

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of
Higher Education

"Ural Federal University named after the First President of Russia B.N. Yeltsin"

Institute of Natural Sciences and Mathematics

APPROVED BY
Vice-Rector for Research
A.V. Germanenko
2023 г.



**PROGRAM OF THE DISCIPLINE
ECOBIOLOGICAL TECHNOLOGIES**

List of information about the work program of the discipline	Credentials
Postgraduate Program Biotechnology	Code PP 1.5.6.
Group of specialties Biological Sciences	Code 1.5.
Federal State requirements (FSR)	Order of the Ministry of Science and Higher Education of the Russian Federation № 951 dated 20.10.2021.
Self-approved requirements (SAR)	Order "On the implementation of the "Requirements for the development and implementation of training programs for scientific and scientific-pedagogical personnel in the graduate school of UrFU" dated 31.03.2022 №315/03

Yekaterinburg
2023

The program of discipline was compiled by the authors:

№	Full name	Academic degree, Academic title	Position	Affiliation
1	Galina G. Borisova	Dr. Sci., Senior Researcher	Professor	Department of Experimental Biology and Biotechnology of the Institute of Natural Sciences and Mathematics
2	Irina S. Kiseleva	PhD, Docent	Head of Department	Department of Experimental Biology and Biotechnology of the Institute of Natural Sciences and Mathematics

Recommended by:

Educational and methodological board of Institute of Natural Sciences and Mathematics

Head of the Educational and Methodological board of
the Institute of Natural Sciences and Mathematics

Record № 1 от 19.01.2023 г.

E. S. Buyanova

Agreed by:

Head of academic staff training department

E.A. Butrina

1. GENERAL CHARACTERISTIC OF THE DISCIPLINE “ECOBIOLOGICAL TECHNOLOGIES”

1.1. Annotation

The discipline «Ecobiotechnologies» refers to the elective part of the PhD program and is aimed at training of highly qualified competent specialists in the field of fundamental and applied biotechnology.

The aim of the discipline: the integration of PhD students' knowledge about using living systems to prevent pollution of environmental components, their restoration and conservation of biodiversity as well as the formation of skills in the use of modern technical means for solving environmental and research problems.

The content of the discipline covers a range of issues related to the basic concepts of fundamental and applied biotechnology, methods and technologies for prevention of environmental pollution, remediation and reclamation of technogenically disturbed lands and other «green technologies».

The study of the discipline involves the following tasks:

- the study of the modern directions in the development of ecobiotechnologies;
- the study of methods of fundamental and applied biotechnology, aimed at restoration of environmental components and conservation of biodiversity;
- the formation of practical skills in the field of ecobiotechnologies.

1.2. The language of study - English

1.3. Expected discipline outcomes

As a result of mastering the discipline, the PhD student should:

Know:

- basic principles of environmental regulation and biomonitoring;
- the main technologies for phytoremediation and biological treatment of polluted media (soil, air and water), their advantages over traditional cleaning methods;
- biological bases of reclamation of technogenically disturbed territories and gardening of urban areas;
- principles of selection of plants for use in phytoremediation, landscaping of urban areas and as alternative fuels.

Be able to:

- analyze, generalize, and systematize scientific information about ecobiotechnologies;
- apply the modern methods of biotechnology to restore the environment;
- choose the right ecobiotechnologies depending on the task.

Demonstrate skills and experience in:

- using of electronic information resources;
- research in the field of ecobiotechnologies;
- presenting scientific and educational material competently in oral and written form.

1.4. The scope of the course

№	Types of academic work	Scope of the discipline		The distribution of the hours in the 4 th semester
		Total hours	Including contact work (hours)*	
1	Lectures	4	4	4
2	Self-study work, including preparation for attestation	104		104
3	Semester attestation	Test	0.25	Test, 4
4	Total scope, hours	108	4.25	108
5	Total scope, credits	3		3

2. THE CONTENT OF THE COURSE

№	Topic	Content
1	Environmental regulation and biomonitoring	Basic principles of environmental regulation of the quality of environmental components. Types of environmental standards. Main tasks and methods of biomonitoring. Biotesting and bioindication. Adventive fraction of flora and fauna. Invasive alien species. Control measures over the introduction of adventive species.
2	Greening agricultural activities	Ecological problems of modern agrarian activity. Ways to activate the soil-forming process: the use of organic and bacterial fertilizers, mixed crops of agricultural crops, agroforestry, etc. Biological methods of combating pests and infections of agricultural plants and animals. Biological methods for the conversion of agricultural waste to obtain feed additives. Technologies for obtaining fodder protein. The use of preparations based on bacteriophages for the protection of cultivated plants and farm animals from bacterial infections. The use of aquaculture to solve the food problem.
3	Phytoremediation technologies	Phytoremediation as a system of technologies for cleaning the environment from organic and inorganic pollutants using plants and their associated microorganisms. Modern tools of phytoremediation: phytoextraction, rhizofiltration, rhizodegradation, phytodegradation, phytovolatilization, phytohydraulics, phytostabilization. The use of phytoremediation for purification of solid, liquid and air media. Plant species selection strategies for different phytoremediation technologies. Obtaining transgenic plants with certain physiological and biochemical properties that contribute to the accumulation of pollutants. Increasing the efficiency of phytoremediation through the use of modern microbiological preparations.
4	Biological methods of wastewater treatment	Methods of biological wastewater treatment in artificial conditions: biofilters, aerotanks, oxygen tanks, submersible biofilters, biotanks-biofilters, anaerobic biofilters. The composition of the biocoenosis that carries out biological oxidation. Methods of biological wastewater treatment in natural conditions: soil treatment, biological ponds, bioplots.
5	Biological reclamation of disturbed lands	Classification of disturbed territories by origin. The main directions of disturbed lands reclamation. Selection of sustainable tree and shrub species for dump reclamation, taking into account the following traits: growth rate, high productivity of the plant community, frost resistance, drought resistance, tolerance to a low level of soil fertility. Selection of metal-, salt- and acid-resistant plants for biological reclamation of disturbed lands. Reclamation of soils contaminated with oil products. Selection of new forms of plants for biological reclamation of industrial dumps and other disturbed lands.
6	Green technologies in urban areas	The most common flue gas pollutants. Adaptive features of smoke and gas resistant plants. Possibilities of genetic engineering for obtaining plants resistant to atmospheric air pollutants. General characteristics of technologies "green roofs" and "green walls". Mobile systems for greening cities. Basic principles of "green building". Ways to solve the problem of disposal of solid household and industrial waste. Biological bases of gardening of industrial territories.
7	Biofuel produc-	Biofuel as a special category of fuel, the source of which is a renewa-

	tion	ble biological material. Types of biofuels: solid, liquid, gaseous. Differences of biofuels from traditional fuels. Types of raw materials used for the production of biofuels. Technologies for obtaining bioethanol, biodiesel, biogas and other types of biofuels. Ecological problems of biofuel production and usage.
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Методы оценки качества научной деятельности и научных публикаций.

3. ORGANIZATION OF PRACTICE AND SELF-STUDY WORK

3.1. Practice

Not provided.

3.2. Approximate topic of independent work

3.2.1. Approximate list of essay topics

The essay should perform analytical review of literature on the corresponding topic:

- Possibilities of genetic engineering to create gas-resistant and metal-tolerant plants.
- Basic technologies for landscaping the territories of industrial enterprises.
- Technologies "green roofs": problems and prospects.
- The use of biological preparations aimed at improving the phytoremediation of contaminated soils

The essay volume is 20–25 typewritten pages in A4 format.

3.2.2. Approximate topics of individual or group projects

Not provided

4. THE SET OF TOOLS FOR INTERMEDIATE AND FINAL ATTESTATION

4.1. The evaluation criteria for the results of current and intermediate attestation

Approved evaluation criteria of the achievements are based on three levels of mastering the competence components: intermediate, advanced, and high.

Competence components	Characteristics of the level of development the components of competencies		
	threshold	advanced	high
Knowledge	A PhD student demonstrates knowledge-acquaintance, knowledge-copy: he recognizes objects, phenomena and concepts, finds differences in them, knows of the sources of information, can independently reproduce knowledge.	A PhD student demonstrates analytical knowledge: confidently reproduces and understands the acquired knowledge, classifies them into one or another classification group, independently systematizes them, establishes relationships between them, productively applies in common situation.	A PhD student can independently get new knowledge from the world around him, creatively use it to make decisions in new and non-standard situations.
Skills	A PhD student is able to correctly perform prescribed actions according to an instruction, an algorithm in a known situation, independently solve typical problems that require a choice from known methods in a predictably changing situation	A PhD student is able to independently solve non-standard tasks that require a choice based on a combination of known methods in an unpredictably changing situation	A PhD student is able to independently solve research problems, demonstrates the creative use of skills (technologies)

Personal qualities	A PhD student has a low motivation for studying, shows an indifferent, irresponsible attitude to learning, and assigned work	A PhD student has a pronounced motivation for studying, demonstrates a positive attitude towards learning and future work, and is active.	A PhD student has a developed motivation for studying and work activities, shows perseverance and dedication, diligence, independence, and creativity.
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4.2. The tools for current and intermediate attestation

Assessment of knowledge, skills and (or) experience that characterize step-by-step formation of competencies in the discipline "Ecobiotechnologies" is carried out in the form of current control and intermediate attestation. Current control is carried out during the semester in order to determine the level of assimilation of knowledge by PhD students, the formation of skills and abilities in the field of ecobiotechnologies. To assess knowledge, skills, abilities and (or) experience at the university, a point-rating system is used.

4.2.1. List of sample questions for attestation:

1. Ecological problems of modern agrarian activity. Ways to activate the soil-forming process: the use of organic and bacterial fertilizers, mixed crops of agricultural crops, agroforestry, etc.
2. The main tools of phytoremediation technologies, their features. Principles of plant selection for remediation of polluted soils and water bodies.
3. The possibility of using the accumulative capacity of plants in relation to heavy metals for the treatment of surface and waste waters.
4. Advantages and disadvantages of different phytoremediation technologies.
5. Biological oxidation as a method of wastewater treatment from organic compounds. The composition of the biocenosis that carries out biological oxidation.
6. Methods of biological wastewater treatment in natural conditions: soil treatment, biological ponds, bioplantos.
7. Methods of biological wastewater treatment in artificial conditions: biofilters, aerotanks, oxygen tanks, submersible biofilters, biotanks-biofilters, anaerobic biofilters.
8. Basic principles of the biological stage of the reclamation of man-made formations
9. Principles and technologies of landscaping the territories of industrial enterprises.
10. -The main types of biological fuels. Benefits of introducing bioconversion technologies designed to produce energy from biomass:

4.2.2. List of sample questions for the exam

not provided

5. EDUCATIONAL, METHODOLOGICAL, AND INFORMATIONAL SUPPORT OF DISCIPLINE

5.1. Recommended literature

5.1.1. Basic literature

1. Sheoran V., Sheoran A.S., Poonia P. Soil reclamation of abandoned mine land by revegetation: a review // Int. J. of Soil, Sediment and matter. 2010. V. 3 (2). Iss.2, Article 13. Интернет-ресурс: <http://scholarworks.umass.edu/intljssw/vol3/iss2/13>

5.1.2. Additional literature

1. Phytoremediation technology for the removal of heavy metals and other contaminants from soil and water. Ed. V. Kumar, M.P. Shan, S.K. Shahi. Amsterdam: Elsevier Inc. 2022. <https://doi.org/10.1016/B978-0-323-85763-5.00015-5>.
2. Biotechnological Innovations for Environmental Bioremediation. Ed. Arora S., Ashwani Kumar A., Shinjiro Ogita S., Yau Y. Springer. 2022. 1063 p. <https://link.springer.com/book/10.1007/978-981-16-9001-3#DOI>

3. Filemon A.U. Biofuels from plant oils. Indonesia, Jakarta: Asean Foundation, 2010. 86 p. Интернет-ресурс: www.aseanfoundation.org/documents/books/biofuel.pdf
4. Miller R.R. Phytoremediation. Technology Overview Report. GWRTAC, 1996. Интернет-ресурс: https://clu-in.org/download/toolkit/phyto_o.pdf
5. Summaru Report of Workshop on Phytoremediation research needs. U.S. Department of Energy. Santa Rosa, California, 1994. Интернет-ресурс: <http://www.iaea.org/inis/collection/NCLCollectionStore/Public/26/036/26036815.pdf>
6. Gupta A.K., Yunus M., Pandey P.K. Bioremediation: Ecotechnology for the Present Century // Enviro News Archives International Society of Environmental Botani, India. V. 9 (2). Интернет-ресурс: http://isebindia.com/01_04/03-04-2.html
7. Susarla S., Medina V.F., McCutcheon S.C. Phytoremediation: An Ecological Solution to Organic Chemical Contamination. Ecological Engineering. 2002. 18: 647-658. www.elsevier.com/locate/ecoleng
8. Grato P.L., Prasad M.N.V., Cardoso P.F., Lea P.J., Azevedo R.A. Phytoremediation: green technology for the clean up of toxic metals in the environment // Braz. J Plant Physiol. 2005. V. 17 (1). P. 53-64. <http://dx.doi.org/10.1590/S1677-04202005000100005>
9. LeDuc D.L., Terry N. Phytoremediation of toxic trace elements in soil and water // J. Ind. Microbiol. Biotechnol. 2005. V. 32. P. 514-520. DOI: [10.1007/s10295-005-0227-0](https://doi.org/10.1007/s10295-005-0227-0)
10. McGrath S.P., Zhao F., Lombi E. Plant and Rhizosphere Processes Involved in Phytoremediation of Metal-Contaminated Soils. Plant & Soil. 2001. 232(1-2): 207-214. DOI <https://doi.org/10.1023/A:101035870>
11. Brownfields and urban agriculture: interim guidelines for safe gardening practice. US: US Environmental Protection Agency, 2011. 24 p. Интернет-ресурс: https://www.epa.gov/sites/production/.../bf_urban_ag.pdf

5.2. Methodical manuals

Not provided

5.3. Software

1. Microsoft office (Word, Excel, Power point);
2. Adobe Reader.

5.4. Databases and search systems

1. Google scholar - <https://scholar.google.ru/>
2. Scopus - <https://www.scopus.com/>
3. ScienceDirect - www.sciencedirect.com
4. eLibrary - <http://elibrary.ru/>

5.5. Electronic learning sources

1. Zonal scientific library <http://lib.urfu.ru/course/view.php?id=M67>
2. UrFU electronic resources <http://lib.urfu.ru/mod/data/view.php?id=2802>
3. Library catalogue <http://lib.urfu.ru/course/view.php?id=M81>

6. MATERIAL RESOURCES AND TECHNICAL SUPPORT OF DISCIPLINE

6.1. Information about the auditorium and laboratory equipment for the discipline

Ural Federal University has special rooms for lecture-type classes, group and individual consultations, current control and intermediate attestation, as well as rooms for independent work, equipped with computers with the access to the Internet and electronic information educational environment, and facilities for storage and preventive maintenance of equipment. Postgraduate students of the departments are provided with special rooms for research work.