PRIVATE HIGHER EDUCATIONAL ESTABLISHMENT
«INTERNATIONAL ACADEMY OF ECOLOGY AND MEDICINE»

Department of fundamental disciplines with a course of pharmacology

SYLLABUS OF THE EDUCATIONAL DISCIPLINE

" Medical and Biological Physics "

LEVEL OF HIGHER EDUCATION The second (master's) level
DEGREE OF HIGHER EDUCATION Master
AREA OF KNOWLEDGE 22 "Health care"
SPECIALTY 221 "Dentistry"

Reviewed and approved
at the meeting of the Department of fundamental disciplines with a course of pharmacology

Protocol № 1 of « 01 » 09 2020
Head of the department Doctor of Biological Sciences, associate professor
M.R. Vergolyas

Kiev 2020

<table>
<tr><th colspan="2">1. General information</th></tr>
<tr><td>Subject</td><td>Medical biology</td></tr>
<tr><td>Lector</td><td>Seleznova R.V</td></tr>
<tr><td>Teacher's contact phone number</td><td></td></tr>
<tr><td>Teacher's e-mail</td><td>kaffund@ukr.net</td></tr>
<tr><td>Discipline format</td><td>Normative discipline.</td></tr>
<tr><td>The volume of the discipline</td><td>120 hours</td></tr>
<tr><td>Link to the distance learning site</td><td>maem.kiev.ua</td></tr>
<tr><td>Consultations</td><td></td></tr>
<tr><th colspan="2">2. Annotation to the course</th></tr>
<tr><td>The subject of "Medical and Biological Physics" is studying physical processes occurring in biological media and the impact of external factors on living organism.
According to the curriculum a medical and biological physics is one the fundamental academic disciplines that forms the theoretical basis for training a highly qualified medical specialists. The studying of medical and biological physics forms in students a basic understanding of general properties and forms of motion of matter, about the most important physical laws that underlie the mechanical, thermal, electrical, magnetic, spectral, polarization and other physical methods of study of various properties of medications.</td><td>Interdisciplinary links:
Medical and Biological Physics as an academic discipline:
Integrate with disciplines such as medical chemistry, medical biology etc; lays the groundwork for the study of physiology, biochemistry, biostatistics, pathological physiology, radiation medicine, hygiene and ecology, ophthalmology, otorhinolaryngology etc.</td></tr>
<tr><th colspan="2">3. Purpose and objectives of the course</th></tr>
<tr><td>The purpose of the discipline "Medical and Biological Physics" is enhancement and improvement of knowledge, skills and practical understanding of biophysical processes in living organisms; physical methods for diagnosis of diseases and the study of biological systems; the impact of physical factors on the human body in treatment; physical properties of materials used in medicine and pharmacy; physical properties and characteristics of the environment.
.</td><td>The goals of training of "Medical and biological physics" are studying:
- the physical bases and biophysical mechanisms of external factors (fields) effects on the human body systems;
- the physical phenomena underlying diagnostic and physiotherapy (curative) methods used in medical equipment;
- the general physical and biophysical regularities that underlie human life.
Achieving these goals will allow a medical students to master the physical, biophysical, technical and mathematical knowledge and skills which are necessary for training a doctor and for study of other</td></tr>
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	theoretical and clinical disciplines in the higher medical educational establishments.

4. Competencies and learning outcomes

As a result of learning of "Medical and Biological Physics" student have to

know:

- ✓ physical bases and biophysical mechanisms of external factors effects on the human body systems;
- ✓ fundamental physical and biophysical laws that underlie the human life;
- ✓ physical bases of diagnostics and physiotherapy (curative) methods used in medical equipment.

able to:

- ✓ perform a statistical analysis of experimental results;
- ✓ model a simple biological systems; analyze the physical processes in the body using physical laws and phenomena.

According to the requirements of Educational Standard of higher education the discipline provides obtaining **competencies** by students:

– *integrated:* ability to solve general and complex specialized tasks and practical problems in careers in health care or in learning, which provides research and/or implementation of innovation and characterized by complexity and uncertainty of the conditions and requirements.

– *general:* ability for abstract thinking, analysis and synthesis; ability to learn and acquire modern knowledge; ability to apply knowledge in practical situations; knowledge and understanding of the subject area and understanding of the profession; ability to make informed decisions; ability to use information and communication technologies; determination and persistence on tasks and responsibilities taken.

– *special (professional)*: ability to determine the list of necessary laboratory and instrumental studies and evaluating their results; skills to perform medical procedures; ability to assess the impact of environmental, social, economic and biological determinants of the health state of the individual, family and population.

Matrix of competencies

-	**Competence**	**Knowledge**	**Ability**	**Communication**	**Autonomy and responsibility**
	Integral competence				
	The ability to solve general and complex specialized tasks and practical problems in careers in healt h care or in learning, which provides research and / or implementation of innovatio n and characterized by complexity and uncertainty of the conditions and requirements.				
	General competences				
1	Ability for abstract thinking, analysis and synthesis, ability to learn and be trained simultaneously.	To know: methods of analysis, synthesis and further modern training.	Be able to: analyze information, make informed decisions, acquire modern knowledge.	Establish appropriate relationships to achieve goals.	To take responsibility for the timely acquisition of modern knowledge.

2	Ability to apply knowledge in practical situations.	To know: specialized conceptual knowledge.	Be able to: solve complex problems and issues that arise in professional activities.	Clear and unequivocal reports of their findings, knowledge and explanations that justify them to specialists and nonspecialists.	To take responsibility for making decisions in difficult conditions.
3	Knowledge and understanding of the subject area and understanding of professional activity.	To know: the structure of professional activity.	Be able to: carry out professional activity that needs updating and integration of knowledge.	Ability to form effective communication strategy in professional activities.	To take responsibility for professional development, ability to further professional training with a high level of autonomy.
4	The ability to make informed decisions; to work in team; skills of interpersonal interaction.	To know: tactics and strategies of communication, laws and methods of communicative behavior.	Be able to: make informed decisions, choose methods and strategies of communication to ensure effective teamwork	Use communication strategies and skills of interpersonal interaction	To take responsibility for the choice of tactics and methods of communication.
5	Skills of using information and communication technologies.	To know: information and communication technologies used in professional activities.	Be able to: use information and communication technologies in the professional field that needs updating and integration of knowledge.	Use information and ommunication technologies in professional activity.	To take responsibility for the development of professional knowledge and skills.
6	Certainty and persistence on tasks and responsibilities taken.	To know: responsibilities and ways to perform the tasks.	Be able to: define goals and objectives, be persistent and diligent in the performance of duties.	Set interpersonal communication for effective implementation of tasks and responsibilities.	To take responsibility for qualitative performance of tasks.
	Special (prof essional) competences				
1	The ability to determine the list of necessary laboratory and instrumental studies and to evaluate their results.	To know: the impact of physical factors on the human body, standard methods of laboratory and instrumental studies.	Be able to: analyze research results.	Select and evaluate research results.	To take responsibility for the decisions on the evaluation of research results.
2	Skills of performing medical procedures.	To know: biophysics of human organs and systems.	Be able to: analyze the biophysical parameters of human organs and systems.	Form and bring the conclusions to patients and professionals about the need for a health care manipulation.	Responsibility, independence.

3	Ability to evaluate the impact of environmental, social, economic and biological determinants on the health of the individual, family and population.	To know: • environmental factors that affect health negatively in the population; • statistical analysis methods for the evaluation of environmental factors and methods for determination of relation between them.	Be able to: • evaluate the environment state and negative impacts on health. know methods of statistical analysis.	Make conclusions about the health of the population on the basis of the relationship with environmental factors.	To take responsibility for the correct conclusions regarding the negative impact of environmental factors.

5. Organization of course training

The volume of the course

Type of lesson	***Total amount of hours 120***
Lectures	10
Practical (seminar) classes	60
Independent work	50

Course signs

Semester: The 1st, 2nd	Specialty 221 "Dentistry"	Course (year of study) The 1st	Normative discipline

Course thematics

The syllabus is structured into 2 thematic modules and 3 submodules.

Module 1. Fundamentals of higher mathematics and biological physics.

Submodule1. Fundamentals of mathematical processing of medical and biological data.

Submodule 2. Biological physics.

Module 2. Fundamentals of medical physics.

Submodule 3. Medical physics.

THEMATIC PLAN OF LECTURES

	The 1st semester
№	Topic
	Module 1. Fundamentals of higher mathematics and biological physics.
1.	Bases of a biomechanics.
2.	Bases of a bioreology and a hemodynamics.
	Total
	The 2nd semester
	Module 2. Fundamentals of medical physics.
3.	Physical bases of an electrocardiography.
4.	X-rays. Interaction of ionizing radiation with biological tissues The use of ionizing radiation in medicine.
5.	Radioactivity. A dosimetry of an ionizing radiation.
	Total

THEMATIC PLAN OF PRACTICAL CLASSES

	The 1st semester	
№	Topic	Ho
	Module 1. Fundamentals of higher mathematics and biological physics.	
1.	Medical and biological values. Functions. Derivative and differential function.	2
2.	Indefinite and definite integrals.	2
3.	Fundamentals of probability theory.	2
4.	The bases of mathematical statistics (1).	2
5.	The bases of mathematical statistics (2).	2
6.	Mechanical properties of biological tissues. Determination of Young's modulus of bones.	2
7.	Biophysics of muscle contractions. Dynamometry. Ergometry.	2
8.	Oscillations and waves. Sound, infrasound and ultrasound. Acoustic methods in medicine.	2
9.	Biophysics of a hearing organ. Audiometry.	2
10.	Surface phenomena. Determination of a surface tension coefficient of a fluid. A gas embolism.	2
11.	Liquid viscosity. Methods of determination of viscosity of fluids.	2

12.	Bases of a blood circulation. Heart work analysis. Methods of arterial tension measurement.	2
13.	Diff.credit	2
	Total	26
	The 2nd semester	
1.	Structure and functions of biological membranes. Active and passive transport. Study of biomembrane permeability.	2
2.	Membrane potentials of rest and activity.	2
3.	Final module control 1.	2
	Module 2. Fundamentals of medical physics.	
4.	Fundamentals of electrodynamics. Analysis of the work of the Wheatstone Bridge.	2
5.	Medical equipment. Devices for recording medical and biological information.	2
6.	Physical bases of electrocardiography.	2
7.	Physical bases of rheography.	2
8.	Electrokinetic appearances. Electrophoresis.	2
9.	Fundamentals of the UHF-therapy and the UHF inductothermy.	2
10.	Refractometry. Determination of fluid refractivity index.	2
11.	Biophysics of vision.	2
12.	Optical microscopy. Microscopy techniques.	2
13.	A thermal irradiation of the bodies, it characteristics. Thermography.	2
14.	Interaction of light with substance (dispersion, absorption, scattering, photoeffect). Photometry.	2
15.	Induced irradiation. Dimensioning of erythrocytes.	2
16.	X-ray radiation. Radioactivity. Ionizing radiation use in a medicine. A dosimetry of an ionizing radiation.	2
17.	Diff.credit	2
	Total	34

THEMATIC PLAN OF INDEPENDENT WORK OF STUDENTS (IWS)

	The 1st semester	
№	Topic	Ho
Module 1. Fundamentals of higher mathematics and biological physics.		
1.	**Preparation for practical classes** - theoretical training and development of practical skills.	
2.	Elaboration of topics that are not included in the lesson plan:	
2.1.	Study of bases of thermodynamics of biological systems.	
2.2.	Study of the transport of substances across biological membranes.	
3.	**Preparation for the differentiated credit.**	
	Total	
	The 2nd semester	

1.	**Preparation for practical classes** - theoretical training and development of practical skills.		14
2.	Elaboration of topics that are not included in the lesson plan:		
2.1.	Study of magnetic properties of biotissues. Physical bases of magnetobiology.		2
2.2.	Study of quantum mechanical processes in biological environments.		2
3.	**Preparation for the differentiated credit.**		2
	Total		**20**

Topics of abstracts

№	Topic
1.	Deformation properties of biological tissues (bones, lungs, skin, vessels).
2.	Thermodynamics and the problem of environmental protection.
3.	Open biological systems are far from equilibrium. The concept of synergetics.
4.	Magnetic properties of biological tissues. Physical foundations of magnetobiology.
5.	Interaction of light with matter. Photoreactions and photoprotection.
6.	Medical optics devices (polarimeter, refractometer, concentration colorimeter, nephelometer,
7.	Fundamentals of quantum mechanics. Resonance methods of quantum mechanics, their appli medicine (NMR, EPR, NMR tomography).
8.	Application of luminescence in medicine
9.	Lasers and their application in medicine.
10	X-ray radiation and its application in medicine (modern technologies).
11	Radioactivity. Physical and biophysical problems associated with the Chernobyl accident
12	Computers in medicine. Use of computer technology to diagnose and treat diseases.

THE LIST OF THEORETICAL QUESTIONS FOR PREPARATION OF STUDENTS FOR THE FINAL MODULAR CONTROL.

THE LIST OF THEORETICAL QUESTIONS FOR PREPARATION OF STUDENTS FOR THE FINAL MODULAR CONTROL.

1. Differential equations. Basic concepts.
2. Differential equations with separable variables.
3. Linear second order differential equations with constant coefficients.
4. Random events. Statistical and classical definitions of the probability of a random event. Addition theorem of probabilities of compatible and incompatible events.
5. Complex event. Probability of complex event which consists of two dependent and independent events.
6. The random variables. The distribution law of a random variable. Bernoulli's formula, Poisson's distribution.
7. Continuous random variable. The distribution function and the probability density function of a random variable. The probability that a random variable is included within the interval.
8. Probable event. The normalization condition for a continuous random variable. The relation between a distribution function $F(x)$ of a continuous random variable x and the probability density function $f(x)$ of a random variable
9. The mathematical expectation of a discrete and a continuous random variable.
10. The variance of a discrete and a continuous random variable.

11. The normal distribution law. The probability density function of a normal distribution.
12. Rule of three sigma. The significance levels.
13. The subject of mathematical statistics. General population. Sample. Representation. Interval variation series.
14. Histogram. Mode. Median. Sample mean.
15. The empirical function of distribution and density distribution for a variation series.
16. Sample variance. Corrected sample variance. Sample standard deviation.
17. Corrected standard deviation of the average of sample. The likely probability and significance levels.
18. The confidence intervals and a probable values. Half-width confidence interval.
19. Correlation. The correlation coefficient of a random variables.
20. Regression analysis.
21. Mechanical properties of a living tissues.
22. Biophysical properties of muscle contraction.
23. Hill equation. The power of contraction of skeletal muscle.
24. Mechanical waves. Wave equation. Doppler effect, its application in biomedical researches.
25. Acoustics. Physical characteristics of sound. Characteristics of auditory sensation and their relation with physical characteristics of sound. Sound measurements. The acoustic impedance. Audiometry.
26. Physics of hearing. The concept of the sound conductive and the sound perceptive systems The physical bases of a sound methods of research used in the clinics.
Reflection and absorption of sound waves. Reverberation.
27. Loudness. Weber-Fechner law.
28. Infrasound, peculiarities of its propagation. Infrasound effects on biological objects.
Noise. Vibration, their physical characteristics.
29. Ultrasound. Sources and receivers of ultrasound. Peculiarities of propagation of ultrasonic waves. Effects of ultrasound on the matter. Biophysical bases of ultrasound effects on cells and tissues. The application of ultrasound in diagnostics and treatment.
30. Hearing threshold and pain threshold. Sound intensity scale and loudness scale, units.
31. Internal friction (viscosity of fluids). A Newtonian and a non-Newtonian fluids. Rheological properties of blood, blood plasma and serum.
32. Laminar and turbulent fluid flow. Reynolds number. The flow of a viscous fluids. Hagen-Poiseuille equation. Hydraulic resistance.
33. Stationary flow of fluids. Continuity equation. Linear and volume flow rate. The basic equation of fluid dynamics.
34. Rheological properties of fluids and blood.
35. Basic hemodynamic parameters.
36. General physical regularities of blood motion in vessels.
37. Methods for determination of viscosity of fluids. The clinical method used for determination of blood viscosity.
38. The physical bases of the clinical method of measurement of blood pressure.
39. Determination of flow velocity.
40. Work and power of the heart.
41. A pulse waves, the dependence of propagation velocity on the vessel parameters.
Methods for determination of blood circulation velocity.
42. The first principle of thermodynamics for processes of an ideal gas.
43. Thermodynamics of biological systems. Subject and terminology.
44. The first law of thermodynamics and its application to living systems.
45. Body energy consumption. Basal metabolic rate.
46. Temperature homeostasis. Chemical and physical thermoregulation.
47. Thermodynamic method for studying of biological systems. Heat exhange, its types.
Thermotherapy. The use of low temperatures in medicine.
48. Work types in the living organism.

49. Thermoregulation in the living organism.
50. The organism as an open system. Prigogine theorem. The comparison of thermodynamic equilibrium and stationary state.
51. The second law of thermodynamics. Criticism of the theory of "heat death" of the universe. Entropy, free energy, electrochemical potential.
52. Thermodynamic potentials.
53. The rate of entropy increase and a dissipative function.
54. Main functions of biological membranes.
55. The structure of biological membranes.
56. Models of biological membranes.
57. Physical methods of studying of structure of biological membranes.
58. Basic types of a passive transport of substances through the membrane.
59. Fick's equation for a passive transport of substances through the membrane.
60. Active transport of substances through the membrane.
61. Electrogenic ion pumps.
62. Secondary active transport of ions.
63. Biomembrane potentials and their ionic nature. Resting membrane potential. Nernst equation.
64. Main properties of an action potential.
65. The mechanism of generation and propagation of action potential in cells.
66. Donnan potential. Donnan equilibrium.
67. Electrodiffusion equation of ions through a membrane. Stationary Goldman-Hodgkin potential.
68. The propagation of excitation along nerve fibers.
69. An electric dipole and characteristics of an electric field.
70. Lead. Integral electric vector of the heart.
71. Einthoven's concept of ECG. A current dipole and its characteristics.
72. Components of normal electrocardiogram. Vectorcardiography.
73. The mechanism of the electrical activity of organs and tissues. Electrical phenomena in cardiac muscle.
74. The electrical properties of cells and tissues. Conduction current and displacement currents.
75. Electrical conductivity of cells and tissues at direct current.
76. Application of direct electric current in medicine. Galvanization. Electrophoresis.
77. Application of the constant electric field of high voltage in medicine. Franklinization. Aeroionotherapy.
78. Effects of electric current on the living organism.
79. Passing of alternating current through biological objects. The impedance of tissues and organs.
80. Dispersion of impedance. Polarization coefficient of tissue. Reography.
81. The physical characteristics of pulsed current. Effects of pulsed electric current on the living organism. Cranial electrotherapy stimulation. Electrical stimulators. Defibrillators.
82. Effects of electromagnetic fields on biological objects. Primary mechanisms, currents and thermal effects, specific action.
83. Therapeutic factors and their application in medical techniques (UHF- and SHFtherapy, microwave resonance therapy).
84. Magnetic field and its characteristics. Effects of magnetic fields on the living organism. Magnetobiology.
85. Resonance methods of quantum mechanics. Nuclear magnetic resonance and electron paramagnetic resonance, their application in medicine (magnetic resonance tomography).
86. The nature of light. Optical refractometry.
87. Magnifying glass. Optical microscope and its main characteristics. Some special methods of optical microscopy.

88. The concept of an ideal centered optical system.
89. The optical system of the eye and some its peculiarities.
90. Anomalies of optical system of the eye and their compensation.
91. Biophysical bases of visual reception.
92. The mechanism of light absorption. Main characteristics of light absorption (intensity, absorption coefficient, optical density of medium, transmittance, extinction).
93. The principle of concentration colorimetry. The Beer-Lambert-Bouguer law.
94. The mechanism of light scattering. Rayleigh law. Nephelometry.
95. Light polarization. Ways to obtain polarized light. Birefringence. Nicolas prism.
96. Optically active substances. Biot's law.
97. Spontaneous and induced radiation. The main structural components of a laser and their functions.
98. The main properties of laser radiation.
99. Effects of laser radiation on living tissue.
100. The main types of a laser radiation application in medicine.
101. The mechanism and main characteristics of thermal radiation. Black body.
102. Laws of thermal radiation (Kirchhoff's law, Planck's radiation law).
103. Laws of thermal radiation (Stefan-Boltzmann law, Wiens displacement law).
104. Peculiarities of thermal radiation of the human body. Temperature topography of the human body. The principles of thermal imaging.
105. Infrared and ultraviolet radiation and their application in medicine.
106. Luminescence. Types of luminescence, basic regularities and its properties. Stokes' law. Luminescence application in medicine.
107. The phenomenon of the photoelectric effect. External and internal photoelectric effects and their application in medicine.
108. Properties of X-rays.
109. The mechanism of production of Bremsstrahlung ("braking radiation"). The boundary wavelength.
110. Nature of the characteristic radiation. Moseley's law.
111. X-ray interaction with matter (coherent radiation, photoelectric effect, Compton effect).
112. The principles of X-ray diagnostics (radiography) and X-ray therapy.
113. Radioactivity. Main types of radioactive dacay.
114. Law of radioactive decay. Activity of radioactive source. Lifetime.
115. The doses of ionizing radiation and their units.
116. Biological effects of ionizing radiation. Basic quantitative characteristics of the interaction of ionizing radiation with biological objects.
117. Methods of radioisotope medicine. The main physical and chemical methods of protection from ionizing radiation.

8. TEACHING METHODS

1. Verbal (lecture, explanation, story, conversation, instruction);
2. Visual (observation, illustration, demonstration);
3. Practical (different types of exercises, graphic works, experiment, practice).

The training process uses the following teaching methods:

-explanatory-illustrative or informational-receptive, which provides for the ready presentation of information by the teacher and its assimilation by students;

-reproductive, which is based on the performance of various types of tasks on the sample;

-method of a problem statement - the teacher puts the problem and he solves it, demonstrating the contradictions that characterize the process of cognition, the task of students is to monitor the sequence of presentation, evidence of materiality, the prediction of the next steps of the teacher; the MN is implemented by teaching students to problem situations to ensure

successful preliminary preparation for upcoming work in real conditions of practical medical institutions; -partially search or heuristic, aims at the mastery of the separate elements of search activity, for example: the teacher formulates the problem, students hypothesis; -research, the essence of which is to organize teacher search creative activity of students by setting new problems and problem tasks. -methods to ensure the perception and assimilation of knowledge by students (lectures, independent work, instruction, consultation); -methods of application of knowledge and acquisition and consolidation of skills (practical sessions, assignments); -methods of verification and assessment of knowledge and skills.	
6. Course evaluation system	
General course evaluation system	**Current control** is performed based on the control of theoretical knowledge, skills and abilities in practical classes. Independent study students are assessed in practical classes, and is an integral part of the final grade of the student. Current control is performed during the training sessions and aims at checking the assimilation of students learning the material. Forms of current control are: a) test tasks with a choice of one correct answer, with the definition of the correct sequence of actions, with determination of the conformity, defining the specific portion of the photo or diagram ("detection"); b) individual oral questioning, interview; c) the solution of typical situational tasks; g) identification of pathogens and carriers of pathogens of parasitic diseases in the photographs, macro - and micropreparats; d) control of practical skills; e) the typical problems of genetics and medical genetics. Grades on the national scale ("excellent" - 5, "good" - 4, "satisfactory" - 3, "unsatisfactory" - 2), received by students, are displayed in the journals of attendance and academic group performance. **Final control** The final control is the form of a differentiated credit at the end of the 1st semester and an exam at the end of the 2nd semester upon completion of the course of medical biology. The semester exam is a form of final control of mastering by the student of theoretical and practical material on academic discipline. The final control (exam) is carried out at the last control lesson. Students are admitted to the FC who have attended all the classes provided by the curriculum in the discipline and while studying the module scored the number of points not less than the minimum (**72 points**). A student who, for good or bad reasons, has missed classes, is allowed to rework academic debt for a certain period of time. **Evaluation of current educational activities.** During the assessment of mastering each topic for the current educational activity of the student scores are set on a 4-point (national) assessment scale. This takes into account all types

of work provided by the discipline program. The student must receive a score on each topic. Scores on the traditional scale are converted into points. The final assessment of the current academic activity is the arithmetic mean (the sum of scores for each lesson is divided by the number of lessons per semester) and translated into points according to **Table 2.**

Table 2. Conversion of the average score for the current activity into a multi-point scale (for disciplines completed by diff.credit, exam)

4-point scale	120-point scale	4-point scale	120-point scale	4-point scale	120-point scale	4-point scale	120-point scale
5	120	4,45	107	3,91	94	3,37	81
4,95	119	4,41	106	3,87	93	3,33	80
4,91	118	4,37	105	3,83	92	3,29	79
4,87	117	4,33	104	3,79	91	3,25	78
4,83	116	4,29	103	3,74	90	3,2	77
4,79	115	4,25	102	3,7	89	3,16	76
4,75	114	4,2	101	3,66	88	3,12	75
4,7	113	4,16	100	3,62	87	3,08	74
4,66	112	4,12	99	3,58	86	3,04	73
4,62	111	4,08	98	3,54	85	3	72
4,58	110	4,04	97	3,49	84	<3	Not enough
4,54	109	3,99	96	3,45	83		
4,5	108	3,95	95	3,41	82		

The maximum number *of points that a student can collect for current educational activity during semester in order to be admitted to the exam is* ***120 points.***

The minimum number *of points that a student can collect for current educational activity during semester in order to be admitted to the exam is* ***72 points.***

Calculating of the number of points is based on obtained marks of student according to traditional scale while learning subject during the semester, by calculating the arithmetic mean (AM) that is rounded to two signs after comma.

Evaluation of independent work of students. Independent work of students, which is provided by the topic of the lesson together with the classroom work, is evaluated during the current control of the topic in the relevant lesson. Assimilation of topics that are submitted only for independent work is checked during the final module control.

Evaluation of final control.

The maximum number of points that a student can score during the exam is **80 points.**

The final control is considered credited if the student scored at least 60% of the maximum amount of points (for a 200-point scale - at least **50 points**).

Determining the number of points that a student scored in the discipline: the number of points that a student scored in the discipline is defined as the sum of points for the current academic activity (Table1) and for the final control (diff.credit, exam) (Table 3).

	Table 3. Scale of assessment of differentiated (exam) credit: Traditional scale: Points «5»: 70-80 «4»: 60-69 «3»: 50-59
Requirements for written work	The final written work is performed in the form of a test.
Practical classes	Classroom work
The 1st semester	
Module 1. Fundamentals of higher mathematics and biological physics.	
Topics 1-12:Classroom work - score from 2 to 5 for each topic.	
Topic 13: Differentiated credit (semester control) Semester control at the end of the 1st semester is provided in the form of Differentiated credit. (Table 2) Provides a final grade on a 120-point scale as the sum of grades for the current control of knowledge (oral examination, written survey, Practical work, abstracts), the results of 2 content modules.	
The 2nd semester	
Topics 1-2:Classroom work - score from 2 to 5 for each topic.	
Topic 3: Final module control1 is evaluated from 50 to 80 points and consists of: Test control - 40 tests = 40 points (1 point for the correct answer to 1 test). Answer to 2 theoretical questions of 20 points for each = 40 points. Amount: 80. Examples of test tasks: **At stationary (steady) flow …** 1. Liquid rate does not depend on a cross-section are; 2. Liquid rate gradually decreases; 3. Liquid rate in all points does not depend on a time 4. Liquid rate gradually increases; 5. Liquid rate does not depend on a distance from center if tube; **Ideal liquid feature is:** 1. in this liquid only normal pressure forses act 2. internal friction does not exist 3. in this liquid viscosity index does not depend on character of movement in this liquid tangential forces exist 4. in this liquid tangential forces exist 5. viscosity index depends on concentration Amount: minimum 72 + 50 = 122, maximum 120 + 80 = 200	
Module 2. Fundamentals of medical physics.	
Topics 4-16:Classroom work - score from 2 to 5 for each topic. Topic 17: Differentiated credit (semester control) Semester control at the end of the 1st semester is provided in the form of Differentiated credit. (Table 2) Provides a final grade on a 120-point scale as the sum of grades for the current control of knowledge (oral examination, written survey, Practical work, abstracts), the results of 2 content modules. STRUCTURE EXAMINATION CARD 1. Theoretical question 2. Theoretical question 3. Practical work Example of CARDS TO THE DIFFERENTIATED CREDIT Card № _ 1. Deformation, its types, physical characteristics.	

2. The nature of α-radiation. The effect of α-particles on the human body. Protection against α-radiation.
3. Practical work "Determination of surface tension"

The diff.credit is evaluated from 50 to 80 points
The traditional score is put in the credit book
"3" 50-60 points
"4" 61-70 points
"5" 71-80 points

Amount: minimum 72 + 50 = 122, maximum 120 + 80 = 200

THE LIST OF THEORETICAL QUESTIONS FOR PREPARATION OF STUDENTS FOR THE FINAL CONTROL (DIFF.CREDIT)

1. Differential equations. Basic concepts.
2. Differential equations with separable variables.
3. Linear second order differential equations with constant coefficients.
4. Random events. Statistical and classical definitions of the probability of a random event. Addition theorem of probabilities of compatible and incompatible events.
5. Complex event. Probability of complex event which consists of two dependent and independent events.
6. The random variables. The distribution law of a random variable. Bernoulli's formula, Poisson's distribution.
7. Continuous random variable. The distribution function and the probability density function of a random variable. The probability that a random variable is included within the interval.
8. Probable event. The normalization condition for a continuous random variable. The relation between a distribution function $F(x)$ of a continuous random variable x and the probability density function $f(x)$ of a random variable
9. The mathematical expectation of a discrete and a continuous random variable.
10. The variance of a discrete and a continuous random variable.
11. The normal distribution law. The probability density function of a normal distribution.
12. Rule of three sigma. The significance levels.
13. The subject of mathematical statistics. General population. Sample. Representation. Interval variation series.
14. Histogram. Mode. Median. Sample mean.
15. The empirical function of distribution and density distribution for a variation series.
16. Sample variance. Corrected sample variance. Sample standard deviation.
17. Corrected standard deviation of the average of sample. The likely probability and significance levels.
18. The confidence intervals and a probable values. Half-width confidence interval.
19. Correlation. The correlation coefficient of a random variables.
20. Regression analysis.
21. Mechanical properties of a living tissues.
22. Biophysical properties of muscle contraction.
23. Hill equation. The power of contraction of skeletal muscle.
24. Mechanical waves. Wave equation. Doppler effect, its application in biomedical researches.
25. Acoustics. Physical characteristics of sound. Characteristics of auditory sensation and their relation with physical characteristics of sound. Sound measurements. The acoustic impedance. Audiometry.
26. Physics of hearing. The concept of the sound conductive and the sound perceptive systems The physical bases of a sound methods of research used in the clinics.
27. Reflection and absorption of sound waves. Reverberation.
28. Loudness. Weber-Fechner law.
29. Infrasound, peculiarities of its propagation. Infrasound effects on biological objects.
30. Noise. Vibration, their physical characteristics.

31. Ultrasound. Sources and receivers of ultrasound. Peculiarities of propagation of ultrasonic waves. Effects of ultrasound on the matter. Biophysical bases of ultrasound effects on cells and tissues. The application of ultrasound in diagnostics and treatment.
32. Hearing threshold and pain threshold. Sound intensity scale and loudness scale, units.
33. Internal friction (viscosity of fluids). A Newtonian and a non-Newtonian fluids. Rheological properties of blood, blood plasma and serum.
34. Laminar and turbulent fluid flow. Reynolds number. The flow of a viscous fluids. Hagen-Poiseuille equation. Hydraulic resistance.
35. Stationary flow of fluids. Continuity equation. Linear and volume flow rate. The basic equation of fluid dynamics.
36. Rheological properties of fluids and blood.
37. Basic hemodynamic parameters.
38. General physical regularities of blood motion in vessels.
39. Methods for determination of viscosity of fluids. The clinical method used for determination of blood viscosity.
40. The physical bases of the clinical method of measurement of blood pressure.
41. Determination of flow velocity.
42. Work and power of the heart.
43. A pulse waves, the dependence of propagation velocity on the vessel parameters.
44. Methods for determination of blood circulation velocity.
45. The first principle of thermodynamics for processes of an ideal gas.
46. Thermodynamics of biological systems. Subject and terminology.
47. The first law of thermodynamics and its application to living systems.
48. Body energy consumption. Basal metabolic rate.
49. Temperature homeostasis. Chemical and physical thermoregulation.
50. Thermodynamic method for studying of biological systems. Heat exhange, its types.
51. Thermotherapy. The use of low temperatures in medicine.
52. Work types in the living organism.
53. Thermoregulation in the living organism.
54. The organism as an open system. Prigogine theorem. The comparison of thermodynamic equilibrium and stationary state.
55. The second law of thermodynamics. Criticism of the theory of "heat death" of the universe. Entropy, free energy, electrochemical potential.
56. Thermodynamic potentials.
57. The rate of entropy increase and a dissipative function.
58. Main functions of biological membranes.
59. The structure of biological membranes.
60. Models of biological membranes.
61. Physical methods of studying of structure of biological membranes.
62. Basic types of a passive transport of substances through the membrane.
63. Fick's equation for a passive transport of substances through the membrane.
64. Active transport of substances through the membrane.
65. Electrogenic ion pumps.
66. Secondary active transport of ions.
67. Biomembrane potentials and their ionic nature. Resting membrane potential. Nernst equation.
68. Main properties of an action potential.
69. The mechanism of generation and propagation of action potential in cells.
70. Donnan potential. Donnan equilibrium.
71. Electrodiffusion equation of ions through a membrane. Stationary Goldman-Hodgkin potential.
72. The propagation of excitation along nerve fibers.
73. An electric dipole and characteristics of an electric field.

74. Lead. Integral electric vector of the heart.
75. Einthoven's concept of ECG. A current dipole and its characteristics.
76. Components of normal electrocardiogram. Vectorcardiography.
77. The mechanism of the electrical activity of organs and tissues. Electrical phenomena in cardiac muscle.
78. The electrical properties of cells and tissues. Conduction current and displacement currents.
79. Electrical conductivity of cells and tissues at direct current.
80. Application of direct electric current in medicine. Galvanization. Electrophoresis.
81. Application of the constant electric field of high voltage in medicine. Franklinization.
82. Aeroionotherapy.
83. Effects of electric current on the living organism.
84. Passing of alternating current through biological objects. The impedance of tissues and organs.
85. Dispersion of impedance. Polarization coefficient of tissue. Reography.
86. The physical characteristics of pulsed current. Effects of pulsed electric current on the living organism. Cranial electrotherapy stimulation. Electrical stimulators.
87. Defibrillators.
88. Effects of electromagnetic fields on biological objects. Primary mechanisms, currents and thermal effects, specific action.
89. Therapeutic factors and their application in medical techniques (UHF- and SHFtherapy, microwave resonance therapy).
90. Magnetic field and its characteristics. Effects of magnetic fields on the living organism. Magnetobiology.
91. Resonance methods of quantum mechanics. Nuclear magnetic resonance and electron paramagnetic resonance, their application in medicine (magnetic resonance tomography).
92. The nature of light. Optical refractometry.
93. Magnifying glass. Optical microscope and its main characteristics. Some special methods of optical microscopy.
94. The concept of an ideal centered optical system.
95. The optical system of the eye and some its peculiarities.
96. Anomalies of optical system of the eye and their compensation.
97. Biophysical bases of visual reception.
98. The mechanism of light absorption. Main characteristics of light absorption (intensity, absorption coefficient, optical density of medium, transmittance, extinction).
99. The principle of concentration colorimetry. The Beer-Lambert-Bouguer law.
100. The mechanism of light scattering. Rayleigh law. Nephelometry.
101. Light polarization. Ways to obtain polarized light. Birefringence. Nicolas prism.
102. Optically active substances. Biot's law.
103. Spontaneous and induced radiation. The main structural components of a laser and their functions.
104. The main properties of laser radiation.
105. Effects of laser radiation on living tissue.
106. The main types of a laser radiation application in medicine.
107. The mechanism and main characteristics of thermal radiation. Black body.
108. Laws of thermal radiation (Kirchhoff's law, Planck's radiation law).
109. Laws of thermal radiation (Stefan-Boltzmann law, Wiens displacement law).
110. Peculiarities of thermal radiation of the human body. Temperature topography of the human body. The principles of thermal imaging.
111. Infrared and ultraviolet radiation and their application in medicine.
112. Luminescence. Types of luminescence, basic regularities and its properties. Stokes' law. Luminescence application in medicine.

113. The phenomenon of the photoelectric effect. External and internal photoelectric effects and their application in medicine.
114. Properties of X-rays.
115. The mechanism of production of Bremsstrahlung ("braking radiation"). The boundary wavelength.
116. Nature of the characteristic radiation. Moseley's law.
117. X-ray interaction with matter (coherent radiation, photoelectric effect, Compton effect).
118. The principles of X-ray diagnostics (radiography) and X-ray therapy.
119. Radioactivity. Main types of radioactive dacay.
120. Law of radioactive decay. Activity of radioactive source. Lifetime.
121. The doses of ionizing radiation and their units.
122. Biological effects of ionizing radiation. Basic quantitative characteristics of the interaction of ionizing radiation with biological objects.
123. Methods of radioisotope medicine. The main physical and chemical methods of protection from ionizing radiation.

Circumstance of admission to the final control	1. Semester control at the end of the 1st semester is provided in the form of a differential credit. (Table 2) Provides a final score on a 120-point scale as the sum of scores for the current control of knowledge (oral examination, written survey, tests, verification of identification of micropreparations, abstracts), the results of 2 content modules. 2. Students are allowed to take the differentiated credit, exam only if there is no debt for the implementation of the curriculum.

7. Course policy

The organization of the educational process is carried out with the use of the European Credit Transfer System (ECTS) to assess student performance. The points gained in the current survey, independent work and points of the final control are credited. This must take into account the student's presence in class and his activity during practical work. Inadmissible: absences and late classes; use of a mobile phone, tablet or other mobile devices during the lesson (except for the cases provided by the curriculum and methodical recommendations of the teacher); copying and plagiarism; untimely performance of the task, the presence of unsatisfactory grades for 50% or more of the submitted theoretical and practical material.

8. RECOMMENDED LITERATURE

Basic:

1. Chalyi A.V., Tsekhmister Ya.V., Agapov B.T. Medical and Biological Physics: textbook for the students of higher medical institutions of the IV accreditation level. – Vinnytsia, Nova Knyha, 2010. – 480 p.
2. Davidovits P. Physics in Biology and Medicine. Elsevier, 2001. – 303 p.
3. Newman J. Physics of the Life Sciences. Springer, 2008. – 718 p.
4. Herman I.P. Physics of the Human Body. Springer, 2008. – 860 p.
5. Hobie R.K., Roth B.J. Intermediate Physics for Medicine and Biology. Springer, 2007. – 616 p.

Additional:

6. Cotterill R. Biophysics. An introduction. J.Wiley&Sons, 2004.
7. Glaser R., Biophysics, Springer, 2004.
8. Ronto G., Tarjan I. (Eds.): An Introduction to Biophysics with Medical Orientation, (3rd ed.), Akadémiai Publishing Company, Budapest, 1999.
9. Hendee W., Ritenour R. Medical imaging physics. J.Wiley&Sons, 2002.

Lector Seleznova R.V