

## **Hematopoiesis     SDG/ UG-HONS/SEM 4**

**Hematopoiesis** is the **process** by which immature precursor cells develop into mature blood cells. The currently accepted theory on how this **process** works is called the monophyletic theory which simply means that a single type of stem cell gives rise to all the mature blood cells in the body.

It occurs within the hematopoietic system, which includes organs and tissues such as the bone marrow, liver, and spleen.

It begins early in the development of an embryo, well before birth, and continues for the life of an individual.

Pluripotent stem cells continuously produce more of themselves. Hematopoietic cells are constantly generated from pluripotent stem cells, where some of these pluripotent cells become unipotential stem cells. Subsequently, some of the cells of this unipotential population differentiate into precursor cells that, once differentiated, are in part committed to becoming one of the mature types of blood cells, which are erythrocytes, monocytes, lymphocytes, thrombocytes and granulocytes.

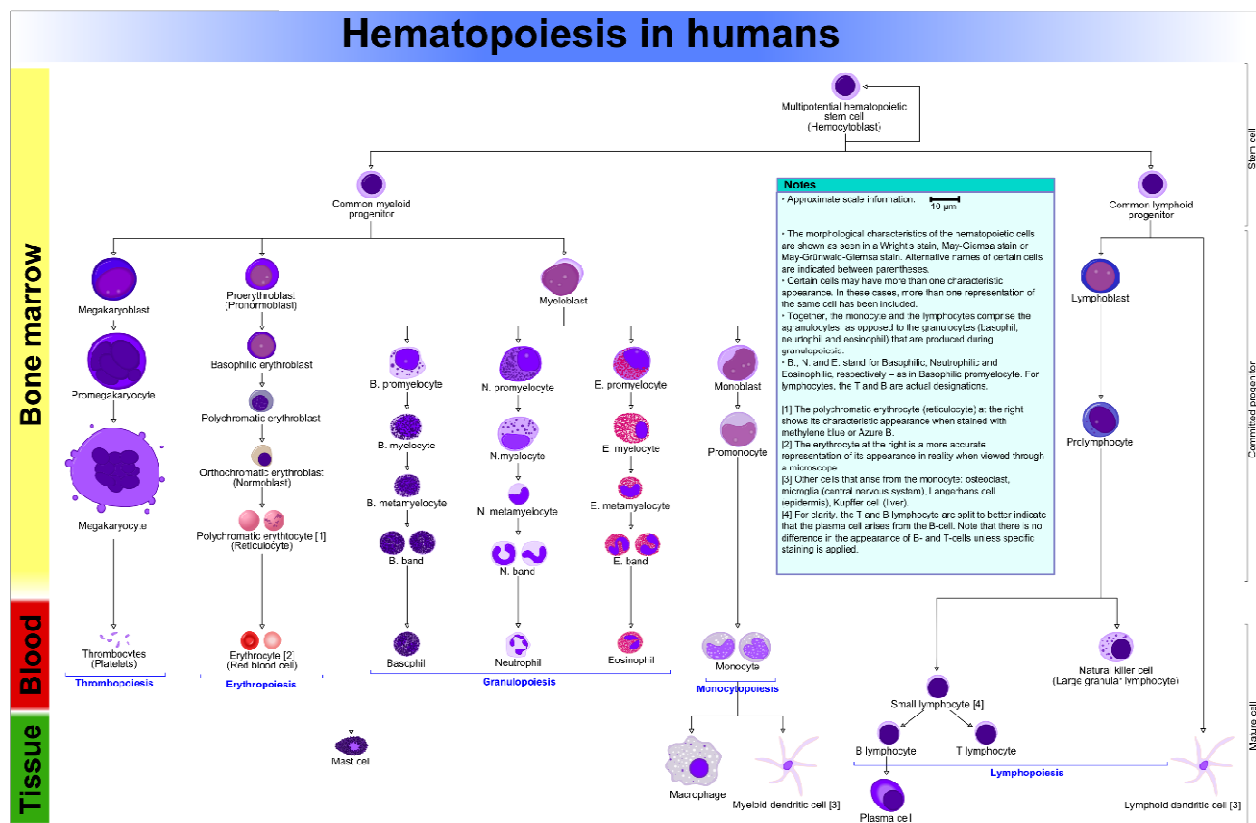
Hematopoietic cells that are immature precursor cells evolve from cells that make a lot of protein to cells that make less protein and structural changes occur with this evolution. These cells have more clumped or condensed chromatin, since it is not being actively transcribed. In addition to this, these cells have fewer nucleoli, smaller Golgi apparatuses, and fewer ribosomes, thus, they exhibit less basophilic hematoxylin staining.

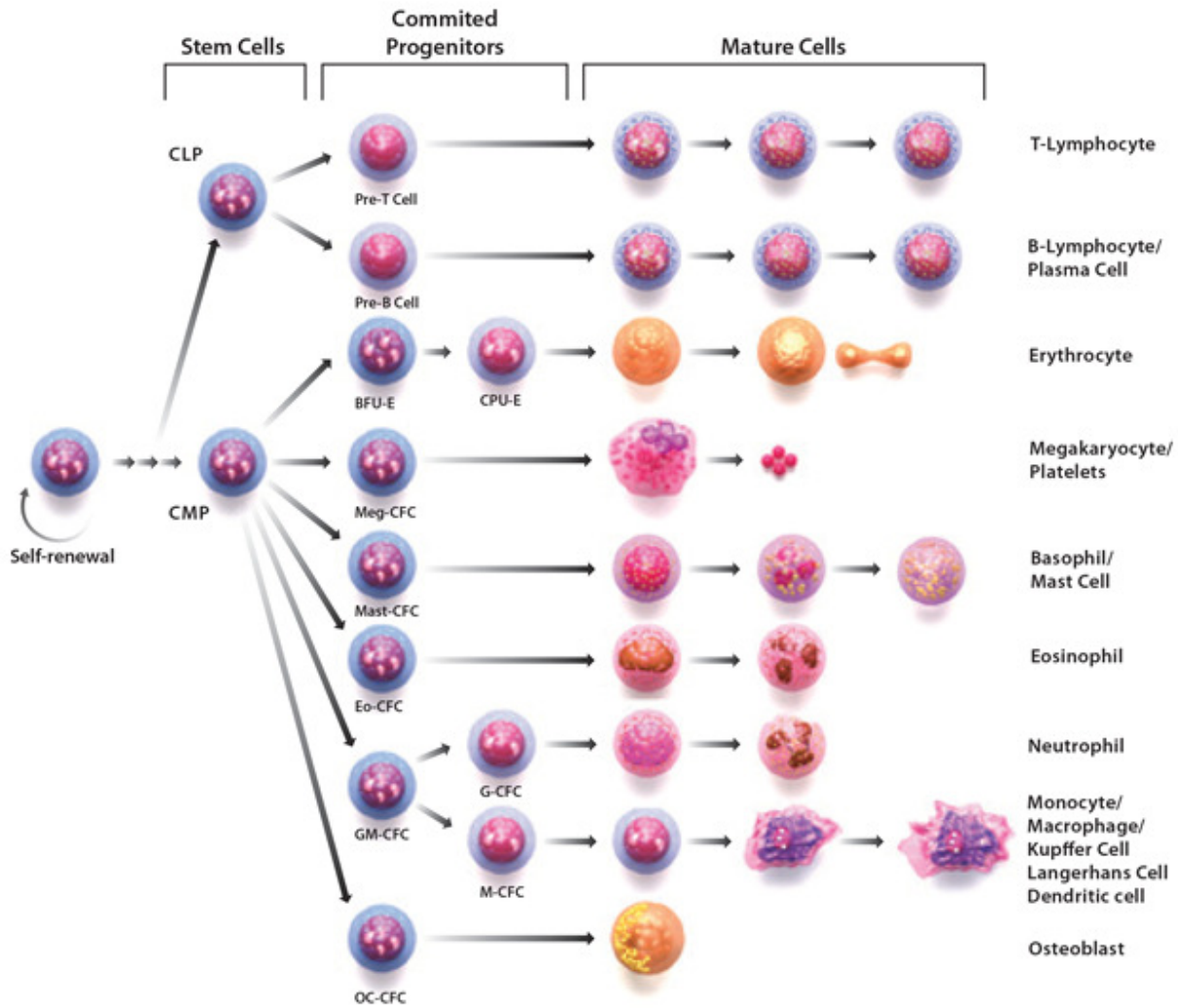
### **Erythropoiesis**

Erythropoiesis is the process by which red blood cells, also known as erythrocytes, are made and are stimulated by decreased levels of oxygen in the blood, which sets into motion the secretion of erythropoietin, a hormone central to the formation of red blood cells. The process of red blood cell formation takes on average 2 days to be completed from unipotential hematopoietic cell to mature red blood cell. In our bodies, there 2 million erythrocytes are produced every second. Hematopoietic cells committed to becoming red blood cells usually get smaller and more condensed as they mature until there is eventually loss of their nuclei.

The unipotential cell becomes what is known as a proerythroblast, which has a nucleus that is not condensed and takes up most of the cell with basophilic or blue cytoplasm. The cell then becomes a basophilic erythroblast, which is followed by a polychromatophilic erythroblast stage,

where the nucleus is more condensed than the latter two stages and the cytoplasm becomes reduced. In the subsequent orthochromatophilic erythroblast stage, the nucleus is much smaller than that of the previous stages with a pinker cytoplasm. In the reticulocyte stage the red blood cell has no nucleus, but still stains somewhat blue due to the remnants of polyribosomes within the cell. Finally, the erythrocyte is the mature red blood cell, which has no nucleus and no polyribosome remnants and as a result stains pink.





## Granulopoiesis

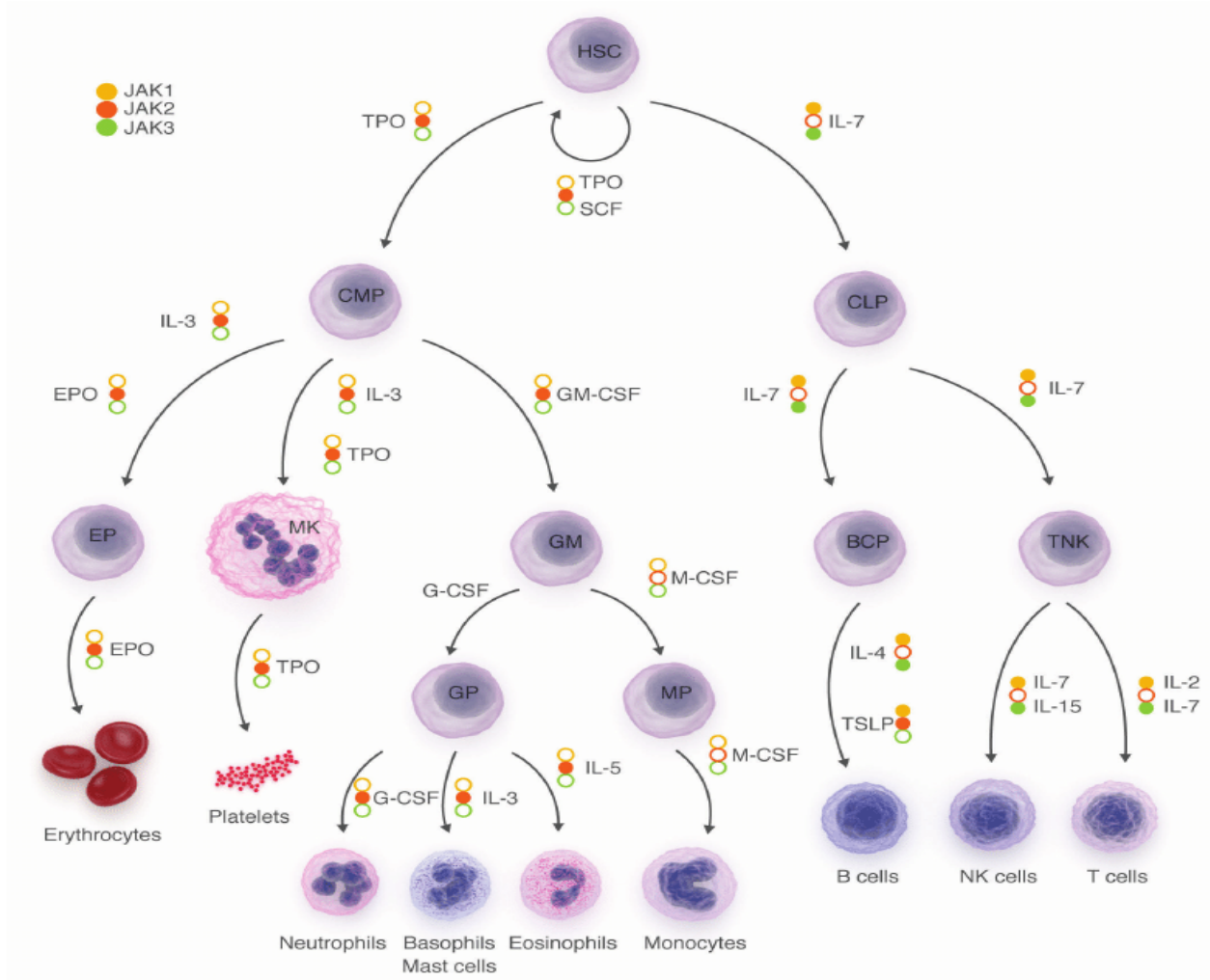
Granulopoiesis is the formation of granulocytes, which are white blood cells with multi-lobular nuclei and cytoplasmic granules. The unipotential hematopoietic cell that becomes a myeloblast is large and has a cytoplasm that stains blue with a large nucleus. This cell metamorphoses into a metamyelocyte, which is similar in size to a mature granulocyte and the nucleus begins to become indented. Following this stage is the band cell stage, where the nucleus has definitive indentation and resembles a horseshoe. Finally, there is the mature granulocyte, which has a lobed nucleus and cytoplasmic granules. The entire process happens over a period of 2 weeks.

## Monopoiesis, Lymphopoiesis and Thrombopoiesis

Monopoiesis is the process by which monocytes are formed. The committed progenitor cell, the monoblast, is found only in the bone marrow and has a basophilic cytoplasm without granules. These evolve into promonocytes, which are smaller with nuclei that become slightly indented, before becoming monocytes, which have kidney-shaped nuclei and can develop into dendritic cells or macrophages.

Lymphopoiesis is the formation of lymphocytes, which start from their first committed progenitor cells, lymphoblasts. These cells go on to mature into lymphocytes that are capable of differentiating into either B, T or natural killer cells.

Thrombopoiesis is the formation of platelets, which come from extremely large cells within the bone marrow called megakaryocytes. The creation of individual platelets occurs when the plasma membranes of megakaryocytes are fragmented, thereby generating platelets containing many granules.



## Hematopoiesis and its regulation

