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
BIOTECHNOLOGY

List of information about the program of the discipline	Credentials
Postgraduate Program Biotechnology	**Code PP** 1.5.6.
Group of specialties Biological Sciences	**Код** 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

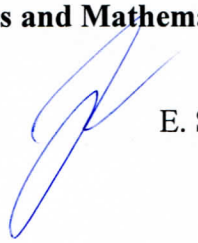
The program of the discipline was compiled by the authors:

№	Full name	Academic degree, Academic title	Position	Affiliation
1	Alexander A. Ermoshin	PhD, Docent	Associate 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
3	Maria V. Ulitko	PhD	Associate Professor	Department of Biology and Fundamental Medicine 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 “BIOTECHNOLOGY”

1.1. Annotation

The discipline "Biotechnology" refers to the basic part of the postgraduate program 1.5.6. Biotechnology. Biotechnology is a discipline that studies the possibilities of using living organisms or their metabolic products to obtain products necessary for humans, as well as the possibility of creating living organisms with the necessary properties by genetic engineering. This discipline plays an important role in the formation of a scientific worldview among future researchers and teachers, a sufficient theoretical basis for the successful mastering of general professional and special disciplines by graduate students.

The purpose of studying the discipline "Biotechnology" by PhD students is to form the ability to carry out research in the field of biotechnology, to find a place for this research in fundamental scientific knowledge and practical activities.

The study of the discipline involves the following tasks:

1. Formation of modern ideas about contemporary fields of biotechnology;
2. Mastering the methodology of research activities in the field of biotechnology;
3. Formation of practical skills in the field of fundamental and applied biotechnology.

1.2. The language of study - English

1.3. Expected discipline outcomes

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

Know:

- fundamentals of biotechnology, key concepts of biology, properties of living systems that allow them to be used for biotechnology;
- modern methods of biotechnology.

Be able to:

- apply modern methods of biotechnology;
- to search, study, generalize and systematize scientific literature in the field of biotechnology.

Demonstrate skills and experience in:

- research skills in the field of biotechnology.

1.4.The scope of the training course

№	Types of academic work	Scope of the discipline		The distribution of the hours in the 6th 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	Exam	1	Exam, 18
4	**Total scope, hours**	**108**	**5**	**108**
5	**Total scope, credits**	**3**		**3**

2. THE CONTENT OF THE COURSE

№	Topic	Content
T 1	Biotechnology as a science. Relationship of biotechnology with other biological sciences	History of the development of biotechnology. Relationship between biotechnology and chemistry. Classification of living organisms features of their structure, metabolism and possibilities of application in biotechnology. Viruses, bacteria, archaea, filamentous and yeast-like fungi, microalgae, higher plants, animals.
T 2	The main directions of development of biotechnology	Biotechnology as a priority direction of scientific and technological progress, based on the use of biological objects and bioprocesses. The concept of both bioindustry and bioeconomy. Biotechnology as a science of technological processes based on the use of living systems. Biotechnology color scale: biopharmaceutical ("red") biotechnology, agricultural ("green") biotechnology, bioenergy ("white" biotechnology), environmental ("gray") biotechnology, marine ("blue") biotechnology.
T 3	Equipment used in biotechnological industries	Conditions for cultivation of producers. Stages of biotechnological production. Production scaling. Equations of material and energy balance. Product yield calculation. Types of bioreactors, features of their application, main components of bioreactors. Substrates used for cultivation of microorganisms. Equipment for isolation, concentration, drying and packaging of biotechnological products: conveyors, dryers, crushers, concentrators. Aseptic methods.
T4	Biotechnologies based on microorganisms	Microorganisms as producers; factors that determine their growth and synthesis of target products. Requirements for producers. The concept of super synthesis. Traditional selection and storage of producers.
T5	Plant Biotechnology	Methods for obtaining plant cell cultures. Production of secondary metabolites based on suspension and callus cultures. Microclonal propagation based on calli and meristems. Obtaining a healthy virus-free planting material. Plant cryobanks. Principles of obtaining transgenic plants.
T6	Animal biotechnology	Cultivation of animal cells. Stem cells. Animal cloning. Medicinal aspects of animal and human cells.
T7	Ecobiotechnology	Biotechnological methods for restoring disturbed and polluted environment: soil, water, air. Biotechnologies of waste disposal. Bioconversion and bioremediation. Biodegradation of xenobiotics. Bioindicators for assessing environmental pollution.
T8	Biotechnology for green energy	Energy saving essence of biotechnology. Production of energy carriers (ethanol, biodiesel, biogas, hydrogen).
T9	Genetic engineering	Recombinant DNA. Vectors in genetic engineering: plasmids, cosmids, phagemids, viruses. Direct transgene injection methods: bioballistics and microinjections. Enzymes in genetic engineering: polymerases, restriction enzymes, ligases, revertase as tools for obtaining recombinant DNA. Scheme of molecular cloning. genome editing.

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 assay should be an analytical review of the scientific literature on the candidate's dissertation.

1. Cell technologies in medicine
2. Cellular technologies in agriculture
3. Plant transgenesis methods
4. Biotechnology in preclinical studies

5. Biotechnology and biosafety issues
The essay volume is 20-25 typewritten pages in A-4 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.

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 "Biotechnology" 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 biotechnology. For the knowledge, skills and abilities acquired by students during their studies, marks are given: "EXCELLENT", "GOOD", "SATISFACTORY", "UNSATISFACTORY". 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:

Not provided.

4.2.2. List of sample questions for the exam

1. Subject, goals, objectives and objects of biotechnology.
2. Main directions of development of biotechnology.
3. Technology of recombinant DNA and expression of recombinant genes.
4. Purposes and methods of obtaining transgenic animals.
5. Purposes and methods for obtaining transgenic plants.
6. Problems of biosafety in biotechnologies.
7. Immunobiotechnology.
8. Recombinant vaccines.
9. Modern biomedical technologies.
10. Goals and methods of preclinical studies.

5. EDUCATIONAL, METHODOLOGICAL, AND INFORMATIONAL SUPPORT

5.1. Recommended literature

5.1.1. Basic literature

1. Glick B.R., Pasternak J.J., Patten C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition - ASM Press, 2009 – 850 p.
2. Schmid R.D., Schmidt-Dannert C. Biotechnology: An Illustrated Primer 1st Edition - Wiley-Blackwell, 2016 – 410 p.

5.1.2. Additional literature

Not provided.

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. GenBank - http://www.ncbi.nlm.nih.gov/genbank/
2. PubMed - http://www.ncbi.nlm.nih.gov/pubmed/
3. Google scholar - https://scholar.google.ru/
4. Scopus - https://www.scopus.com/
5. eLibrary - http://elibrary.ru/

5.5. Electronic learning sources

1. Zonal scientific library http://lib.urfu.ru/course/view.php7idM67
2. UrFU electronic resources http://lib.urfu.ru/mod/data/view.php7id-2802
3. Library catalogue http://lib.urfu.ru/course/view.php7idM 81.

6. MATERIAL RESOURCES AND TECHNICAL SUPPORT

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.