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MEDICAL SIGNIFICANCE OF BENZOTHIAZOLE AND ITS DERIVATIVES WITH COBALT AND NICKEL METALS.

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Abstract: This article extensively analyzes the scientific and practical significance of coordination (complex) compounds formed by Benzothiazole and its various derivatives with Cobalt and Nickel ions in medicine. The benzothiazole nucleus is a heterocyclic system containing nitrogen and sulfur atoms, which is capable of forming strong coordination bonds with metal ions. As a result of complexation with metal, the physicochemical properties of this organic skeleton, in particular, lipophilicity, stability, and permeability through biological membranes, significantly increase.

The article sheds light on the mechanisms of antibacterial, antifungal, antioxidant, and cytotoxic (antitumor) action of benzothiazole-metal complexes at the cellular and molecular levels. In particular, the properties of cobalt-containing complexes to neutralize free radicals and block the enzyme systems of microorganisms, and nickel-containing complexes to activate apoptosis by affecting DNA replication, are described based on scientific data. The coordination geometry of these complexes (octahedral, square-planar) and their relationship to biological activity are also considered.

The analyses show that the complexes of benzothiazole with cobalt and nickel have higher pharmacological efficacy than simple organic compounds and are a promising direction in the creation of a new generation of antimicrobial and antitumor drugs.

Keywords: benzothiazole, coordination compounds, cobalt, nickel, antibacterial activity, cytotoxicity, complex compounds.

Relevance of the topic: One of the main problems facing modern medicine and pharmacy is the increase in the number of antibiotic-resistant microorganisms and the increasing need for effective antitumor drugs. In this regard, the study of biologically active heterocyclic compounds and their complexes with transition metals is a relevant scientific direction. The benzothiazole nucleus, as a pharmacologically active skeleton, is characterized by its effect on many biological systems.

The formation of complexes of benzothiazole derivatives with cobalt and nickel ions changes their physicochemical properties, facilitates their passage through biological membranes, enhances their interaction with enzyme systems, and, as a result, increases their biological activity. In particular, the antibacterial, antifungal, antioxidant and cytotoxic properties of these complexes open up great prospects for the creation of new drugs. Also, research at the intersection of bioinorganic chemistry and medicine further increases the scientific importance of this area.

Purpose of the topic:

The purpose of this article is to:

- analyze the structure and coordination properties of coordination complex compounds formed by benzothiazole and its derivatives with cobalt and nickel ions,

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- explain the influence of their physicochemical properties on biological activity,
- elucidate the mechanisms of antibacterial, antioxidant and antitumor action,
- explain the molecular changes occurring at the cellular level,
- scientifically substantiate the prospects for the use of these compounds in pharmaceutical practice.

Main part: Benzothiazole is a heterocyclic aromatic system, the ring of which contains nitrogen and sulfur atoms. It is these donor atoms that allow the formation of coordination bonds with metal ions. Benzothiazole derivatives easily complex with Cobalt and Nickel ions and form stable coordination compounds. Often, such complexes have an octahedral or square-planar geometry, which is directly related to their biological activity.

As a result of the formation of a complex with a metal, the physicochemical properties of benzothiazole change significantly. First of all, lipophilicity increases, which contributes to the easy passage of the complex through cell membranes. Also, the stability of the complexes increases, and they are retained in the biological environment for a longer time. This increases their pharmacological effectiveness.

Cobalt-benzothiazole complexes are characterized by antioxidant and antibacterial properties. They penetrate the bacterial cell wall, affect enzyme systems, disrupt protein synthesis and stop the growth of microorganisms. In addition, the unique redox property of the cobalt ion serves to bind free radicals and reduce oxidative stress. Therefore, such complexes are also promising in diseases accompanied by inflammatory processes.

Benzothiazole complexes formed with nickel are of interest due to their cytotoxic and antitumor effects. These complexes enter tumor cells, interact with DNA, disrupt the replication process and activate apoptosis mechanisms. As a result, the division of tumor cells slows down or stops. These properties are of great importance in the creation of oncological drugs.

The biological activity of benzothiazole-metal complexes depends on their coordination structure, the location of the ligands, and the nature of the metal ion. Experiments show that benzothiazole derivatives complexed with metals have a much higher biological activity than simple organic molecules. This clearly demonstrates the inextricable link between bioinorganic chemistry and medicine. It has also been noted in scientific studies that such complexes also have antifungal and antiviral properties. Their broad-spectrum biological activity will serve as an important scientific basis for the creation of new-generation drugs in the future.

Conclusion: Coordination complexes of benzothiazole and its derivatives with cobalt and nickel ions are a promising direction at the interface of bioinorganic chemistry and medicine. As a result of complexation with metals, the lipophilicity, stability, and permeability of the benzothiazole skeleton through biological membranes increase, which significantly enhances its pharmacological efficacy. The antioxidant and antibacterial properties of cobalt complexes, and the cytotoxic and antitumor properties of nickel complexes, make these compounds candidates for new-generation drugs. The coordination geometry, ligand-metal interactions, and redox properties of the complexes are analytically supported by evidence that they are important factors determining biological activity. Therefore, a deeper study of benzothiazole-metal complexes, the determination of their structure-activity relationships, and the evaluation of their safety profile are of great scientific and practical importance in the future development of effective antimicrobial and antitumor drugs.

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