Study of the Harmful Effect of Radionucleotides on the Environment in the Development of Environmental Competences in Students

E.T. Torakulov TerDU, independent researcher

ABSTRACT

Global ecological problems involving people, anthropogenic factors, the causes of their origin, the pedagogical model of teaching students of higher educational institutions to protect against these problems, pedagogical foundations have been scientifically researched. A scientific approach to the aspects that should be paid attention to when teaching students to ensure the safety of life activities.

Keywords: Global ecological, Environmental problems

Environmental problems and environmental protection have become one of the most urgent issues in the world. In the conditions of rapid development of science and technology, changes in the geographical and political structure of the world, regulating the harmful effects of humans on the biosphere, adapting the preservation of a favorable natural environment with social development, in the interaction between man and nature. the problems of achieving balance remain relevant.

An ecologically complex situation has arisen in Uzbekistan, which consists of the following problems:

— the land is limited and its quality is low, the soil layer is highly saline;

— acute shortage and pollution of water resources, including surface and underground water;

— Danger of drying up of the Aral Sea;

— atmospheric air pollution.

Professional training in the field of security is of great importance to ensure stable socio-economic and innovative development of Uzbekistan.

The professional activity of bachelors is related to ensuring human safety in the modern world, creating a comfortable technosphere, minimizing the negative impact on the natural environment, and protecting human life and health through the use of modern technical means.

General cultural competences of bachelors in higher education:

— to have a safety culture, to have environmental consciousness, that is, to consider the protection of the natural environment and safety issues as the most important priorities of life;

— to understand the issues of sustainable development and the risks associated with human activity;

- organizing one's life activities in order to reduce the anthropogenic impact on the natural environment, to ensure the safety of individuals and society.

Professional competencies:

— to have a culture of professional safety;

— risk identification and risk assessment;

— application of professional knowledge to minimize negative effects on the environment;

Due to the wide distribution of natural and artificial radionuclides, their use in the national economy, medicine and other fields is increasing day by day, pollution of the environment with radioactive substances is observed. As a result of anthropogenic processes, a large amount of artificial radionuclides, which were not present in its composition before, are entering the biosphere. The phenomenon of radioactivity is the property of emitting light into the environment as a result of the spontaneous decay of the nuclei of some chemical elements (uranium, thorium, radium, potassium, californium, etc.).

The main characteristics of radioactive substances are the type of ionizing radiation, their distribution in nature, chemical properties, physico-chemical state, chemical changes in the environment and in human and animal bodies, biological activity of radiation sources, the form of radionuclides in the environment (aerosol, solution, solid phase) the ability of substances in nature to enter into circular motion, etc.

The phenomenon of radioactivity and its characteristic ionizing radiation existed long before the appearance of life on Earth, that is, before the appearance of the Earth in space. Radioactive radiation is an integral part of our living environment, and life on Earth itself also appeared in the flow of these radiations. It is known that there is always a radiation background in the environment, its average amount is equal to 10-3 Gr/year per organism. This radiation background has remained unchanged throughout the Earth's biological history. This amount of radiation is considered not to have any negative effects on biological systems, and it is also necessary for the development of life, since life itself appeared in this background. But during the last 50-60 years, the level of radiation in the environment has been increasing sharply. This is mainly the radiation generated due to emissions from nuclear power plants and nuclear weapons tests. Therefore, studying the properties of radioactive elements and their harmful effects on the environment is important in radiation protection.

The phenomenon of radioactivity was discovered at the end of the 19th century. In 1896, the French scientist A. Becquerel began to study X-rays discovered by X-rays and determined their properties of light scattering. Later, his research was continued by the great Polish scientist Marie Curie, who identified a number of elements that have the ability to emit light by themselves and called them radioactive elements.

It is known that as a result of nuclear decay of radioactive substances, three types of rays are emitted into the environment, i.e. α(alpha), β(beta), γ (gamma) rays.

α-rays consist of a stream of helium atom nuclei, their atomic weight is 4.00273, and their charge is equal to 2+, so they have a strong electromagnetic effect on the surrounding matter. The speed of the particles is 14-20 thousand km/sec, the distance of propagation is 2.5-8.5 cm.

b-rays consist of electron or positron flow, which are formed when a proton in the nucleus turns into a neutron or a neutron turns into a proton. These changes will be implemented according to the following scheme:

$$\mathbf{n \rightarrow p + \bar{e} + \bar{\upsilon},\ p \rightarrow n + \bar{e} + v}$$

in which:

n - neutron; p —proton; ȳ—antineutrino; n - neutrino.

b - it can be considered that the atomic weight of its elements does not change. The speed of the particles is 300,000 km/sec, and the propagation distance is 100 cm. Due to the electromagnetic effect, electrons are absorbed by the substance, so they are not harmful to humans when a protective layer of minimum thickness is installed. But if there is no protective screen in its path, the strong flow of electrons can cause great harm to a person, that is, it can damage his skin or cause loss of eyesight.

γ-rays are one of the rays produced by the decay of radioactive elements, it is electromagnetic (photon) radiation, that is, electromagnetic waves with a very small wavelength (10-9-10-11 cm). .

Since the energy of g-rays is very high, their ability to cross substances is extremely high, and these rays are extremely dangerous for living organisms when they are exposed from the outside. Their power can be reduced only by a thick barrier made of lead placed in the direction of the rays. If the sources of g-radiation are located in the open air and there is no protective screen nearby, they can cause great harm to living organisms.

Table 1

Type of	Energy of	Wave
Radio waves	0,00001	10
Microwaves	0,00001-0,01	0,01-10
Infrared	0,01-1	0,0001-0,01
Visible spectrum	1-6	10-5-1-4
Ultraviolet rays	6-1000	10-7-2·10-5
X-ray	1000-100000	10-9-10-7
g - radiation	100000	10-9

Radiation can be of two types: ionizing and non-ionizing.

Ionizing radiation means the formation of various charged ions in the environment under its influence:

$$A \rightarrow A^{+} + \bar{e}$$

The main indicator of ionizing radiation is its energy. The energy of ionizing radiation is measured in electron volts.

One electron volt is the work done by an electron charge when passing through a capacitor with a potential difference IV.

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Ionizing radiation can be direct or indirect. Direct ionizing radiation includes a, b - and other radiations that have enough kinetic energy to ionize other atoms when they collide with them.

Indirect ionizing radiation consists of uncharged particles (neutrons, photons), which, as a result of its interaction with the environment, lead to the formation of active particles that can lead to ionization.

Ionizing radiation partially loses its energy when it collides with matter. Part of this energy passes into the substance and turns into the kinetic energy of the active particles formed in its composition. Radiation damage in living organisms mainly depends on the reaction of these charged particles, that is, ions with the molecules of the living substance, resulting in the formation of free radicals.

The main mass of a living organism consists of water (75% in humans). Therefore, as a result of their radiation, most of the ionizing radiation is absorbed into water and leads to the formation of extremely chemically active H and OH radicals. These radicals directly react with molecules of organic matter through oxidizing substances (for example, hydrogen peroxide) formed due to secondary changes, causing the tissue of living matter to decay.

Non-ionizing radiation includes radio waves, ultrasound, television, navigation systems, industrial furnaces, UVC, lasers, photogenerators, and others. This radiation, the degree of their impact on humans depends on their frequency. The higher the frequency, the more they can have a negative effect on the eyes and cause burns.

Natural sources of radiation include cosmic radiation and radioactive sources in the Earth's composition.

Cosmic radiation can be of two types - galactic radiation and solar radiation.

The composition of galactic radiation falling on the Earth's surface is as follows:

90% - protons;
7% - α-particles;
Nuclei of elements heavier than 1% helium.

The energy of galactic radiation is 1015 MeV.

The energy of solar radiation is less, it is equal to 104 MeV. Solar radiation depends on the chromosphere explosion processes taking place in the sun, and its power changes from time to time. The main part of solar radiation consists of heavy elements.

Cosmic radiation that reaches the upper layers of the atmosphere is called primary radiation.

As a result of the process of crossing the atmosphere, it repeatedly reacts with substances in the atmosphere and changes its composition. For example, protons are completely consumed in the atmosphere.

The observed radiation in the sea is called secondary radiation.

Radioactive sources in the earth include elements that form three natural radioactive series and have a long half-life.

These are the elements $^{232}_{90}Th$, $^{235}_{92}U$ va $^{238}_{92}U$ (the half-life of this element is T1/2 =1.4·1010 years, 7·108 years and 4.5·104 years). In addition, the isotopes 40K (T1/2=1.26-1010 years) and rubidium 87Rb (T1/2 =1.26·1010 years) are also present in nature, and as a result of their decay, a number of long-lived and short-lived radionuclides is formed. each radioactive series begins with a specific radioactive nuclide and ends with a specific nuclide.

For example, 1 ton of natural uranium contains 0.36 g of Ra and 1.3* 10-9 g of 238Po nuclides.

Uranium, used as the main raw material in nuclear power, is a very common element in nature. Its average amount in the earth's crust is 1.3·10-9%. Naturally occurring uranium mainly consists of three isotopes - 238U (99.275%), 235U (0.72%) and 234U (0.0054%). and all these isotopes have radioactive properties.

During the decay of radionuclides, thermal energy is released along with the kinetic energy of the particles. For example, in the decay of natural radionuclides, the following amount of specific heat is generated:

238U - 2.97;
235U = 18.8;
234Th = 0.84;
40K = 1.1 · 10-4 J/(g·yr).

The main part of the radiation is received by the inhabitants of the Earth from natural sources. The method of irradiation can be of 2 types:

external method; in which radioactive substances irradiate the body from the outside.

internal method; in which radioactive substances enter the body with air, water or food.

Anthropogenic sources of radiation

In recent years, several hundreds of artificial radionuclides have been created by humans, and they are used for various purposes: in medicine, in the creation of nuclear weapons, in the production of nuclear energy, in the detection of fires, in the production of luminous watch dials, and in the search for minerals. Anthropogenic sources of radiation mainly include the following sources:

Sources of ionizing radiation used in medicine. Currently, the main amount of radiation received from man-made sources is received by people from medical procedures and treatment methods related to the use of radioactive substances. In medicine, radiation is used for diagnosis and treatment.

Radiation sources widely used in medicine include X-ray machines, computed tomography, radiotherapy equipment for cancer treatment, and radioisotopes designed to study various processes in the body. This is the average personal dose received from these sources worldwide

400 μZv per person per year. The total equivalent dose for the population of the earth is 1,600,000 people. It corresponds to the year Zv (Zv).

In order to assess the impact of radiation on biological objects, it is necessary to consider the main indicators of ionizing radiation.

It is known that the number of radioactive atoms decreases over time according to the exponential law:

$$\mathbf{N(t)=N(0)exp^{(-\lambda\tau)}}$$

Here: N(0) is the number of radioactive atoms obtained at the initial time;

λ-decay constant, which represents the rate of decrease in the number of radioactive atoms, S-1.

When working with radioactive substances, not their total amount, but the number of released particles or the number of disintegrating atoms proportional to it, has a fixed value.

The activity of radioactive substances A is the number of nuclear transformations dN that occur during a unit of time in one radioactive source:

$$\mathbf{A = \frac{dN}{dt};}$$

The unit for measuring the activity of radioactive substances is Becquerel (Bk).

1 Becquerel is equal to the activity of a radioactive substance with one decay per second.

In practice, the unit of activity Curie (Ku) is often used:

$$\mathbf{1Ku=3{,}700 * 10^{10}\ Bk}$$

The main indicator adopted in dosimetry to assess the effect of ionizing radiation on living and non-living objects in the environment is the absorbed amount of radiation.

The amount of absorbed radiation Dut is the average energy dE given by the ionizing radiation per unit mass dM of the organism:

$$\mathbf{D_{yut} = \frac{dE}{dM}};$$

The unit of measurement of the absorbed amount is Gray (Gr). 1 Gray is the absorbed amount of 1 J energy of radiation corresponding to 1 kg of irradiated substance.

Another practical unit of measurement of absorbed amount is radian (rad):

1 rad = 10-2Gr.

The concept of exposure quantity is used to estimate the area of photon radiation.

Exposure amount of radiation Dex is the ratio of the total charge dQ of all ions of the same sign formed in air of mass dM to the mass of air in this volume:

$$\mathbf{D_{eks}} = \frac{\mathbf{dQ}}{\mathbf{dM}};$$

The unit of measurement of exposure amount is the amount corresponding to 1 coulomb of charge per 1 kilogram of mass (kl/kg).

In practice, the unit of measurement of exposure quantity is used - X-ray:

1P=2,58*10^{-4} Kl/kg

Equivalent amounts are used to assess the effects of different types of radiation on living organisms. The equivalent amount of radiation Decv is the absorbed amount multiplied by the coefficient of the effect of different radiation on organisms:

$$\mathbf{D_{ekv} = kD_{yut}}$$

where k is a dimensionless quality coefficient representing the biological efficiency of ionizing radiation.

For X-rays, radiation, and β-particles, k = 1,
k =20 for α-radiation.

The equivalent amount of radiation is measured in the sievert (Zv) unit.

1 Sievert is radiation that produces an efficiency equal to the biological efficiency indicated by the absorbed amount of 1 Gr of X-ray or g-radiation. Another unit of measurement of the equivalent quantity is ber:

$$\mathbf{1_{ber} = 0,01Zv}$$

The power of the ingested amount P (the power of the exposure amount - Pex, the power of the equivalent amount - Pex) is the ratio of the ingested amount (of the exposure amount, equivalent amount) to the exposure time:

$$\mathbf{P_{yut} = \frac{dD_{yut}}{dt}; \quad P_{eks} = \frac{dD_{eks}}{dt}; \quad P_{ekv} = \frac{dD_{ekv}}{dt}};$$

Biological effects of ionizing radiation.

As a result of synthesizing radioactive substances and their wide use in various fields, the biosphere was polluted with a new type of pollutant, i.e. radionuclides. As a result of the impact of ionizing radiation on living organisms, complex physical, chemical and biochemical processes occur in their tissues. The breakdown of biological systems depends on the ability of radioactive α, β g-radiation to ionize molecules.

The biological effect of ionizing radiation can be carried out by two mechanisms:

direct impact of proteins on tissues;

indirect, i.e. exposure of water through radiolysis products.

Since living organisms contain a large amount of water, under the influence of radiation, water breaks down and active particles are formed - N,ON. These particles react with biological substances and change them.

Harmful effect of radiation source affecting a living organism from outside depends on the ability of radiation to pass through living matter. For example, g-radiation, like X-rays, is the most harmful for humans, because they actively cross the tissues of a living organism. A thick screen made of lead is used to protect against this radiation.

A large part of α-radiation is absorbed by the skin of a living organism.

β-radiation can penetrate the body to a depth of 1 ml.

Since the flying distance of a, b particles is small, they do not cause significant damage to living organisms when they are exposed from the outside. A 10 cm thick layer of air or a thin foil is enough to protect from these rays. Special clothing also reduces the strength of α-particles. Aluminum, Plexiglas, and glass screens with a thickness of several millimeters completely block b radiation.

Radioactive substances can enter the body through air, breathing, contaminated drinking water and food. According to the degree of danger of radioactive rays in internal damage, they are placed in the following order:

α-radiation is considered the most dangerous, followed by β- and γ-radiation.

The biological effect of ionizing radiation depends on the following indicators:
activity of a radioactive substance;
total amount of radiation;
exposure time of the irradiator;
type of radiation;
the size of the irradiated object area;
rate of radioactive isotopes leaving the body;
personal characteristics of the organism.

The greater the activity of a radioactive substance, the higher its level of danger. Substances with low activity, i.e. the amount of radiation is low, do not have a significant negative effect on the body.

Such substances are used in medicine for treatment purposes (for example, in radon baths).

The level of danger of radioactive substances also depends on the speed of its removal from the body. If these substances are the same as the elements consumed by humans with food (Na, K, Cl, etc.), they will leave the body together with these elements without being stored for a long time. For example, inert gases - Xe, Ar, Kr will completely leave the body after a certain time.

The rate at which radioactive substances leave the body also depends on their half-life. In medicine, radionuclides with a very short half-life are used for diagnosis.

When some radioactive substances enter the body, they are distributed uniformly. Some substances accumulate in certain organs. For example, radium, uranium, and plutonium accumulate in the lungs, and strontium, yttrium, and cobalt accumulate in the esophagus and lungs.

Somatic and genetic effects of radioactive substances on living organisms.

Radioactive substances can have two effects on living organisms:

1 — somatic effect, i.e., changes in the directly irradiated organism that occur later over a certain period of time;

2 - genetic effect, i.e. the effects on future generations through changes in human genes and chromosomes under the influence of radiation.

Radiation sickness can occur in living organisms. Irradiation can be short-term or long-term. in a body irradiated for a short period of time, a decrease in leukocytes in the blood, nausea, and weakness are observed. Acute radiation damage is observed when a large dose of radiation (50 Gr) is exposed for a short time, and chronic radiation damage is observed when a relatively small radiation dose is exposed for a long time. Irradiation with a single dose of 600 rad (6 Gr) causes death of a person after 30 days.

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