



THE ROLE OF BIOLOGICAL FACTORS IN THE DEVELOPMENT OF THE IMMUNE SYSTEM.

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ABSTRACT

This article examines the role of biological factors in the development of the immune system. The immune system is a complex network of cells, tissues, and organs that protects the organism from pathogens and maintains internal homeostasis. The formation and maturation of the immune system are influenced by various biological factors, including genetic background, prenatal developmental conditions, microbial colonization, and environmental influences. Special attention is given to the structural and functional development of primary and secondary lymphoid organs from a histological perspective. The article also discusses how biological factors influence the differentiation of immune cells and the formation of immune responses. Understanding these processes is essential for explaining immune disorders, improving disease prevention, and developing modern immunological therapies..

Introduction

The immune system plays a fundamental role in protecting the organism from infectious agents and maintaining physiological balance. It consists of a coordinated network of immune cells, lymphoid tissues, and signaling molecules that work together to recognize and eliminate pathogens. The development of this complex system begins during the early stages of embryonic life and continues throughout childhood and adolescence.

The formation and maturation of the immune system are strongly influenced by biological factors. These include genetic determinants, prenatal developmental processes, the differentiation of immune cells, and the interaction between the organism and microorganisms. Histological studies demonstrate that the structural organization of lymphoid organs such as the thymus, bone marrow, spleen, and lymph nodes is essential for the proper development of immune responses.

Biological factors regulate the proliferation, migration, and maturation of immune cells. For example, hematopoietic stem cells in the bone marrow give rise to various immune cells, including lymphocytes, macrophages, and granulocytes. The thymus plays a crucial role in T-lymphocyte maturation, while B-lymphocytes develop primarily in the bone marrow. The coordinated development of these cells forms the foundation of adaptive immunity.

Materials and Methods

This study is based on the analysis of scientific literature related to immunology, histology, and human physiology. Academic textbooks and scientific publications were used to examine the biological mechanisms involved in immune system development. The research focused on the histological structure of lymphoid organs and the biological factors influencing immune cell differentiation.

Comparative analysis and descriptive methods were applied to evaluate the developmental stages of the immune system. Special attention was given to prenatal development, postnatal maturation of immune organs, and the role of genetic and microbial factors in immune regulation. The selected materials provided a comprehensive understanding of how biological processes affect immune system formation.

Results and Discussion

The development of the immune system begins during embryogenesis. Hematopoietic stem cells initially appear in the yolk sac and later migrate to the fetal liver and bone marrow, where they differentiate into various immune cell lineages. This process is regulated by genetic factors and molecular signals that control cell proliferation and differentiation.

One of the most important biological factors in immune system development is the formation of primary lymphoid organs. The bone marrow serves as the main site for hematopoiesis and B-lymphocyte development. Histologically, it contains a complex microenvironment consisting of stromal cells, blood vessels, and extracellular matrix components that support immune cell maturation.

The thymus is another essential organ involved in immune development. It is responsible for the maturation and selection of T-lymphocytes. During this process, immature T cells undergo positive and negative selection to ensure that they can recognize foreign antigens while remaining tolerant to the body's own tissues. Histologically, the thymus consists of cortical and medullary regions, each containing specific cell populations that regulate T-cell differentiation.

Secondary lymphoid organs such as lymph nodes, spleen, and mucosa-associated lymphoid tissue play a major role in immune responses after birth. These organs provide sites where immune cells interact with antigens and initiate adaptive immune reactions. Their structural organization allows efficient communication between antigen-presenting cells and lymphocytes.

Another important biological factor is the role of microbiota. After birth, microorganisms colonize the skin, gastrointestinal tract, and respiratory system. These microbial communities stimulate immune system maturation by promoting the development of immune tolerance and protective immune responses. The interaction between host cells and microbiota is essential for maintaining immune homeostasis.

Genetic factors also significantly influence immune system development. Specific genes regulate the production of cytokines, immune receptors, and signaling molecules that control immune cell function. Variations in these genes can affect susceptibility to infections, autoimmune diseases, and allergic conditions.

Environmental biological influences such as nutrition, maternal health during pregnancy, and exposure to pathogens further shape immune development. Adequate nutritional status supports immune cell production and antibody formation, while deficiencies in essential nutrients may impair immune responses.

Conclusion

The development of the immune system is a complex biological process influenced by multiple factors. Genetic background, prenatal development, the formation of lymphoid organs, microbial colonization, and environmental conditions all contribute to immune system maturation. Histological studies demonstrate that the structural organization of immune organs plays a crucial role in the differentiation and function of immune cells.

Understanding the biological mechanisms underlying immune development is essential for improving disease prevention, vaccination strategies, and immunological therapies. Further research in immunology and histology will continue to reveal new insights into how biological factors regulate immune function throughout life.

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