# MORPHOFUNCTIONAL FEATURES BLOOD MORPHOLOGY IN AGE-RELATED CHANGES

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**Resume.** Blood is one of the most important life support systems of the body, which has a number of features. The high mitotic activity of hematopoietic tissue causes its increased sensitivity to the action of damaging factors, and the genetic determinism of reproduction, differentiation, structure and metabolism of blood cells create prerequisites for both genomic disorders and changes in genetic regulation.

**Key words:** erythrocytes, leukocytes, leukocyte formula.

The peculiarity of the blood system also lies in the fact that pathological changes in it occur due to dysfunction not only of its individual components, but also of other organs and systems of the body as a whole. Any disease, pathological process, as well as a number of physiological changes can affect the quantitative and qualitative characteristics of the composition of circulating blood to one degree or another.

Peripheral blood is blood circulating through vessels outside the hematopoietic organs. Depending on the vessels in which blood flows, its types are distinguished: arterial, venous, capillary. There are differences in biochemical and morphological parameters between these types of blood, but they are insignificant. For example, the concentration of hydrogen ions (pH of the medium) in arterial blood is 7.35 - 7.47; venous - 7.33 - 7.45. This value is of great physiological importance, as it determines the rate of many physiological and chemical processes in the body.

The absolute majority of circulating shaped blood elements are red blood cells - red nuclear-free cells. In a healthy person, erythrocytes have a discoid shape with biconvex walls in 85%, and other forms in 15%. Its outer surface consists of lipids, oligosaccharides that determine the antigenic composition of the cell - blood group, sialic acid and protein, and the inner surface consists of glycotic enzymes, sodium, potassium, ATP, glycoprotein and hemoglobin. The erythrocyte cavity is filled with granules containing hemoglobin.

The erythrocyte is a highly specialized cell whose main task is to transport oxygen from the pulmonary alveoli to the tissues and carbon dioxide (CO2) back from the tissues to the pulmonary alveoli. The biconcave shape of the cage allows for the largest surface area of gas exchange. The diameter of the erythrocyte is about 8 microns, however, the features of the cell skeleton and membrane structure allow it to undergo significant deformation and pass through capillaries with a lumen of 2-3 microns. This ability to deform is provided by the interaction between membrane proteins (segment 3 and glycophorin) and cytoplasm (spectrin, ankyrin and protein). Defects in these proteins lead to morphological and functional disorders of erythrocytes. A mature erythrocyte does not have cytoplasmic organelles and nuclei and therefore is not capable of synthesizing proteins and lipids, oxidative phosphorylation and maintenance of tricarboxylic acid cycle reactions. It receives most of its energy through the Embden-Meyerhoff anaerobic pathway and stores it as ATP.

Approximately 98% of the mass of proteins in the cytoplasm of an erythrocyte is hemoglobin (Hb), the molecule of which binds and transports oxygen. The process of binding and releasing oxygen by hemoglobin molecules depends on oxygen pressure, carbon dioxide, pH and ambient temperature.

The lifetime of red blood cells corresponds to 120 days, which is established using a radioactive label. There are young red blood cells (neocytes), mature and old. Neocytes are the most resistant to the effects, which is especially pronounced when they are frozen with various cryoprotectors and thawed. The gradual aging of the cell leads to disruption of metabolic processes and its death. About 200 billion people die in the human body every day. red blood cells. Their residues are absorbed by macrophages of the spleen and liver.

The next largest number of cells in the blood are platelets - blood plates. Their number in the blood of a healthy person is 150,000 - 400,000 / ml. Platelets, the smallest shaped elements of the blood, are formed from the largest bone marrow cells - megakaryocytes. Platelets in the circulating blood have a rounded or oval shape, with a diameter of 2.5 microns. There is no nucleus in the cell. In the structure of blood plates, a single-layer membrane, a peripheral structureless zone (hyalomer) and a central granular zone (granulomer) are distinguished. Dense microtubules are detected in the hyalomer by electron microscopy. They are assigned the role of the cell skeleton, as well as participation in the process of clot retraction. The granulomer contains mitochondria, ribosomes, alpha granules, dense corpuscles, and glycogen particles. Alpha granules contain acid phosphotase, B-glucoronidase, and cathepsin, which makes it possible to classify them as lysosomes that determine cell function. Dense corpuscles contain serotonin, which contracts blood vessels during release, ATP and ADP, which are involved in adhesion and the release reaction.

Platelets are normally distinguished: young, mature, old and degenerative and vacuolated forms of irritation.

It is generally believed that normal hemostasis is achieved through the cooperation of two independent blood coagulation systems:

the humoral (plasma) system consisting of procoagulant proteins;

a cellular system consisting of platelets.

The end result of activation of the humoral blood coagulation system is the formation of a fibrin clot, or red blood clot, while the platelet reaction, accompanied by cell adhesion and aggregation, leads to the formation of a platelet plug, or white blood clot. Although these two folding systems are usually considered separately, it should be understood that in fact their functions are closely intertwined. Soluble coagulation factors (for example, fibrinogen and Willebrand factor) are of great importance for the normal function of platelets, and, conversely, platelets are important suppliers of procoagulant proteins and a necessary catalyst for a number of reactions in the soluble blood coagulation system.

In general, the hemostatic functions of platelets explain their ability to adhere, aggregate, form a primary platelet clot at the site of damage to the blood vessel wall and release clotting factors involved in fibrin deposition and retraction of the formed clot.

In addition to the main function, blood plates carry out the transfer of a number of vasoactive substances - serotonin, histamine and catecholamines, and maintain the function of the vascular endothelium. Platelets, having phagocytic activity, are able to absorb fat droplets, viruses, bacteria, and immune complexes. Blood plates are involved in inflammatory processes and immunological reactions.

The average life expectancy of a platelet is 9.5+-0.6 days. Normally, 2/3 of human blood plates are in the circulating blood and 1/3 in the spleen and are a kind of reserve for rapid mobilization if necessary. There is a dynamic exchange between these parts.

The total number of platelets in the human body ranges from 1.0 to 1.5 trillion. The process of end-stage thrombocytopoiesis has not been sufficiently studied. It is possible that in response to a certain signal, megakaryocytes transform into spider cells, from which many long filamentous processes (prothrombocytes) with uniform foci of constriction depart. Prothrombocytes enter the cerebrospinal sinusoids and fragment into platelets there, possibly due to the shear force of blood flow. Although the terminal stage of thrombocytopoiesis is limited only to the most mature megakaryocytes, it is a regulated process. After a sharp increase in peripheral platelet demand, an increase in the volume of these cells is immediately detected, which reflects changes in the mechanism of platelet formation.

White nucleated blood cells - leukocytes make up the third largest population of shaped blood elements.

White blood cells, or leukocytes, are the basis of the body's antimicrobial defense. This heterogeneous group of "defenses" includes the main effectors of immune and inflammatory reactions.

The term "leukocyte" refers more to the appearance of the cell (leukos - white Greek) observed in a blood sample after centrifugation.

Neutrophils.

Neutrophilic granulocytes are the largest group of circulating leukocytes. The term "neutrophilic" describes the appearance of cytoplasmic granules during Wright-Giemse staining. Together with eosinophils and basophils, neutrophils belong to the class of granulocytes. Due to the presence of a characteristic multi-lobed (segmented) nucleus, neutrophils are also called polymorphonuclear leukocytes (PMYLS), granulocytes have sizes of 9-15 microns, exceeding those of erythrocytes. Granularity is detected in the protoplasm of all granulocytes: aurophilic and special. Auerophilic granules contain mainly acid phosphatase, while special ones contain alkaline phosphatase. The main function of granulocytes is phagocytosis.

The phagocytic activity of neutrophils is most pronounced in young people, and it decreases in old age. In addition to phagocytosis, granulocytes exhibit secretory activity during inflammation, I isolate a number of antibacterial agents: peroxidases, bactericidal lysosomal cationic proteins and other substances. These highly specialized cells migrate to the foci of infection, where they recognize, capture and destroy bacteria. This function is possible due to the ability of neutrophils to chemotaxis, adhesion, movement and phagocytosis. They have a metabolic apparatus for producing toxic substances and enzymes that destroy microorganisms.

Granulocytes live for 1-6 days, on average 6-9 days, while their residence time in the bone marrow is 2-6 days. They circulate with blood from 60-90 minutes to 24 hours, sometimes up to 2 days. A small part of granulocytes is destroyed in the blood, most of them enter the tissues and complete their physiological existence. Granulocytes are destroyed by macrophages of the lungs, spleen, and liver. Some of the granulocytes are excreted from the body with secretions and excretions, sputum, saliva, bile, urine, and feces.

Eosinophils.

Eosinophils have a two-lobed nucleus and a cytoplasm filled with clearly visible granules that turn red after Wright-Giemse staining. The main (positively charged) proteins of these granules turn red due to their high affinity for eosin. Although eosinophils undergo the same stages of maturation as neutrophils, however, due to their small number, eosinophil precursors in the bone marrow are detected less frequently (with the exception of some pathological conditions: worms, allergies).

Eosinophils play a special role in the fight against parasites and allergy control. Since they are rarely found in peripheral blood, their role in protecting against bacterial infections is unclear. However, like neutrophils, eosinophils are capable of chemotaxis, phagocytosis and have bactericidal activity. Eosinophilic granules contain a special group of bactericidal proteins, including eosinophilic cationic protein, Charcot-Leyden protein crystals and eosinophilic peroxdase.

Basophils.

Basophils are the smallest group of circulating granulocytes, making up less than 1% of leukocytes. Large cytoplasmic granules of basophils contain sulfated or carboxylized acidic proteins, such as heparin, which turn blue when stained according to Wright-Giemse. Basophils mediate allergic reactions, especially those based on IgE-dependent mechanisms. They express IgE receptors and, with appropriate stimulation, release histamine in response to exposure to IgE and antigen.

Monocytes.

Monocytes circulate in the peripheral blood in the form of large cells with a blue/gray cytoplasm and a kidney-shaped or folded nucleus containing gently reticulated chromatin. Monocytes are a derivative of COE-GM (a common precursor for granulocytes and monocytes) and COE-M (a precursor of monocytic germ only). Monocytes spend only about 20 hours in the bloodstream, and then enter the peripheral tissues, where they transform into macrophages of the reticuloendothelial system (RES). These tissue macrophages, or histiocytes, are large cells with an eccentrically arranged nucleus and vacuolated cytoplasm containing numerous inclusions.

Monocytes and macrophages are long-lived cells whose functional features are in many ways similar to those of granulocytes. They more effectively capture and absorb microbacteria, fungi and macromolecules; their role in phagocytosis of pyogenic bacteria is less significant. In the spleen, macrophages are responsible for the utilization of sensitized and aging red blood cells. Macrophages play an important role in the processing and presentation of antigens to lymphocytes during cellular and humoral immune responses. Their production of cytokines and interleukins, interferons and complement components promotes coordination in the integrated immune response.

Normally, monocytes make up from 1 to 10% of circulating leukocytes. When the number of monocytes exceeds 100 /µl, we can talk about monocytosis, which is observed in patients with chronic infections (tuberculosis, chronic endocarditis) or inflammatory processes (autoimmune diseases, inflammatory bowel diseases).

Lymphocytes.

Lymphocytes make up a significant population of leukocytes. According to their structure, they are conditionally divided into small (5-9 microns), medium (10 microns) and large (11-13 microns). The lymphocyte is currently considered as the main cell of the immune system. These are small mononuclear cells that coordinate and carry out an immune response by producing inflammatory cytokines and antigen-specific binding receptors.

Lymphocytes are divided into two main categories: B cells and T cells - and several less numerous classes, for example, natural ("natural", normal) killer cells. Lymphocyte subgroups differ in the place of their formation and the effector molecules they express, but have a common feature - the ability to mediate a highly specific antigenic response. Lymphocytes are able to move, to penetrate into other cellular elements. A small part of lymphocytes has phagocytic activity. The main function of the lymphocyte is to participate in immune reactions. For example, T lymphocytes are active participants in the rejection reaction, the graft-versus-host reaction, and B lymphocytes produce antibodies that cause a humoral immune response.

Lymphocytes can retain immunological memory for a long time. Under the influence of a number of immune and chemical (mutogens) factors, they are able to proliferate.

The origin of lymphocytes in an adult occurs mainly in the bone marrow and goiter gland.

The lifespan of lymphocytes varies: in short-lived (obviously, which are involved in immune reactions) - 3-4 days, in long-lived 100-200 days and even 580 days. Their presence in the circulating blood does not exceed 40 minutes. The total number of circulating lymphocytes in an adult is 7.5 x 10.9 lymphocytes, and in the body, taking into account the reserve of these cells in the bone marrow, spleen, lymph nodes, thymus, tonsils and Peyer plaques - 6.0x10.12.

Old lymphocytes die in circulating blood and are eliminated by reticular-macrophage elements of capillaries.

According to the unitary theory, all the shaped elements of blood originate from a single polypotent undifferentiated (stem) cell. It has no morphological differences from a small lymphocyte.

Speaking of the shaped elements of the blood, it should be noted that after maturation in the bone marrow they do not immediately enter the vascular bed. For some time, blood cells remain in special depots in the bone marrow and spleen. This reserve of additional blood is one of the factors regulating the constant composition of blood. Once in the circulating stream, each blood cell functions for a certain time, gradually ages and is eliminated from the vascular bed. In place of old and eliminated cells, young shaped elements enter the circulating blood in the process of physiological regeneration from hematopoietic tissue. This process is the main mechanism for maintaining the constancy of blood composition and an essential factor in ensuring homeostasis in the body.

Plasma makes up most of the blood. It has a complex multicomponent composition. Plasma is based on water (90%), in which various proteins (7-8%) are dissolved, other organic compounds - glucose, enzymes, vitamins, acids, lipoids (1.1%) and minerals (0.9%).

The protein components of plasma provide, together with platelets, the hemostatic function of blood, participate in plastic processes in body tissues, determine humoral immunity, detoxification and transport function of blood. In plasma, the concentration of total protein (normally 70-80 g / l), albumin (40-45%) and globulins (55-60%) is determined electrophoretically. Albumins are formed in the liver, they are a low molecular weight (mm 69000) protein. One third of its total amount (200-300 g) in the adult body is in the circulating blood, and two thirds are outside the vascular bed. There is a continuous exchange of albumin between these basins. It performs several functions: it maintains colloidal osmotic pressure in blood and tissues (it accounts for 80% of the value of this indicator), on which transcapillary fluid metabolism, tissue turgor and fluid volume in the extravascular and vascular spaces depend. Easily combining with organic and inorganic substances, hormones, and medicines, albumin delivers them with blood flow to tissues and simultaneously removes some metabolic products into the vascular bed to the liver, kidneys, lungs, and gastrointestinal tract, contributing to detoxification of the body. It is one of the important components of the plasma buffer system, regulating the acid-base state of the blood. Participates in the nutrition of tissues as an easily digestible protein.

There are several humoral systems in plasma: complementary (complement components are involved in binding antigens to antibodies), coagulation and antiinflammatory systems, oxidant and antioxidant, kallecrein, properdin, nonspecific protection factors, humoral immunity factors and others. Plasma contains various protein complexes (glycoproteins, metalloproteins, lipoproteins, etc.), hormones, and other biologically active substances, which makes it possible to obtain the most valuable therapeutic drugs from it.

The physiological role of a number of plasma ingredients has not yet been sufficiently studied and needs further research.

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