HEMATOPOIESIS

- Hematopoiesis is the lifetime process of ongoing blood cell production and turnover to satisfy both daily needs and to address elevated demands, such as those caused by injury or illness.

- Around one trillion blood cells, including 200 billion erythrocytes (Red blood cells, or RBCs) and 70 billion neutrophils, are produced daily by average human adults.

- Hematopoiesis is derived from two Greek terms:
  Haîma: Blood.
  Poiēsis: To make something.
- The terms hemopoiesis, hematogenesis, and hemogenesis are all used to refer to hematopoiesis.

Organs of Hematopoiesis:

- In humans, hematopoiesis starts in the yolk sac, momentarily moves to the liver, and then eventually establishes itself in the bone marrow and thymus.

Week 3: The yolk sac produces a kind of red blood cell that is slightly less developed.

Weeks 2 and 3: Liver and spleen produce platelets and red blood cells, respectively.

Month 5: Bone marrow produces the majority of your blood cells. Certain kinds of white blood cells are also made by the thymus, spleen, and other lymph tissue.

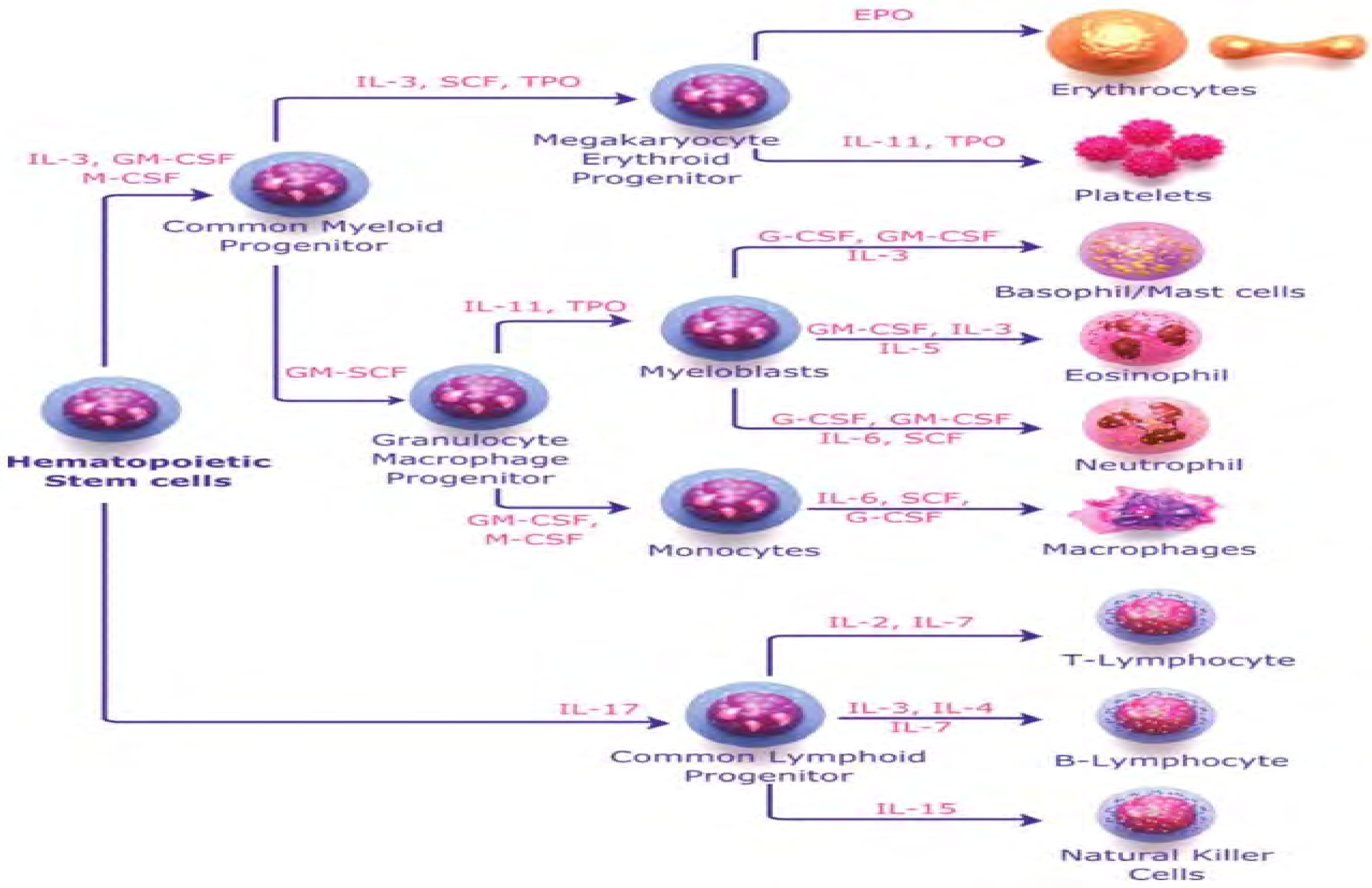
After Birth : The bone marrow is where the majority of blood cells are made from infancy through maturity. Thymus also contributes to the development of certain lymphocyte subtypes of white blood cells.

Process of Hematopoiesis:

- All hematopoietic cells are produced from pluripotent stem cells called as Hematopoietic stem cells, HSCs that then develop into unipotent ones and precursor cells before producing adult blood cells.

- The hematopoietic stem cell (HSC) sits at the pinnacle of hematopoiesis and is characterized by two fundamental properties: the capacity for multipotent differentiation into all mature blood lineages and the capacity for self-renewal.

- HSCs differentiates into different progenitor cells which further differentiate to lymphoid or myeloid progenitor cells that leads to the production of various types of blood cells.



EPO
Erythrocytes
IL-3, SCF, TPO
Megakaryocyte
Erythroid
Progenitor
IL-11, TPO
Platelets
IL-3, GM-CSF
M-CSF
Common Myeloid
Progenitor
G-CSF, GM-CSF
IL-3
Basophil/Mast cells
IL-11, TPO
GM-CSF, IL-3
IL-5
Eosinophil
Myeloblasts
GM-SCF
G-CSF, GM-CSF
IL-6, SCF
Neutrophil
Granulocyte
Macrophage
Progenitor
Hematopoietic
Stem cells
IL-6, SCF,
G-CSF
Macrophages
GM-CSF,
M-CSF
Monocytes
IL-2, IL-7
T-Lymphocyte
IL-17
IL-3, IL-4
IL-7
B-Lymphocyte
Common Lymphoid
Progenitor
IL-15
Natural Killer
Cells

- Common lymphoid progenitor cells differentiate into lymphoid cells, whereas Common Myeloid progenitors differentiates into myeloid cells.
- Cytokine stimulation and transcription factor modulation are required for the commitment of hematopoietic cells to more lineage-restricted cells.
- Lymphoid progenitor cells differentiate into B cells, T cells and NK cells.

- Myeloid progenitor cells differentiate into Granulocyte-Monocyte progenitor cells, Erythrocyte progenitor, or Megakaryocyte progenitor cells.
- Granulocyte-Monocyte progenitor cells differentiate and develop into neutrophil, eosinophil or basophil; and monocyte develops into macrophages.

- Similarly, Erythrocyte progenitor cells and megakaryocyte progenitor cells give rise to erythrocytes (RBCs), and Megakaryocytes (Platelets), respectively.

Regulation of Hematopoiesis:

- The self-renewal and differentiation of HSCs is regulated by different growth factors and transcription factors and Stem cell Factors (SCFs).
- Many transcription factors control the number and stage of differentiation of stem cells.
- A collection of hematopoietic growth factors such as erythropoietin, granulocyte colony-stimulating factor, and thrombopoietin are the physiological regulators of a particular lineage of blood cells.
- Interleukin-3 [IL-3], interleukin-11 [IL-11], granulocyte-macrophage colony-stimulating factor appear to represent hematopoietic growth-promoting activities.

- Transcription factors play important role in self renewal, differentiation, proliferation and survival of HSCs and further down the commitment cells.

- Multi-protein complex assembles together and binds the DNA regulatory elements to modulate the transcription. Epigenetic mechanisms including DNA methylation and histone methylation also has their role in controlling the process.

Conditions interfering with Hematopoiesis:

- Bone marrow may get clogged with fat deposits as we age, leaving less space for hematopoiesis.
- Blood cell production can be hampered by blood conditions and blood diseases such leukemia, lymphoma, and myeloma. These could result in an abundance of unhealthy blood cells that don't perform as they should.
- Low blood cell counts can also result from medicines/drugs that interferes with hematopoiesis. Chemotherapy, for example, destroys cancer cells but also reduces your white blood cells.