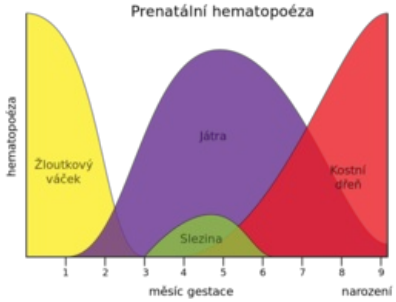
Haematopoiesis (histology)

Haematopoiesis is the process of blood formation in the body. The basic mechanisms that hematopoiesis ensures are proliferation and differentiation of pluripotent cells into unipotent cells, which are then adapted to perform their specific functions. Postnatally, it takes place in the bone marrow (*medulla ossium*). Prenatally, however, hematopoiesis takes place in different parts of the body depending on the period of gestation.

Prenatal hematopoietic period

We distinguish three periods of prenatal hemopoiesis:

1. **Mesoblast Period**
2. **Hepatolienal period**
3. **Medullary Period**



Prenatal hematopoiesis

Mesoblast Period

- **from the 3rd week to the 3rd month** of prenatal development;
- takes place in the **mesenchyme near the wall of the yolk sac (in the splanchnopleura);**
- blood islets are formed, which are formed by common precursor cells (hemangioblasts), which later differentiate into angioblasts;
- the resulting erythrocytes contain **embryonic hemoglobin.**

Hepatolieneal period

- **2. up to the 8th month of prenatal development,** to a lesser extent persists until birth;
- takes place in the **fetal liver** and **partially in the spleen;**
- definitive hematopoietic precursor cells enter the extravasal space of the liver;
- the resulting erythrocytes contain '*fetal hemoglobin.*

Medullary Period

- **4. month prenatally until birth**, persists into **adulthood**;
- takes place in the **bone marrow** (first in the bone marrow of the corpus claviculae*)* [1]*;*
- hematopoiesis of leukocytes and thrombocytes begins from the 5th prenatal month, and erythrocytes from the 7th prenatal month;
- T-lymphocytes travel to the thymus and B-lymphocytes to the lymph nodes and lymph follicles;
- the resulting erythrocytes contain **adult hemoglobin***.*

Postnatal hematopoietic period

Postnatally, hematopoiesis takes place in the **bone marrow (*medulla ossium*)**. Bone marrow is the gelatinous tissue inside the bones. It fills the medullary cavity of long bones and the spaces between the trabeculae in the spongiosa. During life, however, the microscopic structure of the bone marrow changes, according to which we distinguish its **three types**:

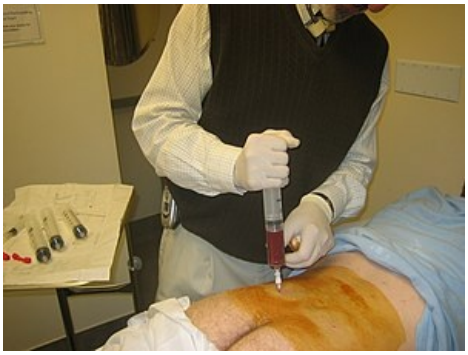
- **red bone marrow** (*medulla ossium rubra*):
- **yellow bone marrow** (*medulla ossium flava*):
- **gray bone marrow** (*medulla ossium grisea*):

To examine the bone marrow, we take it **from the sternum or from the scoop of the hip bone**. The collection is painful for the patient, so it is necessary to use a local anesthetic.

Microscopic structure of bone marrow

- **Stroma:**
  - consists of reticular tissue, which consists of reticular cells (these are specialized fibroblasts) and reticular fibers (collagen type I, collagen type III, fibronectin, laminin, hemonectin, various proteoglycans)
  - reticular cells are in close contact with hemopoietic factors and immature blood cells, which they influence with the help of cytokines and other growth factors
- **haemopoietic stem cells** (often HKB or HSC)
- **fat cells** (see yellow bone marrow)
- **macrophages:**
  - phagocytosis of apoptotic or damaged blood elements
- **capillaries:**
  - fenestrated, without continuous *lamina basalis*
  - significantly large clearance (around 40-80 µm)

Hematopoiesis control


Bone marrow aspiration

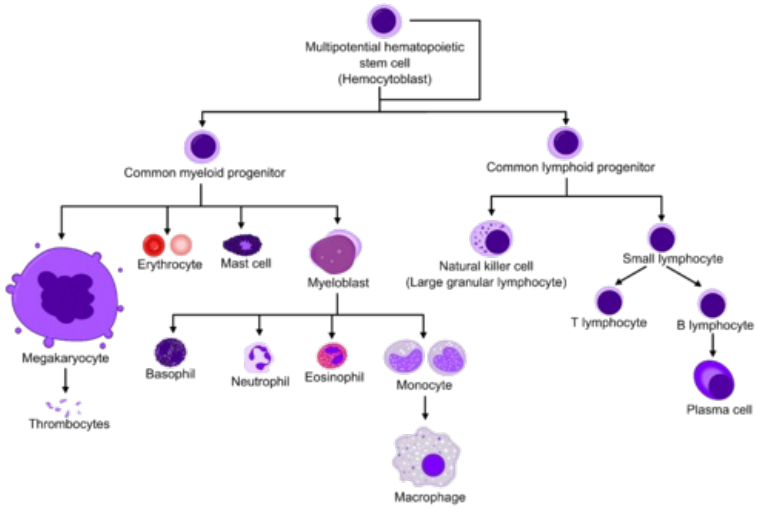
Like every event in the human organism, hemopoiesis is carefully controlled by a number of regulatory mechanisms. They mainly ensure the following events:

1. **differentiation**
2. **proliferation**
3. **ripening induction**
4. **induction to physiological apoptosis**

Various groups of **cytokines**, which act as **colony-stimulating factors** (*colony-stimulating factors*, CSF), are mostly responsible for the events above. Two hormones play a huge and irreplaceable role in the management of hematopoiesis - **erythropoietin** and **thrombopoietin**. Both are produced by the kidneys (erythropoietin) and the liver (thrombopoietin).

Origin of blood cells

Individual lines of development of blood elements are derived from a single group of **pluripotent hemopoietic stem cells**. Their further development represents a strictly controlled hierarchy from which individual cell lines can be derived. Every other type of hematopoietic cell arises as a result of the action of cytokines on the CSF.



Blood formation

Pluripotent hematopoietic cells

- stem cells from which all blood elements can be derived
- they are not differentiated
- they have the ability to renew themselves throughout life (lifetime supply)
- its mitotic activity is low (together with multipotent cells, it constitutes approximately only 0.1-0.3% of cellular elements) [1]

Multipotent hematopoietic cells

- develops in two lines:
  - **myeloid progenitor cells (CMP)** - for erythrocytes, megakaryocytes, granulocytes and monocytes
  - **lymphoid progenitor cells (CLP)** – for lymphocytes

Oligopotent hemopoietic cells

- myeloid lineage further develops into:
  - **oligopotent progenitor cell MEP** - for erythrocytes and megakaryocytes
  - **oligopotent progenitor cell GMP** - for granulocytes and monocytes
- lymphoid lineage develops together for all lymphocytes

Unipotent hemopoietic cells

- a specific progenitor cell for individual blood elements is already developing
- oligopotent MEP progenitor cell further develops into:
  - **progenitors for erythrocytes (ErP)**
  - **megakaryocyte progenitors (MGP)**
- oligopotent GMP progenitor cell further develops into:
  - **progenitors for neutrophil granulocytes (NoP)**
  - **basophilic granulocyte progenitors (BMCP)**
  - **progenitors for eosinophilic granulocytes (EoP)**
  - **monocyte progenitors (MoP)**

We also call cells that do not have the ability to self-renew **progenitor cells**. **Pluripotent cells** are capable of self-renewal, so they cannot be considered progenitors. **Precursor cells** are also cells that already show distinct morphological features. They develop from unipotent cells, and their differentiation leads to the formation of a mature blood element. They contain the suffix-blast in their name (proerythroblast, megakaryoblast, myeloblast, monoblast, lymphoblast). The development of these elements leads to the creation of an already functional element.

Links

Related Articles

- Bone marrow
- Stem cells
- Blood cells (slide)
- Donation, collection and transplantation of hematopoietic cells

Reference

1. JUNQUIERA, L. Carlos – CARNEIRO, José – KELLEY, Robert O, et al. *Základy histologie.* 1. edition. Jinočany : H & H, 1997. 502 pp. ISBN 80-85787-37-7.

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