CELLS OF THE IMMUNE SYSTEM

Stem Cells

The cells which develop into the blood cells are called stem cells. They are undifferentiated embryonic cells. They have the ability to develop into any type of blood cells. So they are said to be pluripotent and totipotent. They are located in the bone marrow. However, in the early embryo they originate in the yolk sac. Later they migrate into the liver. In the adult they reach the bone marrow.

The stem cells develop in three lines, namely lymphoid lineage, myeloid lineage and erythroid lineage.

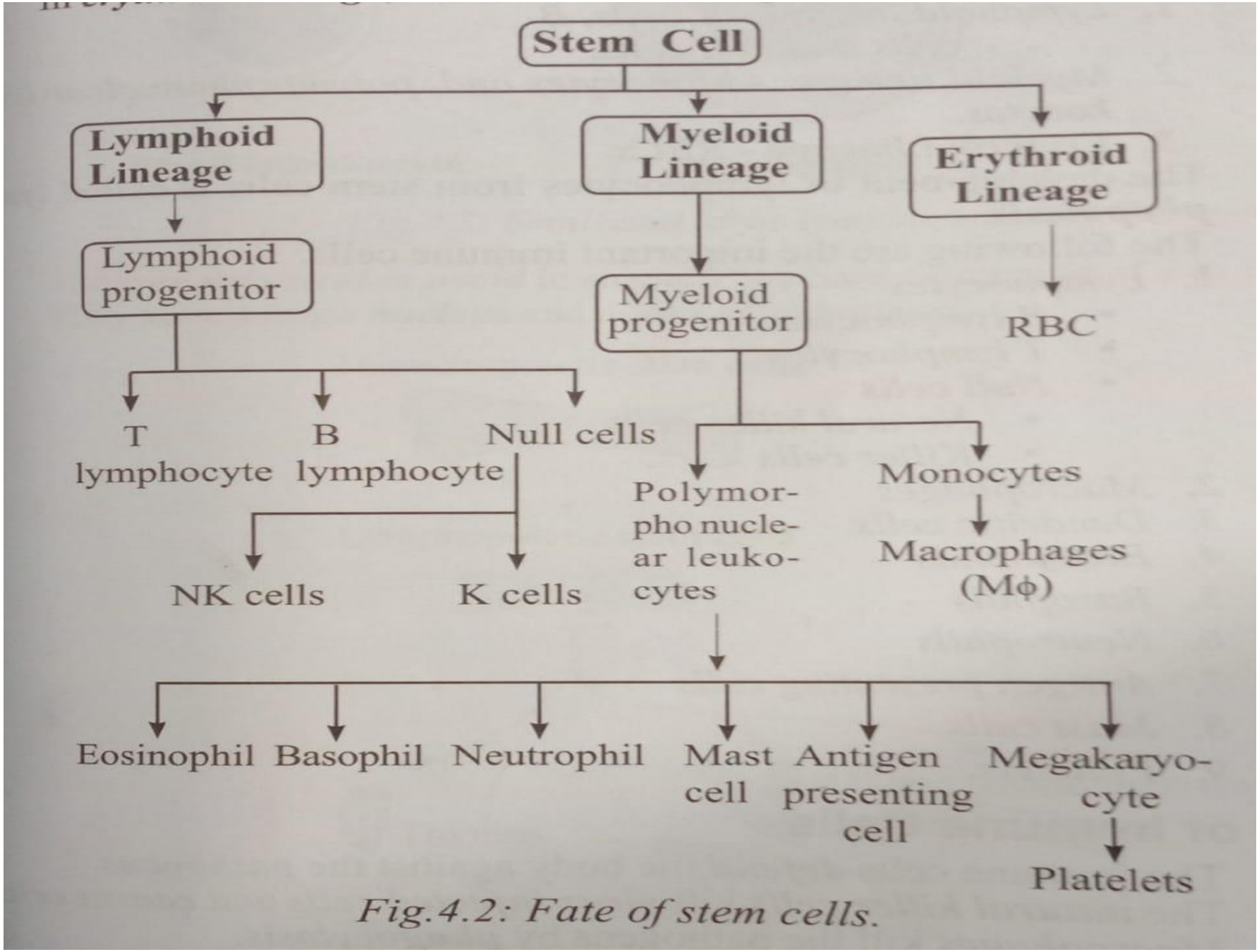

Fig.4.2: Fate of stem cells.

In lymphoid lineage the stem cells develop into lymphoid progenitor. The lymphoid progenitor cell develops into three groups of immune cells, namely T lymphocytes, B lymphocytes and null cells. The null cells are of two types, namely natural killer cells, and killer cells.

In myeloid lineage, the stem cell develops into the myeloid progenitor. The myeloid progenitor develops into two groups, namely monocytes and polymorphonuclear leucocytes. The monocytes differentiate into macrophages.

In erythroid lineage, the stem cell develops into RBCs.

The lymphocytres are of three types. They are

- ❖ B lymphocytes
- ❖ T lymphocytes
- ❖ null cells

The null cells constitute about 3%, the B cells about 27% and the T cells about 70% of the total lymphocytes.

The B lymphocytes mature in in bursa of Fabricius(in Aves) or in bone marrow (in mammals). The B lymphocytes produce antibodies and hence they are responsible for humoral immunity.

B Lymphocytes

The lymphocyte that matures in bursa of Fabricius or bone marrow and that brings about humoral immunity is called B lymphocytes. The B lymphocytes are bursa or bone marrow dependent cell.

The B lymphocytes are mononucleate nongranular leucocytes. They have a large nucleus and a rim of cytoplasm.

They are found in the blood and lymph. But they are highly concentrated in the lymph nodes and spleen. The B lymphocytes contain immunoglobulins on their surface. These are called surface immunoglobulins (SIg).

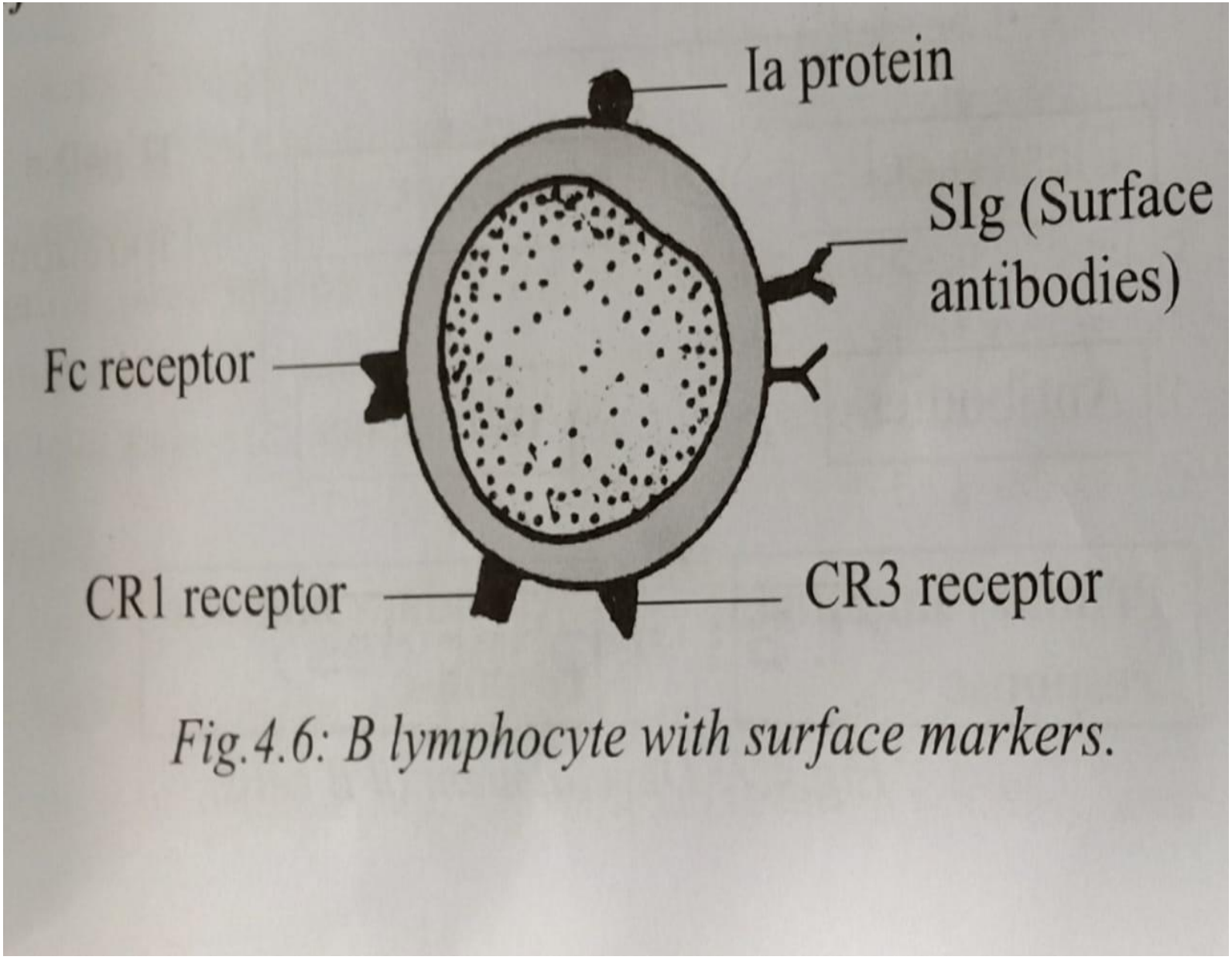

Fig.4.6: B lymphocyte with surface markers.

B Cell Surface Markers

The B cell usually has the following surface markers:

1. Ia protein which binds with the Ia receptor of the T lymphocytes.
2. Fc receptor to bind with the Fc fragment of the immunoglobulins.
3. CRI and CR3 receptors of complement system.
4. SIg – Immunoglobulin on the B cell surface which acts as a specific receptor for antigen.

Histochemical techniques reveal that the surface immunoglobulin is randomly distributed over the B cell surface.

B cells may also be divided into 5 subsets $B\mu, B\gamma, B\alpha, B\delta$ and $B\varepsilon$ depending on the production of specific immunoglobulins.

Plasma Cells

These are the end cells of the B lymphocytes. They secrete immunoglobulins.

Despite their name plasma cells, they are very rarely seen in the plasma of blood but are found mainly in the secondary lymphoid organs namely lymph node and spleen. Plasma cells do not divide and have a half life of about two to four days.

T Lymphocytes

The lymphocyte that matures in thymus and that brings about cell mediated immunity is called T lymphocyte.

The T lymphocyte are thymus dependent cells. They mature under the influence of thymic hormones.

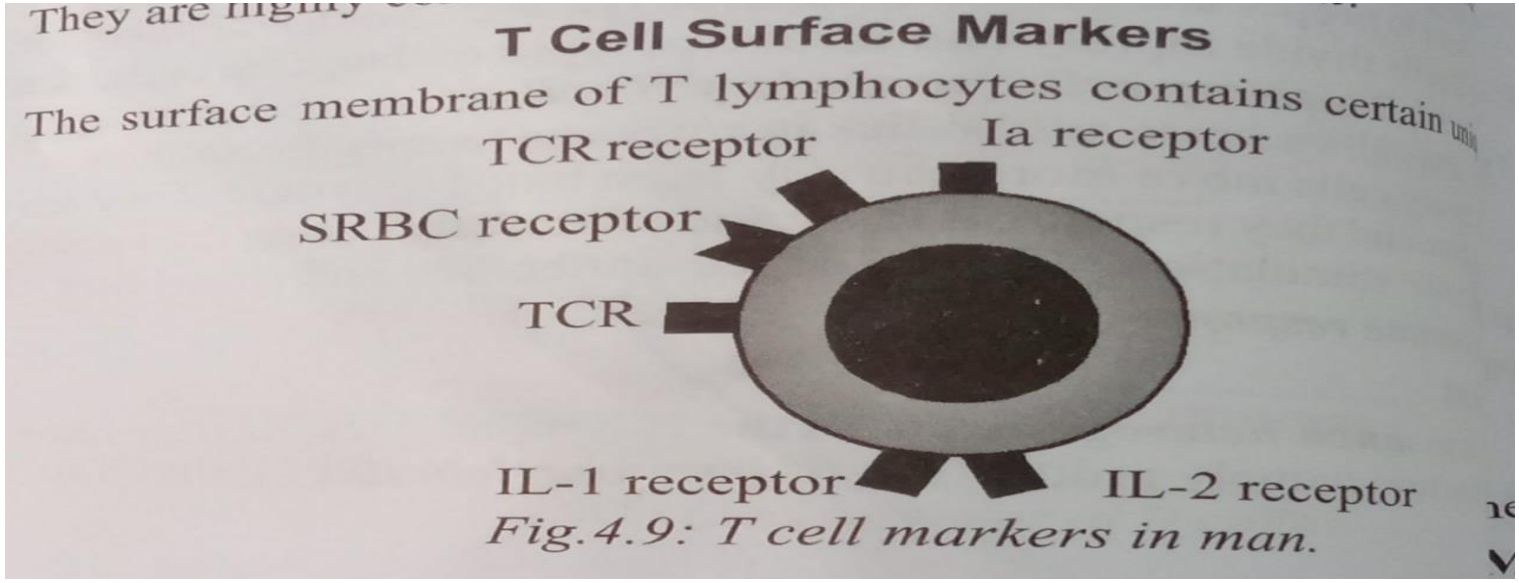

Fig.4.9: T cell markers in man.

The T lymphocytes have a large nucleus and a rim of cytoplasm.

They are highly concentrated in the blood and spleen.

The surface membrane of T lymphocytes contain certain unique group of proteins called T cell surface markers. The following are the T cell surface markers:

1. **Erythrocyte Receptor**

   It recognises the sheep erythrocytes (SRBC).

2. **T cell Receptor**

   It recognises MHC class I and II antigens.

3. The Ia Protein Receptor

It recognises the immune associated protein (Ia protein).

4. Inter Leukin Receptor (IL)

T cell contain IL – I and IL – II receptor recognises the interleukin I produced by the macrophages. IL – II receptor recognises the interleukin II produced by T helper cells (Th cells).

The T lymphocytes are derived from haemopoietic stem cells of bone marrow. Some of these cells turn into lymphpoietic progenitor. The lymphoid progenitor cellsturn into pre – T lymphocytes.

All the T cells are not similar. There are different types of T cells. They are the sub populations orsubsets of T cells. They are the following:

1. T helper cells (Th cells)
2. T suppressor cells (Ts cells)
3. T cytotoxic cells (Tc cells) or T killer cells (Tk cells)
4. T delayed type hypersensitivity cells (td cells)

Difference Between T and B Lymphocytes

1. B cells mature in the bursa of Fabricius or bone marrow. T cells mature in the thymus.
2. B cell bring about humoral immunity. T cells bring about cell mediated immunity.
3. B cell needs the cooperation of a T cell. But a T cell needs the cooperation of another T cell.
4. B cells produce antibodies. But T cells produce lymphokines.
5. B cells can effectively act on intercellular parasites. T cells can also act on intracellular parasites hidden inside cells.

Null Cells

Null cells are lymphocytes with cytotoxic properties. They are neither B cells nor T cell. They are intermediate between t and B cells. They form the third population cells (TPC). They form less than 3%.

There are two types of null cells, namely

- Natural killer cells
- Killer cells

Natural Killer Cells (NK Cells)

NK Cells are a group of null cells. They form the third population of lymphocytes.

The NK cells have 2 or 3 large granules in the cytoplasm. Hence they are also called large granular lymphocyte (LGL). They have a kidney shaped nucleus.

They destroy the cancer cells and cells infected with herpes and mumps virus. They do not need antibody for activity. They are activated by interferons and interleukin-2.

They recognise altered cell surface and bring about cytolysis and cytotoxicity.

Killer Cells (L cells)

Killer cells are a group of null cells They form the third population of lymphocytes. They are antibody dependent.

These cells posses Fc receptors for binding with IgG antibodies. Hence they can bind with cells coated with IgG antibodies and can kill them.

Macrophage

Macrphages are large, mononuclear phagocytic cells derived from monocytes.

The macrophages are of two types, namely resident macrophages and elicited macrophages. The resdient macrophages are stationary and immobile. The elicited macrophages are wandering cells.

The macrophages are named differently according to the tissues in which they live

I. **Kupffer cells**

These are macrophages of liver.

II. **Alveolar macrophages or Dust cells**

These are the macrophages of lungs.

III. **Peritoneal macrophages**

They live in the nervous system.

IV. Microglial cells

These cells live in the nervous system.

V. Giant cells

These are very large macrophages formed by the fusion of many macrophages. They are found in certain inflammatory processes.

The macrophages do the following functions:

a. Phagocytosis

b. Processing of Antigens

c. Processing of Antigens

d. Secretion

Eosinophils

These are acidophilic leucocytes and are called eosinophils because, eosin, an acid dye stains the granules of the cytoplasm of these cells intensely. The granules are rich in hydrolytic enzymes. The nucleus is usually bilobed or ellipsoid. They are about 2 – 5% of the leucocytes in healthy individuals.

Basophils

These cells are named so, because of their cytoplasm containing granules that stain with basic dyes. Basophils constitute about 0.4% of white cells. The basophilic granules are believed to contain heparin, histamine, serotonin, platelet activating factor and other vasoactive amines that may be released at the site of inflammation or regions of immediate hypersensitivity reactions.

Neutrophils

- Neutrophils form the major part of the white blood corpuscles (40-75%). They are motile, short lived cells with multilobed nucleus. The cytoplasm contains granules which do not take up acidic or basic strains strongly and hence named neutrophils.

The major function of the neutrophils is phagocytosis which is very similar to macrophages. Neutrophils can attack and destroy bacteria and viruses even in the circulating blood. When a tissue is damaged or inflamed, the neutrophils reach that area along with macrophages and destroy the unwanted tissues by phagocytosis.

Antigen Presenting Cells (APC)

The cells which process and transfer the antigen to lymphocytes are called antigen presenting cells. Three groups of antigen presenting cells are aviable in the immune system. They are macrophages, dendritic cells and Langerhans cells.