

AMENDMENTS AND CHANGES TO THE CURRICULUM IN THE EDUCATIONAL DISCIPLINE
« BIOMEDICAL PHYSICS »
for the specialty 7-07-0912-01 «Pharmacy»
for 2024/2025 academic year

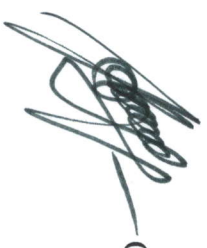
Amendments and changes	Basis/Reason
1. Changes have been introduced into the Explanatory Note (appendix 1)	Educational Plan for 2024/2025 academic year
2. Changes have been introduced into the Thematic Plan (appendix 2)	Educational Plan for 2024/2025 academic year
3. Changes have been introduced into the Educational Discipline Curricular Chart (appendix 3)	Educational Plan for 2024/2025 academic year

The curriculum is revised and approved at the department meeting of the department of Medical and Biological Physics (protocol # 10 of 30.05.2024)

Head of the department of Medical and Biological Physics


M.V. Goltsev

APPROVED
Dean of the Medical Faculty for International Students


O.S. Ishutin

Changes in the Explanatory Note

Total number of hours for the study of the discipline is 207 academic hours, of which 116 classroom hours and 91 hours of student independent work. Classroom hours according to the types of studies: lectures - 26 hours (including 9 hours of supervised student independent work (SSIW)), laboratory classes (practical classes - 75 hours, seminars – 15 hours).

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	7-07-0912-01 «Pharmacy»		Form of intermediate assessment	Number of academic hours	including	lectures (including supervised independent work)	supervised student independent work	laboratory studies (practical classes)	out-of-class self-studies	credit	examination
	1	2									
	semester										
	total										
	in-class										
	59	57				9	3	45	38	53	
	112	95				9	5	45			

THEMATIC PLAN

Section (topic) name	Number of class hours		
	lectures	practical	laboratory
1. Introduction to the discipline «Biomedical physics». Mathematical modeling of biomedical and pharmaceutical processes. Mechanics	1,5	-	21
1.1. Physics and biomedical physics, subject and methods. Introduction to the work-shop	-	-	3
1.2. Mathematical modeling of biomedical and pharmaceutical processes. Study of the functional relationships. Determination of the rates of function change and gradient of function	-	-	6
1.3. Elements of probability theory. Random variables, their distributions and numerical distribution characteristics	-	-	3
1.4. Fundamentals of mathematical statistics. Sampling procedure. Methods of distribution parameters calculation. Graphical representation of a statistical distribution. Elements of correlation analysis. Determination of a correlation between two sets of random variables	-	-	3
1.5. Methods of body mass measurement	-	-	3
1.6. Mechanical oscillations. Oscillations decomposition into a harmonic spectrum	1,5	-	-
1.7. Mechanical waves. Energy characteristics of a mechanical wave		-	-
1.8. Acoustics. Biophysical basics of the acoustic sensation formation. Sound, ultrasound, infrasound. Ultrasound. Acoustic and ultrasound methods of the examination and treatment in medicine		-	3
2. Molecular physics	5	-	9
2.1. General properties and features of the molecular structure of liquids. Molecular motion in liquids. The phenomenon of transport in liquids. Physical basis of	1,5	-	3

Section (topic) name	Number of class hours		
	lectures	practical	laboratory
hydrodynamics of ideal and viscous fluid. Methods of liquid viscosity determination			
2.2. Distribution of blood pressure and velocity in the vascular system. Physical basics of hemodynamics	1,5		
2.3. Surface tension	2	-	3
2.4. Elastic bodies. Elastic properties of solids. Determination of the elasticity modulus of materials		-	3
3. Cell biophysics. Biological processes modeling	3		6
3.1. Physical properties of biological membranes. Substance transport across biological membranes	1,5	-	1
3.2. Resting biopotentials and their ionic nature. Formation of cell membrane potentials during its excitation	1,5	-	1
3.3. Generation and propagation of action potential		-	4
4. Electricity and magnetism	4,5	6	15
4.1. Physical basis of electrography of human tissues and organs	1,5	-	3
4.2. Methods of biomedical information monitoring. Sensors	1,5		3
4.3. Amplification of bioelectrical signals	-		3
4.4. Alternating current. Various loads in the AC circuit. Living tissue impedance to alternating current. Physical basis of rheography	1,5		3
4.5. Characteristics of impulse currents. Physical basis of tissue and organ electrostimulation			
4.6. Effect of high-frequency current and field on the human organism. The use of UHF oscillations in medicine. Study of the methods and equipment for high-frequency therapy	-	6	3
5. Optics	4,5	-	21
5.1. Electromagnetic oscillations and waves	1,5	-	3
5.2. Refraction and refractometry	-	-	3
5.3. Optical microscopy. Fundamentals of electron and scanning probe microscopy	-	-	3

Section (topic) name	Number of class hours		
	lectures	practical	laboratory
5.4.Optical system of the eye. Biophysical foundations of vision	-	-	3
5.5.Laws of light absorption and light scattering. Fundamentals of photolorimetry and spectrophotometry	1,5	-	3
5.6.Atomic and molecular spectra. Emission and absorption spectra. Spectral instruments	1,5	-	3
5.7.Stimulated emission. Lasers. The effect of laser radiation on biological tissues		-	3
6. Physics of atoms and molecules	4,5	6	-
6.1.Thermal radiation	1,5	-	-
6.2.Luminescence. Types and basic characteristics of luminescence	1,5	-	-
6.3.X-rays	1,5	6	
7. Nuclear physics	3	3	3
7.1.Radioactivity	1,5	1	-
7.2.Interaction of ionizing radiation with matter		-	-
7.3.Radiation dosimetry	1,5	2	3
Total hours	26	15	75

ACADEMIC DISCIPLINE CURRICULAR CHART

№	Section (topic) name	number of hours			supervised student independent work	Practical skills	Form of control	
		lectures	laboratory	practical			Of practical skills	of current / intermediate assessment
I semester								
	Lectures	9			5			
1	Mechanical oscillations. Decomposition of oscillations into a harmonic spectrum. Acoustics. Biophysical basis of the formation of auditory sensation. Sound, ultrasound, infrasound. Ultrasound. Acoustic and ultrasonic methods of research and influence in medicine. Elastic bodies. Elastic properties of solids. Mechanical properties of biological tissues.	1,5			-			
2	Physical basis of hydrodynamics of ideal and viscous fluid. Methods of liquid viscosity determination. Fundamental concepts of hydrodynamics. Continuity equation. Bernoulli's equation. Viscous fluid flow. Newton's equation. Poiseuille's	1,5			1			

	formula. Hydraulic resistance. Physical basics of hemodynamics. Factors affecting blood viscosity in the human body. Distribution of blood pressure and velocity in the vascular system. Pulse wave. Heart work and heard power.							
3	Liquid surface tension. Coefficient of surface tension and methods for its determination. Capillary phenomena. Laplace's formula. Gas embolism. Surface-active material. Adsorption. The use of surface-active materials in pharmacy.	1,5			1			
4	Structure and physical properties of biological membranes. Transport of substances across biological membranes. Passive transport of substances through biomembranes, its types and mathematical description. Theorell's equation, Nernst-Planck equation and Fick equation. Active transport. Sodium-potassium pump.	1,5			0,5			
5	Formation of cell membrane potentials at rest and during excitation. Nernst equation and Goldman-Hodgkin-Katz equation. The mechanism of generation of rest potential and action potential. Mechanism of action biopotential generation, its main phases. Refractory period. Action potential propagation along unmyelinated and myelinated axons	1,5						

6	Physical basis of electrography of human tissues and organs. Fundamentals of electrocardiography Einthoven's theory, ECG registration methods. Methods for registration of biomedical information. Sensors. The dependence of metal and semiconductor resistance on temperature. Contact potential difference. Thermoelectromotive force. Thermocouple. The Peltier phenomenon. Amplification of bioelectrical signals. Determination of the frequency (bandwidth) and amplitude (dynamic range) characteristics of the amplifier. Differential amplifier.	1,5	1				
7	Physical basis of tissue and organ electrostimulation. Impulse currents and their characteristics. Electroexcitability of tissues. Strength-duration curve, rheobase and chronaxy. Weiss-Lapicque law. Du Bois-Reymond law. Types of the heart electrical stimulation. Effect of high-frequency current and field on the human organism. Physical basis of diathermy, local d'arsonvalization, inductothermy, ultra-high-frequency therapy, microwave therapy			1,5			
Practical (laboratory or seminar) lessons							

1	Introduction to the discipline «Biomedical physics». Mathematical modeling of biomedical and pharmaceutical processes. Mechanics		24	24			
1.1	Physics and biomedical physics, subject and methods. Introduction to the workshop Laboratory work (L.w.) «Elements of the errors theory»		3	3			Interview, written classroom (home) practical exercises, accounts of home practical exercises with oral defense, written account of laboratory work
1.2	Mathematical modeling of biomedical and pharmaceutical processes. L.w. « Mathematical models compilation of medical and biological processes»		3	3			Interview, written classroom (home) practical exercises, accounts of home practical exercises with oral defense, written account of laboratory work
1.3	Study of the functional relationships. Determination of the rates of function change and gradient of function L.w. «Determination of the rates of function change and gradient of function. Calculation of definite integrals»		3	3			Interview, written classroom (home) practical exercises, accounts of home practical exercises with oral defense,

							written account of laboratory work
1.4	Elements of probability theory. Random variables, their distributions and numerical distribution characteristics L.w. «Determination of the numerical parameters of random variables distributions: expectation, mode, median, variance, standard deviation»		3	3			Interview, written classroom (home) practical exercises, accounts of home practical exercises with oral defense,
1.5	Fundamentals of mathematical statistics. Sampling procedure. Methods of distribution parameters calculation. Graphical representation of a statistical distribution. Elements of correlation analysis. Determination of a correlation between two sets of random variables L.w. «Graphical representation of a statistical distribution. Plotting a correlation field, regression line and calculation of the correlation coefficient»		3	3			written account of laboratory work
1.6	Final lesson on mathematical modeling of biomedical and pharmaceutical processes, elements of probability theory and fundamentals of mathematical statistics		3	3			Interview. Electronic test*
1.7	Methods of body mass measurement L.w. «Body weight measurement»		3	3	Using measuring instruments and tools to	written account of laboratory work	Interview

					determine the size and weight of an object		
1.8	Acoustics. Biophysical basics of the acoustic sensation formation. Sound, ultrasound, infrasound. Ultrasound. Acoustic and ultrasound methods of the examination and treatment in medicine L.w. «Registration of the spectral characteristics of ear sensitivity at the threshold of hearing»		3	3	Registration of the spectral characteristics of ear sensitivity at the threshold of hearing	written account of laboratory work	Interview
2	Molecular physics		9	9			
2.1	General properties and features of the molecular structure of liquids. Molecular motion in liquids. The phenomenon of transport in liquids. Physical basis of hydrodynamics of ideal and viscous fluid. Methods of liquid viscosity determination L.w. «Determination of the liquid viscosity with an Ostwald viscometer»		3	3	Determination of the liquid viscosity with an Ostwald viscometer	written account of laboratory work*	Interview
2.2	Surface tension L.w. «Determination of the surface tension by maximum bubble pressure method»		3	3	Determination of the surface tension by maximum bubble pressure method	written account of laboratory work	Interview

2.3	Elastic bodies. Elastic properties of solids. Determination of the elasticity modulus of materials L.w. «Determining the elasticity modulus of the bone by bending deformation»		3		3	Determining the elasticity modulus of materials by bending	written account of laboratory work	Interview
3.	Cell biophysics. Biological processes modeling		6	6	15			
3.1	Physical properties of biological membranes. Transport of substances across biological membranes. Passive transport of substances through biomembranes, its types and mathematical description. Theorell's equation, Nernst-Planck equation and Fick equation. Active transport. Sodium-potassium pump		3		3			Interview, test
3.2	Formation of cell membrane potentials at rest and during excitation. Nernst equation and Goldman-Hodgkin-Katz equation. The mechanism of generation of rest potential and action potential. Mechanism of action biopotential generation, its main phases. Refractory period. Generation and propagation of action potential along unmyelinated and myelinated axons. Modeling of biological processes as a method of cognition.		3		4			Interview, essay, test

3.3	Final lesson on topics "Introduction to the discipline "Biomedical Physics". Mathematical modeling of biomedical and pharmaceutical processes. Mechanics", "Molecular physics", "Cell biophysics. Modeling of biological processes".			3	4			Interview, essay
3.4	Final lesson on topics «Introduction to the discipline "Biomedical Physics". Mathematical modeling of biomedical and pharmaceutical processes. Mechanics», «Molecular physics», «Cell biophysics. Biological processes modeling»			3	4			Interview, Colloquium. Electronic test* Credit
	Total hours	9	45		53			
	2 Semester							
	Lectures	9			3			
1.	Electromagnetic oscillations and waves. General properties of electromagnetic waves. Natural and polarized light. Types of polarization. Methods for obtaining polarized light. Malus' law. Optical activity. Polarimetry	1,5			1			
2.	Structure and physical properties of the biological membranes. Substance transport across biological membranes. Formation of cell membrane potentials at rest and during its excitation. Generation and propagation of action potential along axons	1,5						
3	Thermal radiation. The main characteristics of thermal radiation. The laws of thermal radiation (Kirchhoff's law, Stefan-Boltzmann's law, Wien's displacement law). Planck's formula. Laws	1,5			1			

	of absorption and scattering of light. Laws of Bouguer and Bouguer-Lambert-Beer. The linear decay constant of a substance, its dependence on the wavelength of light and the concentration of the solution. Transmittance and optical density, their dependence on wavelength and concentration. Photoelectrocolorimeter. Determination of the solution concentration with the photoelectrocolorimeter. Light scattering and its types. Rayleigh's law. Nephelometry						
4	Brennsstrahlung and characteristic x-rays. X-rays properties. Moseley's law. X-rays spectra. Interaction of X-rays with matter. X-ray diffraction analysis. The use of x-rays in diagnostics and radiotherapy. Fundamentals of x-ray computed tomography	1,5		1			
5	Radiactivity. The main types of radioactive decay. The fundamental law of radioactive decay. Half life time. Activity, its units. Drug activity change with time. Interaction of ionizing radiation with matter. Radionuclide methods of diagnostics and radiation therapy. Linear specific ionization, linear energy transfer, mean linear range. Biological effects of radiation	1,5					
6	Dosimetry. Exposure, absorbed and equivalent doses, the relationship between them and their units. Effective equivalent	1,5					

	dose, tissue weighting factor. Collective effective dose. The construction of dosimeters and radiometers. Determination of exposure rate. Background radiation						
	Practical (laboratory or seminar) lessons						
4	Electricity and magnetism	12	3	8			
4.1	Physical basis of electrography of human tissues and organs L.w. «Physical basis of electrography of human tissues and organs»	1,5		2	Determining the main characteristics of an ECG	written account of laboratory work	Interview
4.2	Methods of biomedical information monitoring. Sensors L.w. « Temperature sensors»	3		1	Calibration of electrical temperature sensors	written account of laboratory work	Accounts of home practical exercises with oral defense, interview, essay
4.3	Amplification of bioelectrical signals L.w. «The study of the properties of electrical signals amplifier»	1,5		1	Determining the amplifier's bandwidth and dynamic range	written account of laboratory work	Accounts of home practical exercises with oral defense, interview
4.4	Alternating current. Various loads in the AC circuit. Living tissue impedance to alternating current. Physical basis of rheography L.w. «Determination of the dependence of biological tissue impedance on current frequency»	3		1	Determination of the dependence of biological tissue impedance on current frequency	written account of laboratory work *	Interview, essay
4.5	Effect of high-frequency current and field on the human organism. Methods and equipment for high-frequency therapy L.w. «Physical principles of high-frequency electrotherapy»	3		1	The use of some high-frequency physiotherapy equipment	written account of laboratory work	Interview, essay, test

4.6	Final lesson on topic « Electricity and magnetism»		3	2		Interview, control questioning, essay, electronic test*	
5.	Optics	21		18			
5.1	Electromagnetic oscillations and waves L.w. «Polarimeter use to determine the concentration of optically active substances»	3	2		Polarimeter use to determine the concentration of optically active substances	written account of laboratory work	Interview
5.2	Refraction and refractometry L.w.» Determination of the liquid refractive index with a refractometer»	3	2		Determination of the liquid concentration with a refractometer	written account of laboratory work*	Interview
5.3	Optical microscopy. Fundamentals of electron and scanning probe microscopy L.w. « Measuring the small objects size with a microscope»	1.5	2		Measuring the small objects size with a microscope	written account of laboratory work	Interview
5.4	Optical system of the eye. Biophysical foundations of vision	1.5	2				Interview
5.5	Laws of light absorption and light scattering. Fundamentals of photocolorimetry and spectrophotometry L.w. «Absorption and scattering of light. Fundamentals of colorimetric analysis»	3	3		The use of a single-beam photoelectron-colorimeter (PEC) to determine their concentration of colored solutions	written account of laboratory work*	Interview
5.6	Atomic and molecular spectra. Emission and absorption spectra. Spectral instruments	3	3				Interview, written account of laboratory work, essay

5.7	L.w. «Fundamentals of spectral analysis» Stimulated emission. Lasers. The effect of laser radiation on biological tissues L.w. «The principle of lasers operation, their properties and applications»							Interview, essay
			3		2	Determination of the laser wavelength radiation using a diffraction grating	written account of laboratory work	
5.8	Final lesson on topics «Optics»		3		2			Electronic test*
6	Physics of atoms and molecules			3	4			
6.1	Thermal radiation. The main characteristics of thermal radiation. The laws of thermal radiation (Kirchhoff's law, Stefan-Boltzmann's law, Wien's displacement law). Planck's formula.				2			Interview, essay
6.2	Bremsstrahlung and characteristic X-rays. Moseley's law. X-rays spectra. Interaction of X-rays with matter. X-ray diffraction analysis. The use of X-rays in diagnostics and radiotherapy. Fundamentals of X-ray computed tomography(CT)			3	2			Interview, essay
7	Nuclear physics		1,5	4,5	8			
7.1	Radioactivity. The main types of radioactive decay. The fundamental law of radioactive decay. Half life time. Activity, its units. Drug activity change with time. Interaction of ionizing radiation with matter. Radionuclide methods of diagnostics and radiation therapy.			3	3			Interview, essay
7.2	Radiation dosimetry L.w. «Determination of the specific mass activity of food and building materials using a radiometer»		1,5		3	Determining the radioactivity of food using a radiometer	written account of laboratory work	Interview, essay

