Ministry of Science and Education of the Republic of Azerbaijan, Sumgait State University

PROGRAM of Environmental Chemistry

Sumgait – 2022

Ministry of Science and Education of the Republic of Azerbaijan, Sumgait State University

050504 **–** For undergraduate training in ecology

PROGRAM
of Environmental Chemistry

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Subject program of the Ministry of Science and Education of the Republic of Azerbaijan approved by the decision of the Ministry of Science and Education
No. F-354 dated 30.07.2020 of the bachelor level 050504-Ecology, included by the Ministry of Science and Education in the department of specialty subjects of the Bachelor's degree in Environmental chemistry(IF-B18, 6 credit), corresponding to the professional competencies of the bachelor designed based on requirements.

In the subject program, topics for the sections of Environmental chemistry, a list of recommended literature are given.

EXPLANATORY

One of the scientific directions of modern ecology is environmental chemistry. Since approximately 1950, the rapid improvement of industry and transport, the chemicalization of agriculture, and the increased man-made influence as a result of intensive urbanization have led to changes in the material composition of the environment. It is observed that the expansion of the volume of industrial production and the distribution of chemical industry products in the world increases the concentration of those chemical reagents even far from the place of production. At the present time, there is a need for a more in-depth study of chemical products and materials released from industrial enterprises, because this allows to study the chemical processes occurring in the environment (atmosphere, hydrosphere, lithosphere).

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Characterization of the subject

The subject of ecological chemistry is included in the approved Educational Program of the specialty 050504-Ecology by the Ministry of Science and Education and belongs to the department of specialized subjects. (İF-B18, 6 credit)

The purpose of the subject

The purpose of teaching ecological chemistry is to determine the chemical mechanisms of interaction between the food environment of people and separate ecosystems. Environmental chemistry is designed to train professional ecologists who have a deep understanding of

the mechanisms of chemical processes occurring in the biosphere.

Tasks of the subject:

The task of environmental chemistry is to study the chemical processes and effects occurring in the environment, as well as the consequences of these effects.

- characterization of various types of pollutants due to their effect on ecosystems and living organisms and study of the mechanism of toxic effects of chemicals;
- study of the chemical composition of the biosphere - the amount of chemical elements in water, soil, atmosphere and biota;
- migration of chemical elements in the natural environment and entry into the human body;
- study of toxic properties of organic and inorganic substances.

Students studying the subject should have fundamental knowledge of geography, general chemistry, and biology.

Professional competencies acquired by the student mastering the subject:

- - should be able to interpret modern theoretical issues of chemistry and chemical processes occurring in different environments - atmosphere, hydrosphere and lithosphere, and methods of analysis of chemical substances;

- - should be able to explain the main groups of pollutants, their migration, transformation and accumulation in ecosystems.

- should be aware of the mechanism of the effect of environmental factors on the body and its limit of durability, ways of adapting to the stress effects of the environment;

- should know the characteristics of the effects of different types of pollutants on organisms, biocenosis and the human body.

Learning outcomes of the subject:

LOS 1 - Interprets the Earth's geosphere and its processes, planetary metabolism, pollutants, their sources and distribution in the biosphere;

LOS 2 - Explains the permissible concentrations and threshold levels of pollutants;

LOS 3 - interprets modern theoretical issues of chemistry and chemical processes occurring in different environments - atmosphere, hydrosphere and lithosphere, and methods of analysis of chemical substances;

LOS 4 - Explains the main groups of pollutants, their migration, transformation and accumulation in ecosystems;

LOS 5 - Explains the mechanism of the effect of environmental factors on the organism and its limit of durability, ways of adapting to the stress effects of the environment;

LOS 6 -acquired the ability to interpret the characteristics of the effects of various types of pollutants on organisms, biocenosis, and the human body.

CONTENT OF THE SUBJECT

The subject and issues of environmental chemistry. General information about the Earth's geosphere

Chemical ecology and environmental chemistry. The main difference between these subjects. Biological and chemical aspects. Objectives of environmental chemistry. Comparison of environmental changes due to human activities and natural disasters. Basic issues of environmental chemistry. Research methods used in ecological chemistry (‘hybrid’ methods). Information about the Earth's geosphere. Chemical environmental factors.

Chemical pollutants, their information on sources and distribution in the biosphere

Pollutants. Sources of chemical pollutants. Transport, heating and atomic energy, industrial and agricultural production, municipal utility of cities. Chemical pollutants and their entry into the biosphere. Classification of environmental pollutants. Classification of pollutants according to the nature of their effect on the ecosystem. Local, regional and global pollution.

Classification of substances according to the nature of their effect on living organisms

Chemosphere. Classification of polluting chemicals according to sources of employment, spatial distribution. Classification according to application areas and effects. Biocides. Xenobiotics. Exogenous substances and ecotoxicants. Superecotoxicants. Radioactive substances. Classification of substances in the hemosphere. Molar toxicity. Toxicity and carcinogenicity. Substances harmless to humans. Greenhouse gases and freons. Important substances for the body. Stimulants, therapeutic agents. Ineffective substances. Biological response of the body to the influence of harmful substances.

Hazard class of harmful substances according to the degree of impact on the human body

Very dangerous, highly dangerous, dangerous and less dangerous substances. Synergism. Additivity. Antagonism. Mutagenic and carcinogenic substances. Types of effects of chemicals: cytotoxic, teratogenic and genetic. Classification of toxic substances according to the duration of action on living organisms and the form of manifestation of the effect. Metabolism. Promoters of carcinogenesis. Biotransformation of substances in various living organisms. Detoxification.

Permissible concentration limit of chemical pollutants in biosphere components

Threshold level, principles of environmental quality normalization. The advantages of compliance with the environmental regulations that determine the quality of the environment, the permissible concentration limit (PCL). The permissible emission limit of harmful substances in the atmosphere (PEL) and the permissible flow limit in water bodies (PFL), PCLi.z.,PCLm.b., PCLo.s.,PCLs, PCLb.s. Integral indicators of water (biological consumption of oxygen, chemical consumption of oxygen) and approximate permissible density (APD).

Chemical composition of living organisms

Geochemistry and biogeochemistry. Amount (mass%) of chemical elements in soil, sea water, plants and animals in the earth's crust. Biological solidification of elements. Organogens. Macro- and micronutrients. Ultramicroelements. For life, constant mixed and mixed elements. Biogenic elements. Metals of life. Functions of macro- and microelements. Endemic diseases.

Basic chemical compounds of living organisms

Composition of the human body at the molecular level. The role of water in the vital activity of the body. Amount of water in the body: intracellular and extracellular water. The interaction of water molecules with the components of the

body. Chemical reactions that occur in living nature in the presence of water.

Organic substances. Amount in human and other living organisms. Metabolites. Plastic and energy substances. Inorganic substances. Biological activity of protein and nucleic acid macromolecules. Harmful organic substances. The nature of the toxic effect. Average lethal dose (LD50) and average lethal concentration (LQ50).

Migration of chemical elements in the natural environment and their entry into the human body

Biochemical migration cycle of chemical elements. Producers, consumers, reducers. Migration of anthropogenic pollution. Internal and external migration factors. External factors: Chemical composition of natural waters. Acidity of natural waters. Components of natural waters. Pollution migration scheme and its stages. Metabolism in the human body.

Biochemical role and toxic properties of s-Elements and their inorganic compounds

Organic and inorganic compounds according to their chemical composition. Dependence of toxic properties of elements on their position in the periodic table. Biological role of subgroup IA elements: lithium, sodium, potassium, rubidium and cesium. Biological role of subgroup IIA elements: beryllium, magnesium, calcium, strontium and barium.

Biochemical role and toxic properties of p-elements and their compounds

The position of the p-elements in the periodic table. Elements included in group IIIA. Biological role of boron compounds. Boric acid and its salts. Disadvantages of excess boron. Effects of boron on hydrobionts. Aliminium-as one of the most common elements in nature. Biological

role of gallium, indium and thallium. Elements included in subgroup IVA. Carbon dioxide and carbon monoxide. Their biological role. Cyanic acid and its salts. Silica and its biological role. SiO2 and its harmful effects. Biological role of germanium and tin. Harmful effects of lead on the body. Tetraethyllead. Elements included in the VA subgroup, their biological role and toxic properties. Elements included in subgroup VIA, their biological role and toxic properties. Elements included in subgroup VIIA, their biological role and toxic properties.

d - Biochemical role and toxic properties of elements and their compounds

d- The position of elements in the periodic system. Group IB elements (copper, silver, gold). The role of copper included in enzymes in oxidation-reduction processes. The amount of copper in the body. Bactericidal properties of silver. Harmful effects of copper deficiency and excess. Amount of zinc, cadmium and mercury in the body. Toxic compounds of zinc. Sources of formation of group IIB metals and ways of entering the body. Subgroup IIIB and IVB elements. VB and VIB subgroup elements. Subgroup VIIIB elements. Biological role of iron and its compounds.

Toxic properties of organic compounds

General information about organic compounds. Grouping of chemical substances according to their biological effect: first group, second group of substances. Primary and secondary substances. Classes of organic compounds according to their origin: the first group, the second group and the third group. Dependence of toxic properties of organic compounds on their composition and

structure. Variation in toxicity in the homologous sequence. Ricardson's rule. Effect of carbon chain type on toxicity.

Hydrocarbons

Hydrocarbons (aliphatic, alicyclic and aromatic compounds). Hydrocarbons by type of carbon chain. Comparison of reactivity of alkanes with alkenes and alkynes. Areas of application of hydrocarbons: fuel in internal combustion engines, rocket engines, boilers, various oils, lubricants and solvents, etc. The main ways that hydrocarbons enter the human body. Destruction of hydrocarbons in living organisms. Narcotic effects of hydrocarbons. Variation of toxicity of hydrocarbons in the order of alkane-alkyne-arene. Dependence of the toxic properties of hydrocarbons on the structure of their carbon chain. Effects of hydrocarbons dissolved in water on hydrobionts. Harmful effects of oil and oil products. Oil and oil products in water bodies PCL.

Halogenated derivatives of hydrocarbons

Halogenated derivatives of hydrocarbons. Mono-, di- and poly- halogen derivatives. Polyfunctional and mixed halogen derivatives. Water solubility of halogen derivatives. Application of halogen derivatives. Ways of entry of halogenated derivatives into the human body. YVQH of halogenated derivatives. Effects of halogenated derivatives on organisms and hydrobionts. Major sources of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8- TCDD) and 2,3,7,8 tetrachlorodibenzofuran (2,3,7,8- TCDF). Physico-chemical properties and toxic effects of dioxins.

Toxic properties of functional group organic compounds

Alcohols. Dihydric, dihydric and trihydric alcohols. Solubility of alcohols in water. Areas of application of alcohols. Ways of entering the body of alcohol. Toxic effects of diatomic alcohols. Methyl alcohol, ethyl alcohol, allyl alcohol, ethylene glycol, phenol. Carbonic acids. Acids dissolve in water and ways of entering the body. Simple ethers, their toxic effect. Amens. Variation in the toxicity of amines in homologous order. Alkylhydrazines, their fields of application. Formation of methemoglobin. Nitrocompounds. Decomposition of aliphatic nitro compounds. Nitrobenzene.

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