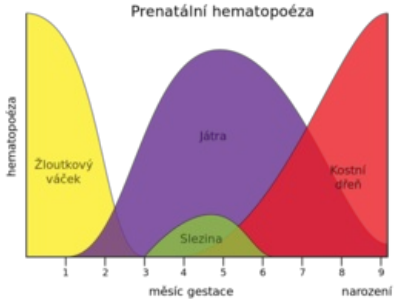
Hematopoiesis (histology)

Hematopoiesis is the process of making blood in the body. The basic mechanisms provided by hematopoiesis are the proliferation and differentiation of pluripotent cells into unipotent cells, which are then adapted to perform their specific functions. It occurs postnatally in the bone marrow (*medulla ossium*). Prenatally, however, hematopoiesis takes place in different parts of the body depending on the period of gestation.

Prenatal period hematopoiesis

We distinguish three periods of prenatal hematopoiesis:

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



prenatal hematopoiesis

Mesoblast period

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

Hepatolienal period

- **2nd to 8th month of prenatal development,** persists to a lesser extent until delivery;
- takes place in the **fetal liver** and **partly in the spleen;**
- definitive hematopoietic progenitor cells enter the extravascular space of the liver;
- he resulting erythrocytes contain **fetal hemoglobin.**

Medullary period

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

Postnatal hematopoiesis

Postnatally, hematopoiesis in the **bone marrow (*medulla ossium*)** takes place. The bone marrow is the gelatinous tissue inside the bones. It fills the medullary cavity of long bones and the spaces between the beams in spongiosis. However, over the course of life, the microscopic structure of the bone marrow changes, according to which we distinguish its **three types:**

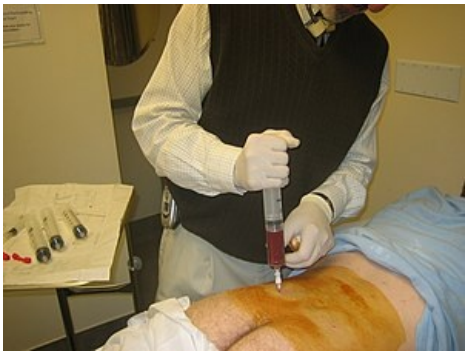
- **red bone marrow** (*medulla ossium rubra*):
- **yellow bone marrow** (*medulla ossium flava*):
- **gray bone marrow** (*medulla ossium grisea*):

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

Microscopic structure of bone marrow

- **Stroma:**
  - they consist of reticular ligament, 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 hematopoietic factors and immature blood cells, which are affected by cytokines and other growth factors
- **hematopoietic 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*
  - considerably large lumen (around 40–80 µm)

Regulation of hematopoiesis


Bone marrow collection

Like every event in the human body, hematopoiesis is carefully controlled by a number of regulatory mechanisms. They mainly provide the following events:

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

The majority are responsible for that matter different groups **of cytokines**, which act as **colony stimulation factors** (*colony-stimulating factors*, CSF). Two hormones - **erytropoietin** and **trombopoietin**- have a huge and irreplaceable role in controlling hematopoiesis . Both are produced by the kidneys (erythropoietin) and the liver **trombopoietin**.

The origin of blood cells

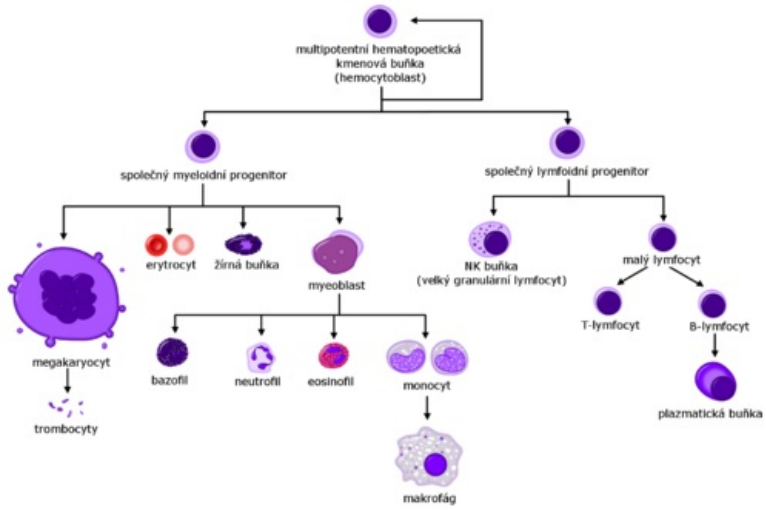
The individual lines of development of blood elements are derived from a single group of **pluripotent hematopoietic stem cells**. Their further development represents a strictly controlled hierarchy from which individual cell lines can be derived. Every other type of hematopoietic cell arises as a result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

Pluripotent hematopoietic cells

- stem cells from which all blood elements can be derived
- they are not differentiated
- have the ability to renew themselves for life (lifetime supply)
- their mitotic activity is low (together with multipotent cells they make up only about 0.1–0.3% of cellular elements) [1]

Multipotent hemopoietic cells

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



Hematopoiesis

Oligopotent hematopoietic cells

- myeloid lineage further develops into:
  - **oligopotent progenitor cell MEP** − for erythrocytes and megakaryocytes
  - **oligopotent progenitor cell GMP** − for granulocytes and monocytes

the lymphoid lineage develops together for all lymphocytes

Unipotent hematopoietic cells

- a specific progenitor cell for individual blood elements is already being developed
- oligopotent progenitor cell MEP further develops into:
  - **erythrocyte progenitors (ErP)**
  - **megakaryocyte progenitors (MGP)**
- the oligopotent progenitor cell GMP further develops into:
  - **progenitors for neutrophilic granulocytes (NoP)**
  - **progenitors for basophilic granulocytes (BMCP)**
  - **progenitors for eosinofilic granulocytes (EoP)**
  - **progenitory for monocytes (MoP)**

We also call **progenitor cells** cells that do not have the ability to self-renew. **Pluripotent cells** are able to regenerate, so they cannot be considered progenitors. **Precursor cells (precursors)** jare also cells that already show clear 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.

References

Related Articles

- Bone marrow
- Stem cells

References

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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