


Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		



APPROVED

by the decision of the Academic Council of the Institute of Medicine, Ecology and Physical Culture of USU of « 19 » June 2019, protocol № 10/210

Chairman V. I. Midlenko
(signature, signature clarification)

« 19 » June 2019

WORKING PROGRAM

Discipline	NANOTECHNOLOGIES IN MEDICINE Б1.Б.1. ДВ.06.02
Faculty	Faculty of medicine T. Z. Biktimirova
Department	Human Anatomy
Course	3

Field (speciality) 31.05.01 General medicine
course code (speciality), full name

Orientation (profile / specialization) _____
full name

Form of study intramural
intramural, extramural, intra-extramural (specify only those that are implemented)

Date of introduction in the teaching process at USU: « 02 » september 2019

The program was updated at the department session: protocol № 21/393 of 16.03.2020

The program was updated at the department session: protocol № 21/396 of 22.06.2020


The program was updated at the department session: protocol № 1 of 31.08.2021

The program was updated at the department session: protocol № _____ of _____ 20__

Information on authors:

Initials	Department	Degree, title
Zerkalova J.F.	Human Anatomy	Candidate of Medical Sciences, assistant professor
Vorotnikova M.V.	Human Anatomy	Candidate of Biological Sciences, assistant professor

AGREED	AGREED
Head of the department of Human Anatomy	Head of the department of Hospital Therapy
<u>Khayrullin R.M.</u> / <i>Signature</i> Initials « 17 » June 2019	<u>Vize-Khripunova M. A.</u> / <i>Signature</i> Initials « 17 » June 2019

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

THE COURSE AIMS AND OBJECTIVES

Goals of mastering the discipline:

Goals of mastering the discipline is to form students ' knowledge about the essence of nanotechnologies, taking into account the medical orientation of students, with the specifics of NanoBio - and bio-nanotechnologies.

Tasks of mastering the discipline::

- to form students ' knowledge about the main directions of nanotechnologies in medicine, the main objects of nanotechnologies developments;
- know nanobiotechnological processes and their implementation in various branches of science, medicine and pharmacology;
- to study the classification and properties of nanostructured materials; features of the influence of nanomaterials on living organisms.

1. PLACE OF THE COURSE IN THE CURRICULUM


The academic discipline "Nanotechnology in medicine" refers to the disciplines of choice of the professional cycle of disciplines.

The discipline "Nanotechnology in medicine" provides the formation of knowledge and ideas about nanomedicine, the purpose of which is to monitor, correct, construct and control human biological systems at the molecular level using the developed nanodevices and nanostructures. The unique properties and biological activity of nanomaterials cause wide opportunities for their use in biology and medicine, in particular, for targeted drug delivery, for the fight against cardiological and oncological diseases, for the purposes of genetic, molecular and tissue engineering, improving the quality of the environment and in many other areas.

In the process of mastering this discipline, the student forms and demonstrates the following professional competencies: GPC-1, PC-1.

The results of mastering the discipline will be necessary for the further learning process in the framework of the gradual formation of competencies in the study of the following special disciplines:


- Physics, mathematics
- Medical informatics
- Latin language
- Modern medical information systems.
- Preparation for and passing the state exam
- Hygiene
- Endocrinology
- Phthysiology
- Physiology of visceral systems
- Preparation for clinical practice
- Analysis of scientific text obstetrics
- Dialogue between a doctor and a patient (diseases of the cardiovascular system)
- Analysis of scientific text (gynecology)
- Dialogue between a doctor and a patient (diseases of the gastrointestinal tract)
- Basics of scientific speech style
- Dialogue between a doctor and a patient (diseases of the excretory system)

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

- Basics of rational nutrition
- Diagnosis and treatment of extrapulmonary tuberculosis
- Analysis of scientific text (therapy)
- Analysis of scientific text (surgery)
- Diabetology and emergency endocrinology
- Dialogue between a doctor and a patient (diseases of the hepatobiliary system)
- Dialogue between a doctor and a patient (respiratory system diseases)
- Preparation for and passing the state exam
- Biopsychosocial approach to medical rehabilitation
- Practical application of the International classification of functioning in rehabilitation for various pathologies
- Practice in obtaining primary professional skills, including primary research skills (Care for therapeutic and surgical patients. (Part 1))
- Clinical practice (Care of therapeutic and surgical patients. (Part 2))
- Assistant to Junior medical staff

3. PROPOSED RESULTS:

Competence index. Content of a competence (or a part of it)	The proposed results of the course students are:
GPC-1 the willingness to solve standard tasks of professional activity using information, .., information and communication technologies and taking into account to the basic requirements of information security	<p>To know: - -the main directions of nanotechnologies in medicine; - methods of obtaining nanostructures; - properties of nanostructured materials</p> <p>To be able to: -confidently navigate the information flow (use reference data and bibliography on the problem);</p> <p>To be skilled at: scientific, educational and reference literature to find the necessary information</p>
PC 1-the ability and readiness to implement a set of measures aimed at preserving and strengthening health and including the formation of a healthy lifestyle, preventing the occurrence and (or) spread of diseases, their early diagnosis, identifying the causes and conditions of their occurrence and development, as well as aimed at eliminating harmful effects on human health of environmental factors	<p>To know: - methods of directed transport of medicines; - principles of using biochips in biomedical research; - main achievements of nanotechnology in gene, cell and tissue engineering; - features of the influence of nanomaterials on living organisms</p> <p>To be able to: predict the results of biological processes occurring in living systems, based on theoretical positions; -solve situational problems, based on theoretical knowledge, laws, and laws of biological and genetic processes occurring in living organisms</p> <p>To be skilled at: basic concepts of nanotechnologies; - systemic and historical approaches to the study of living systems at the molecular, cellular and tissue levels of their organization</p>

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

4. GENERAL COMPLEXITY OF THE DISCIPLINE

4.1. The amount of discipline in credits (total)

The total complexity of the discipline is 2 credit units (72 hours)


4.2. Volume discipline by type of study (in hours)

Type of educational work	Number of hours (The form of training ___ fill-time)			
	Workload	Hours per term		
		5 sem.		
1	2	3	4	5
Contact work of students with the Lecturer in accordance with the educational plan	36	36	-	-
Classroom:	-	-	-	-
Lectures	18	18	-	-
Seminars and practical's	18	18	-	-
Laboratory and work practical's	-	-	-	-
Individual work	36	36	-	-
Form of current control of knowledge and control of individual work	Quiz Interview	Quiz Interview	-	-
Term paper	-	-	-	-
Scope of testing (examination, test, the credit)	a credit	a credit	-	-
Total course of workload	72 (2 credit units)	72 (2 credit units)	-	-


4.3 SECTIONS OF THE DISCIPLINE (MODULE) AND THE COMPLEXITY OF THE TYPES OF TRAINING SESSIONS (IN ACADEMIC HOURS)

Form of study: intramural

Units / Themes of discipline	Total labor intensity (in hours)	Types of training sessions					Forms of the progress monitoring
		Classroom			Classes in an interactive form	Individual work	
		Lectures	Seminars and practical's	Laboratory and work practical's			
1	2	3	4	5	6	7	8

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Section 1. Fundamentals of nanobiotechnologies							
Unit 1. Introduction. Basic concepts of nanotechnology	4	1	1			2	Quiz, Interview
Unit 2. Methods and tools of nanotechnology	4	1	1			2	Quiz, Interview
Unit 3. Investigation of nanostructures using scanning probe microscopy	2	1	1				Quiz, Interview
Unit 4. Nanomaterials: classification and properties	5	1	1			3	Quiz, Interview
Unit 5. Self-organization in biological systems	5	1	1			3	Quiz, Interview
Section 2. The main directions of development of nanotechnologies in medicine							
Unit 6. The main directions of development of nanotechnologies in medicine	5	1	1			3	Quiz, Interview
Unit 7. Directed transport of medicines	5	1	1			3	Quiz, Interview
Unit 8. Nanotechnology in the diagnosis and treatment of cancer	5	1	1			3	Quiz, Interview
Unit 9. Biochips in biomedical research	7	2	2			3	Quiz, Interview
Unit 10. Nanotechnology in the field of Transplantology and implantology	10	2	2			6	Quiz, Interview
Unit 11. Nanotechnology in gene, cell and tissue engineering	6	2	2			2	Quiz, Interview
Unit 12.	6	2	2			2	Quiz,

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Nanotechnologies based on nucleic acids							Interview	
Section 3. Risks of using nanotechnologies								
Unit 13. Safety assessment of nanomaterials	10	2	2			6	Quiz, Interview	
Total	72	18	18			36	A credit	

5. COURSE CONTENTS (MODULE).

Section 1. Fundamentals of nanobiotechnologies.

Unit 1. Introduction. Basic concepts of nanotechnology.

1. Definition of concepts "nanotechnology", "nanobiotechnology", "nanomedicine".
2. The history of the emergence and development of nanotechnology.
3. Application of technical methods in biological nanosystems (direction "from nano to bio"). The use of biological strategies in technical nanosystems (direction "from bio to nano", biomimetics, bionics). Interdisciplinarity of nanotechnology. Prospects of nanotechnology development.

Unit 2. Methods and tools of nanotechnology.

1. The main approaches to the creation of nanoobjects: "top-down" and "bottom-up".
2. Methods for obtaining nanostructures. Preparation of nanocrystalline powders and compact materials.
3. Methods of nanoparticle stabilization: matrix isolation, functionalization of nanoparticle surface, localization of nanoparticles on the surface of carriers of different types. Living organisms as bioreactors of nanoparticles.

Unit 3. Investigation of nanostructures by scanning probe microscopy.


1. Nanotechnology instruments: electron microscope, scanning probe microscope. Optical tweezers.
2. General principles of scanning probe microscopes. The main modes of operation of the atomic force microscope: contact, non-contact and semi-contact.
3. Biomedical applications of scanning probe microscopy: nanoscopy, nanodiagnostics and nanotechnology.

Unit 4. Nanomaterials: classification and properties.

1. Classification of nanomaterials based on their shape, chemical composition, method of production. Properties of bulk and nanostructured materials. Size effect.
2. Carbon nanostructures: fullerenes, graphene, single- and multi-walled nanotubes, nanofibers. Nanoporous substances, nanostructured films. Carbon-encapsulated nanomaterials. Metal-polymer nanocomposites.
3. Applications of nanomaterials. Nanomaterials in medicine. Nanocrystals for biomedical research. Supramolecular complexes of the type "guest-host". Biological activity of metal nanoparticles. Wound healing activity, regenerating and bactericidal properties of metal nanoparticles (silver, gold, magnesium, copper). Silver and bismuth nanobiocomposites. Water-soluble derivatives of fullerenes. Magnetic nanoparticles in biological objects.

Unit 5. Self-organization in biological systems.

1. Definition of concepts "self-Assembly", "self-organization". Self-organization of cell

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

fragments, multinucleated cells, Assembly of viral particles.
2. Using the principles of self-organization in nanotechnology.

Section 2. The main directions of development of nanotechnologies in medicine

Unit 6. The main directions of nanotechnology development in medicine.

1. The main areas of application of nanotechnology in medicine: targeted drug delivery, nanodiagnostics of pathological conditions and infections, nanobiosensors, bio-compatible materials, molecular machines.
2. The work "molecular motors": ATP synthetase, aktinomitinov complex, kinesin. Nanotechnology in medicine today.
3. Medicinal nanopreparations in Oncology, neurology, immunology. Regenerative medicine.

Unit 7. Directed transport of medicines.

1. Liposomes. The principles of organization of the lipid bilayer. Structure of phosphatidylcholine. Formation of micelles. Reverse micelles. Physicochemical and dynamic properties of lipids. Lipid phase transitions. The advantages and prospects of application of liposomal forms of drugs.
2. Capsules on the basis of polymeric materials. Dendrimers. Structure and dimensions of macromolecules of dendrimers. Properties and application of dendrimers in biology and medicine: directed drug transport, molecular sieves, contrast agents. Preparation of dendrimers with adjustable internal cavity for catalytic reactions.
3. Self-assembling lipid nanotubes as a tool for delivering nucleic acids to cells. Using bacteria for intracellular drug delivery.

Unit 8. Nanotechnology in the diagnosis and treatment of cancer.


1. New approaches of cell and molecular biology to solving problems of Oncology.
2. Immunotherapy, RNA interference, epigenetic regulation of genes. Inhibition of angiogenesis in tumors by gold nanoparticles. Photodynamic therapy of malignant neoplasms. Nanoparticles with a dielectric core surrounded by an ultrathin metal shell.
3. "Optical transparency window" of biological tissues. Passive targeting. Functionalization of nanoparticles by tumor-specific antibodies. Mechanism of action of General and local hyperthermia.

Unit 9. Biochips in biomedical research.

1. Prospects for the use of biological microchips. Oligonucleotide Protein biochips.
2. Determination of nucleotide sequences (sequencing) of DNA. Hybridization of nucleic acids. The amplification of the DNA. Polymerase chain reaction: new possibilities. Mapping of genetic information of DNA and RNA, determination of mutations and level of expression of genetic material. Enzyme-based biochips.
3. Cell biosensors: creation, characterization, application. Properties of immobilized cells.

Unit 10. Nanotechnology in the field of Transplantology and implantology.

1. Methods of creation and application of artificial nanofibers in biology and medicine. The use of nanotechnology to improve the biocompatibility of transplants.
2. Nano-structured titanium in implantology. Ultra-fine-grained biocomposites. Nano-materials that mimic natural bone tissue.
3. The receipt and use of GID-oxyapatite for medical purposes. Nanodisperse calcium preparations.

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Unit 11. Nanotechnology in gene, cell and tissue engineering.

1. Technology of recombinant DNA production. Obtaining genes for transplantation.
2. Technologies of gene transfer in a cell. Achievements and prospects of genetic engineering.
3. Gene therapy and gene targeting.

Unit 12. Nanotechnology based on nucleic acids.

1. DNA is a universal component for creating nanostructured devices. Branched DNA. "Sticky ends." Design strategy: "step by step" (N. Seaman), "all at once" (Y. M. Yevdokimov).
2. Prospects of creation and application of nanoconstructions based on double-stranded DNA molecules. Two-dimensional nanoscale DNA lattices are the basis for the creation of new types of catalysts, molecular sieves, biochips.

Section 3. Risks of using nanotechnology

Unit 13. Safety assessment of nanotechnology.

1. Methodological approaches to assessing the safety of nanomaterials. The main components of the nanomaterials risk assessment system. The problem of determining the "dose" and "dose-effect" dependence for nanoparticles. Influence of carbon nanomaterials on respiratory organs.
2. Dependence of the degree of toxicity on the extent of nanostructures. Neuro-, cardio- and hepatotoxicity of nanomaterials. Effect of fullerenes, single- and multi-layer carbon nanotubes on the blood coagulation system.
3. Physico-chemical basis of the biological action of nano-objects.
4. The main ways of nanoparticles entering the human body. Distribution and accumulation of nanoparticles in various organs and tissues. Penetration of nanoparticles through the blood-brain barrier.
5. The use of nanotechnology methods in the field of ecology and energy. Nanomaterials and wastewater treatment. Composite nanofilters.

6. TOPICS OF PRACTICAL CLASSES (FOR DISCUSSING AND SELF-PREPARING OF STUDENTS)

Unit 1. Introduction. Basic concepts of nanotechnology.

Questions to the topic:


1. The history of the emergence and development of nanotechnology.
2. Definition of concepts "nanotechnology", "nanobiotechnology", "nanomedicine".
3. Application of technical methods in biological nanosystems (direction "from nano to bio").
4. The use of biological strategies in technical nanosystems (direction "from bio to nano", biomimetics, bionics).

Unit 2. Methods and tools of nanotechnology.

Questions to the topic:

1. The main approaches to the creation of nanoobjects: "top-down" and "bottom-up".
2. Methods for obtaining nanostructures.
3. Methods of nanoparticle stabilization: matrix isolation, functionalization of nanoparticle surface, localization of nanoparticles on the surface of carriers of different nature.

Unit 3. Investigation of nanostructures by scanning probe microscopy.

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Questions to the topic:

- 1.Nanotechnology instruments: electron microscope, scanning probe microscope. Optical tweezers.
- 2.General principles of scanning probe microscopes.
- 3.The main modes of operation of the atomic force microscope: contact, non-contact and semi-contact.
- 4.Biomedical applications of scanning probe microscopy: nano-scopy, nanodiagnostics and nanotechnology.

Unit 4. Nanomaterials: classification and properties.

Questions to the topic:

- 1.Classification of nanomaterials based on their shape, chemical composition, method of production.
- 2.Size effect.
- 3.Carbon nanostructures: fullerenes, graphene, single and multi-walled nano-tubes, nanofibers.
- 4.Applications of nanomaterials. Nanomaterials in medicine.
- 5.Biological activity of nanomaterials.
- 6.Wound healing activity, regenerating and bactericidal properties of metal nanoparticles (silver, gold, magnesium, copper).
- 7.Magnetic nanoparticles in biological objects.

Unit 5. Self-organization in biological systems.

Questions to the topic:

- 1.Definition of concepts "self-Assembly", "self-organization".
- 2.Self-organization of cell fragments, multinucleated cells, Assembly of molecular particles.
- 3.Using the principles of self-organization in nanotechnology.

Unit 6. Nanotechnology in medicine: a panorama of directions.


Questions to the topic:

- 1.The main areas of application of nanotechnology in medicine: targeted drug delivery, nanodiagnostics of pathological conditions and infections, nanobiosensors, biocompatible materials, molecular machines.
- 2.The work "molecular motors": ATP synthetase, aktinomitinov complex, kinesin.
- 3.Medicinal nanopreparations in Oncology, neurology, immunology.

Unit 7. Directed transport of medicines.

Questions to the topic:

- 1.Liposomes. The principles of organization of the lipid bilayer.
- 2.Formation of micelles. Reverse micelles.
- 3.The advantages and prospects of application of liposomal forms of drugs.
- 4.Capsules on the basis of polymeric materials.

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

5.Dendrimers. Structure and dimensions of macromolecules of dendrimers.

6.Properties and application of dendrimers in biology and medicine: directed drug transport, molecular sieves, contrast agents.

7.Preparation of dendrimers with adjustable internal cavity for catalytic reactions.

Unit 8. Nanotechnology in the diagnosis and treatment of cancer.

Questions to the topic:

1.New approaches of cell and molecular biology to the solution of ontology problems.

2.Immunotherapy, RNA interference, epigenetic regulation of genes.

3.Inhibition of angiogenesis in tumors by gold nanoparticles.

4.Photothermal therapy of malignant neoplasms.

5. Passive targeting.

6.Functionalization of nanoparticles by tumor-specific antibodies.

Unit 9. Biochips in biomedical research.

Questions to the topic:

1.Prospects for the use of biological microchips.

2.Oligonucleotide Protein biochips.

3.Determination of nucleotide sequences (sequencing) of DNA.

4.Mapping of genetic information of DNA and RNA, determination of mutations and level of expression of genetic material.

5.Enzyme-based biochips.

6.Cell biosensors: creation, characterization, application.

Unit 10. Nanotechnology in gene, cell and tissue engineering.

Questions to the topic:

1.Obtaining genes for transplantation.

2.Technologies of gene transfer in a cell.

3.Achievements and prospects of genetic engineering.

4.Gene therapy and gene targeting.

Unit 11. Nanotechnology based on nucleic acids.

Questions to the topic:


1.DNA is a universal component for creating nanostructured devices.

2.Branched DNA. "Sticky ends."

3.Prospects of creation and application of nanoconstructions based on double-stranded DNA molecules.

4.Two-dimensional nanoscale DNA lattices are the basis for the creation of new types of catalysts, molecular sieves, biochips.

Unit 12. Safety assessment of nanotechnologies.

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Questions to the topic:

1. Methodological approaches to assessing the safety of nanomaterials.
2. The main components of the nanomaterials risk assessment system.
3. The problem of determining the "dose "and" dose-effect " dependence for nanoparticles.
4. The main ways of nanoparticles entering the human body.
5. Distribution and accumulation of nanoparticles in various organs and tissues.
6. Influence of carbon nanomaterials on respiratory organs.
7. Neuro -, cardio- and hepatotoxicity of nanomaterials.

7. LABORATORY AND WORK PRACTICAL'S


This type of work is not provided

8. SUBJECTS OF COURSE, TEST PAPERS AND ABSTRACTS


This type of work is not provided

9. THE LIST OF QUESTIONS TO A CREDIT

№	Question
1.	Definition of concepts "nanotechnology", "nanobiotechnology", "nanomedicine".
2.	Application of technical methods in biological nanosystems and use of biological strategies in technical nanosystems.
3.	Interdisciplinarity of nanotechnology.
4.	Prospects of nanotechnology development in Russia
5.	The main approaches to the creation of nanoobjects
6.	Nanotechnology instruments: electron microscope, scanning probe microscope, optical tweezers
7.	Methods for obtaining nanostructures
8.	Methods of nanoparticle stabilization: matrix isolation, functionalization of nanoparticle surface, localization of nanoparticles on the surface of carriers of different nature.
9.	Living organisms as nanoparticle bioreactors
10.	Classification of nanomaterials based on their shape, chemical composition, method of production
11.	Properties of bulk and nanostructured materials. Size effect.
12.	Carbon nanostructures: fullerenes, graphene, single- and multi-walled nanotubes, nanofibers.
13.	Nanoporous substances, nanostructured films.
14.	Applications of nanomaterials. Nanomaterials in medicine.
15.	Wound healing activity, regenerating and bactericidal properties of metal nanoparticles (silver, gold, magnesium, copper).
16.	Magnetic nanoparticles in biological objects
17.	Definition of concepts "self-assembly", "self-organization".
18.	Using the principles of self-organization in nanotechnology.
19.	The work of "molecular motors": ATP synthetase, aktinomitinov complex, kinesin.
20.	Nanotechnology in medicine today. Nanopreparations in Oncology, neurology,

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

	immunology.
21.	Regenerative medicine.
22.	Liposomes. The advantages and prospects of application of liposomal forms of drugs.
23.	The principles of organization of the lipid bilayer. Structure of phosphatidylcholine.
24.	Formation of micelles. Reverse micelles.
25.	Physicochemical and dynamic properties of lipids. Lipid phase transitions.
26.	Dendrimers. The structure and size of macromolecules, dendrimers.
27.	Properties and applications of dendrimers in biology and medicine: directed drug transport, molecular sieves, contrast agents.
28.	Self-assembling lipid nanotubes as a tool for delivering nucleic acids to cells.
29.	Using bacteria for intracellular drug delivery.
30.	Photodynamic therapy of malignant neoplasms.
31.	Nanoparticles with a dielectric core surrounded by an ultrathin metal shell.
32.	Passive targeting.
33.	Functionalization of nanoparticles by tumor-specific antibodies.
34.	Mechanism of action of General and local hyperthermia.
35.	Prospects for the use of biological microchips.
36.	Oligonucleotide Protein and protein biochips.
37.	Determination of nucleotide sequences (DNA sequencing).
38.	Nucleic acid hybridization.
39.	The amplification of the DNA. Polymerase chain reaction: new possibilities
40.	Enzyme-based biochips.
41.	Cell biosensors: creation, characterization, application. Properties of immobilized cells.
42.	Technology of recombinant DNA production.
43.	Achievements and prospects of genetic engineering.
44.	Gene therapy and gene targeting.
45.	Methods of creation and application of artificial nanofibers in biology and medicine.
46.	The use of nanotechnology to improve the biocompatibility of transplants.
47.	Nanomaterials that mimic natural bone tissue.
48.	DNA is a universal component for creating nanostructured devices. Branched DNA. "Sticky ends».
49.	Design strategy: "step by step" (N. Seaman), "all at once" (Y. M. Yevdokimov).
50.	Prospects of creation and application of nanoconstructions based on double-stranded DNA molecules.
51.	Medical nanorobots R. Fritsa: respirocyte, clothecity, microporosity.
52.	Problems of designing nanorobots.
53.	Methodological approaches to assessing the safety of nanomaterials.
54.	The problem of determining the "dose "and" dose-effect " dependence for nanoparticles.
55.	Influence of carbon nanomaterials on respiratory organs.
56.	Dependence of the degree of toxicity on the extent of nanostructures.
57.	Neuro -, cardio-and hepatotoxicity of nanomaterial.
58.	Effect of fullerenes, single-and multi-layer carbon nanotubes on the blood coagulation system.
59.	Physico-chemical basis of the biological action of nano-objects.
60.	The main ways of nanoparticles entering the human body.
61.	Distribution and accumulation of nanoparticles in various organs and tissues.
62.	Penetration of nanoparticles through the blood-brain barrier.
63.	The main components of the system of risk assessment of nanomaterials.
64.	Use of nanotechnology methods in the field of ecology and energy.


Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

65.	Nanomaterials and wastewater treatment. Composite nanofilters.
66.	Congenital malformations of the urinary and reproductive system.
67.	Congenital malformations of the musculoskeletal system


10. INDIVIDUAL WORK

Form of study: intramural

Units / Themes of discipline	Type of individual work (study of educational material, problem solving, essay, report, examination, preparation for the exam, etc.)	Hours	Form of control (checking the solution of problems, abstract, etc.)
Unit 1. Introduction. Basic concepts of nanotechnology	Study of educational material, performing exercises 1. Interdisciplinarity of nanotechnology. 2. Prospects of nanotechnology development in Russia.	2	Quiz, Interview
Unit 2. Methods and tools of nanotechnology	Study of educational material, performing exercises 1. Preparation of nanocrystalline powders and compact materials. 2. Living organisms as bioreactors of nanoparticles.	3	Quiz, Interview
Unit 4. Nanomaterials: classification and properties	Study of educational material, performing exercises 1. Properties of bulk and nanostructured materials. 2. Nanoporous substances, nanostructured films. 3. Carbon-encapsulated nanomaterials. Metal-polymer nanocomposites. 4. Nanocrystals for biomedical research. Supramolecular complexes of the type "guest-host". Silver and bismuth nanobiocomposites. Water-soluble derivatives of fullerenes.	3	Quiz, Interview
Unit 6. Nanotechnology in medicine: a panorama of directions	Study of educational material, performing exercises 1. Regenerative medicine	3	Quiz, Interview
Unit 7. Directed transport of medicines	Study of educational material, performing exercises 1. Structure of phosphatidylcholine. 2. Physicochemical and dynamic properties of lipids. Lipid phase transitions. 3. Self-assembling lipid nanotubes as a tool for delivering nucleic acids to cells. 4. Using bacteria for intracellular drug delivery.	3	Quiz, Interview
Unit 8.	Study of educational material, performing	3	Quiz, Interview

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

Nanotechnology in the diagnosis and treatment of cancer	exercises 1.Nanoparticles with a dielectric core surrounded by an ultrathin metal shell. 2."Optical transparency window" of biological tissues. Mechanism of action of General and local hyperthermia.		
Unit 9. Biochips in biomedical research	Study of educational material, performing exercises 1.Hybridization of nucleic acids. 2.The amplification of the DNA. Polymerase chain reaction: new possibilities. 3.Properties of immobilized cells	3	Quiz, Interview
Unit 10. Nano-technology in the field of Transplantology and implantology.	Study of educational material, performing exercises 1.Methods of creation and application of artificial nanofibers in biology and medicine. 2.The use of nanotechnology to improve the biocompatibility of transplants. 3.Nanostructured titanium in dental implantology. 4.Ultra-fine-grained biocomposites. 5.Nanomaterials that mimic natural bone tissue. 6.Preparation and use of hydroxyapatite for medical purposes. Nanodisperse preparations of calcium	6	Quiz, Interview
Unit 11. Nanotechnology in gene, cell and tissue engineering	Study of educational material, performing exercises 1.Technology of recombinant DNA production.	2	Quiz, Interview
Unit 12. Nanotechnologies based on nucleic acids	Study of educational material, performing exercises 1.Design strategy: "step by step" (N. Seaman), "all at once" (Y. M. Yevdokimov).	2	Quiz, Interview
Unit 13. Risk assessment of nanomaterials	Study of educational material, performing exercises 1.Dependence of the degree of toxicity on the extent of nanostructures. 2.Physico-chemical basis of the biological action of nano-objects. 3.Penetration of nanoparticles through the blood-brain barrier. Effect of fullerenes, single-and multi-layer carbon nanotubes on the blood coagulation system. 4.The use of nanotechnology methods in the field of ecology and energy. 5.Nanomaterials and wastewater treatment. Composite nanofilters.	6	Quiz, Interview
TOTAL:		36	A credit

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

a) List of recommended literature:

Core reading

1. Selected topics in nanomedicine / [edited by] Thomas Ming Swi Chang. - New York: Momentum Press, 2012. p. ; cm. -- (Regenerative medicine, artificial cells and nanomedicine ; vol. 3). - index. ISBN 978-9814472852 -
<http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=689741&site=ehost-live>
2. Koprowski, Eugene J. Nanotechnology in Medicine : Emerging Applications / Koprowski, Eugene J. - [New York, N.Y.] [222 East 46th Street, New York, NY 10017] : Momentum Press. 2012. - ISBN-13: 978-1-60650-250-1 (e-book). -
<http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=501152&site=ehost-live>

Supplementary reading

1. PHealth 2013 : Proceedings of the 10th International Conference on Wearable Micro and Nano Technologies for Personalized Health. V. 189 / Parv, Liisa, Pharow, Peter, Blobel, Bernd. - Amsterdam : IOS Press. 2013. -
<http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=638732&site=ehost-live>
2. Avery, Gordon B. Avery's Neonatology : Pathophysiology and Management of the Newborn / Avery, Gordon B., MacDonald, Mhairi G., Seshia, Mary M. K. . - Seventh edition. Philadelphia : Wolters Kluwer Health. 2016. - ISBN: 9781451192681. 9781496318688. -
<http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=1473073&site=ehost-live>
3. Riva, Giuseppe Annual Review of Cybertherapy and Telemedicine : Advanced Technologies in Behavioral, Social, and Neurosciences / Riva, Giuseppe, Bouchard, Stéphane, Wiederhold, B. K.. - Amsterdam : IOS Press. 2011, Series: Studies in Health Technology and Informatics, v.167. -
<http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=395251&site=ehost-live>

Educational-methodical reading


1. Guidelines for Individual work of students for discipline "Nanotechnology in medicine" [Электронный ресурс] / comp. by J.F. Zerkalova, M.V. Vorotnikova ; Ulyanovsk State University, Faculty of Medicine, Department of Human Anatomy. - Электрон. текстовые дан. (1 файл : 279 Кб). - Ulyanovsk : UISU, 2019. - Загл. с экрана. - Неопубликованный ресурс.
<http://lib.ulsu.ru/MegaPro/Download/MObject/1838/Zerkalova2019-5.pdf>

AGREED:

М. Добросотеева / *М. Добросотеева* / *Ринат*
Должность сотрудника научной библиотеки ФИО подпись

b) Computer software

The laboratories, instrumentation and demonstration technologies of Ulsu, documentary and Internet content of the scientific library Ulsu, certified databases and open resources (openaccess) of Internet portals of the world publishers Springer, Thompson&Reuters, WilleyBlackwell, Elsevier, ScienceDirect, computer classes of Ulsu.

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

c) Professional databases, information and reference systems:

1. Digital Library System:

1.1. **IPRbooks** [Электронный ресурс]: электронно-библиотечная система / группа компаний Ай Пи Эр Медиа . - Электрон. дан. - Саратов , [2019]. - Режим доступа: <http://www.iprbookshop.ru>.

1.2. **ЮРАЙТ** [Электронный ресурс]: электронно-библиотечная система / ООО Электронное издательство ЮРАЙТ. - Электрон. дан. – Москва , [2019]. - Режим доступа: <https://www.biblio-online.ru>.

1.3. **Консультант студента** [Электронный ресурс]: электронно-библиотечная система / ООО Политехресурс. - Электрон. дан. – Москва, [2019]. - Режим доступа: <http://www.studentlibrary.ru/pages/catalogue.html>.

1.4. **Лань** [Электронный ресурс]: электронно-библиотечная система / ООО ЭБС Лань. - Электрон. дан. – С.-Петербург, [2019]. - Режим доступа: <https://e.lanbook.com>.

1.5. **Znanium.com** [Электронный ресурс]: электронно-библиотечная система / ООО Знаниум. - Электрон. дан. – Москва, [2019]. - Режим доступа: <http://znanium.com>.

2. **КонсультантПлюс** [Электронный ресурс]: справочная правовая система. /Компания «Консультант Плюс» - Электрон. дан. - Москва : КонсультантПлюс, [2019].

3. **База данных периодических изданий** [Электронный ресурс] : электронные журналы / ООО ИВИС. - Электрон. дан. - Москва, [2019]. - Режим доступа: <https://dlib.eastview.com/browse/udb/12>.

4. **Национальная электронная библиотека** [Электронный ресурс]: электронная библиотека. - Электрон. дан. – Москва, [2019]. - Режим доступа: <https://нэб.рф>.

5. **Электронная библиотека диссертаций РГБ** [Электронный ресурс]: электронная библиотека / ФГБУ РГБ. - Электрон. дан. – Москва, [2019]. - Режим доступа: <https://dvs.rsl.ru>.

6. Федеральные информационно-образовательные порталы:

6.1. Информационная система [Единое окно доступа к образовательным ресурсам](http://window.edu.ru). Режим доступа: <http://window.edu.ru>

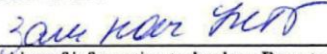


6.2. Федеральный портал [Российское образование](http://www.edu.ru). Режим доступа: <http://www.edu.ru>

7. Образовательные ресурсы УлГУ:

7.1. Электронная библиотека УлГУ. Режим доступа : <http://lib.ulsu.ru/MegaPro/Web>

7.2. Образовательный портал УлГУ. Режим доступа : <http://edu.ulsu.ru>


AGREED:

 |  | 
Position of information technology Department employee full name signature date

12. MATERIAL AND TECHNICAL BASE NECESSARY FOR THE IMPLEMENTATION OF THE EDUCATIONAL PROCESS IN THE DISCIPLINE (MODULE)

Audience for lectures, laboratory and practical work, for ongoing monitoring and interim certification, group and individual consultations.

Classrooms are equipped with specialized furniture and technical means of training, serving for the presentation of educational information (set of multimedia equipment: PC, multimedia projector, screen, speakers). Rooms for independent work are equipped with computer equipment with the ability to connect to the Internet and provide access to electronic information and educational environment, electronic library system.

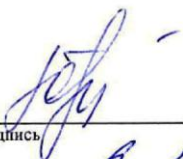

Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE »		

13. SPECIAL CONDITIONS FOR STUDENTS WITH DISABILITIES

Teaching Students with Physical Disabilities is carried out taking into account the peculiarities of psychophysical development, individual capabilities and health status of such students. Education of students with disabilities can be organized both jointly with other students and separately. If necessary, students from among persons with disabilities (at the request of the student) may be offered one of the following options for the perception of information, taking into account their individual psychophysical features:

- for visually impaired persons: in print in an enlarged font; in the form of an electronic document; in the form of an audio file (translation of educational materials into audio format); in printed form in Braille; individual consultations with the involvement of tactile interpreter; individual tasks and consultations.
- for persons with hearing impairments: in hard-copy form; in electronic form; video with subtitles; individual consultations with the involvement of a sign language interpreter; individual assignments and consultations.
- for persons with disorders of the musculoskeletal system: in hard-copy form; in electronic form; in the form of an audio file; individual assignments and advice."





Разработчики:

_____ /  / _____ /
 Доцент / подпись / ФИО Зеркалова Ю.Ф. /
 _____ /  / _____ /
 Доцент / подпись / ФИО Воротникова М.В. /

Согласовано:

_____ /  / _____ /
 Зав. кафедрой / подпись / ФИО Хайруллин Р.М. /

REVISION SHEET No.1
to the working program « Nanotechnology in medicine » 2019
speciality 31.05.01 General medicine

No	Content of the change or link to the attached text of the change	Head of the department, implementing the discipline	Signature	Date
1.	Amendments to item 4 “Total workload of the discipline” sub-item 4.2 “Volume discipline by type of study” with the design of Supplement 1	Vorotnikova M.V.		16.03.2020
2.	Amendments to item 13 “Special Conditions For Students With Disabilities” with the design of Supplement 2	Vorotnikova M.V.		16.03.2020
3.	Amendments to sub-item a) “List of recommended literature” item 11 "Educational-methodological and information support of the discipline" with the design of Supplement 3	Vorotnikova M.V.		22.06.2020
4.	Amendments to sub-item c) “Professional databases, information and reference systems” item 11 "Educational-methodological and information support of the discipline" with the design of Supplement 4	Vorotnikova M.V.		22.06.2020

4.2. Volume discipline by type of study (in hours)

Type of educational work	Number of hours (The form of training <u> </u> fill-time)			
	Workload	Hours per term		
		5 sem.		
1	2	3	4	5
Contact work of students with the Lecturer in accordance with the educational plan	36	36/36*	-	-
Classroom:	-	-	-	-
Lectures	18	18/18*	-	-
Seminars and practical's	18	18/18*	-	-
Laboratory and work practical's	-	-	-	-
Individual work	36	36	-	-
Form of current control of knowledge and control of individual work	Quiz Interview	Quiz Interview	-	-
Term paper	-	-	-	-
Scope of testing (examination, test, the credit)	a credit	a credit	-	-
Total course of workload	72 (2 credit units)	72 (2 credit units)	-	-

*The number of hours of teaching staff working with students in a distance format using e-learning.

13. SPECIAL CONDITIONS FOR STUDENTS WITH DISABILITIES

Education for BPEP HE students with disabilities is carried out taking into account the peculiarities of psychophysical development, individual empowerment and health status of the students. Education of students with disabilities can be arranged as a shared with other students, as well as separately. If necessary, students from the number of persons with disabilities (at the request of the student) can offer some of the following information perception options tailored to their individual psycho-physical features:

– for the visually impaired: in printed form in large print; in the form of an electronic document; in the form of an audio file (translation of educational materials in audio format); in printed form in Braille; individual consultations involving tactile interpreter; individual tasks and advice.

– for persons with hearing impairments: in printed form; in the form of an electronic document; videos with subtitles; individual counseling with the involvement of a sign language interpreter; individual tasks and advice.

– for people with disorders of the musculoskeletal system: in printed form; in the form of an electronic document; in the form of an audio file; individual tasks and advice.

If it is necessary to use partially / exclusively distance educational technologies in the educational process, the organization of teaching staff work with students with disabilities and disabled people is provided in the electronic information and educational environment, taking into account their individual psychophysical characteristics.

11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

a) List of recommended literature:

Core reading

1. Selected topics in nanomedicine / [edited by] Thomas Ming Swi Chang. - New York: Momentum Press, 2012. p. ; cm. -- (Regenerative medicine, artificial cells and nanomedicine ; vol. 3). - index. ISBN 978-9814472852 - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=689741&site=ehost-live>
2. Koprowski, Eugene J. Nanotechnology in Medicine : Emerging Applications / Koprowski, Eugene J. - [New York, N.Y.] [222 East 46th Street, New York, NY 10017] : Momentum Press. 2012. - ISBN-13: 978-1-60650-250-1 (e-book). - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=501152&site=ehost-live>

Supplementary reading

1. PHealth 2013 : Proceedings of the 10th International Conference on Wearable Micro and Nano Technologies for Personalized Health. V. 189 / Parv, Liisa, Pharow, Peter, Blobel, Bernd. - Amsterdam : IOS Press. 2013. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=638732&site=ehost-live>
2. Avery, Gordon B. Avery's Neonatology : Pathophysiology and Management of the Newborn / Avery, Gordon B., MacDonald, Mhairi G., Seshia, Mary M. K. . - Seventh edition. Philadelphia : Wolters Kluwer Health. 2016. - ISBN: 9781451192681. 9781496318688. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=1473073&site=ehost-live>
3. Riva, Giuseppe Annual Review of Cybertherapy and Telemedicine : Advanced Technologies in Behavioral, Social, and Neurosciences / Riva, Giuseppe, Bouchard, Stéphane, Wiederhold, B. K.. - Amsterdam : IOS Press. 2011, Series: Studies in Health Technology and Informatics, v.167. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=395251&site=ehost-live>

Educational-methodical reading

1. Guidelines for Individual work of students for discipline "Nanotechnology in medicine" [Электронный ресурс] / comp. by J.F. Zerkalova, M.V. Vorotnikova ; Ulyanovsk State University, Faculty of Medicine, Department of Human Anatomy. - Электрон. текстовые дан. (1 файл : 279 Кб). - Ulyanovsk : Ulsu, 2019. - Загл. с экрана. - Неопубликованный ресурс. <http://lib.ulsu.ru/MegaPro/Download/MObject/1838/Zerkalova2019-5.pdf>

AGREED:

1.1 Библиотекарь ООП Сагадымова Ана, 2020
Position of scientific library employee

full name

signature

date

11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

с) Database, information and reference, search systems:

1. Электронно-библиотечные системы:

1.1. IPRbooks : электронно-библиотечная система : сайт / группа компаний Ай Пи Ар Медиа. - Саратов, [2020]. – URL: <http://www.iprbookshop.ru>. – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.2. ЮРАЙТ : электронно-библиотечная система : сайт / ООО Электронное издательство ЮРАЙТ. – Москва, [2020]. - URL: <https://www.biblio-online.ru>. – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.3. Консультант студента : электронно-библиотечная система : сайт / ООО Политехресурс. – Москва, [2020]. – URL: http://www.studentlibrary.ru/catalogue/switch_kit/x2019-128.html. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.4. Лань : электронно-библиотечная система : сайт / ООО ЭБС Лань. – Санкт-Петербург, [2020]. – URL: <http://www.studentlibrary.ru/pages/catalogue.html><https://e.lanbook.com>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.5. Znanium.com : электронно-библиотечная система : сайт / ООО Знаниум. - Москва, [2020]. - URL: <http://www.studentlibrary.ru/pages/catalogue.html> <http://znanium.com>. – Режим доступа : для зарегистрир. пользователей. - Текст : электронный.

2. КонсультантПлюс [Электронный ресурс]: справочная правовая система. /ООО «Консультант Плюс» - Электрон. дан. - Москва :КонсультантПлюс, [2020].

3. Базы данных периодических изданий:

3.1. База данных периодических изданий : электронные журналы / ООО ИВИС. - Москва, [2020]. – URL: <https://dlib.eastview.com/browse/udb/12>. – Режим доступа : для авториз. пользователей. – Текст : электронный.

3.2. eLIBRARY.RU: научная электронная библиотека : сайт / ООО Научная Электронная Библиотека. – Москва, [2020]. – URL: <http://elibrary.ru>. – Режим доступа : для авториз. пользователей. – Текст : электронный

3.3. «Grebennikon» : электронная библиотека / ИД Гребенников. – Москва, [2020]. – URL: <https://id2.action-media.ru/Personal/Products>. – Режим доступа : для авториз. пользователей. – Текст : электронный.

4. Национальная электронная библиотека : электронная библиотека : федеральная государственная информационная система : сайт / Министерство культуры РФ ; РГБ. – Москва, [2020]. – URL:<http://www.studentlibrary.ru/pages/catalogue.html><https://нэб.рф>. – Режим доступа : для пользователей научной библиотеки. – Текст : электронный.

5. [SMARTImagebase](https://ebsco.smartimagebase.com/?TOKEN=EBSCO-1a2ff8c55aa76d8229047223a7d6dc9c&custid=s6895741) // EBSCOhost : [портал]. – URL: <https://ebsco.smartimagebase.com/?TOKEN=EBSCO-1a2ff8c55aa76d8229047223a7d6dc9c&custid=s6895741>. – Режим доступа : для авториз. пользователей. – Изображение : электронные.

6. Федеральные информационно-образовательные порталы:

6.1. [Единое окно доступа к образовательным ресурсам](http://window.edu.ru/) : федеральный портал / учредитель ФГАОУ ДПО ЦРГОП и ИТ. – URL: <http://window.edu.ru/>. – Текст : электронный.

6.2. [Российское образование](http://www.edu.ru) : федеральный портал / учредитель ФГАОУ ДПО ЦРГОП и ИТ. – URL: <http://www.edu.ru>. – Текст : электронный.

7. Образовательные ресурсы УлГУ:



7.1. Электронная библиотека УлГУ : модуль АБИС Мега-ПРО / ООО «Дата Экспресс». – URL: <http://lib.ulsu.ru/MegaPro/Web>. – Режим доступа : для пользователей научной библиотеки. – Текст : электронный.

7.2. Образовательный портал УлГУ. – URL: <http://edu.ulsu.ru>. – Режим доступа : для зарегистрир. пользователей. – Текст : электронный.

Согласовано:

зам. нач. УИиТФИО | Ключкова СВ | [подпись] 09.06.2020г.
Должность сотрудника УИиТФИО ФИО подпись дата

REVISION SHEET No.2
to the working program « Nanotechnology in medicine » 2019
speciality 31.05.01 General medicine

No	Content of the change or link to the attached text of the change	Head of the department, implementing the discipline	Signature	Date
1.	Amendments to sub-item a) "List of recommended literature" item 11 "Educational-methodological and information support of the discipline" with the design of Supplement 1	Vorotnikova M.V.		31.08.2021
2.	Amendments to sub-item c) "Professional databases, information and reference systems" item 11 "Educational-methodological and information support of the discipline" with the design of Supplement 2	Vorotnikova M.V.		31.08.2021

11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

a) List of recommended literature:

Core reading

1. Selected topics in nanomedicine / [edited by] Thomas Ming Swi Chang. - New York: Momentum Press, 2012. p. ; cm. -- (Regenerative medicine, artificial cells and nanomedicine ; vol. 3). - index. ISBN 978-9814472852 - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=689741&site=ehost-live>
2. Koprowski, Eugene J. Nanotechnology in Medicine : Emerging Applications / Koprowski, Eugene J. - [New York, N.Y.] [222 East 46th Street, New York, NY 10017] : Momentum Press. 2012. - ISBN-13: 978-1-60650-250-1 (e-book). - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=501152&site=ehost-live>


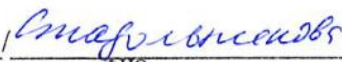
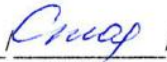

Supplementary reading

1. PHealth 2013 : Proceedings of the 10th International Conference on Wearable Micro and Nano Technologies for Personalized Health. V. 189 / Parv, Liisa, Pharow, Peter, Blobel, Bernd. - Amsterdam : IOS Press. 2013. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=638732&site=ehost-live>
2. Avery, Gordon B. Avery's Neonatology : Pathophysiology and Management of the Newborn / Avery, Gordon B., MacDonald, Mhairi G., Seshia, Mary M. K. . - Seventh edition. Philadelphia : Wolters Kluwer Health. 2016. - ISBN: 9781451192681. 9781496318688. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=1473073&site=ehost-live>
3. Riva, Giuseppe Annual Review of Cybertherapy and Telemedicine : Advanced Technologies in Behavioral, Social, and Neurosciences / Riva, Giuseppe, Bouchard, Stéphane, Wiederhold, B. K.. - Amsterdam : IOS Press. 2011, Series: Studies in Health Technology and Informatics, v.167. - <http://search.ebscohost.com/login.aspx?direct=true&db=e600xww&AN=395251&site=ehost-live>

Educational-methodical reading

1. Guidelines for Individual work of students for discipline "Nanotechnology in medicine" : Specialty - 31.05.01 "General medicine". Form of study: intramural / J. F. Zerkalova, M. V. Vorotnikova; Ulyanovsk State University, Faculty of Medicine, Department of Human Anatomy. - Ulyanovsk : UISU, 2021. - 16 p. - Неопубликованный ресурс. - URL: <http://lib.ulsu.ru/MegaPro/Download/MObject/10614> . - Режим доступа: ЭБС УлГУ. - Текст : электронный.

AGREED:

Должность сотрудника научной библиотеки ФИО подпись дата

11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

c) Professional databases, information and reference systems:

1. Digital Library System:

1.1. IPRbooks : электронно-библиотечная система : сайт / группа компаний Ай Пи Ар Медиа. - Саратов, [2021]. – URL: <http://www.iprbookshop.ru>. – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.2. ЮРАЙТ : электронно-библиотечная система : сайт / ООО Электронное издательство ЮРАЙТ. – Москва, [2021]. - URL: <https://urait.ru>. – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.3. Консультант студента : электронно-библиотечная система : сайт / ООО Политехресурс. – Москва, [2021]. – URL: <https://www.studentlibrary.ru/cgi-bin/mb4x>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.4. Консультант врача : электронно-библиотечная система : сайт / ООО Высшая школа организации и управления здравоохранением-Комплексный медицинский консалтинг. – Москва, [2021]. – URL: <https://www.rosmedlib.ru>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.5. Большая медицинская библиотека : электронно-библиотечная система : сайт / ООО Букап. – Томск, [2021]. – URL: <https://www.books-up.ru/ru/library/>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.6. Лань : электронно-библиотечная система : сайт / ООО ЭБС Лань. – Санкт-Петербург, [2021]. – URL: <https://e.lanbook.com>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.7. Znanium.com : электронно-библиотечная система : сайт / ООО Знаниум. - Москва, [2021]. - URL: <http://znanium.com>. – Режим доступа : для зарегистрир. пользователей. - Текст : электронный.

1.8. Clinical Collection : коллекция для медицинских университетов, клиник, медицинских библиотек // EBSCOhost : [портал]. – URL: <http://web.b.ebscohost.com/ehost/search/advanced?vid=1&sid=9f57a3e1-1191-414b-8763-e97828f9f7e1%40sessionmgr102>. – Режим доступа : для авториз. пользователей. – Текст : электронный.

1.9. Русский язык как иностранный : электронно-образовательный ресурс для иностранных студентов : сайт / ООО Компания «Ай Пи Ар Медиа». – Саратов, [2021]. – URL: <https://ros-edu.ru>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

2. **КонсультантПлюс** [Электронный ресурс]: справочная правовая система. /ООО «Консультант Плюс» - Электрон. дан. - Москва : КонсультантПлюс, [2021].

3. Базы данных периодических изданий:

3.1. База данных периодических изданий : электронные журналы / ООО ИВИС. - Москва, [2021]. – URL: <https://dlib.eastview.com/browse/udb/12>. – Режим доступа : для авториз. пользователей. – Текст : электронный.

3.2. eLIBRARY.RU: научная электронная библиотека : сайт / ООО Научная Электронная Библиотека. – Москва, [2021]. – URL: <http://elibrary.ru>. – Режим доступа : для авториз. пользователей. – Текст : электронный

3.3. «Grebennikon» : электронная библиотека / ИД Гребенников. – Москва, [2021]. – URL: <https://id2.action-media.ru/Personal/Products>. – Режим доступа : для авториз. пользователей. – Текст : электронный.

4. **Национальная электронная библиотека** : электронная библиотека : федеральная государственная информационная система : сайт / Министерство культуры РФ ; РГБ. – Москва, [2021]. – URL: <https://нэб.рф>. – Режим доступа : для пользователей научной библиотеки. – Текст : электронный.

5. **SMART Imagebase** // EBSCOhost : [портал]. – URL: <https://ebSCO.smartimagebase.com/?TOKEN=EBSCO-1a2ff8c55aa76d8229047223a7d6dc9c&custid=s6895741>. – Режим доступа : для авториз. пользователей. – Изображение : электронные.

6. Федеральные информационно-образовательные порталы:

6.1. **Единое окно доступа к образовательным ресурсам** : федеральный портал / учредитель ФГАОУ ДПО ЦРГОП и ИТ. – URL: <http://window.edu.ru/>. – Текст : электронный.

6.2. **Российское образование** : федеральный портал / учредитель ФГАОУ ДПО ЦРГОП и ИТ. – URL: <http://www.edu.ru>. – Текст : электронный.

7. Образовательные ресурсы УлГУ:

7.1. Электронная библиотека УлГУ : модуль АБИС Мега-ПРО / ООО «Дата Экспресс». – URL: <http://lib.ulsu.ru/MegaPro/Web>. – Режим доступа : для пользователей научной библиотеки. – Текст : электронный.

AGREED:

Зам. зам. зам. зам. | Ключкова Н.В. | 1/1/2021
Position of information technology Department employee full name signature date