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Physiological Features Of Blood.

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ABSTRACT

Blood is a fluid medium of the body, ensuring its integration and self-regulation during the whole ontogenesis. It carries oxygen and a lot of nutrients and biologically active substances to all tissues of the body. The following main functions of the blood are distinguished: respiratory, excretory, nutritional, homeostatic, regulatory, protective and thermoregulatory. Thanks to the respiratory function, the blood carries oxygen from the lungs to the tissues and carbon dioxide from them to the lungs. The excretory function is the transport of metabolic products to the excretion organs for the purpose of their subsequent removal from the body. The nutritional function is associated with the transport of nutrients (glucose, amino acids and lipids), formed as a result of digestion, to organs and tissues. Homeostatic function is the even distribution of blood between organs and tissues, maintaining a constant osmotic pressure and pH with the help of plasma proteins. Regulatory function is the transfer of hormones produced by the internal secretion glands to certain target organs for transmitting information inside the body. The protective function is to neutralize the blood cells of microorganisms and their toxins, the formation of antibodies, the removal of decay products of tissues, stop bleeding during the formation of a blood clot. The thermoregulatory function is accomplished by distributing heat between organs and the skin as a result of the high heat capacity and thermal conductivity of the blood. Blood has a complex composition, on the optimum of which depends on the state of health of the body at any age. For this reason, there is still a study and refinement of all aspects of the functioning of the blood in the body.
Keywords: physiology, blood, blood cells, plasma, health.

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INTRODUCTION

Blood is a fluid medium of the body, ensuring its integration and self-regulation throughout ontogenesis [1, 2]. It carries oxygen and a lot of nutrients and biologically active substances into all tissues of the body [3, 4, 5]. Depending on the nature of the transported substances, a number of blood functions are distinguished: respiratory, excretory, nutritious, homeostatic, regulatory, protective and thermoregulatory [6, 7].

Thanks to the respiratory function, the blood transports oxygen from the lungs to organs and tissues and carbon dioxide from peripheral tissues to the lungs. The excretory function transports the metabolic products to the excretion organs for the purpose of their subsequent removal as substances harmful to the body. The nutritional function is based on the movement of nutrients (glucose, amino acids and lipids), formed as a result of digestion, to organs and tissues. Homeostatic function is the even distribution of blood between organs and tissues, maintaining a constant osmotic pressure and pH with the help of plasma proteins. Regulatory function is the transfer of hormones produced by the internal secretion glands to certain target organs for transmitting information inside the body. The protective function is to neutralize the blood cells of microorganisms and their toxins, the formation of antibodies, the removal of decay products of tissues, stop bleeding as a result of blood clots. The thermoregulatory function is carried out by transferring heat to the outside of the deep-lying organs to the skin vessels, as well as by the uniform distribution of heat in the body as a result of the high heat capacity and thermal conductivity of the blood [8, 9]. Given the enormous biological significance of blood, the goal was set in the work: to examine the basics of blood physiology.

In humans, the mass of all blood is 6-8% of body weight and in normal conditions it is approximately 4.5-5.0 l. At rest, only 40-50% of all blood circulates, the rest of it is in the depot (liver, spleen, skin). In the small circle of blood circulation contains 20-25% of blood volume, in a large circle - 75-85% of blood. In the arterial system, 15–20% of the blood circulates, in the venous system, 70–75%, and in the capillaries, 5–7% [10].

The blood consists of cellular (shaped) elements (45%) and the liquid part - plasma (65%). The plasma contains salts dissolved in water, proteins, carbohydrates, biologically active compounds, and also carbon dioxide and oxygen. Plasma contains about 90% water, 7–8% protein, 1.1% other organic substances, and 0.9% inorganic components. It ensures the constancy of the volume inside the vascular fluid and the acid-base balance, and also participates in the transfer of active substances and metabolic products.

Plasma proteins are divided into two main groups: albumin and globulins. About 60% of plasma proteins belong to the first group. Globulins are represented by fractions: α_1, α_2, β_2 and γ- globulins. The globulin fraction also contains fibrinogen. Plasma proteins are involved in such processes as the formation of tissue fluid, lymph, urine and water absorption. The nutritional function of plasma is associated with the presence of lipids in it, the content of which depends on the diet [11].

Blood serum does not contain fibrinogen, this is different from plasma and does not coagulate. Serum is prepared from blood plasma by removing fibrin from it. The blood is placed in a cylindrical vessel, after a certain time it coagulates and turns into a clot, from which a light yellow liquid is removed - blood serum [12].

Blood is a colloid-polymer solution, the solvent in which is water, and soluble substances are salts, low-molecular-weight organic compounds, proteins, and their complexes [13].

Osmotic pressure of blood is the strength of the movement of the solvent through a semi-permeable membrane from a less concentrated solution to a more concentrated one. Osmotic pressure of blood is at a relatively constant level for metabolism and is 7.3 atm (5600 mm Hg. Art., or 745 kPa). It depends on the content of ions and salts, which are in a dissociated state, as well as on the amount of fluids dissolved in the body. The concentration of salts in the blood is 0.9%, the osmotic pressure of the blood mainly depends on their content [14].

Osmotic pressure is determined by the concentration of various substances dissolved in body fluids at the required physiological level. With the help of osmotic pressure, water is distributed evenly between cells and tissues [15]. Solutions in which the osmotic pressure level is higher than in the cell contents (hypertonic solutions) cause the cells to wrinkle as a result of water passing from the cell to the solution. Solutions with a lower level of osmotic pressure than in the cell contents (hypotonic solutions) increase the volume of cells as a result of the transfer of water from solution to cell. Solutions whose osmotic pressure is equal to the osmotic pressure of the cell contents and which do not cause changes in the cells are called isotonic [16, 17].

The regulation of osmotic pressure is neurohumoral. In addition, in the walls of blood vessels, tissues, the hypothalamus are special osmoreceptors that respond to changes in osmotic pressure. Irritation leads to a change in the activity of the excretory organs (kidneys, sweat glands) [17,18].

The blood pH is maintained constant pH. The reaction of the medium is determined by the concentration of hydrogen ions, which are expressed in the pH of pH, which is of great importance, since the absolute majority of biochemical reactions can normally take place only at certain pH values. Human blood has a weak alkaline reaction: the pH value of venous blood is 7.36; arterial - 7.4. Life is possible in a fairly narrow range of pH shift - from 7.0 to 7.8. Despite the continuous flow of acidic and alkaline metabolic products into the blood, the pH of the blood is maintained at a constant level. This constancy is maintained by physicochemical, biochemical, and physiological mechanisms [18].

There are several buffer blood systems (carbonate, plasma proteins, phosphate and hemoglobin) that bind hydroxyl and hydrogen ions and, therefore, keep the blood reaction at a constant level. In this case, an excess of the formed acidic and alkaline metabolic products of the kidney exchange with urine is excreted from the body, and carbon dioxide is emitted from the lungs [19, 20].

Red blood cells, leukocytes and platelets are among the blood cells [21].

Red blood cells - red blood corpuscles of biconcave shape. They have no core. The average diameter of erythrocytes is 7-8 microns; it is approximately equal to the internal diameter of the blood capillary. The form of the erythrocyte increases the possibility of gas exchange, contributes to the diffusion of gases from the surface to the entire cell volume. Red blood cells are very elastic. They easily pass through capillaries having a diameter twice as small as the cell itself. The total surface area of all erythrocytes of an adult is about 3,800 m^2, which is 1,500 times larger than the surface of the body [22, 23].

The blood of men contains about 5×10^{12}/l of erythrocytes, in the blood of women - 4.5×10^{12}/l. With increased physical exertion, the number of red blood cells in the blood may increase to 6×10^{12}/l. This is due to the flow of deposited blood into the circulation [24].

The main feature of red blood cells - the presence of hemoglobin in them, which binds oxygen and gives it to peripheral tissues. Hemoglobin consists of globin protein and heme, which are attached to the four polypeptide chains of globin and give the blood a red color. Normally, blood contains about 140 g/l of hemoglobin: for men - 135-155 g/l, for women - 120-140 g/l. Hemoglobin, given away oxygen, is called restored or reduced, it has the color of venous blood. Having given up oxygen, the blood gradually absorbs the final product of metabolism - CO2 (carbon dioxide). The reaction of hemoglobin to CO_2 is more difficult than binding to oxygen. This is explained by the role of CO_2 in the formation of acid-base balance in the body. A hemoglobin that binds carbon dioxide is called a carbo-hemoglobin. Under the influence of the carbonic anhydrase enzyme in erythrocytes, carbonic acid is split into CO2 and H_2O. Carbon dioxide is released by the lungs and there is no change in the blood reaction. Hemoglobin is particularly easy to attach to carbon monoxide (CO) due to its high chemical affinity (300 times higher than O_2) to hemoglobin. Hemoglobin blocked by carbon monoxide can no longer serve as a carrier of oxygen and is called carboxyhemoglobin. As a result, oxygen starvation occurs in the body, accompanied by vomiting, headache, loss of consciousness [25, 26].

Reducing the amount of hemoglobin in the blood is called anemia. It is observed with bleeding, intoxication, deficiency of vitamin B_{12}, folic acid.

The life of red blood cells is about 3-4 months. The process of destruction of red blood cells, in which hemoglobin comes out of them into the plasma, is called hemolysis [27].

When the blood is in a vertically arranged test tube, erythrocyte sedimentation is observed downward. This is because the specific density of erythrocytes is higher than the plasma density (1.096 and 1.027). The erythrocyte sedimentation rate is expressed in millimeters of the height of the plasma column over the erythrocytes per unit of time (usually 1 hour). This reaction characterizes some physico-chemical properties of blood. The erythrocyte sedimentation rate in men is normally 5–7 mm/h, in women - 8–12 mm/h. The erythrocyte sedimentation mechanism depends on many factors, for example, on the number of erythrocytes, their morphological features, charge size, ability to agglomerate, plasma protein composition, etc. Increased erythrocyte sedimentation rate is typical for pregnant women - up to 30 mm/h, patients with infectious and inflammatory processes as well as with malignant tumors - up to 50 mm/h and more [28].

White blood cells - white blood cells. In size, they are larger than erythrocytes, they have a nucleus. The life span of leukocytes is several days. The number of leukocytes in a person's blood is normally 4-9×10^9/l and fluctuates during the day. The least of them in the morning on an empty stomach. An increase in the number of leukocytes in the blood is called leukocytosis, and a decrease is called leukopenia. There are physiological and reactive leukocytosis. The first is more often observed after a meal, during pregnancy, with muscle loads, pain, emotional stress. The second type is characteristic of inflammatory processes and infectious diseases. Leukopenia is observed in some infectious diseases, exposure to ionizing radiation, medication [29].

Leukocytes of all types possess mobility of amoebas and, if there are appropriate chemical stimuli, they pass through the capillary endothelium (diapedez) and rush to the stimulus: microbes, foreign bodies or antigen-antibody complexes. According to the presence of granularity in the cytoplasm, leukocytes are divided into granular (granulocytes) and non-granular (agranulocytes).

Cells whose granules are stained with acidic dyes (eosin) are called eosinophils; main colors (methylene blue, etc.) - basophils; neutral colors - neutrophils. The first are painted in pink, the second - in blue, the third - in pink-violet [30].

Granulocytes make up 72% of the total leukocyte count, of which 70% are neutrophils, 1.5% are eosinophils, and 0.5% are basophils. Neutrophils are able to penetrate the intercellular spaces to infected areas of the body, absorb and digest the bacteria. The number of eosinophils increases with allergic reactions, bronchial asthma, hay fever, they have an antihistamine effect. Basophils produce heparin and histamine [31].

Agranulocytes are leukocytes that consist of an oval-shaped nucleus and non-granular cytoplasm. These include monocytes and lymphocytes. Monocytes have a bean-shaped nucleus, are formed in the bone marrow. They actively penetrate into the foci of inflammation and absorb (phagocytic) bacteria. Lymphocytes are formed in the thymus gland (thymus gland), from the stem lymphoid cells of the bone marrow and spleen [32]. Lymphocytes produce antibodies and participate in cellular immune responses. There are T-and B-lymphocytes. With the help of enzymes, T-lymphocytes independently destroy microorganisms, viruses, cells of a transplanted tissue and are called killer killer cells. When B-lymphocytes meet with a foreign substance with the help of specific antibodies, they neutralize and bind these substances, preparing them for phagocytosis. A condition in which the number of lymphocytes exceeds the normal level of their content is called lymphocytosis, and a decrease is called lymphopenia [33,34].

The number of certain types of leukocytes increases with a number of diseases [35]. For example, in whooping cough, typhoid fever, the level of lymphocytes increases, in malaria, monocytes, and in pneumonia and other infectious diseases, neutrophils [36]. The number of eosinophils increases with allergic diseases (bronchial asthma, scarlet fever, etc.). Typical changes in leukocyte formula make it possible to make an accurate diagnosis [37,38].

Platelets are colorless spherical nuclear-free bodies with a diameter of 2-5 microns [39,40]. They are formed in large cells of the bone marrow - megakaryocytes [41]. The life span of platelets is from 5 to 11 days [42]. They play an important role in blood coagulation. Much of them are stored in the spleen, liver, lungs, and as needed enters the blood [43]. During muscular work, eating, pregnancy, the number of platelets in the blood increases. Normally, the platelet count is about 250×10^9/l [44].

Blood groups are immunogenetic and individual signs of blood that unite people according to the similarity of certain antigens - agglutinogens - in erythrocytes and in the blood plasma of antibodies - agglutinins. In this regard, four blood types are distinguished: 0 (I), A (II), B (III) and AB (IV). The combination of similar agglutinogens of erythrocytes with plasma agglutinins leads to the agglutination (gluing) of erythrocytes, which underlies the group incompatibility of blood [45].

The study of blood types has become much more complicated due to the discovery of new agglutinogens. For example, group A has a number of subgroups, in addition, new agglutinogens — M, N, S, P, etc. — have been found. These factors sometimes cause complications during repeated blood transfusions [46,47].

People with the first blood group are considered universal donors. However, it turned out that this universality is not absolute. This is due to the fact that immune anti-A and anti-B-agglutinins have been significantly detected in people with the first blood group. Transfusion of such blood can lead to serious complications and possibly fatal. These data served as the basis for transfusion of only one-group blood [48].

In addition to the main agglutinogens A and B, there may be others in the erythrocytes, in particular the so-called Rh factor, which was first found in the blood of the monkey rhesus monkey. According to the presence or absence of the Rh factor, Rh-positive (about 85% of people) and Rh-negative (about 15% of people) organisms are isolated. In medical practice, the Rh factor is of great importance. Thus, in Rh-negative people, blood transfusions or repeated pregnancies cause the formation of Rh antibodies. Rhesus-positive blood transfusions to people with Rh antibodies show severe hemolytic reactions, accompanied by destruction of transfused red blood cells [49].

The basis of the development of Rh-conflict pregnancy is getting into the body through the placenta of the Rh-negative woman's Rh-positive fetus erythrocytes and the formation of specific antibodies. In such cases, the first child who inherited the Rh-positive affiliation is born normal. And during the second pregnancy, the mother’s antibodies that have entered the fetal blood cause the destruction of red blood cells, the accumulation of bilirubin in the blood of the newborn and the appearance of hemolytic jaundice with damage to the internal organs of the child [50].

Blood coagulation is a defensive reaction that prevents blood loss and the entry of pathogens into the body. This constitutes a multistep process [51]. It involves 12 factors that are in the blood plasma, as well as substances released from damaged tissues and platelets. In coagulation of blood, there are three stages. In the first stage, the blood flowing from the wound is mixed with the substances of damaged tissues, destroyed platelets and in contact with air. Then, released thromboplastin precursor under the influence of plasma factors of calcium ions is converted into active thromboplastin [52]. In the second stage, with the participation of thromboplastin, plasma factors, calcium ions, the inactive plasma protein prothrombin is converted to thrombin. In the third stage, thrombin (a proteolytic enzyme) breaks down the plasma protein molecule fibrinogen. Into small parts and creates a network of fibrin filaments (insoluble protein), which precipitates. In the networks of fibrin, the formed elements of the blood linger and form a clot that prevents the loss of blood and the penetration of microorganisms into the wound. After removal of fibrin from plasma, a liquid remains - serum [53].

Blood can be used as a remedy. In practical medicine, blood transfusion and its preparations are widely used. To ensure blood donation is widespread. People who donate blood for medicinal purposes are called donors. In active donors, a single dose of blood donation is 250-450 ml. As a rule, this results in a decrease in the amount of hemoglobin and erythrocytes in proportion to the amount of blood taken. The rate of return to normal blood donor depends on many reasons, including the dose of blood taken, age, sex, nutrition [54].

CONCLUSION

Blood is an important tissue in the body that is constantly in a liquid state. It has a complex composition and performs a lot of important functions for the body. The state of health of an organism at any age depends on the optimum of its parameters. Until now, the study and clarification of all aspects of the functioning of the blood in the body in humans and animals.

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