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About the ways of biological participation of iodine in maintenance of homoeostasis and determination of iodine deficiency in an organism

Deficiency of iodine in environment is the long-term factor which doesn't change throughout centuries of human existence. Certainly, in iodic security of an organism food plays large role, by means of which geochemical features of the territory and social conditions are realized. Results of numerous researching work by iodic security of an organism testify that in the conditions of lack of iodic prevention, iodine deficiency conditions of the population have mass character. By carrying out hygienic researches on Kazakhstan, practically in all regions, in a varying degree, iodic insufficiency was revealed.

Key words: thyroxine, diiodotyrosine, triiodothyronine, oxidizing processes, toxic hyperfunction, pathological processes.

The main biological function of iodine consists in maintenance of a thyroid gland and creation of a hormone — a thyroxine. Iodine is the only microcell participating in formation of a hormone, making deep and strong impact on the general development of an organism. Iodinated hormones — thyroxine, diiodotyrosine, triiodothyronine, increase oxidizing processes and influence to the general physical and mental development [1]. Deficiency of these hormones causes development of the compensatory and adaptive reaction directed on maintenance of a hormonal homeostasis, hypertrophy, to iodine capture increase by a thyroid gland and increases in formation of yodtironin in an organism [2]. Increasing of yodtironin level in blood oppresses tireotropny function of a hypophysis and indirectly sekretory activity of a thyroid gland that causes development of a hypothyroidism [3]. Formation of a hormone of a thyroid gland is defined by synthesizing diiodtiroziny, further by thyroxine which by joining with protein, turns in thyreoglobulin [1–3].

Allocation of a thyroid gland hormone is carried out by the impulses proceeding from the central nervous system, at getting in blood it suppresses secretion of a thyritropic hormone of a hypophysis. At small quantity of a thyritropic hormone activity of a thyroid gland is weakened and, so, allocation of a thyroxine, thus, stops suppression of a hypophysis, and the hypophysis begins to throw out the thyritropic hormone activating formation of a thyroxine etc. At insufficiency of iodine thyroxine isn't formed and the thyritropic hormone continues to activate a thyroid gland, causing its swelling. If enter iodine into an organism secretion of a thyroxine is restored, the thyritropic hormone suppressed and a thyroid gland is normalized. A physiological role of a thyroxine is the formation of iodine which controls the main exchange: the water-salt, fatty and carbohydrate.

Thyroxine is in a constant communication with a hypophysis and sexual glands, participating in regulation of activity of the central nervous system, influencing the emotional status and activity of cardiovascular system. Deficiency of iodine is widespread among the population of Kazakhstan, which is shown by increasing of a thyroid gland (an endemial craw). The hypothyrosis (insufficiency of function of a thyroid gland) can develop. During the diagnosing on a deficiency of iodine condition among the children's population of Kazakhstan in all areas was noted the intense situation, moderately expressed deiciency of iodine revealed among all age groups of the children's population in the Southern region of Kazakhstan (Shymkent, Kyzylorda). During this research period, which characterized by lack of iodic prophylaxis and mass distribution the iodine deficiency conditions among the children's population, physiological features of an organism, noted by children's age and a sex, weren't shown in a formation of a iodine deficiency.

The main source of getting of iodine in an organism is food. Food, in turn depend on existence of a state to the soil, biological features of plants and some other factors. As iodine deficiency directly depends on getting it with food, concentration of iodine easily decreases in all bodies, except thyroid gland which holds the iodine, generally containing in a colloid. Use of iodinated fertilizers can become one of the main actions providing increase of the content of iodine in plants. Importation of chlorine-containing fertilizers and acid applications of sour cespitose and podsolic soils cause reduction of getting of iodine in plants and as a result, promote strengthening iodine deficiency in soils and plants.

For definition of iodine deficiency it is necessary to know concentration of this element in an organism. The greatest concentration of iodine contains in a thyroid gland (8mg on total), in a human body contains from 20 to 50 mg. The daily need of the adult from 0,05 to 0,2 mg that completely provides an organism with iodine. Therefore, definition of iodine in blood is a control method of activity of a thyroid gland.

According to authors, concentration of iodine in blood can serve as way of control of activity of a thyroid gland, than the main exchange. At hyperfunction of a thyroid gland, the increase in iodine of blood, in particular the fraction connected with proteins is noted. At toxic hyperfunction of a thyroid gland therapy by iodine leads to reduction in blood of fraction of the iodine connected with protein whereas the fraction of free (inorganic) iodine, on the contrary, increases. Hyperthyreodizm is followed by the strengthened release of iodine with urine, excepting: pregnancy, menstrual cycle, mental excitement. According to some authors the increase in iodine in blood is noted at cholecystitises, myeloid and lymphatic leukemias, obstructive jaundice, remissions at people with malignant anemia, at some types of malignant tumors. In a question of, whether the iodine amount increases in blood at an essentsialny hypertension, the consensus isn't present.

The primary and main sources of trace elements for living organisms are natural soil and water. At the time, Vernadsky pointed out that the composition of the soil is closely related to the composition of other parts of the biosphere. Circulation of the elements in the atmosphere – Natural water – soil – plant – animal organisms is the territorial law, which may violate the presence of foci with increased content of trace elements.

Environmental contamination with heavy metals — copper, zinc, chromium, lead, mercury, cadmium and others. Is formed by emissions into the atmosphere and further subsidence in the soil cover of ferrous and non-ferrous metallurgy, thermal power, etc. The processes of smelting and processing of steel accompanied by the release into the atmosphere of manganese, lead, mercury vapor, rare metals. The emissions and open-hearth steelworks convector present dust from the metal charge, and a pair of metal oxides, prevalent of which are iron and aluminum trioxide. Non-ferrous metals are the source of atmospheric air in aluminum, copper, lead, tin, zinc, nickel and others. Metal. Out of metals in the environment comes from the combustion of fuel and fuel at thermal power plants. The coal contains all the metals of the periodic table, and especially lead, mercury, arsenic, vanadium, nickel, chromium. It was found that most of the metal is deposited in the range of 1–2 km from the source of emissions, and 10–40 % — in the range of 8–10 km from the business [1–3].

The high level of metal contaminants observed in residential areas of industrialized regions [4, 5]. Precipitation adequately reflect the air pollution in populated areas. As part of the snow in accumulative indicators reflecting the specific anthropogenic load on individual sources or industrial areas. High concentrations of toxic and potentially toxic elements found in the snow cover settlements [5, 6].

Heavy metals can exchange or non-exchange captured the different components of the soil to fall in the form of insoluble salts. Possibilities of transfer of toxicants into the slow-moving state are not the same in different soils. Distribution of heavy metals on the surface of the soil is determined by many factors. It depends on the specific sources of pollution and meteorological characteristics of the region, geochemical factors of landscape environment in general and other factors [6, 7]. Elements — toxicants, soil contaminants are concentrated in the upper (0–10 cm) layer. It has been established that 57–74 % of the lead and in anthropogenic mercury contamination fixed in the 0–10 cm layer and only 3–8 % migrate to a depth of 30–40 cm [8–10]. An important role in the accumulation of heavy metals play a secondary mineral complexes with organic matter and hydroxides of iron and aluminum. Many organic compounds are soluble or insoluble complexes with copper, and therefore the capacity of the soil to bind or containing copper in solution is largely dependent on the nature and amount of organic substances. Organic components sorb and bind zinc in its stable shape, whereby the last accumulation is observed in the surface layers. An important role in enhancing the properties of migration of heavy metals water-soluble organic compounds play is associated with 60–90 % of migrating in the soil profile of metals [7, 11]. Understanding the processes of migration and transition elements from one medium to another is of great practical significance to study the mechanisms and pathways of human exposure, assess the toxicity of chemical elements [8, 12].

According to the observations, when the body of any one of trace elements in high concentrations change content and other trace elements. Redistribution, what is happening in the content of trace elements in the body tissues in the earliest period of receipt of any trace elements in high or low concentrations, is adaptive and protective in nature, aimed at ensuring the best performance of the tissues and organs under varying conditions. In the event that a trace element enters the body at concentrations that exceed the adaptive capacities necessary for normal functioning of the body, equilibrated relations between trace elements are broken and out of control of physiological regulation, and begins to show the action of pathogenic micronutrient. Recently established ecological conditionality of about 20 diseases occurring in the population [2, 9, 13–15].

Excessive concentrations of metals can cause serious changes in metabolism and disruption of metabolic processes, thereby reducing non-specific resistance of the organism, leads to disruption of allergic and physical status, and, consequently, to a violation of the functions of various organs and systems. Under the influence of metal damaged hematopoietic process, which in turn leads to an increase in the body immunodeficient state [10, 12, 13, 16, 17].

Under the action of toxic metals in varying degrees, suffer from circulatory, excretory, digestive, endocrine, immune, hematopoietic system. However, for all the polymorphism pattern of toxic effects for each metal is characterized by the greatest defeat of one of the above systems.

Lead in contact with the human body interacts with the sulfhydryl groups of proteins and blocking various enzyme systems. Lead is toxic to the central and peripheral nervous system, it is capable of accumulation in the body, especially in bone. Correlation method established the relationship between levels of lead and cadmium in the hair of students and their intellectual development. Lead exposure leads to the defeat of the renal tubules, accompanied by proteinuria and glucosuria. In the future, this leads to a deficiency of vitamin D and parathyroid hormone, to a violation of calcium metabolism in the body and causes the subsequent systemic bone loss — osteoporosis and osteomalacia. There is evidence that an imbalance in the body can lead to predict tumor cell growth. The excess copper leads to disruption of the blood, stimulates the development of anemia with degeneration of the liver and its complete atrophy. Since copper metabolism disorders in the body bind the early stages of malignant tumors. Zinc has no specific toxic properties, but when hit in significant quantities into the body causes dyspepsia. Inorganic cadmium compounds with prolonged inhalation and ingestion into the body, along with a general toxic causes gonadal — and embryotoxic effect [18–20].

Manganese is a neurotropic metals causes hyperplasia of the thyroid gland. There is information on the mutagenic effects of manganese and Gonadotoxic action. Pathological processes in the body due to the intake of manganese, associated with the metabolism of the latter. Manganese enters the plasma and associated with B-globulin and then distributed throughout the body. Manganese is concentrated in tissues that are rich in mitochondria, with the highest concentrations found in the liver, pancreas, kidneys and intestines. He is able to penetrate the blood-brain and placental barriers (WHO data). When studying the manganese uptake from the gastrointestinal tract it has been found that the presence of iron deficiency anemia increases the rate of absorption of manganese (Meno et al. 1969). At high levels of manganese in the body increases the rate of excretion of manganese which is accompanied by increased excretion of iron. This exacerbates the already existing interconnection anemia, thus increasing the rate of absorption of manganese (WHO data). By the end of the 80s in animal experiments shown transplacental carcinogenic substances are more than 60, and combinations thereof, belonging to different classes, including compounds of metals such as cobalt, zinc, magnesium, lead. The metal ions are capable of binding oxygen, sulfur, nitrogen, forming part of proteins and nucleic acids, and can affect the activity and correct operation of the DNA and RNA polymerases. The ability of metals to the carcinogenic effect is characterized as follows: As > Cr > Ni > Be > Pb > Cd > Hg [11, 21].

Iron deficiency anemia (IDA) — an extremely common form of clinical manifestations of iron deficiency states — to reach groups of the population is one of the first places, presenting a major challenge as the global and the national health care. According to the World Health Organization (WHO), about 2.5 billion earthlings have problems with the status of iron in the body, and the prevalence of anemia among the most vulnerable people on the planet is about 50–60 % of pregnant women and children in developing and

10–20 % — developed countries [22, 23]. IDA problems caused not only widespread, but also with serious consequences for health of vulnerable populations like young children, teenagers, pregnant women, women of childbearing age, the elderly [24]. With the presence of iron deficiency in the body are associated deterioration of mental and physical activity, reduced efficiency and productivity, increased risk of infectious diseases, impaired function of many organs and body systems. Iron deficiency in women adversely affects the course of pregnancy and labor, increases maternal and perinatal mortality, the birth of children with low birth weight. The infant is the child's psychomotor retardation, cognitive impairment and behavioral reactions irreversible backlog of mental and physical development [25].

The high prevalence of anemia in children and women of reproductive age has a negative impact on the intellectual, social and economic potential of communities and states. There is no doubt that its decision is an important condition for social and economic progress of many countries, including Kazakhstan and Central Asia. The exceptional importance of the prevention and treatment of IDA for our republic is reflected in documents such as the Declaration and Plan of Action on Nutrition in Kazakhstan and the Central Asian Republics, adopted at the International Conference of 1996, documents on national policy power in Kazakhstan [22–25].

Mutagenic effects of some metals is manifested in the prevailing impact on the genetic structures, and others — to disrupt the metabolic situation in the cells. Most obviously reproductive disorders develop in cities with developed metallurgical industry. So, the residents of the industrial center more frequently observed spontaneous abortions, stillbirths and higher [1, 11, 25]. When transplacental chemical action, in particular blastomogenic agents, the embryo may occur disorders that depend on the nature of the compound, dose, timing and exposure period. Thus, under the influence of the agent on blastomogenic 1–6 weeks after fertilization (the period of division of the zygote, implantation, organogenesis, placentation) is implemented embryotoxic effect leading to the death of the fetus and spontaneous abortion, from 2nd to 8th week (organogenesis) — teratogenny effect as malformations of the embryo (placentation periods, histogenesis, organogenesis and fetal growth) — carcinogenic effects — there are malignant tumors [22].

Thus, numerous publications and conducting independent research, found a direct linear relationship between the content of chemical elements in the environment (soil, water, air), and the incidence among the population.

The diagnosis «cretinism» is made only when there are irreversible signs in lag of development of the child; success of therapy, as we know, is higher, than it is begun earlier. In this case, definition of iodine in blood, has, according to a number of authors, important practical value as allows to establish cretinism threat in due time when other methods of research are still powerless.

This article is attempt to bring completeness and clarity of biological function of iodine, providing normal, full functioning of a human body and as statistical data, determination of concentration of iodine in biological material (blood, urine) testify, can prevent development of illnesses (a thyrotoxicosis, an endemichesky craw and some other).

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Г.Ж.Мукашева, Б.Зернке, М.А.Мукашева

Гомеостазды бір қалыпта ұстауға және ағзадағы йодтапшылықты анықтауға йодтың қатысының биологиялық жолдары жайлы

Мақалада қоршаған ортада йодтың тапшылығы адамзаттың жүздеген жылдар бойы өзгермей келе жатқан, адамзатқа төнген, ұзақ уақытқа созылған фактор болып табылады. Авторлар ағзаны йодпен қамтамасыз етуде басты рөлді атқаратын тамақтану және оның көмегімен аймақтың және әлеуметтік жағдайдың геохимиялық ерекшеліктері іске асырылады деп белгілейді. Ағзаның йодпен қамтамасыз етілуін зерттеу нәтижелері бойынша йодты профилактика жүргізілмеген жағдайда тұрғындарда жаппай йодтапшылығы байқалатыны дәлелденген. Қазақстан бойынша гигиеналық зерттеулер жүргізу кезінде барлық аймақта әр түрлі дәрежеде йодтың жетіспеушілігі анықталған.

Г.Ж.Мукашева, Б.Зернке, М.А.Мукашева

О путях биологического участия йода в поддержании гомеостаза и определения йододефицита в организме

Дефицит йода в окружающей среде является долговременным фактором, не меняющимся на протяжении столетий человеческого существования. Безусловно, в йодной обеспеченности организма большую роль играет питание, посредством которого реализуются геохимические особенности территории и социальные условия. Результаты многочисленных исследований йодной обеспеченностью организма свидетельствуют о том, что в условиях отсутствия йодной профилактики йододефицитные состояния населения имеют массовый характер. При проведении гигиенических исследований по Казахстану было выявлено, что практически во всех регионах в той или иной степени наблюдается йодная недостаточность.

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