



## 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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**Supervisor**  
**Supervisor's contact**  
**information (e-mail)**

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## DESCRIPTION OF COURSE

Discipline studies chemical, physical, geological and biological processes that are regulating the micronutrient content and migration through the environment, biogeochemical cycles in their interaction with living matter through the biological systems of the Earth in time and space. The course includes the laws of the chemical composition formation of the ecosphere; principles of biogeochemical zoning, biogeochemical provinces and endemic diseases in them connected with distribution of metal-micronutrients; ways and types of biogenic and anthropogenic migration of chemical elements; methods for predicting chemical transformations of metal-micronutrients; mechanisms of isotope fractionation with living matter; the role of living matter in their migration; biogeochemical patterns based on methods of chemical indication of the environmental state; chemical transformation of these elements at passing through the biological systems and environment.

### ***General competencies (CG)***

CG3. To be able to form a systematic scientific outlook, generate new ideas (creativity), produce and make informed decisions.

CG5. To be able 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 competences of the specialty (PC)***

PC1. To be able to formulate a scientific problem, working hypotheses of the investigated problem in the field of chemistry.

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

PC4. To be able to possess 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 (PLO)***

PLO1. To 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.

PLO2. To have the basics of statistical processing of arrays of numerical data and to be able to interpret the results of experimental studies.

PLO10. To plan, organize and implement experimental research in chemistry and related scientific areas using modern methods, technologies and equipment.

PLO11. To 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.

PLO12. 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.

PLO13. To understand the principles of building quantitative models of geochemical cycles of organogenesis, macro- and microelements, toxicants, the chemical mechanism of action of geochemical barriers on the migration of chemical elements in the environment.

PLO14. To 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.

PLO15. To 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.

PLO17. To have the basics of public speaking, oral and written professional communication.

PLO20. To 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

Chapter	Hours (lectures/labs)	Results of learning	Tasks	Grading, scores
<b>The fall semester, the 4<sup>th</sup> year of study</b>				
<b>Module the 1<sup>st</sup>. Biogeochemical characteristics of the ecosphere composition</b>				
<b>Chapter 1.</b> Introduction. The object of research and the goal of the discipline. The general chemical properties of metal-micronutrients.	4/6	<b>Know</b> the subject and objectives of the course; areas of environmental issues related to biogeochemical cycling; modern ideas about the chemical properties and biochemical behavior of these elements <b>Be able to work and analyze</b> scientific and educational literature on the subject; <b>Gain practical skills and be able to apply</b> methods and equipment of rapid analysis on the example of determining the content of Ca and Mg in; statistical processing of experimental results.	Lab works processing and its defending; online testing on Elern platform	<b>7</b>
<b>Chapter 2.</b> The biogeochemical laws and chemical functions metal-micronutrients	4/4	<b>Know</b> different approaches to the formulation of the biosphere concept in terms of its chemical structure and laws of function; <b>Understand</b> the role of living matter as the main driving force of chemical transformation of metal-micronutrients; the reasons for the existence of different types of classification of bioactive elements; biogeochemical functions of living matter in migration of micronutrients. <b>Apply</b> quantitative laws (eg, Redfield atomic ratio, Le Chatelier principle)	Lab works processing and its defending	<b>7</b>

		for environmental forecasts; <b>Gain practical skills</b> to perform analyzes of underground water (total iron and manganese content)		
<b>Chapter 3.</b> Biogeochemical zoning, endemic diseases connected with the abnormal distribution of metal-micronutrients	8/6	<b>Know</b> the basic concepts of biogeochemical zoning and biogeochemical chains according to Kowalski; types and causes of typical endemic diseases, especially in Ukraine connected with the abnormal distribution of metal-micronutrients (goiter, iron-dependent anemia) <b>Understand</b> the consequences of the anomalous distribution of chemical elements in the hydrosphere and lithosphere on the functioning of living matter; methods of prevention and treatment of endemic diseases; <b>Gain practical skills</b> of analytical determination of the content of Barium, Strontium, Potassium and Sodium.	Lab works processing and its defending; Module control test	<b>20</b>
<b>Total the 1<sup>st</sup> module</b>	16/16			<b>34</b>
<b>Module the 2<sup>d</sup>: Biogeochemical cycles of the main metal-micronutrients</b>				
<b>Chapter 1.</b> General notions about Biogeochemical cycles. Features of sediment biogeochemical cycles. Biogeochemical barriers.	12/10	<b>Know</b> classification, physical, chemical, and biological processes founded of biogeochemical cycling; the energy sources for the realization of the biogeochemical cycling; how to apply chemical processes for the organization of biogeochemical barriers for the prevention of migration of pollutants (acid-basic, clay; RedOx barriers etc.). Understand the experimental proofs of alive matter role in cycling of metal-micronutrients; degree of anthropogenic pressure into biogeochemical cycles; why different scientists give the various quantitative assessment of pools, fluxes, exchange and reserve funds; <b>Gain practical skills</b> of analytical determination of heavy metals (Zn, Cu, Cd, Pb as anthropogenic pollutants of natural waters)	Lab works processing and its defending; online testing on Elern platform	<b>16</b>
<b>Chapter 2.</b> <b>Chemical forms of metal-micronutrients in the environment</b>	2/4	<b>Know</b> the theoretical foundations of application and chemical mechanism of natural and artificial sources of meta-micronutrients <b>Understand</b> the risks for human health of excess uptake of metal-micronutrients and their concentration limits for transformation in toxic elements <b>Apply</b> the knowledge of ecological safety and risks of their excess in everyday life; <b>Gain practical skills</b> of analytical determination of Pb determination in dust and milk	Lab works processing and its defending; Module control test	<b>20</b>

<b>Total the 2d module</b>	14/14			<b>36</b>
<b>All</b>				<b>70</b>
<b>Final testing</b>				<b>30</b>
<b>Finally</b>				<b>100</b>

### EVALUATION POLICY

<b><i>Deadline policy and exam retake allowing:</i></b>	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.).
<b><i>Academic Integrity Policy:</i></b>	Write-offs during tests and exams are prohibited (including using mobile devices).
<b><i>Attendance Policy:</i></b>	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

<b>Rating of Higher education applicant, scores</b>	<b>National grade according to the results of written examination</b>	
	<b>exam</b>	<b>test</b>
90-100	Excellent	Pass
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactory	Fail

### 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, Academic Press, San Diego, CA. (available on Amazon.com)
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.)

#### 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. Думка, 2007. – 457 с.
3. Мікроелементози сільськогосподарських тварин. – К.: Урожай, 1974. – 151 с.

#### 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 у 2011 році. – К.: Мінрегіонрозвитку України, 2012. – 642 с. [Електронний ресурс] /Режим доступу: [http://minregion.gov.ua/images/Pidrozdily/MEDVED/\\_.2011\\_.pdf](http://minregion.gov.ua/images/Pidrozdily/MEDVED/_.2011_.pdf)
3. 15. Екологічні карти України (25 карт) - [Електронний ресурс]. Режим доступу: [http://road.elitno.net/?attachment\\_id=21](http://road.elitno.net/?attachment_id=21)
4. Vladimir I. Vernadsky, 2007, *Essays on Geochemistry & the Biosphere*, tr. Olga Barash, Santa Fe, NM, Synergetic Press, ISBN 0-907791-36-0 (originally published in Russian in 1924)
5. Schlesinger, W. H. 1997. *Biogeochemistry: An Analysis of Global Change*, 2nd edition. Academic Press, San Diego, Calif. ISBN 012625155X.
6. Schlesinger, W.H., 2005. *Biogeochemistry*. Vol. 8 in: *Treatise on Geochemistry*. Elsevier Science. ISBN 0080446426
7. Vladimir N. Bashkin, 2002, *Modern Biogeochemistry*. Kluwer, ISBN 1-4020-0992-5.
8. Samuel S. Butcher et al. (Eds.), 1992, *Global Biogeochemical Cycles*. Academic, ISBN-0-12-147685-5.
9. Susan M. Libes, 1992, *Introduction to Marine Biogeochemistry*. Wiley, ISBN 0-471-50946-9.
10. Dmitrii Malyuga, 1995, *Biogeochemical Methods of Prospecting*. Springer, ISBN 978-0306106828.