
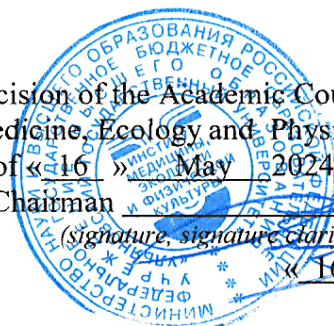


Ministry Science and Higher Education of the Russian Federation Ulyanovsk State University	Form	
Working program on discipline «NANOTECHNOLOGIES IN MEDICINE»		

**APPROVED**  
by the decision of the Academic Council of the Institute  
of Medicine, Ecology and Physical Culture of USU  
of «16» May 2024, Record No. 9/260  
Chairman V. V. Mashin  
(signature, signature clarification)  
«16» May 2024



### WORKING PROGRAM

Discipline	NANOTECHNOLOGIES IN MEDICINE Б1.Б.ДВ.06.02
Faculty	Faculty of medicine T. Z. Biktimirova
Department	General and Clinical Morphology
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: « 01 » september 2024

The program was updated at the department session: protocol № \_\_\_\_\_ of \_\_\_\_\_ 20\_\_ .

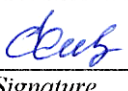
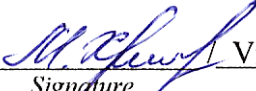
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The program was updated at the department session: protocol № \_\_\_\_\_ of \_\_\_\_\_ 20\_\_ .

**Information on authors:**

Initials	Department	Degree, title
Zerkalova J.F.	General and Clinical Morphology	Candidate of Medical Sciences, assistant professor
Vorotnikova M.V.	General and Clinical Morphology	Candidate of Biological Sciences, assistant professor

AGREED	AGREED
Head of the Department of General and Clinical Morphology, implementing the discipline	Head of the Graduating Department of Hospital Therapy
 / <u>Slesareva E.V.</u> / <i>Signature</i> <i>Initials</i>	 / <u>Vize-Khripunova M. A.</u> / <i>Signature</i> <i>Initials</i>
« 16 » May 2024	« 16 » May 2024

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

## 1. OBJECTIVES AND AIMS OF MASTERING THE DISCIPLINE

### Objectives 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.

The process of mastering the discipline " Nanotechnology in medicine" is aimed at the formation of universal and professional competencies (UC-1, PC-5).

### Aims 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.

## 2. PLACE OF DISCIPLINE IN THE STRUCTURE OF THE BASIC PROFESSIONAL EDUCATIONAL PROGRAM: the discipline Б1.Б.ДВ.06.02

The academic discipline Б1.Б.ДВ.06.02 "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.

Mastering the discipline "Nanotechnology in medicine" is based on the knowledge, skills and abilities formed by previous disciplines:

- Bioethics
- Physics, Mathematics
- Chemistry
- Biochemistry
- Philosophy
- Immunology.

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:

- Medical rehabilitation
- Pathophysiology of extreme conditions
- Hygiene
- Faculty therapy
- Occupational diseases
- Current issues of andrology
- Diabetology and Emergency endocrinology
- Current issues of hospital surgery
- Polyclinic therapy


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

- Palliative medicine
- Concomitant injury
- Clinical electrocardiography
- Practice on obtaining primary professional skills of a doctor of an inpatient institution
- Practice on obtaining primary professional skills and skills of an outpatient clinic doctor

### 3. LIST OF PLANNED LEARNING OUTCOMES ON DISCIPLINE, CORRELATED WITH THE PLANNED RESULTS OF MASTERING THE BASIC PROFESSIONAL EDUCATIONAL PROGRAM

Name of the category (group) of universal competencies	The code and name of the universal competence	The code and name of the indicator (indicators) of achieving universal competence
Systematic and critical thinking	<b>UC -1</b> Able to carry out a critical analysis of problem situations on the basis of a systematic approach, to develop a strategy of actions	IA-1uc1 Know the methods of developing an action strategy for identifying and solving a problem situation IA-2uc1 Be able to apply the methods of a systematic approach and critical analysis of problem situations IA-3uc1 Master the methodology of system and critical analysis of problem situations

Name of the category (group) of professional competencies	Code and name of professional competence	Code and name of the indicator of achievement of professional competence
Conducting and monitoring the effectiveness of measures for the prevention and formation of a healthy lifestyle and sanitary and hygienic education of the population	<b>PC-5</b> Ability and readiness to implement a set of measures aimed at preserving and strengthening health and including the formation of a healthy lifestyle, prevention of the occurrence and (or) spread of diseases, their early diagnosis, identification of the causes and conditions of their occurrence and development, as well as aimed at eliminating the harmful effects of environmental factors on human health	<b>Know:</b> methods of conducting anthropometry; dietary tables and their significance in therapeutic measures for the recovery of patients; methods of measuring blood pressure; methods of studying the pulse on the arteries and its properties; methods of counting respiratory movements. <b>Be able to:</b> conduct anthropometry; count respiratory movements and evaluate the result; measure blood pressure; examine the pulse on the arteries and evaluate the result. <b>Master:</b> the method of anthropometry; the method of counting respiratory move-

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

		ments; the method of measuring blood pressure; the method of studying the pulse on the arteries.
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#### 4. TOTAL WORKLOAD OF THE DISCIPLINE

4.1. Volume of discipline in credit units (total) 72 hours (2Credit)


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

Type of academic workload	Number of hours (Form of study_ intramural )			
	Total in the plan	Hours per term		
		1	2	3
1	2	term № 5	4	5
Contact work of students with the Lecturer in accordance with the EP	36	36	-	-
Classroom	36	36	-	-
Lectures (includind__PrP)*	-	-	-	-
Seminars and practical's (includind__PrP)*	36	36	-	-
Laboratory and work practical's (includind__PrP)*	-	-	-	-
Individual work	36	36	-	-
the form of the current control of knowledge and control of independent work, testing, control work, colloquium, abstract, etc. (at least 2 types)	Quiz Interview	Quiz Interview	-	-
Term paper	-	-	-	-
Types of interim attestation (exam, credit(test))	a credit	a credit	-	-
Total hours in discipline	<b>72 (2credit units)</b>	<b>72 (2 credit units)</b>	-	-

\* If it is necessary to use partially/exclusively distance learning technologies in the educational process, the number of hours of teaching staff working with students for conducting classes in a distance format using e-learning is indicated in the table using a slash.

**4.3. The contents of discipline (module). Distribution of hours on the themes and types of academic work: number of hours- 72**

Form of study		intramural					Forms of the progress monitoring
Units / Themes of discipline	Total labor intensity (in hours)	Types of training sessions					
		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
<b>Section 1. Fundamentals of nanobiotechnologies</b>							
Unit 1. Introduction. Basic concepts of nanotechnology	4		2			2	Quiz, Interview
Unit 2. Methods and tools of nanotechnology	4		2			2	Quiz, Interview
Unit 3. Investigation of nanostructures using scanning probe microscopy	2		2				Quiz, Interview
Unit 4. Nanomaterials: classification and properties	5		2			3	Quiz, Interview
Unit 5. Self-organization in biological systems	5		2			3	Quiz, Interview
<b>Section 2. The main directions of development of nanotechnologies in medicine</b>							
Unit 6. The main directions of development of nanotechnologies in medicine	5		2			3	Quiz, Interview
Unit 7. Directed transport of medicines	5		2			3	Quiz, Interview
Unit 8. Nanotechnology in the diagnosis and treatment of cancer	5		2			3	Quiz, Interview
Unit 9. Biochips in biomedical research	7		4			3	Quiz, Interview

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

Unit 10. Nano-technology in the field of Transplantology and implantology	10		4			6	Quiz, Interview	
Unit 11. Nano-technology in gene, cell and tissue engineering	6		4			2	Quiz, Interview	
Unit 12. Nanotechnologies based on nucleic acids	6		4			2	Quiz, Interview	
<b>Section 3. Risks of using nanotechnologies</b>								
Unit 13. Safety assessment of nanomaterials	10		4			6	Quiz, Interview	
<b>Total</b>	<b>72</b>		<b>36</b>			<b>36</b>	A credit	

## 5. CONTENT OF THE DISCIPLINE

### Section 1. Fundamentals of nanobiotechnologies.

#### Unit1. 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.

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

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 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, nanodiagnosics 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.

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

### **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.

### **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**

### **Unit13. 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 INDIVIDUAL WORK 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:



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

- 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.**

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:

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

- 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.
- 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."

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

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.

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. LIST OF QUESTIONS FOR 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.

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


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, 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.
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.)
<b>Unit 1.</b> 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
<b>Unit 2.</b> 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
<b>Unit 4.</b> 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
<b>Unit 6.</b> Nanotechnology in medicine: a panorama of directions	Study of educational material, performing exercises 1. Regenerative medicine	3	Quiz, Interview
<b>Unit 7.</b> Directed transport of medicines	Study of educational material, performing exercises 1. Structure of phosphatidylcholine.	3	Quiz, Interview

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

	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.		
<b>Unit 8.</b> Nano-technology in the diagnosis and treatment of cancer	Study of educational material, performing 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.	3	Quiz, Interview
<b>Unit 9.</b> 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
<b>Unit 10.</b> 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
<b>Unit 11.</b> Nano-technology in gene, cell and tissue engineering	Study of educational material, performing exercises 1.Technology of recombinant DNA production.	2	Quiz, Interview
<b>Unit 12.</b> Nano-technologies 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
<b>Unit 13.</b> 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	6	Quiz, Interview

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

	field of ecology and energy. 5.Nanomaterials and wastewater treatment. Composite nanofilters.		
TOTAL:		36	A credit

## 11. EDUCATIONAL-METHODICAL AND INFORMATION SUPPORT OF DISCIPLINE

### a) List of recommended literature:

#### Core reading

1. Remizov, A. N. Medical and biological physics : textbook / A. N. Remizov. - Moscow : GEOTAR-Media, 2022. - 576 с. - ISBN 978-5-9704-7102-9. - Текст : электронный // ЭБС "Консультант студента" : [сайт]. - URL : <https://www.studentlibrary.ru/book/ISBN9785970471029.html>
2. Medical informatics for medical school students in EnglishL: lecture course / compiled by S. V. Ronomarev, N. M. Poroova. — Ижевск : ИГМА, 2020. — 56 с. — Текст : электронный // Лань : электронно-библиотечная система. — URL: <https://e.lanbook.com/book/245366>

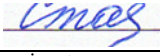
#### Supplementary reading

1. Medical informatics = Информатика в медицине : пособие для студентов учреждений высшего образования, обучающихся по специальности 1-79 01 01 «Лечебное дело» [на англ. яз.] : manual for students of higher education institutions studying in the specialty 1-79 01 01 "General Medicine" / С. И. Клинецвич, Е. П. Наумюк, В. М. Завадская и др. - Гродно : ГрГМУ, 2020. - 108 с. - ISBN 9789855952979. - Текст : электронный // ЭБС "Букап" : [сайт]. - URL : <https://www.books-up.ru/ru/book/medical-informatics-13570186/>
2. Guidelines for students to practical lessons for the discipline "Modern medical information systems" Specialty - 31.05.01 «General medicine» Form of study: intramural / J. F. Zerkalova, M. V. Vorotnikova; Ulyanovsk State University, Faculty of Medicine. - Ulyanovsk : UISU, 2019. - Загл. с экрана; На англ. яз.; Неопубликованный ресурс. - Электрон. текстовые дан. (1 файл : 369 Кб). - Текст : электронный. <http://lib.ulsu.ru/MegaPro/Download/MObject/5609>

#### Educational-methodical reading


1. Guidelines for Individual work of students for the 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. - 2023. - 14 p. - Неопубликованный ресурс. - URL: <http://lib.ulsu.ru/MegaPro/Download/MObject/14770>. - Режим доступа: ЭБС УЛГУ. - Текст : электронный.

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Leading specialist	Стадольникова / 	2024
The position of the worker scientific library	Full name	signature / data

### b) Software:

Information infrastructure of the department includes web-page on the official website of the University, its own computer lab for testing students at 8 workplaces, personal computers, the current generation (equipped with every job faculty, staff and graduate students), multimedia lecture complex (2 stationary and portable), all computers, without exception, are in the local network of university and have access to the Internet, printers, copiers, computer hardware. 100% of lectures in the field of medical faculty provided multimedia presentations, including animations and video

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

clips. The training process uses more than 30 electronic textbooks and open Internet resources, including the use of on-line mode during practical classes and lectures, a DVD-videos on certain sections of the subjects taught, the department organized base of electronic textbooks and atlases with your network access to the local network of educational building of the medical Faculty.

### c) Database, information and reference, search systems:

#### 1. Digital Library System:

1.1. Цифровой образовательный ресурс IPRsmart : электронно-библиотечная система : сайт / ООО Компания «Ай Пи Ар Медиа». - Саратов, [2024]. – URL: <http://www.iprbookshop.ru>. – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.2. Образовательная платформа ЮРАЙТ : образовательный ресурс, электронная библиотека : сайт / ООО Электронное издательство «ЮРАЙТ». – Москва, [2024]. - URL: <https://urait.ru> . – Режим доступа: для зарегистрир. пользователей. - Текст : электронный.

1.3. База данных «Электронная библиотека технического ВУЗа (ЭБС «Консультант студента») : электронно-библиотечная система : сайт / ООО «Политехресурс». – Москва, [2024]. – URL: <https://www.studentlibrary.ru/cgi-bin/mb4x>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.4. Консультант врача. Электронная медицинская библиотека : база данных : сайт / ООО «Высшая школа организации и управления здравоохранением-Комплексный медицинский консалтинг». – Москва, [2024]. – URL: <https://www.rosmedlib.ru>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.5. Большая медицинская библиотека : электронно-библиотечная система : сайт / ООО «Букап». – Томск, [2024]. – URL: <https://www.books-up.ru/ru/library/> . – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.6. ЭБС Лань : электронно-библиотечная система : сайт / ООО ЭБС «Лань». – Санкт-Петербург, [2024]. – URL: <https://e.lanbook.com>. – Режим доступа: для зарегистрир. пользователей. – Текст : электронный.

1.7. ЭБС Znanium.com : электронно-библиотечная система : сайт / ООО «Знаниум». - Москва, [2024]. - URL: <http://znanium.com> . – Режим доступа : для зарегистрир. пользователей. - Текст : электронный.

2. **КонсультантПлюс** [Электронный ресурс]: справочная правовая система. / ООО «Консультант Плюс» - Электрон. дан. - Москва : КонсультантПлюс, [2024].

3. **eLIBRARY.RU**: научная электронная библиотека : сайт / ООО «Научная Электронная Библиотека». – Москва, [2024]. – URL: <http://elibrary.ru>. – Режим доступа : для авториз. пользователей. – Текст : электронный

4. **Федеральная государственная информационная система «Национальная электронная библиотека»** : электронная библиотека : сайт / ФГБУ РГБ. – Москва, [2024]. – URL: <https://нэб.рф>. – Режим доступа : для пользователей научной библиотеки. – Текст : электронный.

5. **Российское образование** : федеральный портал / учредитель ФГАУ «ФИЦТО». – URL: <http://www.edu.ru>. – Текст : электронный.

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

#### AGREED:


Инженер ведущий



Щуренко Ю.В.

2024



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

## 12. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

Audiences for the conduct lectures, for practical work, for ongoing monitoring and intermediate certification, group consultations.

### **Conducting lectures:**

1. The lecture hall (№ 404, Building 4, Sviyaga River Embankment, 106)

### **Conducting practical training, ongoing monitoring and intermediate certification, group consultations:**

1. Classroom № 01 for 16 seats.
2. Classroom № 02 for 26 seats.
3. Classroom № 04 for 26 seats.
4. Classroom № 012 for 26 seats.
5. Classroom № 014 for 40 seats.

Audiences are located at: Ulyanovsk, st. Architect Livchak, 2/1, Faculty of Medicine (ground floor). The classrooms are equipped with specialized furniture, a training board. The lecture halls are equipped with multimedia equipment to provide information to a large audience. The premises for independent work are equipped with computer equipment with the ability to connect to the Internet and provide access to an electronic educational information environment, an electronic library system.

The rooms for independent work are equipped with computer equipment with the ability to connect to the Internet and provide access to an electronic educational information environment, an electronic library system.

### **The list of equipment used in the educational process:**


1. Multimedia projector - 1 pc.
2. Screen - 1 pc.
3. Speakers - 1 pc.
4. Laptop - 1 pc.
5. Epson printer - 3 pcs.

## 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.

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

**Developers:**

Assistant Professor /  / Zerkalova J.F.  
 position signature full name

Assistant Professor /  / Vorotnikova M.V.  
 position signature full name

**Agreed:**

Head of Department /  / Slesareva E.V.  
 position signature full name