



Supervisor
Supervisor's contact
information (e-mail)

SYLLABUS
«The biogeochemical cycles of metal-micronutrients»
Degree of Higher Education – PhD student
Specialty 102 Chemistry
Educational program - Chemistry
Year of training – the second; Semester: 3
Learning form – full-time; part-time
Amount of the ECTS credits - 5
Language of instruction - English

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DESCRIPTION OF COURSE

Biogeochemistry of metal-microelements is the study of biological controls on the trace metals chemistry of the environment and geochemical regulation of their ecological structure and function. Additionally, It will utilize the scientific literature from peer-reviewed journals to explore specific case studies on the micronutrients global biogeochemistry (e.g., precipitation, deposition, soil solution exchange, etc.). Trace elements play a critical role in biosphere functioning. Although the concentration, distribution, and bioavailability of trace metals have changed with environmental evolution, their distribution and migration processes are relatively stable. The advent of clean techniques together with advances in analytical procedures and instrumentation, have led to a significant improvement in our understanding of trace metal-micronutrient biogeochemistry due to their activity as ferment active centers etc. The study of the biological, geological and chemical factors that influence the movement of metal-micronutrients through living systems across space and time is the main idea of an educational activity. Processes can be studied at the microbial, ecosystem and global scales. Scales are becoming increasingly integrated.

Biogeochemistry of metal-microelements is the professional-oriented subject. It is a discipline of the elective choice of PhD training in Chemistry. The program shows types of migrations, biological circulation and biogeochemical cycles of metal-microelements and their role in the life of plants and animals. The principles of metal biogeochemical zoning are defined, the practical aspects of metal-microelement biogeochemistry as a science, its importance for environmental protection at the current stage of human development are revealed. The principles of mathematical modeling of chemical and physicochemical processes in the cycle of such chemical elements are presented.

The objectives of studying the discipline are to give graduate students knowledge about the cycle of trace metals and their impact on living nature, which would contribute to the understanding of the chemical aspects of environmental protection measures, the organization of the environmentally friendly products and the provision of safe sanitary and hygienic living conditions.

Requirements to the knowledge and skills

General competences:

GC3. The ability to form a systematic scientific outlook, to generate new ideas (creativity), produce and make informed decisions.

GC5. Ability to use a foreign language for presentation scientific results in oral and written forms, for understanding foreign-language scientific and professional texts for communication in foreign-language scientific and professional environments.

Professional (Special) competences:

PC1. The ability to formulate a scientific problem, working hypotheses of the investigated problem in the field of chemistry

PC2. The ability to carry out a critical analysis of scientific sources, author's methods, specific educational, scientific and professional texts in the field of chemistry.

PC4. Possession of the general methodology of carrying out scientific research, the ability to organize, plan and implement a chemical experiment, calculate and process the obtained data.

Program learning outcomes:

PO1. Understand the scientific concepts and modern theories of chemistry and the fundamental foundations of related sciences. Be able to critically evaluate hypotheses in the field of chemical sciences.

Formulate the conceptual foundations of the modern understanding of the chemical level of the organization of matter, the philosophy of scientific knowledge.

PO9. To have the basics of statistical processing of arrays of numerical data and to be able to interpret the results of experimental studies.

PO10. Plan, organize and implement experimental research in chemistry and related scientific areas using modern methods, technologies and equipment.

PO11. Know the relationships between the chemical composition of living organisms and the role of chemical elements in their development; methods of researching ways and mechanisms of biogenic and technogenic migration of chemical elements in the environment.

PO12. To be able to evaluate the nature of chemical processes that determine the state and properties of the environment - atmosphere, hydrosphere and soils, ecological phenomena and problems related to chemical pollution of the environment.

PO13. Understand the principles of building quantitative models of geochemical cycles of "Big Six", macro- and micronutrients, toxicants; the chemical mechanism of action of geochemical barriers on the migration of chemical elements in the environment.

PO14. Know the procedures for registration of intellectual property rights and registration of security documents. Be able to conduct a patent search in the field of chemical inventions, technologies and objects.

PO15. Communicate freely in English and (if possible) another foreign language on professional matters, orally and in writing present the results of research in chemistry in a foreign language, participate in the discussion of chemistry problems.

PO17. To have the basics of public speaking, oral and written professional communication.

PO20. Possess communication skills and know the principles of organization, forms of implementation of the educational process in modern conditions, its scientific, educational-methodical and normative support, processing of scientific and informational sources when preparing classes, application of innovative teaching methods.

STRUCTURE OF COURSE

Content of modules and chapters	Hours (lectures/ labs)	Content of the activities evaluated	Scores
Module the 1st. Biogeochemical characteristics of the ecosphere composition			
Chapter the 1st. Introduction. Ecosphere as the highest level of alive matter chemical organization.	2/2	Lab 1. Qualitative analysis of the model solution containing cations of metal micronutrients and toxic metal and metalloids Lab 2. Quantitative spectrophotometric determination of metal micronutrients in natural waters (On the example of Iron, Manganese) Lab 3. Quantitative electrochemical (method of inversion chronopotentiometry) determinations of metal micronutrients in soil soils (on the example of Copper, Zinc, Cobalt, Nickel). Module control test (via Elern)	10
Chapter the 2d. Chemical elements as a matter foundation of inorganic and organic nature. Biochemical migration of chemical elements	2/2		20
Chapter the 3d. Features of trace elements migration. Primary, secondary and tertiary dispersions of trace elements in the environment.	4/4		20
Total the 1st module	8/8		100
Module the 2d. The biogeochemical laws and chemical functions metal-micronutrients			
Chapter the 4th. Bioinorganic compounds and physiological role of trace elements. Kowalsky's concept of biogeochemical provinces. The role of trace elements in the endemic diseases occurrence.	4/2	Lab 4. Quantitative determination of metal microelements in organic matter via extraction by water and organic solvents (on the example of Copper and Selenium) Module written report and oral presentation	30
Chapter the 5th. Biogeochemical zoning, landscape-geochemical	2/2		50 20

zoning of Ukraine. Zonal and diffuse provinces in Ukraine, human and animal endemic diseases in Ukraine as a result of abnormal distribution of metal-micronutrients.		Discussion	
Total the 2d module	6/4		100
Module the 3d. Technogenic emission and redistribution of trace metals			
Chapter the 6th. Technophilicity of chemical elements including typical potentially toxic elements and amount of waste. Technogenesis and technogenic geochemical anomalies.	2/2	Lab 5. Phytotoxic assessment of natural waters by biotesting methods using hydrobionts of different systematic groups.	40
Chapter the 7th. Anthropogenic stage of biosphere development. The concept of biogeochemical functions and biogeochemical principles of living matter. Organisms - concentrators of trace metals.	2/4	Module control work	60
Chapter the 8th. Mathematical modeling of metal microelements chemical transformation processes in the environment	2/2		
Total the 3d module	6/6		100
Education activity	20/20		300/70
Exam			30
Finally			100

EVALUATION POLICY

<i>Deadline policy and exam retake allowing:</i>	Works that are submitted in violation of deadlines without good reason are evaluated at a lower grade. Retake of tests takes place with the lecturer's permission if there are good reasons (for example, student was sick and has the hospital sheet; took part in university event, scientific meeting etc.).
<i>Academic Integrity Policy:</i>	Write-offs during tests and exams are prohibited (including using mobile devices).
<i>Attendance Policy:</i>	Attendance is a mandatory component of the grade for which points are earned. For objective reasons (such international internship, sickness), teaching may be provided on-line, in agreement with the Dean.

GRADING SYSTEM

Rating of Higher education applicant, scores	National grade according to the results of written exam
90-100	Excellent
74-89	Good
60-73	Satisfactory
0-59	Unsatisfactory

RECOMMENDED LITERATURE

Basic

1. Kopilevich, V.A. et al. (2004), Environmental chemistry, Fenix Publ., Kyiv (412 pp.) (In Ukrainian) (available in NUBiP Library).

2. Schlesinger, W. H. 1997. Biogeochemistry: An Analysis of Global Change, 2nd edition. Academic Press, San Diego, Calif. ISBN 012625155X.
3. Domy C. Adriano. Biogeochemistry of Trace Metals: Advances In Trace Substances Research 1st Edition, CRC Press Revivals Kindle Edition, 2019. – 526 p.
4. Voitenko, L.V. et al. (2015), Lab manual of Biogeochemistry for Bachelor students of Ecology, NUBIP Publ., Kyiv (120 pp.)
5. Войтенко Л.В. Хімія з основами біогеохімії. – К.: Наукова столиця, 2019. – 400 с.

Additive

1. Аналітична хімія природного середовища: Підручник/Б.Й. Набиванець, В.В. Сухан, Л.В. Калабіна. – К.: Либідь, 1996. – 304 с.
2. Аналітична хімія поверхневих вод //Б.Й. Набиванець, В.І. Осадчий, Н.М.Осадча та ін. – Київ: Наук. Іумка, 2007. – 457 с.
3. Skalniy A. Microelementoses of man: hygienic diagnostics and correction, Microelem. in med. 1 (2000).

IT resources

1. Ayers R.S. Water quality for agriculture/ R.S. Ayers, D.W. Westcot // FAO Irrigation and Drainage paper. – Roma, 1994. – 147 pp. [Електронний ресурс] / Режим доступу: <http://www.fao.org/DOCREP/003/T0234E/T0234E00.HTM>
2. Національна доповідь про якість питної води та стан питного водопостачання в Україні за 2020 рік – К.: Мінрегіонрозвитку України, 2021. [Електронний ресурс]/ - Режим доступу: <https://www.minregion.gov.ua/napryamki-diyalnosti/zhkh/teplo-vodopostachannya-ta-vodovidvedennya/natsionalna-dopovid/nacjonalna-dopovid-pro-yakist-pytnoyi-vody-ta-stan-pytnogo-vodopostachannya-v-ukrayini-za-2020-rik-2/>
3. Екологічні карти України (25 карт) - [Електронний ресурс]. Режим доступу: http://road.elitno.net/?attachment_id=21
4. World Water Day: A Billion People Worldwide Lack Safe Drinking Water - [Електронний ресурс]. – Режим доступу: <http://environment.about.com/od/environmentalevents/a/waterdayqa.ht>
5. Ayers R.S. Water quality for agriculture/ R.S. Ayers, D.W. Westcot // FAO Irrigation and Drainage paper. – Roma, 1994. – 147 pp. [Електронний ресурс] / Режим доступу: <http://www.fao.org/DOCREP/003/T0234E/T0234E00.HTM>
6. Malyuga D. Biogeochemical Methods of Prospecting Part 8. Global Biogeochemical Cycles. Springer, 1995. – URL: <http://www.agu.org/journals/gb/>
7. Kakareka S, Kukharchyk T, Kurman P. Major and trace elements content in freshwater lakes of Vecherny Oasis, Enderby Land, East Antarctica / Environ Pollut. 2019 Dec;255(Pt 1):113126. doi: 10.1016/j.envpol.2019.113126. – URL: <https://pubmed.ncbi.nlm.nih.gov/31542663/>
8. Bargagli R. Trace metals in Antarctica related to climate change and increasing human impact. Rev Environ Contam Toxicol. 2000;166:129-73. PMID: 10868078. – URL: <https://pubmed.ncbi.nlm.nih.gov/10868078/>
9. Winkel Lenny H. E., Sunderland E. M. Introduction to the biogeochemistry of the trace elements / Environ. Sci.: Processes Impacts, 2022. Vol. 24, Article 1277. – URL: <https://pubs.rsc.org/en/content/articlepdf/2022/em/d2em90031a>