TOXICOLOGICAL ACTION DEPENDENCE OF THE ELEMENTS' ATOMS ON THEIR ELECTRONIC STRUCTURE AND POSITION IN THE MENDELEEV'S PERIODIC TABLE OF THE ELEMENTS

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Introduction. The physiological role of bioelements is determined their physical and chemical properties, which are determined by their position in the Mendeleev's periodic table of the elements and the electronic structure of the atoms.

We need to study role of the chemical elements, establish the possibility of their interaction with bio-ligands. It promotes the development of effective medicines to determine the effective doses, which needed for treatment.

Aim. The purpose of our work was to investigate and study the dependence of the toxicological effects of the elements on their electronic structure of the atoms and position in the Mendeleev's periodic table of the elements.

Materials and methods. During the research, we carried out a literary analysis of the toxicity of the chemical elements.

Results and discussion. In the human body, the physiological role of the chemical elements depends on the concentration, since in the body a balance of optimal concentrations of nutrients is maintains, which is called chemical homeostasis. Concentration imbalance is causes the appearance of pathologies and various diseases due to shortage or excess of the biogenic element. Paracelsus said, "All things are poison and nothing is without poison; only the dose makes a thing not a poison."

Indicator of the negative influence of elements and compounds on living organisms is their toxicity. That is ability to cause disorder of various functions in the body, adversely affect on the health and efficiency of a person.

It is proved that with increasing charge of the atomic nucleus, the toxicity of the elements is increases and their content is decreases in the organism. It can be explained by an increase atomic radii, a decrease in the ionization energy, the complication of electronic configuration and a decrease in the solubility their compounds.

Mainly, biological action is associated with the electronic structure of atoms and ions (close values of atomic and ionic radii, ionization energies, the ability to complex, identical coordination numbers). This effect leads to replacing elements in biological systems, which increase (synergism), or decrease (antagonism) in the activity of the substituting element.

The high toxicity compounds of Cd is due to the displacement of ions Ca^{2+} in bone by Cd^{2+} ions, which causes a decrease strength in bone (Ca^{2+} and Cd^{2+} ions have similar radii: Ca^{2+}, - 99 pm, Cd^{2+} - 97 pm).

It has been established that metabolic processes on the cellular and subcellular levels are provided by the functioning about 200 enzymes, each of which catalyzes a certain chemical reaction. The catalytic activity of enzymes is ensured by the presence coenzymes of non-proteinaceous origin in the molecule, preferably ions of inorganic compounds.

In some cases, the replacement of cation of one element to another inhibits the activity of enzymes. For example, the ion of Beryllium inhibits the activity of many magnesium-containing enzymes, especially alkaline phosphatase, because it forms more solid complexes with oxygen-containing ligands.

Elements of the IIA group have the same electronic configuration in the external energy level ns^2, and their ions ns^0, and therefore similar physical and chemical properties. Because this ions Ca^{2+}, Sr^{2+}, Ba^{2+} can substitute each other in biosystems, while there is a phenomenon synergism and antagonism. For d-elements, physico-chemical characteristics similarity a more characteristic horizontal, which determines their interdependence and the similarity of biological action.

Toxic action can be determined by chemical bonding with certain elements. The energy and the length of the connection determining their level of toxicity.

For example, sulfur is a member in many biomolecules: proteins, amino acids, hormones, vitamins etc. The ability of many elements, Tl^{+}, Pb^{2+}, Sb^{3+}, Al^{3+}, Ag^{+}, Cd^{2+}, Hg^{2+} and others, to form stable compounds with sulfuviral ligands , according to the scheme:

$RSH + Tl^{+} = RSTl + H^{+}$ або $2RSH + Pb^{2+} = Pb(RS)_2 + 2H^{+}$

It blocks sulfhydryl groups, suppresses the activity of enzymes, damages the synthesis of proteins.

The list of the most toxic substances - 20 elements. Of these, 3 are global pollutants - Hg, Pb, Cd. These ions form strong bonds with -SH, and alkylthio groups –AlkS. It causes loss of functions of biomolecules. Complexes of some elements are similar in properties to amino acids, hormones, mediators and can bind to the corresponding receptors. The complex Hg^{2+} with cysteine simulates methionine, which is necessary for the composition of adrenaline and choline and prevents their synthesis.

Conclusion. The toxicity of the elements depends on their electronic structure of the atoms and position in the Mendeleev's periodic table of the elements, which determines the ability of the elements to interact with enzymes, hormones, proteins, amino acids etc and block their physiological effect.