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MORPHOLOGICAL AND FUNCTIONAL FOUNDATIONS OF HEMATOPOIESIS

Fergana medical institute of public health
Akbarova Ra'noxon Komiljonovna

Abstract

The process of blood formation - hematopoiesis - is one of the most crucial biological systems that sustain the vital functions of an organism. Through this process, the formed elements of blood: erythrocytes, leukocytes, and thrombocytes are produced and continuously renewed. Hematopoiesis is a complex, multi-stage, and strictly regulated process, which is directly linked to the morphological structure and intercellular functional connections of bone marrow and lymphoid tissues. This article comprehensively covers the morphological substrates of the hematopoiesis process, the stages of cellular differentiation, regulatory mechanisms, and their functional significance.

Keywords

Hematopoiesis, bone marrow, stem cells, erythropoiesis, leukopoiesis, thrombopoiesis, hematopoietic microenvironment, cytokines, morphology, functional system.

INTRODUCTION

The hematopoietic system is the central system that ensures the body's adaptability, immune defense, gas exchange, and stability of hemostasis. Disorders in the hematopoiesis process lead to anemias, leukemias, myelodysplastic syndromes, thrombocytopenias, and immunodeficiency states. The increasing number of hematological diseases in modern medicine necessitates a deep study of the morphological and functional foundations of hematopoiesis. Therefore, pathoanatomical and physiological analysis of hematopoiesis mechanisms plays a crucial role in improving diagnostic, prognostic, and treatment strategies.

Hematopoiesis is a continuous biological process associated with the formation, maturation, and achievement of functional activity of blood cells, which continues throughout life, starting from the period of embryonic development. During the embryonic period, hematopoiesis occurs in several stages: initially, primary hematopoiesis takes place in the yolk sac, later the liver and spleen become the main centers of hematopoiesis, and after birth, the red bone marrow functions as the primary hematopoietic organ.

The process of hematopoiesis forms in the early stages of an organism's ontogenesis and is characterized by the succession of several sequential morphological and functional centers during embryonic development. In the initial weeks of fetal development, blood cells begin to form in the wall of the yolk sac from cells originating in the mesoderm[1,2]. Hematopoiesis occurring during this period is primarily temporary, with primary erythrocytes distinguished by their large size, presence of nuclei, and content of embryonic hemoglobin. These cells are adapted to supply oxygen to the rapidly growing fetal tissues, and their morphology differs fundamentally from mature erythrocytes.

In later stages of fetal development, the center of hematopoiesis gradually shifts from the yolk sac to the liver and spleen. During hepatic hematopoiesis, the differentiation of blood cells becomes more complex, and alongside the erythroid lineage, myeloid and lymphoid cells begin to form. Morphologically, during this period, clusters of hematopoietic cells located between hepatocytes and proliferation foci in close contact with sinusoidal capillaries are identified. In the spleen, hematopoiesis occurs mainly in the pulp areas and develops in close association with elements of the immune system, which lays an important foundation for the future formation of the immune response.

From the final trimester of fetal development, the main burden of hematopoiesis begins to shift to the bone marrow[3,4]. By the time of birth, almost all bone cavities are involved in active hematopoiesis, and the red bone marrow becomes the organism's primary hematopoietic organ. In the postnatal period, the morphological localization of hematopoiesis becomes clearly defined,

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mainly persisting in the epiphyseal regions of long bones and flat bones, while fatty bone marrow forms in the diaphyses. This morphological redistribution is directly linked to the age-specific physiological needs of the organism[5,6].

Functionally, this gradual relocation of hematopoiesis is an adaptive mechanism aimed at ensuring the qualitative and quantitative maturity of blood cells. Each hematopoietic center specializes in producing cells corresponding to a specific developmental period, which demonstrates the evolutionary sophistication of the hematopoietic system[7,8,9]. It is precisely the mature hematopoietic system, formed in the bone marrow, that enables the continuous renewal of blood's formed elements throughout the organism's lifespan, ensuring immune defense and maintaining hemostasis stability.

In an adult organism, the main center of hematopoiesis is the red bone marrow, which is located in flat bones, vertebrae, ribs, sternum, and the epiphyseal parts of long bones. Morphologically, red bone marrow has a complex cellular structure, functioning based on the close interaction of hematopoietic cells and stromal elements[10,11]. The bone marrow stroma consists of fibroblasts, endothelial cells, macrophages, adipocytes, and reticular fibers, which create a specialized microenvironment for hematopoietic cells.

The primary source of hematopoiesis is hematopoietic stem cells. These cells possess the ability to self-renew and differentiate, serving as the origin of all blood cells. Morphologically, stem cells are characterized by a large nucleus, relatively small cytoplasm, and high mitotic activity. Functionally, they ensure the continuity of hematopoiesis[12,13].

Erythropoiesis is the process of red blood cell formation, which occurs through the sequential differentiation of erythroid lineage cells. Morphologically, from the proerythroblast stage to the mature erythrocyte, the cell volume decreases, the nucleus condenses and eventually disappears, and the cytoplasm becomes saturated with hemoglobin. Functionally, erythropoiesis meets the body's oxygen requirements[14,15]. This process is primarily regulated by the hormone erythropoietin, which is produced by the kidneys under hypoxic conditions.

Leukopoiesis is the process of white blood cell formation, which occurs through myeloid and lymphoid pathways. Granulocytes, monocytes, and lymphocytes undergo complex stages of morphological maturation. The functional significance of leukopoiesis lies in protecting the body from infections, regulating inflammatory processes, and forming the immune response. From a pathoanatomical perspective, disorders of leukopoiesis manifest as leukemias and immunodeficiency states.

Thrombopoiesis is the process of platelet formation, which occurs through the separation of platelets from the cytoplasm of megakaryocytes[16,17]. Megakaryocytes are the largest cells in the bone marrow and have a polyploid nucleus. Morphologically, thrombopoiesis is closely associated with vascular sinusoids, with platelets entering directly into the bloodstream. Functionally, platelets play a crucial role in maintaining hemostasis and vascular integrity.

The process of hematopoiesis is strictly controlled by numerous biologically active substances - cytokines, growth factors, and hormones. Interleukins, colony-stimulating factors, thrombopoietin, and erythropoietin coordinate the proliferation and differentiation of hematopoietic cells[18,19]. When morphological and functional balance is disrupted, pathological hematopoiesis develops.

Thus, hematopoiesis is the central system that ensures the vital activity of the organism, and its morphological and functional foundations are closely interrelated. Disruption of this process leads to the development of many severe hematological and systemic diseases.

References

1. Hoffbrand A.V., Moss P.A.H. *Essential Haematology*. Wiley-Blackwell.
2. Junqueira L.C., Carneiro J. *Basic Histology*. McGraw-Hill.
3. Rahmatjonovna, I. N. (2024). Fast foods are the potential of human health. *Ethiopian International Journal of Multidisciplinary Research*, *11*(05), 365-369.

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4. Isaqova, N. (2022). Bolalarning antropometrik ko'rsatkichlarini turli omillarga bog'liqligi. *Science and innovation*, *1*(D8), 1000-1003.
5. Рахматжоновна, И. Н. Алиментарного ожирение и репродуктивное здоровье женшин в современном аспекте физической реабилитации. *O'zbekiston harbiy tibbiyoti*, *4*(4), 368-370.
6. Isaqova, N. (2022). Қабзиятнинг болалар антропометрик кўрсаткичларига таъсири. *Science and innovation*, *1*(D8), 888-892.
7. Isaqova, N. (2024). MICROSCOPIC EXAMINATION OF SPUTUM. *Развитие и инновации в науке*, *3*(6), 63-66.
8. Исакова, Н., & Усмонова, Г. (2024, June). ЛАБАРАТОРНАЯ ДИАГНОСТИКА ТРИХОМОНИЗА. In *международная конференция академических наук* (Vol. 3, No. 6, pp. 59-65).
9. Raxmatjonovna, I. N. (2024). Labaratory diagnostics of trichomonisis disease. *Ethiopian International Journal of Multidisciplinary Research*, *11*(05), 496-499.
10. Raxmatjonovna, I. N. (2023). The problem of acceleration of children's development (literature review). *International Multidisciplinary Journal for Research & Development. Volume10*, (12), 160-164.
11. Исакова, Н., & Усмонова, Г. Кишечный дисбактериоз//Models and methods in modern science.–2024. *T*, *3*, 106-112.
12. Raxmatjonovna, I. N. The most pressing problem today is iodine deficiency. *World Bulletin of Public Health*, *23*, 97-100.
13. Raxmatjonovna, I. N. Anthropometric indicators of children. *Scientific Impulse*, *1*(5), 883-887.
14. Isakova, N. R. (2021). The effect of constipation due to diseases of the colon on the anthropometric parameters of children. *ASIAN JOURNAL OF MULTIDIMENSIONAL RESEARCH*, *10*(5), 666-669.
15. Kumar V., Abbas A.K., Aster J.C. *Robbins and Cotran Pathologic Basis of Disease*. Elsevier.\
16. Guyton A.C., Hall J.E. *Textbook of Medical Physiology*. Elsevier.
17. Lichtman M.A. et al. *Williams Hematology*. McGraw-Hill.
18. Young N.S., Abkowitz J.L., Luzzatto L. *New insights into hematopoiesis*. Blood Journal.
19. Abbas A.K., Lichtman A.H. *Cellular and Molecular Immunology*. Elsevier.