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Modern Concepts of Hemopoiesis

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Annotation: This paper presents information on the blood system, which includes hematopoietic organs and peripheral blood cells, united by neurohumoral regulation of the dynamic processes of hematopoiesis and hematopoietic breakdown. It is shown that cells gradually age, the enzyme composition and structure of cell membranes change, and energy production decreases, leading to their destruction. Monocytes circulate briefly in the peripheral blood; they are carried by the bloodstream to organs and tissues and transform into macrophages, forming the mononuclear phagocyte system.

Keywords: lymphocyte, formen, element, antigen, mitogen, organ, hematopoiesis, cell, neurohumoral, enzyme, membrane, monocyte, peripheral.

The blood system is multicomponent and multifunctional, encompassing hematopoietic organs and peripheral blood cells, united by neurohumoral regulation of the dynamic processes of hematopoiesis and hematopoiesis. Functionally, the blood system is closely linked to other organs and systems (respiratory, cardiovascular, digestive, etc.), and peripheral blood parameters are critical parameters of homeostasis. Disorders in the blood system can develop under the influence of a variety of factors, both directly affecting the system itself and indirectly, as a result of pathological processes affecting other systems [1-2].

This is why blood is called the mirror of the body's life; blood analysis serves as the first step in diagnosing many diseases, allowing us to judge the severity of the process and the degree of expression of compensatory adaptive reactions.

Over the past decade, theoretical and clinical hematology has accumulated new information on the mechanisms of hematopoiesis and the development of many blood diseases, primarily tumors, which has led to changes in disease classifications. Fundamental research in molecular and cellular biology, immunology, oncology, and other sciences has provided the foundation for new diagnostic and therapeutic methods, leading to advances in the treatment of hematological diseases previously considered incurable.

Hematopoiesis – a multi-stage process of formation of various types of blood cells in specialized hematopoietic organs.

Myelopoiesis —the formation of red blood cells, granulocytes, monocytes, and platelets— occurs in the bone marrow. Lymphopoiesis occurs in the organs of the lymphoid system, where T- and B-lymphocytes mature . Hematopoiesis is a continuous process, and peripheral blood cells are constantly renewed throughout a person's life.

Thus, erythrocytes circulate for about 4 months, platelets - 1 week, granulocytes - 10 hours. Hematopoietic tissues have high mitotic activity, since as a result of aging and destruction, about 100 billion blood cells are lost daily and replenished by the bone marrow.

On average, during a person’s lifetime, about 5400 kg of granulocytes, 460 kg of erythrocytes, 275 kg of lymphocytes and 40 kg of platelets are produced.

Blood cells are formed through the proliferation and differentiation of progenitor cells. This process is conventionally divided into six stages, each corresponding to a specific class of cells.

The generally accepted hierarchical model of hematopoiesis posits that all blood cell types originate from a pluripotent hematopoietic stem cell (HSC). HSCs possess the ability to reproduce (self-renew) and differentiate (transform) into more mature cells, occupying the first step of the hierarchical ladder and belonging to the first class of cells.

Under the influence of the microenvironment and hematopoietic factors, HSCs undergo several stages of differentiation, specific to each hematopoietic lineage. Gradually, the cells' proliferative activity decreases, and they acquire the characteristic morphological and functional properties of mature cells.

The existence of HSCs has been proven by functional research methods based on their ability to completely restore hematopoiesis in irradiated animals and form various colonies of blood cells *in in vitro* and *in vivo* .

The mechanisms regulating the self-renewal and differentiation of pluripotent stem cells are being actively studied. It is believed that stem cells occur at a frequency of 1:106–107 nucleated cells in the bone marrow and constitute approximately 0.01% of all hematopoietic cells.

Most hematopoietic stem cells are in a quiescent state. Their morphological properties resemble those of small lymphocytes, while in the dividing phase, HSCs resemble primitive blast cells. The proliferation and constant recirculation of HSCs in the bloodstream ensure the necessary intensity of hematopoiesis.

It is believed that the SCCs are heterogeneous in their properties and there are 2 pools of SCCs.

The first pool consists of early HSCs, which self-renew and divide approximately 50 times, maintaining blood cell production throughout life. The second pool includes multipotent proliferating HSCs, capable of restoring hematopoiesis and forming colonies in the spleen of lethally irradiated mice.

In this way, a balance is maintained between the number of stem cells and the formation of precursor cells of certain hematopoietic lineages.

The second class of cells consists of pluripotent committed progenitors, which, unlike HSCs, can develop not in all, but only in a few (2–5) directions. This class includes the common progenitor cell myelopoiesis (CFU-GEMM), from which granulocytes, erythrocytes, monocytes (macrophages) and platelets, as well as the lymphopoiesis precursor cell, are subsequently formed .

It also includes common progenitor cells for several types of myeloid cells:

KOE-GM – a precursor of granulocytes and macrophages,

KOE-GE – precursor of granulocytes and erythrocytes,

CFU-G – precursor of granulocytes, etc.

The abbreviated names of cells characterize their ability to form colonies (CFU – colony-forming unit), consisting of different cells.

The third class includes monopotent (unipotent) committed precursors of certain types of blood cells (Pre-T – T lymphocytes and Pre-B – B lymphocytes, KOE-B – basophils, KOE-E – eosinophils, KOE-M – monocytes, KOE-E – erythrocytes, KOE-MHC – platelets).

Cells of the second and third classes make up about 1% of all cells hematopoiesis . Like stem cells, they are morphologically indistinguishable, but differ in clonogenic capacity and differentiation markers detected by immunocytochemical , molecular genetic, and biochemical methods.

It should be noted that information about cells belonging to the upper steps of the hierarchical ladder (I–III classes) is constantly being supplemented and the hematopoiesis scheme is being adjusted taking into account new data obtained by experimental hematology.

The fourth class consists of morphologically recognizable blast (immature) cells of all hematopoietic lineages. With conventional cell staining methods, morphological signs of differentiation at this stage are weak. For a more detailed characterization, cytochemical methods and immunophenotyping are used .

The fifth class includes morphologically recognizable proliferating and maturing cells of all hematopoietic lineages, comprising 2–10% of cells. The number of morphologically characterized maturation stages varies among hematopoietic lineages; granulocytes and erythrocytes have the highest number [3-16].

The sixth, most numerous class (90% of cells) consists of mature cells that enter the peripheral blood. Erythrocytes, granulocytes, and platelets released from the bone marrow into the peripheral blood have a fixed lifespan.

Gradually, cells age, the composition of enzymes and the structure of cell membranes change, energy production decreases, which leads to their destruction.

Monocytes circulate briefly in the peripheral blood—they are carried by the bloodstream to organs and tissues and transform into macrophages, forming the mononuclear phagocyte system. Some lymphocytes, unlike other mature formed elements, are capable of proliferating (blast transformation reaction) when stimulated by antigens or mitogens , forming clones of cells with new properties.

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