MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Petro Mohyla Black Sea National University

Medical Institute

Department of medical biology, microbiology, histology, physiology and pathophysiology

2019 p.

Course Discription

«MEDICAL AND BIOLOGICAL PHYSICS»

field of knowledge 22 «Health care»

in the specialty 222 «Medicine»

Developer	Yaremchuk O.M.
Head of the Developer's Department	Kozii M.S.
Guarantor of the Educational Program	Klymenko M.O.
Director of the Institute	Hryshenko G.V.
Head of educational and methodical department	Shkirchak S.I.

Mykolaiv - 2019

Discription of the educational discipline (annotation)

Title of indices	Characterization of educational discipline	
	«Medical and Biological Physics»	
Field of knowledge	22 «Health care»	
Specialty	222 «Medicine»	
Educational program	Master of Medicine	
Higher education level	Master	
Status of discipline	Normative	
Curriculum	1	
Academic year	2019/2020	
Semester number	Full-time	External form of education
	1 - 2	-
Total ECTS credits / hours	5 credits (2,5 / 2,5) / 150	
Course structure: – lectures – seminars (practical) – hours of independent work of students	Full-time	External form of education
	20 (10 / 10) 60 (30 / 30) 70 (35 / 35)	-
Percentage of classroom load	53 %	
Language of instruction	english	
Form of final control	Exam – second semester	

INTRODUCTION

The purpose of teaching the discipline is the formation of student systems knowledge of the basic physical principles of the approach to the study of processes in wildlife, physical and technical principles of functioning of medical and technical devices used in practical dentistry, the use of mathematical methods in biomedical research. competencies in the field of medical and biological physics and neurological warehouse professional competence of the future doctor and specialist in the field of health care, as well as research of academic disciplines.

The tasks of teaching / studying the discipline are the acquisition by students of practical-oriented professional competence:

• interpret the general physical and biophysical patterns that underlie the functioning of the human body;

• explain the physical basis and biophysical mechanisms and effects of the interaction of physical fields with the human body;

• explain the physical basis of operation and use of modern (electronic) medical devices;

• process the results of medical and biological research, prove the probability of conclusions using mathematical (statistical) methods.

Prerequisites for studying the discipline (interdisciplinary connections). Medical and biological physics as a discipline:

• integrates with such disciplines as medical chemistry, medical biology, and others;

• lays the physical and biophysical foundations for students to study normal and pathological physiology, biological and bioorganic chemistry, biostatistics, histology, radiology and radiation medicine, hygiene and ecology, ophthalmology, otorhinolaryngology, dentistry and other disciplines.

Expected learning outcomes. As a result of studying the discipline, students have:

- know:

• basics of mathematical processing of medical and biological data;

• general physical and biophysical patterns that underlie the processes occurring in the human body;

• characteristics of physical external factors affecting the human body and biophysical mechanisms of these influences;

• purpose and principles of operation of electronic medical equipment, safety precautions when working with it;

be able to:

• perform mathematical and computer processing of medical and biological information;

• use medical equipment used in dentistry, diagnostics, electrical stimulation and physiotherapy (in particular, in electrocardiography, rheography, impedance plethysmography, audiometry, optical and quantum mechanical devices and systems, radiometric and dosimetric control devices).

3. The program of the discipline

The developed program corresponds to the educational-professional program (EPP) and is focused on the formation of competencies:

- general (GC) - GC 1 EPP:

GC 1. Ability to abstract thinking, analysis and synthesis, the ability to learn and master modern knowledge;

- professional (PC) – PC 2,3,5,14 EPP:

PC2. Ability to determine the required list of laboratory and instrumental studies and evaluate their results.

PC3. Ability to establish a preliminary and clinical diagnosis of the disease.

PC5. Ability to determine the nature of nutrition in the treatment of diseases.

PC14. Ability to carry out sanitary and hygienic and preventive measures.

According to the educational-professional program, the expected program learning outcomes (PLO) include the skills of PLO, P PLO 12 EPP:

- To know the methods of analysis, synthesis and further modern learning. Be able to analyze information, make informed decisions, be able to acquire modern knowledge. Establish appropriate connections to achieve goals. Be responsible for the timely acquisition of modern knowledge.

- Evaluate information about the diagnosis in the health care facility, its unit, using a standard procedure, using knowledge about the person, his organs and systems, based on the results of laboratory and instrumental studies (according to list 4).

The educational process is organized according to the European Credit Transfer and Accumulation System (ECTS).

The curriculum consists of two blocks:

BLOCK 1. FUNDAMENTALS OF HIGHER MATHEMATICS AND BIOLOGICAL PHYSICS.

SECTIONS:

1. Fundamentals of mathematical processing of medical and biological data.

2. Biological physics.

BLOCK 2. FUNDAMENTALS OF MEDICAL PHYSICS.

SECTIONS:

3. Medical physics.

BLOCK 1. FUNDAMENTALS OF HIGHER MATHEMATICS AND BIOLOGICAL PHYSICS.

SECTION 1. Fundamentals of mathematical processing of medical and biological data.

Topic 1. Fundamentals of differential calculation.

Differential function of one variable. Partial derivatives and differentials of a function of two or more variables. Full differential.

Topic 2. Fundamentals of integrated computing.

Indefinite and definite integrals. Integration by the method of variable replacement and parts.

Topic 3. The concept of differential equations.

First-order differential equations with separable variables. Linear, homogeneous differential equations of the second order with constant coefficients. Methods for solving differential equations.

Topic 4. Elements of probability theory. Addition theorems and

multiplication of probabilities.

Topic 5. Elements of mathematical statistics

Mathematical expectation, variance, standard deviation. Laws of distribution of random variables. Confidence probabilities and confidence intervals. Functional and correlation. Regression equation. Correlation coefficient.

Topic 6. Practical skills in section 1 "Fundamentals of mathematical processing of medical and biological data".

SECTION 2. Biological physics

Basic concepts of mechanics of translational and rotational motions. Equations of motion, conservation laws. Elements of biomechanics. The musculoskeletal system of man. Dynamic and statistical work of the person at various kinds of its activity. Ergometry. Methods and devices for measuring biomechanical characteristics.

Topic 8. Oscillatory processes in living organisms. Bioacoustics.

Unquenchable, damped and forced oscillations. Differential equations of harmonic, damped, forced oscillations and their solution. Decrement and logarithmic decrement of attenuation. Resonance. Self-oscillation. Relaxation oscillations.

Wave processes and their characteristics. Wave equation. Differential wave equation. Energy flow. Vector Condition. Doppler effect.

Physics of hearing. Objective and subjective characteristics of sound. Intensity, intensity level, volume, their units. Threshold of audibility and pain. Weber-Fechner law. Biophysical bases of auditory sensation. Physical basics of audiometry. Audiogram and curves of equal volume.

Ultrasound and infrasound. Ultrasound and infrasound sources and catchers. Features of distribution and biophysical bases of action of ultrasound and infrasound on biological tissues. The use of ultrasound in medicine.

Topic 9. Surface phenomena. Definition of CPN. Gas embolism.

Surface tension. Surface tension coefficient. Methods of its definition. Gas embolism. South Africa in biology and medicine.

Topic 10. Biomechanics of blood circulation. Elements of heart biomechanics.

Stationary fluid flow. The continuity equation and the Bernoulli equation. Linear and volumetric velocities. The basic equation of fluid dynamics. Flow of viscous liquids. Poiseuille formulas. Hydraulic resistance. Methods of measuring blood pressure and blood flow rate. Pulse waves.

Topic 11. Physical foundations of hemodynamics

Internal friction, viscosity. Newton's formula for the force of internal friction. Newtonian and non-Newtonian fluids. Methods and devices for measuring viscosity. Laminar and turbulent fluid flow. Reynolds number.

Topic 12. Thermodynamic method of studying medical and biological

systems. Thermodynamics of open systems.

Thermodynamic method of studying medical and biological systems. The first and second laws of thermodynamics, entropy, thermodynamic potentials.

Thermodynamics of open systems near equilibrium (linear law for flows and thermodynamic forces, cross transfer processes, entropy, flow conjugation, steady state).

Thermodynamics of open systems, far from equilibrium (ordering processes in physical, chemical and medical-biological systems, the concept of synergetics). The importance of thermodynamics and synergetics in the problem of environmental protection.

Topic 13. Structural elements of biological membranes.

Passive and active transport of substances through membrane structures.

Physical properties of biomembranes. Liquid crystalline state of biomembranes.

Dynamic properties of membranes. Fick's equation. Membrane permeability coefficient for a certain substance. Nernst-Planck equation. Electrochemical potential. Active transport, main types. Molecular organization of active transport on the example of Na + -K + pump operation. Conjugation of flows.

Topic 14. Membrane potentials of rest. Action potential.

The nature of the resting membrane potential (Nernst equilibrium potential, diffusion potential, stationary Goldman-Hodgkin-Katz potential).

Action potential. Action potential (PD) and reasons for its occurrence. Equivalent electrical circuit of the membrane. Phenomenological equations of Hodgkin-Huxley. Hodgkin-Huxley equation for the process of PD propagation in nerve fibers. Speed and features of PD propagation in axons.

Topic 15. Practical skills in section 2 "Fundamentals of biological physics".

BLOCK 2. FUNDAMENTALS OF MEDICAL PHYSICS.

SECTION 3. Medical physics.

Topic 16. General characteristics and classification of electronic medical devices.

Use of electronic medical equipment in diagnostics, electrical stimulation and physiotherapy. Electrodes and sensors. Signal amplification and generation. Safety rules when working with electronic medical equipment.

Topic 17. The concept of electrography of organs and tissues. Physical and biophysical bases of electrocardiography.

Physical and biophysical bases of electrocardiography. Einthoven's first concept of the genesis of the ECG (heart - electric dipole, electric dipole potential, lead system). Ohm's law in differential form, electrical conductivity of biological tissues. The second concept of the ECG (heart - current dipole, current dipole potential).

Topic 18. Dispersion of impedance of biological tissues. Physical and biophysical bases of rheography.

Relationship between deformation of blood vessels and changes in their electrical resistance. AC circuits containing active, capacitive and inductive supports. Vector charts and impedance. Capacitive properties and equivalent electrical circuits of biological tissues.

Topic 19. Magnetic field and its characteristics. Electromagnetic oscillations and waves in biological media.

The effect of an electric field on biological tissues. Physical and biophysical processes occurring in biological tissues under the action of constant and alternating electric fields (conduction and displacement currents, thermal effects).

Therapeutic factors and their use in medical methods (galvanization, electrophoresis, franklinization, electrostimulation, electropulsation, diathermy, electrotomy, electrocoagulation, etc.).

Topic 20. The effect of electromagnetic fields on biological objects.

The effect of constant and alternating magnetic field on biological objects. Primary mechanisms, induction currents, thermal effects. Therapeutic factors and their use in medical methods (magnetic therapy, inductothermy, etc.).

The effect of electromagnetic fields on biological objects. Primary mechanisms, currents and thermal effects, specific action. Therapeutic factors and their use in medical methods (UHF therapy, microwave therapy, microwave resonance therapy, etc.).

Topic 21. Study of the characteristics of an optical microscope. Biophysics of vision. Elements of geometric optics. Centered optical system. Optical microscopy. The main characteristics of the microscope.

Topic 22. Fundamentals of refractometry

Dispersion of light. Refractometry and fiber optics, their use in medicine. The concept of holography.

Topic 23. Polarization of light. Fundamentals of polarimetry.

Polarization of light. Methods of obtaining polarized light. Double refraction. Prism of Nicolas. Malus's law. Optically active substances. Bio Law. Concentration polarimetry.

Topic 24. Light absorption. Light scattering. Dispersion of light. The phenomenon of the photo effect.

Light absorption. Bouguer's law. Absorption of light by solutions, Bouguer-Lambert-Behr law. Concentration colorimetry. Light scattering. Light scattering in dispersion media. Molecular scattering of light. Rayleigh's law. Nephelometry.

Topic 25. Thermal radiation of bodies, its characteristics.

Absolutely black and gray bodies. Kirchhoff's law. Laws of radiation of an absolutely black body: Planck's law of radiation, Stefan-Boltzmann's law, Vin's law of displacement. Thermal radiation of the human body. The concept of thermography.

Topic 26. Basic ideas of quantum mechanics. Quantum-mechanical methods of studying biological objects.

Wave properties of microparticles, de Broglie's formula, wave function and its physical content, Heisenberg uncertainty relation. The concept of the electron microscope. Schrödinger's equation.

Quantum mechanical model of the hydrogen atom. Quantum numbers. Energy levels. Pauli principle. Radiation and absorption of light by atoms and molecules. Radiation and absorption spectra. Spectrophotometry.

Resonance methods of quantum mechanics. Nuclear magnetic resonance, electronic paramagnetic resonance, their application in medicine (NMR tomography, etc.).

Topic 27. Induced radiation. Lasers, their use in medicine.

Induced radiation. Equilibrium (Boltzmann) and inverse population of energy levels. Lasers, principle of action and application in medicine.

Topic 28. Ionizing radiation. X-rays.

Spectrum and characteristics. Primary mechanisms of interaction of X-rays with matter. Law of attenuation and protection against X-rays. Application of X-rays in medicine (X-ray therapy, X-ray tomography, etc.)

Topic 29. Radioactivity, basic types and properties. Dosimetry of ionizing radiation.

The law of radioactive decay. Half-life. Activity, units of activity. Ionizing radiation, properties and basic mechanisms of interaction with biological objects. Protection against ionizing radiation. Physical and biophysical problems related to the Chernobyl accident.

Dosimetry of ionizing radiation. Exposure and absorbed doses. Equivalent biological dose. Dose power. Units of doses and capacities of doses.

Topic 30. Practical skills in section 3 "Medical Physics"

The structure of the discipline

Topic	Lectures	Practical classes	individual
BLOCK 1. FUNDAMENTALS OF HIGHER MATHEMATICS AND BIOLOGICAL PHYSICS			

SECTION 1. Fundamentals of mathematical processing of medical and biological data				
Basics of differential calculation.	1	2	2	
2. Fundamentals of integrated computing.		2	2	Individual work - a review of the scientific literature or experimental research
3. The concept of differential equations.			2	
4. Elements of probability theory. Addition theorems and		2	2	
multiplication of probabilities.	1	2	2	
5. Elements of mathematical statistics.		2	2	
Section 2. Biological physics				
7. Fundamentals of biomechanics.	1	4	2	
8. Oscillatory processes in living organisms. Bioacoustics.	1	4	2	
9. Surface phenomena. Definition of CPN. Gas embolism.	1	2	2	
10. Biomechanics of blood circulation. Elements of biomechanics	1	2	2	
11. Physical foundations of hemodynamics	1	2	2	
Thermodynamic method of studying medical and biological systems. Thermodynamics of open systems.	1	2	2	
13. Structural elements of biological membranes.	1	-	2	
Passive and active transport of substances through membranes	1	2	2	
structures.			4	
FINAL TEST WORK BY BLOCK 1	-	2	3	-
Total – 60. ECTS – 2,5	10	30	35	-
BLOCK 2. Fundamentals of medical physics				
Section 3. Medical physics				Individual work - a review of the scientific literature or experimental research
16. General characteristics and classification of electronic medical devices.	1	2	2	
17. The concept of electrography of organs and tissues. Physical and biophysical bases of electrocardiography.	1	2	2	
18. Dispersion of impedance of biological tissues. Physical and biophysical bases of rheography.	1	2	2	
19. Magnetic field and its characteristics. Electromagnetic oscillations and waves in biological media.	1	2	2	
20. The effect of electromagnetic fields on biological objects.	-	2	2	

21. Study of the characteristics of an optical microscope. Biophysics of vision.	1	2	2	
22. Fundamentals of refractometry		2	2	
23. Polarization of light. Fundamentals of polarimetry.		2	2	
24. Light absorption. Light scattering. Dispersion of light. The phenomenon of the photo effect.	1	2	2	
25. Thermal radiation of bodies, its characteristics.		2	2	
26. Basic ideas of quantum mechanics. Quantum-mechanical methods of studying biological objects.	1	2	2	
27. Induced radiation. Lasers, their use in medicine.	1	2	2	
28. Ionizing radiation. X-rays.	1	2	2	
29. Radioactivity, main types and properties. Dosimetry of ionizing radiation.	1	2	2	
30. FINAL TEST WORK ON BLOCK 2	-	2	7	-
Total – 60. ECTS – 2,5	10	30	35	

1. The content of the discipline

1.1. Lecture plan

BLOCK 1

№ з.п.	Topic	Кількість годин
1.	Topic 1. Fundamentals of differential calculation. Elements of mathematical statistics. 1) Differential function of one variable. 2) Partial derivatives and differentials of the function of two or more variables. Full differential. 3) Elements of mathematical statistics.	2
2.	Topic 2. Fundamentals of biomechanics. Oscillatory processes in living organisms. Bioacoustics. 1) Basic concepts of mechanics of translational and rotational motions. Equations of motion, conservation laws. Elements of biomechanics. The musculoskeletal system of man. 2) Ergometry. Methods and devices for measuring biomechanical characteristics. 3) Non-damping, damping and forced oscillations. Differential equations of harmonic, damped, forced oscillations and their solution. Wave processes and their characteristics. Wave equation. Differential wave equation. Energy flow. Physics of hearing. Objective and subjective characteristics of sound.	2

3.	Topic 3. Surface phenomena. Definition of CPN. Gas embolism. Biomechanics of blood circulation. Elements of biomechanics 1) Surface tension. Surface tension coefficient. Methods of its definition. Gas embolism. South Africa in biology and medicine. 2) Stationary fluid flow. The continuity equation and the Bernoulli equation. Linear and volumetric velocities. The basic equation of fluid dynamics. 3) The flow of viscous liquids. Poiseuille formulas. Hydraulic resistance. Methods of measuring blood pressure and blood flow rate. Pulse waves.	2
4.	Topic 4. Physical foundations of hemodynamics. Thermodynamic method of studying medical and biological systems. Thermodynamics of open systems. 1) Internal friction, viscosity. Newton's formula for the force of internal friction. Newtonian and non-Newtonian fluids. Methods and devices for measuring viscosity. Laminar and turbulent fluid flow. Reynolds number. 2) Thermodynamic method of studying medical and biological systems. The first and second laws of thermodynamics, entropy, thermodynamic potentials. 3) Thermodynamics of open systems near equilibrium (linear law for flows and thermodynamic forces, cross-transfer processes, entropy, flow conjugation, steady state).	2
5.	Topic 5. Structural elements of biological membranes. Passive and active transport of substances through membrane structures. Membrane potentials of rest. Action potential. 1) Physical properties of biomembranes. Liquid crystalline state of biomembranes. Dynamic properties of membranes. Fick's equation. Membrane permeability coefficient for a certain substance. Nernst-Planck equation. Electrochemical potential. 2) The nature of the resting membrane potential (Nernst equilibrium potential, diffusion potential, stationary Goldman-Hodgkin-Katz potential). 3) Action potential. Action potential and reasons for its occurrence. Equivalent electrical circuit of the membrane. Phenomenological equations of Hodgkin-Huxley. Hodgkin-Huxley equation for the process of PD propagation in nerve fibers. Speed and features of PD propagation in axons.	2
TOTAL		20

BLOCK 2

№ з.п.	Topic	Кількість годин
1.	Topic 6. General characteristics and classification of electronic medical devices. The concept of electrography of organs and tissues. Physical and	2

	biophysical bases of electrocardiography. 1) The use of electronic medical equipment in diagnostics, electrical stimulation and physiotherapy. Electrodes and sensors. Signal amplification and generation. 2) Safety rules when working with electronic medical equipment. 3) Physical and biophysical foundations of electrocardiography. Einthoven's first concept of the genesis of the ECG (heart - electric dipole, electric dipole potential, lead system). Ohm's law in differential form, electrical conductivity of biological tissues. The second concept of the ECG (heart - current dipole, current dipole potential).	
2.	Topic 7. Impedance dispersion of biological tissues. Physical and biophysical bases of rheography. Magnetic field and its characteristics. Electromagnetic oscillations and waves in biological media. 1) The relationship of deformation of blood vessels with changes in their electrical resistance. AC circuits containing active, capacitive and inductive supports. Vector charts and impedance. Capacitive properties and equivalent electrical circuits of biological tissues. Specificity of vector diagrams and impedance of biological tissues. Impedance dispersion coefficient. 2) The effect of an electric field on biological tissues. Physical and biophysical processes occurring in biological tissues under the action of constant and alternating electric fields (conduction currents and displacements, thermal effects). 3) Therapeutic factors and their use in medical methods (galvanization, electrophoresis, franklinization, electrostimulation, electropulsation, diathermy, electrotomy, electrocoagulation, etc.).	2
3.	Topic 8. Study of the characteristics of an optical microscope. Biophysics of vision. Light absorption. Light scattering. Dispersion of light. The phenomenon of the photo effect. 1) Elements of geometric optics. Centered optical system. Optical microscopy. The main characteristics of the microscope. 2) Light absorption. Bouguer's law. Absorption of light by solutions, Bouguer-Lambert-Behr law. Concentration colorimetry. 3) Light scattering. Light scattering in dispersion media. Molecular scattering of light. Rayleigh's law. Nephelometry.	2
4.	Topic. 9. Basic ideas of quantum mechanics. Quantum-mechanical methods of studying biological objects. Induced radiation. Lasers, their use in medicine. 1) Wave properties of microparticles, de Broglie's formula, wave function and its physical content, the ratio of Heisenberg uncertainties. The concept of the electron microscope. Schrödinger's equation. 2) Quantum-mechanical model of the hydrogen atom. Quantum numbers. Energy levels. Pauli principle. Radiation and absorption of light by atoms	2

	and molecules. Radiation and absorption spectra. 3) Induced radiation. Equilibrium (Boltzmann) and inverse population of energy levels. Lasers, principle of action and application in medicine.	
5.	Topic 15. Ionizing radiation. X-rays. Radioactivity, main types and properties. Dosimetry of ionizing radiation. 1) Spectrum and characteristics. Primary mechanisms of interaction of X-rays with matter. Law of attenuation and protection against X-rays. The use of X-rays in medicine 2) The law of radioactive decay. Half-life. Activity, units of activity. Ionizing radiation, properties and basic mechanisms of interaction with biological objects. Protection against ionizing radiation. Physical and biophysical problems related to the Chernobyl accident. 3) Dosimetry of ionizing radiation. Exposure and absorbed doses. Equivalent biological dose. Dose power. Units of doses and capacities of doses.	2
TOTAL		20

Plan of practical classes
BLOCK 1

№ з.п.	Topic	Кількість годин
1.	Topic 1. Fundamentals of differential calculation.	2
2.	Topic 2. Fundamentals of integrated computing.	2
3.	Topic 3. Elements of probability theory. Addition theorems and	2
4.	multiplication of probabilities.	2
5.	Topic 4. Elements of mathematical statistics.	2
	Section 2. Biological physics	2
6.	Topic 6. Mechanical properties of biological tissues. Jung's module.	2
7.	Topic 7. Biophysics of muscle contractions. Dynamometry Ergometry.	2
8.	Topic 8. Oscillations and waves. Sound, infrasound and ultrasound. Acoustic methods in medicine.	2
9.	Topic 9. Biophysics of hearing. Audiometry.	2
10.	Topic 10. Surface phenomena. Definition of CPN. Gas embolism.	2
11.	Topic 11. Biomechanics of blood circulation. Elements of biomechanics	2
12.	Topic 12. Physical foundations of hemodynamics	2

13.	Topic 13. Thermodynamic method of studying medical and biological systems. Thermodynamics of open systems.	2
14.	Topic 14. Membrane potentials of rest. Action potential.	2
15.	FINAL TEST WORK ON BLOCK 1	2
TOTAL		30

BLOCK 2

№ з.п.	Topic	Кількість годин
1.	Topic 16. General characteristics and classification of electronic medical devices.	2
2.	Topic 17. The concept of electrography of organs and tissues. Physical and biophysical bases of electrocardiography.	2
3.	Topic 18. Dispersion of impedance of biological tissues. Physical and biophysical bases of rheography.	2
4.	Topic 19. Magnetic field and its characteristics. Electromagnetic oscillations and waves in biological media.	2
5.	Topic 20. The effect of electromagnetic fields on biological objects.	2
6.	Topic 21. Study of the characteristics of an optical microscope. Biophysics of vision.	2
7.	Topic 22. Fundamentals of refractometry	2
8.	Topic 23. Polarization of light. Fundamentals of polarimetry.	2
9.	Topic 24. Light absorption. Light scattering. Dispersion of light. The phenomenon of the photo effect.	2
10.	Topic 25. Thermal radiation of bodies, its characteristics.	2
11.	Topic 26. Basic ideas of quantum mechanics. Quantum-mechanical methods of studying biological objects.	2
12.	Topic 27. Induced radiation. Lasers, their use in medicine.	2
13.	Topic 28. Ionizing radiation. X-rays.	2
14.	Topic 29. Radioactivity, main types and properties. Dosimetry of ionizing radiation.	2
15.	Topic 30. FINAL TEST WORK ON BLOCK 2	2
TOTAL		30

4.3. Tasks for independent work

№ з.п.	Topic	Кількість годин
BLOCK 1		

1.	Preparation for practical classes (theoretical training, development of practical skills)	32
2.	Independent elaboration of topics that are not included in the classroom plan Block 1 (list attached)	
3.	Preparation for the final test	3
TOTAL		35
BLOCK 2		
1.	Preparation for practical classes (theoretical training, development of practical skills)	28
2.	Independent elaboration of topics that are not included in the lesson plan Block 2 (list attached)	
3.	Preparation for the final test	7
TOTAL		35

Ensuring the educational process

1. Multimedia projectors, computers, screens for multimedia presentations, lecture presentations, reference books on the discipline, descriptions of laboratory work.
2. Demonstration screens, laptops, equipment of the laboratory of medical and biological physics, files in Power Point and Word with tasks for practical and final classes.
3. Exam tickets.

Final control
List of final control issues

1. Differential function of one variable. Partial derivatives and differentials of functions of two or more variables. Full differential.
2. Indefinite and definite integrals.
3. Differential equations of the 1st order Classification of phenomena. Probability of random phenomena, probability addition theorem.
4. Probability multiplication theorem for independent random phenomena, conditional probability, probability multiplication theorem for dependent random phenomena.
5. Distribution of random phenomena, mathematical expectation, variance, standard deviation.
4. Basic laws of distribution of random variables (normal law, Poisson distribution, binomial distribution and others).
5. Deformations, their types. Elasticity and plasticity. Hooke's law. Jung's module. Poisson's ratio. Deformation properties of biological tissues.
6. Surface tension. Surface tension coefficient and methods of its determination. Gas embolism.
7. Internal friction. Viscosity. Newton's formula for internal friction. Newtonian and non-Newtonian fluids. Blood viscosity.
8. Stationary fluid flow. Continuity equation. Linear and volumetric velocities. The basic equation of fluid dynamics.

9. Laminar and turbulent flow. Reynolds number. Bernoulli's equation. Flow of viscous liquids. Poiseuille's formula. Hydraulic resistance.
10. The main provisions of equilibrium thermodynamics. Entropy. Boltzmann principle. The value of thermodynamics in the problem of environmental protection.
11. The main provisions of nonequilibrium thermodynamics (linear law, entropy production, conjugation of flows). Steady state of open systems. Prigogine's theorem.
12. Structural organization of biological membranes. Physical properties of biomembranes. Liquid crystalline state of biomembranes. Dynamic properties of membranes.
13. Passive transport of substances through membrane structures. Fick's equation. Diffusion rate. Nernst-Planck equation. Electrochemical gradient and potential. Theorell's equation.
14. Active transport, main types. Molecular organization of active transport on the example of K-Na-pump operation. Conjugation of flows.
15. The nature of the resting membrane potential (Nernst equilibrium potentials for various ions, diffusion potential, Donnan potential).
16. The nature of the membrane resting potential (stationary Goldman-Hodgkin-Katz potential, stationary conditions, basic equations of electrodiffusion of ions in the steady state, the permeability of the membrane for ions at rest).
17. Action potential (PD). Hypothesis of PD occurrence. Equivalent electrical circuit of the membrane. Phenomenological equations of Hodgkin-Huxley. The concept of gate ion currents.
18. Propagation of action potential in biological membranes. Telegraph equation. Speed of potential spread. Features of distribution of action potential in myelin fiber.
19. Non-damped and forced oscillations, differential equations and their solution. Resonance. Self-oscillation.
20. Damping oscillations. Differential equation of damped oscillations, its solution. Attenuation coefficient, decrement and logarithmic decrement.
21. Mechanical waves. Wave equation. Energy flow. Vector Condition.
22. Acoustics. Physical characteristics of sound. Physics of hearing, characteristics of auditory sensation. Weber-Fechner law.
23. Audiometry. Intensity scale and volume scale, units. Thresholds of audibility and pain. Audiogram.
24. Ultrasound. Basic properties and features of ultrasound propagation. Infrasound, physical characteristics of infrasound. Effect of ultrasound and infrasound on biological tissues and human organs.
25. Electrical characteristics of biological tissues. Ohm's law in differential form. Conductivity of biological tissues. Capacitive properties. Equivalent electrical circuit.
26. Biophysical foundations of electrography. The concept of an equivalent electric generator. Einthoven's concept of the genesis of the ECG (integral electrical vector of the heart, dipole potential, lead system).
27. Heart as a current electric dipole (current dipole and its characteristics, dipole potential of the heart).
28. Alternating current circuit containing active, capacitive and inductive resistance. The concept of a vector chart. Impedance.
29. Impedance of biological tissues. Impedance variance. Physical foundations of rheography.
30. Magnetic field and its characteristics. Bio-Savar-Laplace law. Magnetic properties of substances. Physical foundations of magnetobiology.
31. Maxwell's theory of electromagnetic waves (bias current, Maxwell's equation, velocity of electromagnetic waves).

32. Physical processes in biological objects under the action of electric, magnetic fields and electromagnetic field (polarization, conduction currents, inductive and displacement).
33. Physical bases of therapeutic methods (galvanization, franklinization, diathermy, inductothermy, darsonvalization, UHF and microwave therapy, microwave resonance therapy). Thermal and specific action.
34. Elements of geometric optics. Centered optical system. Optical microscopy. Characteristics of the microscope.
35. Polarization of light. Methods of obtaining polarized light. Double refraction. Prism of Nicolas. Malus's law.
36. Optically active substances. The angle of rotation of the plane of polarization. Bio Law. Concentration polarization.
37. Absorption of light. Bouguer's law. Absorption of light by solutions. Bouguer-Lambert-Behr law. Concentration colorimetry.
38. Light scattering in dispersed media. Molecular scattering of light. Rayleigh's law. Nephelometry.
39. Basic ideas of quantum mechanics: wave properties of microparticles, de Broglie's formula, wave function and its physical content, the ratio of Heisenberg uncertainties. The concept of the electron microscope.
40. Quantum-mechanical model of the hydrogen atom. Schrödinger's equation. Quantum numbers. Energy levels. Pauli principle.
41. Radiation and absorption of light by atoms and molecules. Radiation and absorption spectra. Spectrophotometry.
42. Thermal radiation of bodies, its characteristics. Absolutely black and gray bodies. Kirchhoff's law. Thermal radiation of the human body. The concept of thermography.
43. The law of radiation of an absolutely black body: Planck's law of radiation, Stefan-Boltzmann's law, Vin's law of displacement.
44. Photo effect and its application. Internal and external photo effects. Photovoltaic devices in medicine.
45. Luminescence: types, basic patterns, properties. Stokes' law. Application of luminescence in medicine.
46. Induced radiation. Equilibrium and inverse population of energy levels. Lasers, principle of action and application in medicine.
47. Resonant methods of quantum mechanics, their application in medicine. Electronic paramagnetic and nuclear magnetic resonances.
48. X-rays, spectrum and characteristics, applications in medicine. Interaction of X-rays with matter. The law of attenuation of X-rays.
49. Radioactivity. Types of radioactivity. The basic law of radioactive decay. Half-life. Activity, units of activity.
50. Ionizing radiation and its types. Interaction of ionizing radiation with matter. Protection against ionizing radiation. Biophysical bases of interaction of ionizing radiation with biological tissues.
51. Dosimetry of ionizing radiation. Exposure and absorbed doses. Biological action of radiation, biologically equivalent dose. Dose rate. Dose units and dose rates.

0" version of the test / exam ticket

Petro Mohyla Black Sea National University
Level of higher education - master
Area of knowledge: 22 Health
Specialty 222 Medicine
Course - Medical and Biological Physics

Option № 0

1. Unquenchable and forced oscillations, differential equations and their solution. Resonance. Self-oscillation - maximum number of points - 30.
2. Dosimetry of ionizing radiation. Exposure and absorbed doses. Biological action of radiation, biologically equivalent dose. Dose rate. Units of doses and capacities of doses - the maximum number of points - 30.
3. Classification of phenomena. Probability of random phenomena, theorem of addition of probabilities - maximum number of points - 20.

Approved at the meeting of the Department of "Medical Biology and Chemistry, Biochemistry, Microbiology, Physiology, Pathophysiology and Pharmacology", the protocol № ___ from "__" _____ 2020.

The head of the department _____ is professor Koziy M.S.

Examiner _____ is Professor Chuyko GP

Evaluation criteria and tools for diagnosing learning outcomes

Control methods

- Survey (testing of theoretical knowledge and practical skills).
- Test control.
- Writing a review of scientific literature (abstracts), performing individual tasks, their defense.

Current control. Testing in practical classes of theoretical knowledge and the acquisition of practical skills, as well as the results of independent work of students. Supervised by teachers according to the specific purpose of the curriculum. Assessment of the level of students' training is carried out by: surveying students, solving and analyzing physical problems, test tasks, interpreting the results of experimental and laboratory research, monitoring the acquisition of practical skills.

Intermediate control. Checking the possibility of students using the theoretical knowledge and practical skills on all topics studied, as well as the results of independent work of students. Carried out in the last lesson by section by passing practical skills, solving physical problems and testing.

The final test is carried out at the end of the study of all topics of the block at the last test of the semester.

In order to assess the learning outcomes of the entire discipline "Medical and Biological Physics" is the final control in the form of an exam.

Students who have attended all lectures, classroom classes, completed full-time independent work and scored at least 70 points in the course of study are admitted to the intermediate final control (attestation) and final control (exam). in the fall semester and 40 points in the spring semester.

Only students who have passed both final tests (according to blocks 1 and 2) in the discipline are admitted to the exam.

Distribution of points received by students

In the autumn semester, a positive assessment in each practical session can be from 5 to 8.5 points. A score below 5 points means "unsatisfactory", the lesson is not credited and is subject to practice in the prescribed manner. At the final test (RCC) for block 1, the student can get a maximum of 80 points. PKR is considered credited if the student scored at least 50 points.

In the spring semester, a positive assessment in a practical session can be from 3 to 5-6 points. A score below 3 points means "unsatisfactory", the lesson is not credited and is subject to practice in the prescribed manner. At the RCC in block 2, a student can get a maximum of 40 points. PKR is considered credited if the student scored at least 30 points.

Assessment of student performance

Type of activity (task)	Maximum number of points
Block 1	
Topic 1	8,5
Topic 2	8,5
Topic 3	8,5
Topic 4	8,5
Topic 5	8,5
Topic 6	8,5
Topic 7	8,5
Topic 8	8,5
Topic 9	8,5
Topic 10	8,5
Topic 11	8,5
Topic 12	8,5
Topic 13	8,5
Topic 14	8,5
TOTAL	120
FINAL TEST WORK ON BLOCK 1	80

TOTAL	200
Блок 2	
Topic 1	5
Topic 2	5
Topic 3	5
Topic 4	5
Topic 5	6
Topic 6	6
Topic 7	6
Topic 8	6
Topic 9	6
Topic 10	6
Topic 11	6
Topic 12	6
Topic 13	6
Topic 14	6
TOTAL	80
FINAL TEST WORK ON BLOCK 2	40
TOTAL	120
Exam	80
TOTAL	200

Criteria for assessing knowledge

A score of 8.5 points in the autumn semester (5-6 points in the spring semester) (A on the ECTS scale and 5 on the national scale) the student's response is evaluated if it demonstrates deep knowledge of all theoretical positions and ability to apply theoretical material for practical analysis and not has no inaccuracies.

A score of 6-7 points in the autumn semester (4 points in the spring semester) (B and C on the ECTS scale and 4 on the national scale) the answer is evaluated if it shows knowledge of all theoretical principles, ability to apply them in practice, but some fundamental inaccuracies are allowed.

A score of 5 points in the autumn semester (3 points in the spring semester) (D and E on the ECTS scale and 3 on the national scale) the student's answer is evaluated provided that he knows the main theoretical provisions and can use them in practice.

Main sources.

1. Chaliy A.V. at all., Biological and medical physics. – A.V. Chaliy et all.– Ed.A.V. Chaliy. – Vinnitsia, Nova Knyha, 2013. – 480 pp.
2. L.D.Korovina. Biophysics with beginnings of mathematical analysis and statistics. Extended course of lectures. – Vol.1. Basis of mathematical analysis, probability theory and mathematical statistics. Biomechanics. –Poltava, 2008. –120 p.

Additional textbook, journals and references:

1. Compendium of Medical Physics, Medical Technology and Biophysics for students, physicians and researchers. Nico A.M. Schellart.
2. Roland Glaser. Biophysics: An Introduction.– 2010.─ Philip Nelson. Biological Physics (Updated Edition).– 2007.
3. Paul Davidovits. Physics in Biology and Medicine, Third Edition (Complementary Science). – 2007
4. Department of Biomedical Engineering and Physics Academic Medical Center University of Amsterdam.– Amsterdam.– 2009 (electronic book).