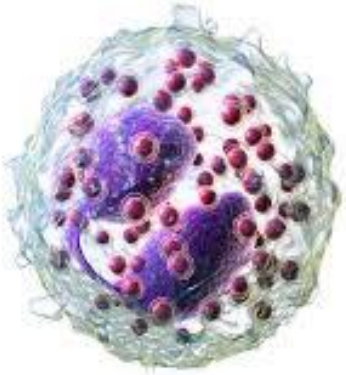
- Phagocytic role in acute inflammatory response.
- **It is the first immune cell to responds in inflammation.**

Eosinophils

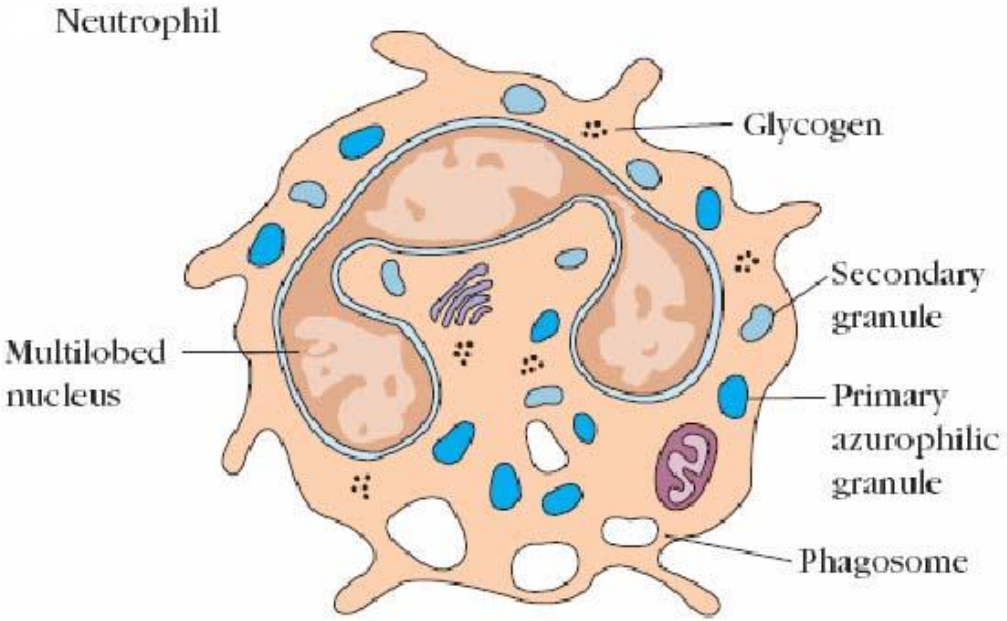
- Eosinophils are (11-15µm) in diameter, heavily granulated with **bilobed nucleus**
- It is stained by acidic dye ie **Eosin**
- They are phagocytic and motile

Immunological functions of Eosinophil:

- **Granules contain various hydrolytic enzymes** that kill parasites which are too large to be phagocytosed by neutrophils.
- Provide **allergic inflammation**



Eosinophil



Basophils

- Basophils are non-phagocytic cell found in small number in blood and tissue
- Cytoplasm contains large number of prominent **basophilic granules containing histamine, heparin, serotonin, and other hydrolytic enzymes**
- Stained by basic dyes

Immunological functions:

- Provide anaphylactic and atopic allergic reaction

Basophil