Blood cell formation

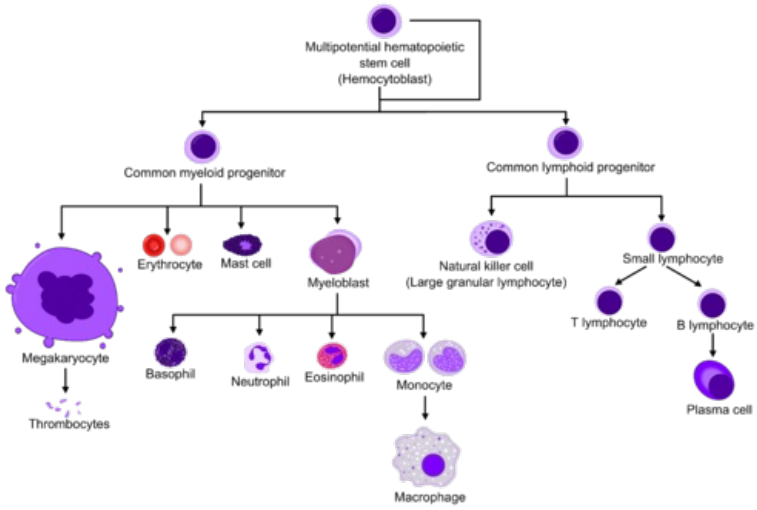
Blood cell formation is the process in which stem cells differentiate into the red or white blood cells. The primary organ for blood cell formation is the bone marrow

Bone Marrow

- The bone marrow is made of many cells as well as fat cells (stromal cells), forming rich connective tissue. This whole tissue is surrounded by blood vessels called blood sinuses, where new blood cells are discharged.
- All blood cells come from the haematopoietic stem cell, which is pluripotent as it gives rise to all differentiated types of blood cell.
- A pluripotent stem cell can generate more stem cells (self-renewal) or differentiate into lymphoid or myeloid stem cells, becoming committed progenitor cells/unipotent stem cells.
- The committed stem cells will produce colonies of its cell type and these committed cells are called Colony-Forming Unit (e.g. CFU-E for red blood cells and CFU-GM for cells that form granulocytes and monocytes).
- The stem cells are stimulated to proliferate by **growth factors** e.g. Interleukin-3, which promotes the proliferation of both pluripotent stem cells and unipotent progenitor cells. There are other growth factors that only induce specific committed progenitor cells.
- The progenitor cells progressively lose their ability to divide and finally become terminally-differentiated blood cells. Differentiation is stimulated by proteins called **differentiation inducers**.

Differentiation of Red Blood Cell

1. **Pro-erythroblast**: it is formed from CFU-E progenitor cells
2. **Basophilic erythroblast**: it is basophilic as it contains little Haemoglobin
3. **Polychromatophilic erythroblast**: more Haemoglobin is being produced by the mitochondria and the nucleus starts to condense
4. **Orthochromatophilic erythroblast**: the cell is now mainly filled with Haemoglobin, most organelles are excreted and the pyknotic nucleus is ejected to become a reticulocyte
5. **Reticulocyte**: it passes around the bloodstream for 1-2 days to secrete any other remaining organelles, Golgi apparatus and mitochondria by **diapedesis** (squeezing through the pores of the membrane) and then it becomes a mature erythrocyte
6. **Erythrocyte**



Haematopoiesis

Requirements for Red Blood Cell Maturation

- Nuclear maturation: **Vitamin B12 and Folic Acid** - it regulates the synthesis of DNA by increasing the speed of erythroblast proliferation (deficiency causes a decrease in the speed and causes the erythrocytes to develop into larger and weaker megaloblasts)

- Cytoplasmic maturation (rich in haemoglobin): **Iron, Fe^{2+}** - important component of Haemoglobin as it binds oxygen

Regulation of Red Blood Cell Production

- The basic regulator is the level of **tissue oxygenation**
- The principal factor that stimulates red blood cell production is **erythropoietin**, which stimulates CFU-E to differentiate into pro-erythroblasts
- **Interleukin-3** is produced from T-lymphocytes, during reaction to a stimuli such as inflammation

Production of Granulocytes and Macrophages

- These cells develop from the CFU-GM cells in the bone marrow
- Granulocytes circulate for a few hours before returning to the tissues, where they survive for a few days and then die
- Macrophages can survive for weeks or even months outside the bloodstream, where they are activated by local signals
- Their production is regulated by Colony-Stimulating Factors (CSFs), which are produced from: lymphocytes,

macrophages, fibroblasts and endothelial cells
- The concentration of CSFs increase rapidly in response to bacterial infection

Production of Lymphocytes

- Lymphocytes develop from lymphoid stem cells that are in the haematopoietic tissues of the bone marrow, giving rise to B and T progenitor cells
- B-lymphocytes develop in the bone marrow
- Precursors of T-lymphocytes migrate to the thymus, where they undergo thymic selection
- B-cells and selected T-cells migrate to the secondary lymphoid organs (lymph nodes, spleen, Mucosa-Associated Lymphoid Tissue, etc).

Links

Bibliography

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POKORNY, . *Haematopoiesis* [lecture for subject Blood Cell Formation, specialization Physiology, First Faculty of Medicine Charles University]. Prague. 2011.

2 students were here in 2016 novemeber (forever remember us please) hope you have fun studying love you all peeps be kind!