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Věra Křížková et al.

BLOOD and BLOOD COMPONENTS

Hematopoiesis, Selected Methods Used in Cytology, Histology, and Hematology

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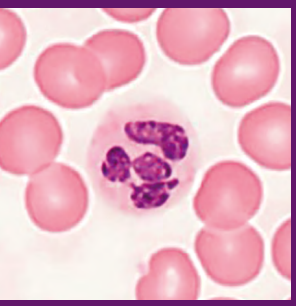
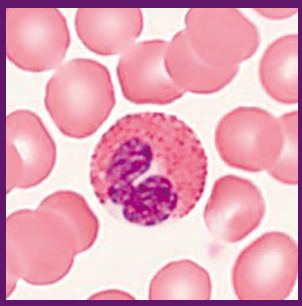
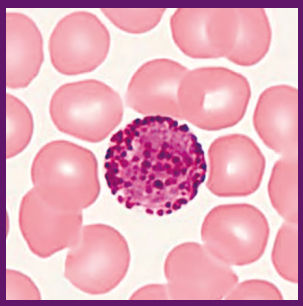
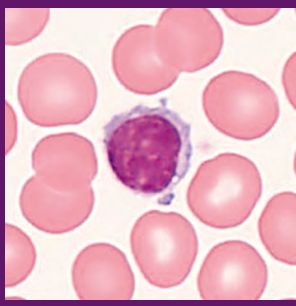

Blood and Blood Components
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This text is dedicated to our families and friends
and to the memory of Assoc. Prof. MUDr. Jitka Kočová, CSc.,
and Prof. MUDr. RNDr. Jaroslav Slípka, DrSc.

CONTENT

Dear colleagues,

We would like to fill in the blank spaces in teaching of histology and embryology with these study materials.

We would like to express our thanks to all colleagues who have given us a piece of advice, inspiration, helped us revise our materials or have supported us in other ways. For help with taking of blood for electron-microscopy, we thank Mrs. Jindřiška Horáková; our thanks go to Assoc. Prof. MUDr. Jitka Kočová, CSc., for the valuable comments on the topics; Prof. MUDr. Milena Králíčková, Ph.D., Prof. Ing. Jaroslav Hrabák, Ph.D., Assoc. Prof. Ing. Jan Nevoral, Ph.D., MUDr. Zdeňka Hajšmanová, RNDr. Pavel Pitule, Ph.D., Ing. Lucie Vištejnová, Ph.D., Prof. MUDr. Václav Liška, Ph.D., MUDr. Jan Brůha, Ph.D., Assoc. Prof. RNDr. Marie Kalbáčová, Ph.D., MUDr. Vladimír Korečko, Ing. Markéta Šlajerová and many colleagues from the Biomedical Center and from the Department of Clinical Biochemistry and Hematology, University Hospital Pilsen for their support with methodology. As a thank-you for inspiration also goes to Ms. Tatiana Andrejová, Prof. MUDr. Mgr. Zbyněk Tonar, Ph.D., RNDr. Alena Němečková, CSc., and Mgr. Alena Kvasilová.

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We believe these materials may serve to prepare students not only for education in our subject but also for subsequent branches of study, particularly hematology, hematooncology, and pathology. That is exactly why we completed the original morphological module (based on the previous MEFANET module) with additional facts, which are beyond our branch.

Team of authors

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1 BLOOD

During phylogenesis, blood appears with the multicellular organisms called metazoans, where the majority of cells lose direct contact with the body surface. Cells are not able to accept oxygen and nutrients from the body surface and give away products of their metabolism. Therefore, the internal environment has developed. In vertebrates, there is vascular circulation (in a closed system of tubes) and lymphatic circulation. Blood enables exchange of substances between distant cellular populations and thus their specialization, regulation, etc. The circulation in humans is in one direction, of which the heart is the driving engine.

Blood[1] is a **suspension of blood elements in plasma**. It is a transporting medium responsible for transport of blood gases, nutrients, products of metabolism, hormones, and other substances. It constitutes about 8% of body weight, women have 4 to 5 L, and men 5 to 6 L; blood pH is 7.35. The main functions of blood are transport of the substances listed above, distribution of heat, regulation of various processes, and protection of the body through actions of immune cells and elements. Irreplaceable roles of blood include maintaining acid-base and osmotic balance, body temperature regulation and mediation of many other functions.

Plasma, the fluid component of blood, is a slightly yellowish liquid consisting of 90% water and 7% proteins (albumin, globulins, fibrinogen, prothrombin). The remaining 2% consists of organic compounds (aminoacids, vitamins, hormones, lipoproteins) and 1% is inorganic salts. Serum is the liquid, formed after blood coagulation. Compared to plasma, coagulable components, such as fibrinogen, are lacking in serum.

1.1 HEMATOCRIT

= ratio of blood elements volume to blood plasma volume. The normal range of hematocrit for women is 0.42±0.04, for men 0.47±0.05 (i.e. on average 44%)[2].

Blood cells consist of three populations of cells: **erythrocytes (red blood cells), thrombocytes (platelets), and leukocytes (white blood cells)**. Blood cells are not represented

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1 Blood (haima), from Greek base for the name hematology – science of blood and blood elements.

2 It can be very well observed during blood centrifugation. The sediment is also called packed blood cells (on the bottom there are red blood cells, then on top of them there is an opalescent layer with white blood cells and platelets), and the supernatant is the fluid above the sediment, plasma.

equally; for every 1 000 erythrocytes, there is approximately 1 leukocyte. Leukocytes are subdivided into **granulocytes** and **agranulocytes** according to the presence or absence of granules (Fig. 1).

In a blood smear, blood cells can be detected by the Pappenheim panoptical method (a combination of May-Grünwald and Giemsa-Romanowski staining)[3] but also by many other different staining methods. On the basis of this staining, we can observe morphological attributes of blood elements (even potential deviations) and determine quantitative representation of each type of white blood cells.

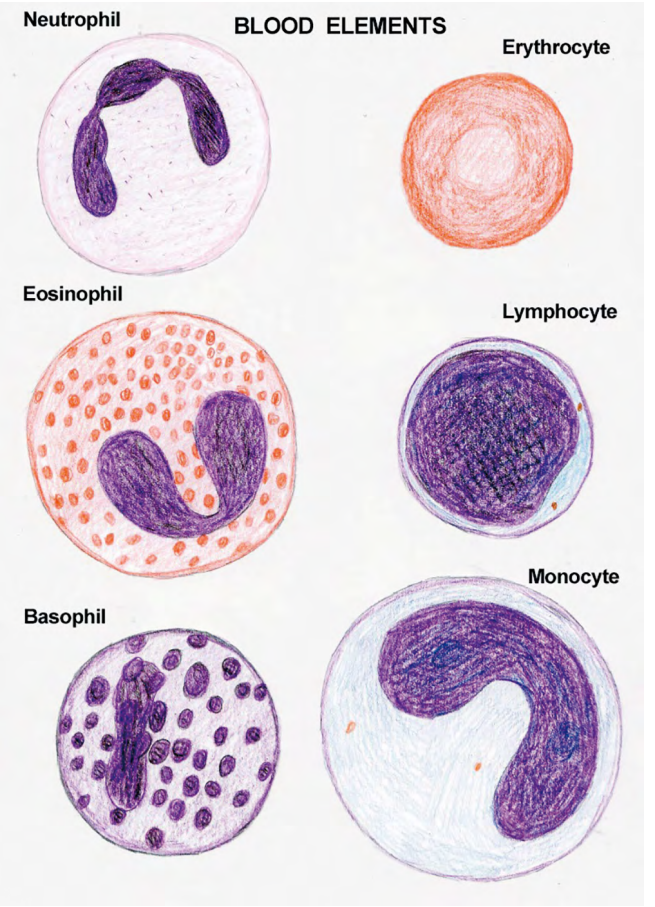

Fig. 1 Overview of blood elements

[3] The principle of the staining is in interaction between molecules of stains and differently charged cell structures. Eosinophilic (pink) structures have a lot of cationic bonds, whereas basophilic structures (purple-blue, stainable for example with methylene blue) have anionic bonds.