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The mechanism of action and manifestation of toxic effects of heavy metals on an organism (the literature review)

The literary review containing data on the main sources of intake of heavy metals in objects of environment and in an organism is presented in article. The characteristic of the term «heavy metals» is given to, the elements getting to group of heavy metals are defined the biological role and participation of heavy metals in biological processes is opened. Toxic properties of heavy metals, sources and ways of receipt them in an organism are lit. Besides, in article the general principles of impact of separate metals on an organism, and also their mechanisms are considered. The main attention is paid to toxic effect of lead, cadmium and copper on an organism.

Key words: heavy metals, mechanism of action, toxic effects, human organism.

The condition of health of the population directly depends on pollution of food source and food by contaminants of the chemical nature. One of the most dangerous pollutants of an ecosystem is heavy metals. Heavy metals include big group of the polluting substances which were widely adopted in environment. The term «heavy metals» has various treatments, and the quantity of the elements relating to this group changes over a wide range. Criteria of belonging to heavy metals are the atomic mass, density, toxicity, prevalence in an environment, degree of an involvement into natural and technogenic cycles. More than 40 elements of periodic system of D.I.Mendeleyev with atomic mass over 50 belong to heavy metals. Thus an important role is played their high toxicity for live organisms in rather low concentration and ability to bio-accumulation and a biomagnifikation.

According of Yu.V.Alekseev, heavy metals are a group of the chemical elements having density more, than 5 g/cm^3. In biological classification metals with the atomic mass more than 40 (manganese, iron, cobalt, copper, zinc, molybdenum, cadmium, mercury, lead, etc.) belong to heavy metals.

Otherwise definition of heavy metals and microcells at V.B.Ilyin (1991) who carries to heavy metals chemical elements with atomic mass over 50, with properties of metals and metalloids looks. Cobalt, nickel, copper, zinc, lead, cadmium, mercury are considered as the most toxic.

Biological classification of chemical elements relates heavy metals to micro and ultramicrocells groups [1]. It is known that at hit in environment in excess quantity, heavy metals are toxicant and ecotoxicant. The priority group relating to toxicant is distinguished from heavy metals. Among them is cadmium, copper, arsenic, nickel, mercury, lead, zinc and the chrome which are hazardous to human and animal health.

The greatest interest is represented by metals, accumulated in objects of environment and constituting serious danger from the point of view of their biological activity and toxic properties. Heavy metals separate on the following classes on toxicity degree for anhuman organzim: 1st class (most dangerous): Cd, Hg, Se, Pb, Zn; 2nd class: Co, Ni, Cu, Mo, Sb, Cr; 3rd class: Ba, V, W, Mn, Sr.

Environmental pollution by heavy metals has anthropogenous character and is caused by vigorous human activity. The main contribution to saturation of the atmosphere of the earth by xenobiotics is made by numerous industries, first of all: metallurgy, oil refineries, production of ceramics and glass [2]. Intake of heavy metals in an organism happens generally through respiratory organs, a digestive tract and by absorption through skin. In the most adverse way of penetration is hitting xenobiotics in an organism, in pneumatic ways in the form of dust aerosols that provides instant intake of heavy metals in blood. The progressing deterioration of an ecological situation leads to increase in concentration of heavy metals in drinking water and food that testifies to a significant role of an alimentary factor in receipt of xenobiotics in an organism [3]. Getting into the blood system, heavy metals accumulate in fabrics and bodies, and extent of accumulation of xenobiotics directly depends on the volume of blood supply and a sensity of fabrics to metals. Heavy metals influence practicallyall systems of an organism, rendering toxic, allergic, cancerogenic, gonadotropny action.

The range of ecological influences at the molecular, fabric, cellular and system levels in many respects depends on concentration and duration of an exposition of toxic substance, its combination with other factors, the previous state of human health and his immunological reactivity. Genetically caused sensitivity to influence of xenobiotics is of great importance. Mechanisms and speed of their penetration through different biological barriers and mediums depend on physical and chemical properties of the specified substances, a chemical composition and conditions of the internal environment of an organism.

In a number of works participation of metals in biochemical processes of activity of live organisms is studied and revealed that they can act as the limiting factor, or behave as toxicant. Harmful effects of ions of heavy metals on biologically active macrocells are connected with various processes: replacement of the metals by toxic metals; binding of part of a macromolecule necessary for normal organism activity; formation of the biological units harmful to an organism; depolymerization of biologically important macromolecules; the directed pairing of the bases of nucleotides and emergence of mistakes in proteinaceous synthesis [4].

The main pathogenetic mechanisms of cytotoxic effect of metals are considered: strengthening of peroxide oxidation of lipids, violation of a calcic homeostasis and oxidatemetabolism of a cell [5].

Pereoxidateoxidation of lipids is directly catalyzed by ions of metals with a transitional valency (arsenic, chrome, iron). Their accession can be connected also with reduction of anti-oxidizing protection of a cell. The last includes: cellular enzymes (a superoxiddismutaze, a glutationtransferasa, a catalase), some components of plasma (trans-ferrine, ceruloplasmin, albumine), capable to connect metals with transitional valency; small water-soluble antioxidant components (uric acid, bilirubin, vitamin C and fat-soluble vitamins — tocopherol and beta carotene) [6].

In animal experiments was shown that introduction of high doses of salts of cadmium and arsenic have led to activation of free radical oxidation that was connected on the one hand from hyperproductions of superoxidic anions and accumulation of metabolites of oxidizing reaction, with another — with exhaustion of natural antioxidants (ascorbic acid and tocopherol) in cells and/or with change of activity of anti-oxidizing enzymes [7]. The peroxidateoxidation of lipids induced by effect of salts of mercury and cadmium most intensively proceeded in mitochondrions, causing violation of their function [8].

One of targets of toxic effect of heavy metals ismitochondrions that was confirmed in experiences with the animals who were affected by salts of heavy metals. Change of a form, structure and the sizes of mitochondrions in the cell of kidneys and liver of experimental animals were revealed [5]. It is possible that on function of mitochondrions their ability to change the membrane cell potential is the cornerstone of the inhibiting effect of metals. So, influence of lead led to decrease by 75 % potential — dependent fraction of rhodamine in mitochondrions of an astroglia [9].

Cadmium is capable to inhibit enzymes of a cycle of lemon acid and an electronic transport chain: citrate-synthitase, a suczynate-dehydrogenase, cytochrome-C-oxidase [10]. Accumulation of proline in mitochondrions and decline in the ability of mitochondrions was shown to oxidize nicotinamide-adeninedinucleotide for 35 % under the influence of cadmium. Accumulation of proline is noted at effect of inhibitors of a respiratory chain of mitochondrions (cyanide of potassium, a rotenon) that is followed by decrease in concentration of the restored nicotinamide adenine dinucleotide with the subsequent violation of transformation of gliceraldehigrid-3-phosphate into 1,3-diphosphoglicerine acid. Compensative raises activity of processes with a nicotinamide adenine dinucleotide exit: transformation of a piruvat into ethanol or a lactate, an oxy acetate — in malat, a glicooxolate — in glycolate, a glutamate — in proline with development of metabolic acidosis. Thus, accumulation of proline in a cell reflects decrease in functional activity of

a respiratory chain of mitochondrions. A.Kesseler (2000) showed that cadmium stimulates leakage of protons, reducing thereby efficiency of oxidizing phosphorylation.

In vivo and in vitro was shown ability of cadmium to inhibit cytochrome-C-oxidase. Activity change ofcytochrome-R-450 plays a role in toxic effect of lead and cadmium [11].

Malfunction of mitochondrions at influence of mercury, cadmium, lead, arsenic, chrome finally is shown by decrease in production of macro-ergs, falling of activity of ATPh-dependent fermental systems and first of all K-Na-ATPhase to which share about 1/3 all cellular ATPh fall.

Refer to universal mechanisms of cytotoxicity also violation of a calcic homeostasis of a cell. Calcic receptors include a universal calmodulin, a protein-kinase C, specific to certain cell of a calcium medine, troponine C, etc. [12]. Researches showed that almost at a half of the patients living in the area polluted by salts of heavy metals took place decrease of Ca-ATphaseand Mg-ATPhase.

It was revealed that heavy metals can influence calcium — receptor system directly, by replacement of calcium on receptors or indirectly, through change of a stream of metal in a cell. In particular, it is established that lead, cadmium, mercury, arsenic block potential — sensitive calcic channels of cells. Along with it, lead, using calcic channels, gets through cellular membranes. The complex «lead-calmodulin» or «lead-proteinkinase C» increased activity of some intracellular enzymes [12]. It was shown that peak-molecularconcentration of lead activate a calmodulin for lack of calcium, and cadmium is capable to induce synthesis of a calmodulin [5]. The total calcium amount increased by 1 mg of a cellular protein at intoxication lead and cadmium, thus the most part of calcium was in mitochondrial fraction that could be caused by increase of cellular permeability and insolvency of the cells which were affected by xenobiotics to extract calcium [12]. Increase of concentration of intracellular calcium was followed by death of cells, perhaps, due to irreversible activation of phosphor-lypases, endo-nucleases, proteases and change of a cytoskeleton of a cell as a result of depolarization of an aktin and a tubulin [13].

Thus, modern researches proved that cytotoxicity of heavy metals can be caused by three mechanisms: 1) strengthening of pereoxidaseoxidation of lipids both due to decrease in anti-oxidizing protection of a cell, and due to direct pro-oxidatic activity of heavy metals, 2) oppression of mitochondrial breath owing to change of membrane potential of mitochondrions and violation of activity of enzymes of a respiratory chain and Krebs's cycle, 3) violation of a calcic homeostasis of a cell due to change of an intracellular stream of calcium, replacement of calcium on specific receptors with the subsequent activation calcium — dependent enzymes.

Bivalent metals contact to sulfgidrilny groups of the specific or not specific proteins which are carrying out transport function. To specific proteins belong methaltioneine, the connecting cadmium and zinc, lead — the connecting protein, transferrine, and ceruloplasmin. Metallotioneinis low-molecular protein with a molecular weight of 6500 daltons, characterized by the high content of cysteine. Structural researches of a molecule of a protein by method of nuclear magnetic spectroscopy revealed 2 metal clasters: the first is highly affine to zinc, the second is specific to cadmium. Metallotionein is synthesized mainly in a liver and kidneys. Its concentration is directly proportional to cadmic and zinc loading. Besides, the cadmium which came to an organism, first of all, accumulated in liver tissues. The ions of cadmium, which are freely circulating in blood, form strong complexes with low-molecular proteins –metallotioneins, which being filtered in the chanaldevice of kidneys, accumulate inside them and lead to damage of tubular department of nefron [14].

Zinc is one of the main pollutants of environment in connection with production and processing the zinc-content ores, during burning of mineral fuel, in metallurgical and chemical production. As a rule, together with zinc other pollutants get also to environment, such as cadmium and lead. Toxicity of zinc is caused by ability gradually to concentrate in food chains: plant-animal-person. By the rule of a trophic pyramid, the organic substance of each of the subsequent links of a food chain progressively decreases, and the amount of the absorbed metal remains and its concentration gradually increases, reaching the maximum at the human organism.

The biological role of zinc is defined by that it, being a component more than 300 enzymes, takes part in all types of an exchange, it is a part of the genetic device of a cell (there is about 100 zinc-content nucleoproteids). Without it, the correct replication of DNA and RNA is impossible. Zinc is a part of the greatest number of enzymes which take part in processes of blood formation and transport of oxygen, regulate a proteinaceous, carbohydrate and fatty exchange [15].

Differences between necessary amount of the zinc consumed with food and its toxic level is rather great. In spite of the fact that zinc is an important bio-element, its receipt in an organism in the increased quantities causes violations of a functional condition of separate bodies and systems. The hypoglycemia, a

hypoholesterinemia, increase of the maintenance of an urobilin and porphyrines in urine, violation of functions of a pancreas and liver, fibrosis of lungs are found in many workers occupied in production of oxide of zinc. Even when using respirators dust of oxide of zinc causes changes in the content of polysaccharides, peroxidases and sour phosphatases in blood cells; at an experience of 10 years anemia develops. In some cases not surplus, but a lack of zinc is toxic. It is caused by that zinc carries out a number of biological functions [16].

At hit zinc inside of organism glicoliticand oxidizing processes in muscles are broken. Oppression of a functional condition of barrier functions is observed as at surplus, and a lack of zinc of an organism. Activity NAD- and some PhAD-dependent enzymes sharply decrease at the low content of zinc that conducts to oxygen starvation of hydrobionts and other violations of a metabolism [17].

Participation of zinc in formation of immunity and functioning of intracellular membranes is known, that is essential acting for processes of regeneration of skin, growth of hair and nails, secretion of sebaceous glands. Besides, zinc takes part in an exchange of vitamins A and E, blood formation and activation of secretion of insulin. It is noticed that at increase in the content of zinc, cadmium, copper and manganese iron accumulation worsens. Excess of iron reduces ability of an organism to acquire copper and zinc. High concentration of zinc shows a sinergizm, strengthening effect of other pollutants [18].

Specifics of manifestations of symptoms at poisoning with cadmium are established, so at the sharp intoxication connected with inhalation receipt of a xenobiotic in an organism, pathological changes of pneumatic ways and respiratory organs develop in the shortest possible time. The further stage of poisoning is characterized by formation of bronchial pneumonia which leads to hypostasis of lungs and death of an organism [19].

Chronic poisoning with cadmium is characterized by considerable decrease in sensitivity of olfactory touch system, existence of frequent nasal bleedings and formation of emphysema of lungs. Possessing expressed gepato-and nephron-toxic action, in the conditions of chronic poisoning cadmium leads to destruction of a liver and injury of kidneys [20].

Cadmium comes to a human body orally, inhalation and through skin, and removed through intestines, with urine, a saliva, hair and breast milk [21]. At deficiency of calcium, iron and protein absorption of cadmium amplifies. About 50 % of the cadmium which came to an organism is found in kidneys, about 15 % — in a liver and about 20 % — in muscles. By different estimates the period of semi-removal of cadmium makes from 10 to 38 years. The critical organs characterizing intensity of cadmic load of an organism are kidneys [22].

Cadmium is the highly toxic element possessing polytropic action and is classified as one of the most dangerous cancerogenic substances for the human body [23]. Numerous clinical and pilot studies established direct dependence between intake of cadmium in an organism and development of oncological pathology of lungs, red marrow, liver, prostate gland, kidneys, a pancreas and stomach.

Cancerogenic effects of cadmium are connected with its ability to damage of structures of DNA by formation of the expressed oxidizing stress and thus to inhibition of processes of a reparation. Besides cancerogenic action, cadmium renders mutagen and teratogenic effects on an organism that is caused by partial destruction of the cellular device of a placenta and embryonic fabrics at early stages of an organogenesis [24].

Cadmium is polytoxic poison, in the pathogenetic mechanism of its action lies ability to reduce activity of enzymes, by inhibition carboxyl and the sulfgidrilnykh of groups. As result fermentative dis-function, violation of exchange processes and destruction of cellular membranes are evolved.

At chronic intake of cadmium in an organism was observedneurotoxic action that the ethyologocalfactors of development of neurodegenerate diseases, such as Parkinson's illness and Alzheimer's disease. By means of pilot studies was establishedthe expressed diabetogeneticeffect of cadmium shown in damage β-cell islands of a pancreas and suppression of secretion of insulin [25].

The pilot studies conducted by A.I.Vishnyakov and etc. (2011) established existence at cadmium of powerful toxic action on reproductive system that was connected with formation of changes of processes of an exchange of chemicals, in particular decrease in concentration of selenium in reproductive organs. Selenium is a natural antioxidant therefore it is obvious that formation of active forms of oxygen and an oxidizing stress is the cornerstone of the developing pathology.

In works of L.Wan is establishedthe cytostatic effect of cadmium caused by decrease in concentration of calcium in cells. Violation of a homeostasis of calcium is led in turn to damage by the actinovethreads of a cytoskeleton of cells and to braking of their growth.

Along with the functional violations which are formed at chronic poisoning with a xenobiotic, cadmium also leads to development of irreversible morphological changes in renal fabric. In work of M.N.Gonokhova (2007) was shown that the histologic picture of renal fabric in the conditions of cadmic intoxication was characterized by existence of an atrophy of a ball with a simultaneous hypertrophy of a capsule of Boumen-Shumlyansky, continuous hydro-dystrophy of mainly distalny department of tubules and sites of a necrobiosis the epitelium cells.

Cadmium possesses the expressed cardio-and angiotoxicaction. One of numerous mechanisms of vazoconstractiveeffect of cadmium is connected with its ability to change activity of calcic channels, to block effects of nitrogen oxide and other vasodilating substances. However in work of J.K.Angeli (2011) the vascular reactivity devoted to change in the conditions of cadmium influence, it is specified that damage the endotailed cells is products of pereoxidateoxidation of lipids whereas bioavailability of nitrogen oxide remains invariable the paramount reason of system vasoconstrictive action of a pollyutant.

It is established that men are more susceptible to destructive influence of cadmium on cardiovascular system. In the conditions of chronic poisoning, cadmium changes functional conditions of adrenal glands that are expressed in systematic increase in secretion of adrenaline which receipt in blood is starting mechanisms of development of arrhythmia [26]. In modern literature there are works which are proving existence of negative influence of cadmium on reducing ability of a myocardium.

Work of J.L.Peters and etc. (2010) confirms that toxic influence of cadmium increases chances of developing of a stroke of 35 % and chronic heart failure — by 48 %.

It is experimentally shown that the mechanism of toxic effect of cadmium on a liver is realized in two directions. At direct impact of cadmium on structures of a liver there are damages the endoteilcells of vessels of a liver connected with ability of a toxicants to interact with sulphhydrilgroups of molecules of proteinaceous structures in mitochondrions that leads to development of mitochondrial disfunction. Development of the ischemic phenomena arising owing to damage the endoteilcells of vessels of a liver leads to formation of a hepatic-cellular trauma. Formation of the inflammatory centers in the hepatobiliar structures causes development of the second mechanism of the toxic action connected with activation of activity of cells of Kupfer, powerful formation of cytotoxic and pro-inflammatory substances and also with the expressed infiltration of tissues of liver neutrophils [27].

In pilot studies it was shown that cadmium leads to formation of considerable changes in biochemical indicators of blood, and also causes activization of the hepatic enzymes (an alanine-aminotransferase, alkaline phosphatase and gamma glutamine transferase) which are markers of a hepatic trauma that testifies to a hepatotoxic activity of cadmium [28].

Gutnikova (2012) showed that the greatest sensitivity to toxic influence of cadmium mitochondrions and an endoplasmic network of hepatocytes possess. Toxic effect of cadmium promotes development of the total hydro dystrophy of hepatocytes passing with places into ballonny dystrophy.

A.A.Fouad (2013), etc. established that destructive effect of cadmium on a liver is led to massive formation of a factor of a necrosis tumor-α, cyclo-oxygenase-2 and substances from cysteine proteases family which in turn aggravate the pathological processes proceeding in liver tissue. Accumulationcadmium in hepatic fabric leads to activation of processes of apoptosis of hepatocytes that is connected with powerful stimulation of creation by a xenobiotic apoptosis — the inducing factor and considerable emission of cytochrome C in cellular cytosol. In the course of pilot studies it was established that cadmium in the conditions of poisoning leads to activation of an expression of the genes c-fos in hepatic tissue of experimental animals which are protooncogenes. Chronic influence of cadmium promotes the expressed decrease of the activity of ceruloplasmin in plasma of blood, the enzyme which is one of the main components of antioxidant protection of an organism.

The polytropy effect of toxic effect is caused by its ability to get into all systems of an organism as orally (with water and food), so through skin. Absorption of lead in a digestive tract at adults makes from 15 % arrived with food, and at children and pregnant women its absorption can reach 50 %. The lead-connecting protein has molecular weight about 27000 daltons is rich with glutamin, asparaginaminoacids, glycine, cysteine and connects about 40–50 mg of lead on 1mg a protein. Transport proteins cause a nephrotoxityof metals that the extra-cellular metal protein complex formed in a liver; it is a transport form of metal and promotes its filtration and absorption in kidneys [5].

The main places of application of toxic action of a toxicant are centraland peripheral system, cardiovascular system, system of blood and a kidney. The «lead polyneuritis» developing in the conditions of chronic poisoning belongs to clinical manifestations of defeat of nervous system, shown by paralysis of the top and

lower extremities. The formed cerebral violations in the conditions of lead poisoning are characterized by existence of speech disturbance, and in hard cases development of a toxic coma [29].

From the moment of penetration into an organism lead has toxic effect on system of blood. As a result of destructive effect of lead, there is a violation of elasticity of membranes of erythrocytes and development of a gemoliz. In the conditions of the created «lead anemia», the organism activates processes of an eritropoez owing to what predecessors of erythrocytes — retikulocytes come to the general blood-groove [30].

The expressed toxic activity of lead concerning a digestive tract is the reason of formation of functional changes of a stomach. In the conditions of chronic poisoning, the epithelium of a mucous membrane of a stomach actively sekretirut lead ions that leads to blocking of the enzymes necessary for start of regenerator processes of a mucous membrane, development of atrophic changes in a stomach is a consequence of that [31].

Destructive effect of lead on kidneys, as at sharp, so at chronic influence leads to formation of pathological changes in the glomerule-tubulyar device of kidneys. Decrease in level of chanalreabsorption in the conditions of intoxicationlead is a consequence of primary defeat of proximal tubules of a nefron [32].

Activating education and slowing down removal from an organism of aminolevuline acid, lead in the conditions of chronic poisoning promotes its accumulation in an organism that the histo-structural damages of glomerular and the chanal components of a kidney which are confirmed by increase of lead concentration in final urine β2-microglobuline [33].

One of mechanisms of nephrotoxicaleffect of lead is ability to activate processes of apoptosis. Works of Q.H.Jia, carried out in 2011, allowed to establish existence at lead of pronounced ability to lead to creation by a vacuole in cytoplasm of cells of kidney tubules with activation of processes of acaryo-picnosisthat confirmed existence of the initial stages of apoptosis of a tubular epithelium. In addition, lead is capable to start processes of apoptosis not only in the chanal device of kidneys, but also in the mesogial cells of the usta-glomeratedevice, by activation of processes of peroxidantoxidation of lipids and accumulation of products of a lipoperoxidationin cytoplasm of cells.

In experiments is shown that effect of lead on cardiovascular system is caused by change of excitability and a reduction of a cardiac muscle; decrease in formation of nitrogen oxide; the raised tone of the centers of sympathetic nervous system. Besides, activation renin-angiotensin-aldosteron system, strengthening of synthesis of an endotelin, formation of atherosclerotic damages of vessels walls is revealed.

In the researches L.Molero and etc. (2006), was established that at intoxication increase of activity of the endotelin in the vascular course causing growth of arterial pressure happens lead. Blocking processes of synthesis and secretion of the fabric activator of a plazminogen in the epitelial cells of the vascular course, lead causes probability of development of processes of an intra vascular trombo-creation.

The researches conducted by O.S.Choubina and etc. (2011) allowed to establish existence of structural changes in a cardiac muscle at chronic lead intoxication. Total change of the sizes and forms of the cellular kernels enriched chromatin was noted.

Lead has direct hepatotoxic action which realized by direct influence of a xenobiotic on processes of peroxide oxidation of lipids in hepatic fabric. In the conditions of chronic lead poisoning there is an activation of processes of a lipoperoksidation to at the same time happening decrease of the activity of enzymes of antioxidant protection which leads to strengthening of processes of fragmentation of DNA. Formation the histological changes of a liver in the conditions of lead poisoning confirms hepatotoxic action of a toxicant. The lead-mediated hepatic hyper-cholesterolemia is connected with activation of the enzymes participating in cholesterol synthesis (3-hydroxy-3-methylglutaril-KoA reductase, farnezil-diphosphate synthetase, a squavel-synthetase), with synchronous decrease of the activity catabolic of the enzymes (7a-hydroxylase) influencing cholesterol [34]. Degree of expressiveness of functional and morphological changes in a liver at chronic influence of lead depends on age of an organism.

In works of Yu.V.Kireeva (2006) and N.I.Kucherko (2007) morphological features of toxic influence of lead are also established. Total hypostasis of hepatocytes which cytoplasm was vacuolization was noted. Changes in structure of blood vessels were characterized by a thickening of walls with perivascular hypostasis.

Copper is irreplaceable element necessary for normal activity of an organism. Adverse effects can be observed both at surplus, and at a lack of copper. Excess of copper leads to its accumulation in a liver with the subsequent destruction of erythrocytes and increase of concentration of bilirubin. At excess of copper is oppressedthe lipase, pepsin, urease and amylase. Copper takes part in phenolic, nitrogenous and nucleinic exchanges; is a structural specific component of a number of oxidases; plays large role in processes of blood

formation participation in synthesis of hemoglobin and other iron-porphirine (cytochromoxydase, cytochrome and catalase). In physiological doses copper increases immunobiological activity and resilience of organism to adverse effects. Besides, copper stimulates activity of hormones of a hypophysis.

It is studied that excess of copper causes functional frustration of nervous system, and at steam inhalation can be shown as «copper fever». Violation of functions of a liver and kidneys with development of cirrhosis and secondary damage of a brain is known as Wilson-Konovalov's illness and is connected with genetic disorders of an exchange of copper and proteins [35].

Mechanisms of toxicity of copper are connected with increase of cellular permeability of erythrocytes owing to interaction with their sulphichydrilgroups, glutationreductaseinhibition, decrease in the restored glyutation, agglutination of erythrocytes, and excess stimulation of the hexozomonophosphateshunt. Copper possesses selen-antogenousproperties (causes deficiency of selenium in high doses). Copper takes part in providing an immune homeostasis, high doses supressirut the T-dependent immune answer, reduce synthesis of IL-1V and IL-2V and hemo-taxis of leukocytes [35]. For animals copper, in assigned amounts, is necessary as a blood formation stimulator. It promotes binding of toxins, intensifies processes of free oxidation in fabrics, influences reproduction processes, normalizes an exchange of calcium and phosphorus. Copper is necessary for a normal keratinization of a feather and normalization of an embryonal development.

Thus, influence of heavy metals on live organisms very variously, is noted them a dual biological role: metals as elements necessary for life, and metals as toxicant. It is caused by biochemical functions which they carry out in an organism; physical and chemical properties, specific features of behavior of metals in environment, forms of existence of metals in ecosystems.

Due to the intensive growth and development of the industry, transport, and chemical using in agriculture in recent years receipt in environment of heavy metals of a technogenic origin considerably increased. Uncontrollableenvironmentalpollutionby heavy metals threatens human health. It indicates the need carrying out environmental monitoring of the content of heavy metals in air, water, the soil, plants and animals; condacting of sanitary and hygienic monitoring of food raw materials and food on availability in them of heavy metals; further studying of chains of migration of heavy metals from their source to the person.

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Ауыр металдардың ағзаға уытты әсерінің пайда болуы және әсер ету тетігі (әдебиетке шолу)

Мақалада ауыр металдардың қоршаған ортаға және ағзаға негізгі түсу көздері туралы ақпаратты қамтитын негізгі әдебиетке шолу жасалған. «Ауыр металдар» терминіне анықтама берілді, ауыр металдардың тобына кіретін элементтер анықталды, биологиялық процестегі ауыр металдардың қатысуы және биологиялық рөлі ашылды. Ауыр металдардың уытты қасиеттері, ағзаға түсу жолдары мен көздері қамтылды. Сонымен қатар жекелеген металдардың ағзаға әсерінің жалпы қағидалары, сондай-ақ олардың механизмдері сипатталды. Қорғасын, кадмий және мыстың токсикологиялық әсеріне басты назар аударылды.

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Механизм действия и проявления токсических эффектов тяжелых металлов на организм (обзор литературы)

В статье представлен литературный обзор, содержащий сведения об основных источниках поступления тяжелых металлов в объекты окружающей среды и в организм. Дана характеристика термину «тяжелые металлы», определены элементы, попадающие в группу тяжелых металлов, раскрыты биологическая роль и участие тяжелых металлов в биологических процессах. Освещены токсические свойства тяжелых металлов, источники и пути поступления их в организм. Кроме того, в статье рассматриваются общие принципы воздействия отдельных металлов на организм, а также их механизмы. Основное внимание уделяется токсическому действию свинца, кадмия и меди на организм.

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