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THE MEDICAL SIGNIFICANCE OF BIOGENIC ELEMENTS

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Abstract

This article explores the biological role of biogenic elements in the human body, their involvement in physiological processes, and their medical importance. Biogenic elements play a crucial role in cell structure, enzyme activity, blood composition, and the functioning of the skeletal and nervous systems. The article provides information about diseases related to deficiencies or excesses of macro- and microelements, as well as methods for diagnosis and treatment. Additionally, it discusses the prospects of using biogenic elements in modern diagnostics and treatment processes.

Keywords

biogenic elements, medicine, microelements, macroelements, physiology of the organism, diseases, diagnostics, calcium, iron, iodine, magnesium, minerals, balance.

Introduction

The human body is a complex and perfect biological system in which numerous chemical elements participate to sustain life. Among these, biogenic elements hold a special place. They are found in the cells and tissues of the body and are actively involved in vital physiological processes such as metabolism, enzymatic reactions, hormone synthesis, and the transmission of nerve impulses.

Biogenic elements are divided into two main groups: **macroelements** (e.g., calcium, sodium, potassium, magnesium) and **microelements** (e.g., iron, iodine, zinc, copper). Adequate and balanced intake of these elements is essential for a healthy lifestyle. Deficiency or excess of these substances can lead to numerous diseases, including anemia, thyroid disorders, bone fragility, and nervous system dysfunctions.

This article provides a broad overview of the importance of biogenic elements, health conditions linked to their deficiency, and their application in modern medicine.

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Biogenic Elements: Biological Functions and Medical Importance

Biogenic elements are chemical substances essential for life and found in living cells. They contribute not only to the structure of cells and tissues but also participate directly in metabolism, energy exchange, genetic information transmission, enzyme activity, nerve impulse conduction, and hormonal control. Based on their quantity, they are classified as macroelements, microelements, and sometimes ultramicroelements.

Macroelements: Structural Support of the Organism

Calcium (Ca) is the most abundant mineral element in the human body, with 99% found in bones and teeth. The remaining portion is located in blood plasma, intercellular fluids, and inside cells. Calcium plays an essential role in bone tissue formation, blood clotting, muscle contraction, heart activity, and signal transmission through cell membranes. The body contains about 1.5 kg of calcium, stored in bone reserves and in fluid as active calcium.

Phosphorus (P) is present in ATP, DNA, RNA, phospholipids, and many enzymes. It is crucial for energy metabolism, cell membrane stabilization, and signal transmission. Alongside calcium, it contributes to bone mineralization.

Sodium (Na) and **Potassium (K)** are vital for the neuromuscular system, water-salt and acid-base balance, and osmotic pressure regulation. Sodium is primarily extracellular, while potassium is mostly intracellular. These elements are actively transported by ion pumps, particularly the Na^+/K^+ pump.

Magnesium (Mg) acts as a cofactor for many intracellular enzymes, especially those involving ATP. It is involved in muscle tone, heart rhythm, and nerve impulse conduction.

Chlorine (Cl) is a primary component of hydrochloric acid in gastric juice and is essential for digestion.

Sulfur (S) is found in amino acids like methionine and cysteine, as well as in coenzymes and detoxification processes.

Microelements: Small Amounts – Big Roles

Iron (Fe) is found in hemoglobin, myoglobin, and many enzymes such as catalase and cytochromes. It is crucial for oxygen transport and redox reactions. It is stored in the body in the form of heme, ferritin, transferrin, and hemosiderin. Iron deficiency results in hypochromic anemia.

Iodine (I) is essential for the synthesis of thyroid hormones (thyroxine and triiodothyronine), which regulate metabolic processes. Iodine deficiency can lead to endemic goiter and cretinism.

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Zinc (Zn) plays a role in insulin synthesis and secretion, wound healing, antioxidant defense, and the functioning of many enzymes. Deficiency leads to growth retardation, decreased immunity, and delayed sexual development.

Copper (Cu) is required for cytochromes, oxidases, and heme synthesis. Deficiency may result in anemia, neurological disorders, and bone deformities.

Manganese (Mn) is involved in the synthesis of bone and connective tissues, and in the activity of hormones and enzymes. Deficiency may cause hypogalactia, fetal resorption, and degeneration of the testes.

Fluorine (F) is found in tooth enamel and dentin and is vital in the prevention of dental caries. Deficiency leads to enamel demineralization.

Other important microelements such as **selenium (Se)**, **cobalt (Co)**, and **molybdenum (Mo)** are involved in antioxidant enzymes, vitamin B12 activity, and other biochemical processes.

Deficiency, Excess, and Diagnostics

Imbalances in biogenic elements can cause various diseases. For example:

- **Iron deficiency** – anemia, fatigue, dizziness
- **Iodine deficiency** – enlarged thyroid (goiter), slowed metabolism
- **Calcium deficiency** – fragile bones, muscle spasms
- **Zinc deficiency** – slow wound healing, weakened immunity, skin disorders
- **Selenium deficiency** – heart muscle degeneration, reduced antioxidant protection

Modern medical practice uses blood tests and analytical techniques such as spectrophotometry, ion-selective electrodes, and atomic absorption to determine microelement levels. These tests are important for identifying the causes of diseases, monitoring patient conditions, and planning individual treatment.

Biogenic Elements in Medical Practice

Medical treatments developed based on biogenic elements include:

- **Supplements** (iron, calcium, iodine, magnesium, zinc)
- **Parenteral solutions** (Ringer's, Trisol)
- **Vitamin-mineral complexes**

For instance, in iron deficiency anemia, iron sulfate, iron lactate, and ascorbates are used. Iodized salt and iodine preparations help prevent iodine deficiency. In bone diseases, vitamin D3 and calcium supplements are important.

Physiological and Biochemical Effects of Biogenic Elements

Biogenic elements impact every stage of metabolism. Together with hormones, enzymes, vitamins, and other biologically active compounds, they ensure the functional balance of body systems. For example, selenium in glutathione peroxidase protects cells from free radicals, while copper is a component of

superoxide dismutase. These mechanisms help protect the body from internal and external stressors and enhance their physiological importance.

Biogenic elements are not only vital in normal physiology but also in identifying and treating pathological processes. For example, disturbances in heart rhythm may signal potassium or magnesium deficiency, and thyroid disorders often reflect iodine metabolism issues. Clinical biochemistry and laboratory diagnostics utilize quantitative analysis of these elements for differential diagnosis and personalized therapy.

Moreover, biogenic elements are crucial in preventive medicine. Microelement deficiencies are widespread, especially among children, pregnant women, the elderly, athletes, and patients with chronic diseases. Maintaining their balance is essential for health. Hence, enriching foods with microelements (e.g., iodized salt, iron-fortified flour, fluoridated water) is a key public health strategy.

Conclusion

Biogenic elements play a decisive role in metabolism, energy production, enzyme and hormone activity, transmission of genetic information, neuromuscular excitability, and the structure of bones and connective tissues. Although they are classified as macro- or microelements based on the required quantity, both are equally important biologically.

Maintaining normal levels of these elements is a primary factor in preventing, identifying, and treating diseases. Deficiency or excess of biogenic elements can lead to various pathological conditions. Therefore, determining their levels, constant monitoring, and supplementing them pharmacologically when needed is a crucial focus in modern clinical biochemistry.

In conclusion, understanding the biological and medical significance of biogenic elements forms the foundation of medical knowledge and is vital for shaping a healthy lifestyle, disease prevention, and enhancing comprehensive therapy. Every physician should fully understand the physiological roles of these elements and use them appropriately in clinical practice.

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