MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY

Department of Medical and Biological Physics and Medical Informatics
Academic year 2025-2026

SILLABUS
THE EDUCATIONAL DISCIPLINE

«MODERN PROBLEMS OF BIOPHYSICS»

(title of the educational discipline)

Normative or selective educational discipline selective

Form of education full-time form of education
(full-time form of education; correspondence form of education; distance form of education)

Field of knowledge 22 «Health Care»
(code and title of the field of knowledge)

Specialty 221 «Dentistry»
(code and title of the specialty)

Educational and professional program (educational scientific program) «Dentistry»

Second (master's) level of higher education

Academic year: 2nd

The syllabus of the educational discipline was considered at the meeting of the Department of Medical and Biological Physics and Medical Informatics

Protocol No. 1
"26" August 2024

Head of the Department

prof. O.V. Zaytseva

Approved by the Methodological Committee of KhNMU on Problems of general and natural science training

Protocol No.1
"30" August 2024

Head

prof. M.S. Myroshnychenko

SYLLABUS DEVELOPERS

1. Zaytseva Olga, Head of the Department, professor, Dr. Sci. (Biology).

2. Bondarenko Maryna, associate professor, PhD (Physics and Mathematics).

INFORMATION ABOUT TEACHERS OF THE EDUCATIONAL COMPONENT

1. Surname, name, position, academic title, scientific degree:
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3. Surname, name, position, academic title, scientific degree:
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Consultations (face-to-face consultations: schedule and venue; online consultations: schedule, links to electronic resources): face-to-face and online consulting is conducted according to the schedule of the department or by prior arrangement with the teacher.

Location: Kharkiv, 4 Nauki Ave., main building, 2nd floor, Department of Medical and Biological Physics and Medical Informatics, teacher's rooms No. 1, 2, 4.

INTRODUCTION

The syllabus of the discipline "Modern problems of biophysics" is compiled in accordance with the educational-professional program 221 " Dentistry " and the Standard of Higher Education of Ukraine, the second (master's) level, field of knowledge 22 "Health care", specialty 221 "Dentistry"

Description of the discipline (abstract)

The discipline "Modern problems of biophysics" is offered for study to 2nd year students and is elective. Scope of the discipline (in ECTS credits with the definition of the distribution of hours for lectures, practical classes, seminars, self-study): **3 ECTS credits**, **90 hours**, of which **0** hours of lectures, **30** hours of practical classes, **60** hours of self-study. Type of assessment - **credit**.

The subject of study of the discipline "Modern problems of biophysics" is basic physical concepts, laws, principles and approaches in the study of natural processes, physical and technical principles of medical devices, applications of mathematical methods in biomedical research, which form the basis of subject competences and are a significant component of the professional competence of the future doctor, as well as the basis for the study of professionally oriented natural and clinical disciplines in higher medical educational institutions of Ukraine.

Co-requisites of the discipline

Discipline "Modern problems of biophysics" involves simultaneous mastering of the disciplines “Biochemistry”, “Normal Physiology”, “Histology” and integrates with these disciplines; promotes the study of students of other fundamental, as well as clinical, hygienic and social disciplines.

In the general system of training a future doctor, the discipline "Modern problems of biophysics" belongs to the cycle of natural science training.

Prerequisites of the discipline

The study of the discipline "Modern problems of biophysics" involves the prior mastering of the disciplines “Medical and biological physics; medical information technologies”, "Medical Biology", "Medical Chemistry" etc.

Post-requisites of the discipline

The basic concepts of the discipline "Modern problems of biophysics" should be used during the study of such disciplines as "Hygiene and Ecology", "Physiotherapy", "Medical Radiology (radiation diagnostics and radiation therapy)", "Clinical Biochemistry", "Ophthalmology" etc.

Link to the page of the educational discipline in Moodle:
http://distance.knmu.edu.ua/course/view.php?id=4004

1. PURPOSE AND OBJECTIVES OF THE DISCIPLINE

1.1. The purpose of the discipline "Modern problems of biophysics" is to form in students a system of knowledge and new competencies about basic physical principles and approaches to the study of processes in nature, physical and technical principles of medical devices, use of mathematical methods in biomedical research. The above is the basis of subject competencies in medical and biological physics and is an integral part of the professional competence of the future doctor, as well as the basis for the study of professionally oriented natural and clinical disciplines in higher medical educational institutions of Ukraine.

1.2. The main objectives of studying the discipline are the acquisition of knowledge and skills in mathematical methods in biology and medicine, biomechanics and biological thermodynamics, electrical phenomena in biology and medicine, basics of medical electronics, medical and biological aspects of atomic and nuclear physics.

1.3. Competences and learning outcomes, the formation of which is facilitated by the discipline "Modern problems of biophysics" (relationship with the normative content of training of higher education, formulated in terms of learning outcomes in the Standard of Higher Education of Ukraine).

1.3.1. Studying of the educational component ensures mastering of **competencies**:

1	Integral competence	The ability to solve complex problems and problems in the field of health care in the specialty «Dentistry» in professional activity or in the process of learning, which involves conducting research and/or carrying out innovations and is characterized by uncertainty of conditions and requirements.
2	General competencies	GC 1. Ability to abstract thinking, analysis and synthesis. GC 2. Knowledge and understanding of the subject area and understanding of professional activity. GC 3. Ability to apply knowledge in practical activities. GC 4. Ability to communicate in the state language both orally and in writing. GC 6. Skills in the use of information and communication technologies. GC 7. Ability to search, process and analyze information from various sources. GC 8. Ability to adapt and act in a new situation. GC 9. Ability to identify, pose and solve problems. GC 10. Ability to be critical and self-critical. GC 11. Ability to work in a team. GC 13. Ability to act socially responsibly and consciously.
3	Special (professional) competencies	SC 1. The ability to collect medical information about the patient and analyze clinical data. SC 2. Ability to interpret the result of laboratory and instrumental studies. SC 12. Ability to organize and conduct a screening examination in dentistry.

		SC 13. The ability to assess the impact of the environment on the state of health of the population (individual, family, population).

1.3.2. The study of the educational component ensures that education seekers acquire the following program learning outcomes (PLO):

PLO 6. Plan and implement measures for the prevention of dental diseases among the population to prevent the spread of dental diseases.

PLO 7. Analyze the epidemiological state and carry out measures of mass and individual, general and local drug and non-drug prevention of dental diseases.

PLO 8. Determine the approach, plan, type and principle of treatment of a dental disease by making an informed decision according to existing algorithms and standard schemes.

PLO 9. Determine the nature of the regime of work, rest and the necessary diet in the treatment of dental diseases based on a preliminary or final clinical diagnosis by making a well-founded decision according to existing algorithms and standard schemes.

PLO 14. To analyse and evaluate public, social and health information using standard approaches and computer information technologies.

PLO 15. Evaluate the impact of the environment on the state of health of the population in the conditions of a medical institution according to standard methods.

PLO 17. Adhere to a healthy lifestyle, use methods of self-regulation and self-control.

PLO 18. To be aware of and guided in their activities by civil rights, freedoms and obligations, and to raise the general educational cultural level.

PLO 20. Organize the necessary level of individual safety (own and persons of concern) in the event of typical dangerous situations in the individual field of activity.

1.3.3. The study of the discipline provides students with the following **special skills (soft skills)**:

1. communicativeness (implemented through: the method of working in groups and brainstorming during analysis, clinical cases, the method of presenting the results of independent work and their protection in a group),
2. teamwork (implemented through: group work method and brainstorming during analysis, clinical cases),
3. conflict management (implemented through: business games),
4. time management (implemented through: the method of self-organization during classroom work in groups and independent work),
5. leadership skills (implemented through: the method of presenting the results of independent work and their protection in a group).

INFORMATION CONTENT OF THE EDUCATIONAL DISCIPLINE

<table>
<tr><td rowspan="2">Credits and credit hours</td><td rowspan="2">Field of knowledge, specialty, educational degree, educational professional program</td><td>Characteristics of the discipline</td></tr>
<tr><td>Full-time study</td></tr>
<tr><td>Credits: 3.0</td><td>Field of knowledge:
22 “Healthcare”</td><td>Elective discipline</td></tr>
<tr><td rowspan="5">Total hours: 90</td><td rowspan="5">Specialty:
221 “Dentistry”</td><td>Academic year (course):</td></tr>
<tr><td>2nd</td></tr>
<tr><td>Semester</td></tr>
<tr><td>3rd or 4th</td></tr>
<tr><td></td></tr>
<tr><td rowspan="11">Hours for full-time (or evening) form of study:
classes: 30
self-study: 60</td><td rowspan="11">Educational degree:
master

Educational professional program:
221 “Dentistry”</td><td>Lectures</td></tr>
<tr><td>–</td></tr>
<tr><td>Practical classes</td></tr>
<tr><td>30 hours</td></tr>
<tr><td>Seminar classes</td></tr>
<tr><td>–</td></tr>
<tr><td>Laboratory classes</td></tr>
<tr><td>–</td></tr>
<tr><td>Self-study</td></tr>
<tr><td>60 hours</td></tr>
<tr><td>Individual tasks: 0 hours</td></tr>
<tr><td>Assessment form: credit</td></tr>
</table>

2.1. Discipline description

2.1.1. Lectures

No.	Topic	Duration (hours)	Lecture type
	Total hours	**0**	

2.1.2. Seminars

No.	Topic	Duration (hours)	Study methods	Assessment forms
	Total hours	**0**		

2.1.3. Classes

No.	Topic	Duration (hours)	Study methods	Assessment forms
1	Acoustical methods in diagnostics and therapy	2	Narrative-explanation, conversation, demonstration, presentation, discussion, modeling of processes and situations, case method, "Brainstorming" method, webinar, virtual consultation and tutorial, briefing	Oral questioning, written (or computerized) test, individual tasks, portfolio method (abstracts, essays, abstracts, workbooks, etc.)
2	Diagnostics and monitoring of hemodynamics in human organs and systems	2		
3	Physical characteristics of modern materials, their influence on the organism. Nanotechnologies in medicine	2		
4	Final lesson No. 1	2		Final written (or computerized) test, portfolio method
5	Biophysical principles of generation of electric potentials in living organisms	2	Narrative-explanation, conversation, demonstration, presentation, discussion, modeling of processes and situations, case method, "Brainstorming" method, webinar, virtual consultation and tutorial, briefing	Oral questioning, written (or computerized) test, individual tasks, portfolio method (abstracts, essays, abstracts, workbooks, etc.)
6	Methods of studying the bioelectrical activity of human organs and systems	2		
7	Effects of electric currents and electromagnetic fields on the organism. Devices and systems for physiotherapy	2		
8	Electronic medical equipment	2		
9	Final lesson No. 2	2		Final written (or computerized) test, portfolio method
10	Biophysics of vision. Modern methods of diagnostics and correction of human vision	2	Narrative-explanation, conversation, demonstration, presentation, discussion, modeling of processes and situations, case method, "Brainstorming" method, webinar, virtual consultation and tutorial, briefing	Oral questioning, written (or computerized) test, individual tasks, portfolio method (abstracts, essays, abstracts, workbooks, etc.)
11	Microscopy methods and laser technologies in medicine	2		
12	Ionizing radiations. X-radiation	2		
13	Methods of radiation	2		

	diagnostics			
14	Radiobiology. Radiation therapy. Dosimetry. Methods of radiation protection	2		
15	Final lesson No. 3. Credit	2		Final written (or computerized) test, portfolio method
	Total hours	**30**		

2.1.4. Self-study

No.	Topic	Duration (hours)	Study methods	Assessment forms
1	Acoustic waves and their physical characteristics. Acoustic methods in medicine. Biophysics of human hearing. (For topic No. 1)	5	Narrative-explanation, conversation, demonstration, presentation, discussion, modeling of processes and situations, case method, "Brainstorming" method, webinar, virtual consultation and tutorial, briefing	Oral questioning, written (or computerized) test, individual tasks, portfolio method (abstracts, essays, abstracts, workbooks, etc.)
2	Fluid mechanics. Biorheology. Hemodynamics (For topic No. 2)	5		
3	Fundamentals of materials science. Mechanical properties of materials. (For topic No. 3)	5		
4	Biophysics of membrane processes in the cell. Generation of electric potentials in living organisms. (For topic No. 5)	5		
5	Electrographic methods in medicine. (For topic No. 6)	5		
6	The effect of electric currents and electromagnetic fields on biological objects. (For topic No. 7)	5		
7	Electronic medical equipment (For topic No. 8)	5		
8	Fundamentals of geometric optics. Apparatus of human vision as an optical system. (For topic No. 10)	5		
9	Methods of microscopy in medicine. Biophysical principles of the use of laser radiation in medicine (For topic No. 11)	5		
10	Ionizing radiation. The use of X-rays in diagnosis. (For topic No. 12)	5		
11	Basic provisions of quantum mechanics. Application of quantum	5		

	mechanical phenomena in medicine. (For topic No. 13)			
12	Physical foundations of nuclear medicine. Dosimetry and methods of radiation protection. (For topic No. 14)	5		
	Total hours	**60**		

3. ASSESSMENT CRITERIA

3.1. Evaluation of the educational progress of students is carried out in accordance with the current "Instructions for evaluating the educational activities of students of KhNMU".

3.1.1. Evaluation of current learning activities (CLA).

The grade for current learning activities is calculated as the arithmetic mean of the grades:

- for the current testing on all topics for classroom work,
- for all final classes, which include material for classroom and independent work.

- **Current assessment** (topic testing) is carried out during classes using entrance or summarizing test control, oral questioning, checking individual "Workbooks" of students and assessing computer practical tasks on the current topic.
- **The final lesson** includes a test of mastering the material of each of the sections and is conducted in the form of a written test (25 multiple-choice questions).
- If the student has thoroughly filled in his/her individual “Workbook” on the corresponding section of the discipline, then **1 to 3 points are added** to the points obtained when performing the final test on this section.

The total score is converted into a score on a 5-point scale.

Criteria for evaluating the final lesson:

- 15-19 correct answers - 15-19 points - grade "3",
- 20-23 correct answers - 20-23 points - grade "4",
- 24-25 correct answers - 24-25 points - grade "5".

During the test at the final lesson student can use his "Workbook";

At the end of the course, the arithmetic mean score is calculated (on a traditional scale), which is then converted into a score on a 200-point scale in accordance with Table 1.

Table 1

Conversion of the average score for current activities in a 200-point scale (for disciplines ending with credit)

4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale
5	200	4.3-4.31	172	3.6-3.61	144
4.97-4.99	199	4.27-4.29	171	3.57-3.59	143
4.95-4.96	198	4.24-4.26	170	3.55-3.56	142
4.92-4.94	197	4.22-4.23	169	3.52-3.54	141
4.9-4.91	196	4.19-4.21	168	3.5-3.51	140
4.87-4.89	195	4.17-4.18	167	3.47-3.49	139
4.85-4.86	194	4.14-4.16	166	3.45-3.46	138
4.82-4.84	193	4.12-4.13	165	3.42-3.44	137
4.8-4.81	192	4.09-4.11	164	3.4-3.41	136
4.77-4.79	191	4.07-4.08	163	3.37-3.39	135
4.75-4.76	190	4.04-4.06	162	3.35-3.36	134
4.72-4.74	189	4.02-4.03	161	3.32-3.34	133
4.7-4.71	188	3.99-4.01	160	3.3-3.31	132
4.67-4.69	187	3.97-3.98	159	3.27-3.29	131
4.65-4.66	186	3.94-3.96	158	3.25-3.26	130
4.62-4.64	185	3.92-3.93	157	3.22-3.24	129
4.6-4.61	184	3.89-3.91	156	3.2-3.21	128
4.57-4.59	183	3.87-3.88	155	3.17-3.19	127
4.54-4.56	182	3.84-3.86	154	3.15-3.16	126
4.52-4.53	181	3.82-3.83	153	3.12-3.14	125
4.5-4.51	180	3.79-3.81	152	3.1-3.11	124
4.47-4.49	179	3.77-3.78	151	3.07-3.09	123
4.45-4.46	178	3.74-3.76	150	3.05-3.06	122
4.42-4.44	177	3.72-3.73	149	3.02-3.04	121
4.4-4.41	176	3.7-3.71	148	3-3.01	120
4.37-4.39	175	3.67-3.69	147		
4.35-4,36	174	3.65-3,66	146		
4.32-4,34	173	3.62-3,64	145	Less than 3	Not enough

3.1.2. Individual student's tasks (**IST**) are evaluated in points (not more than 10), which are added to the points scored for the CLA at the end of the course. Points for individual work are awarded if the student has completely and thoroughly filled in his Workbook or performed other tasks proposed by the teacher in the discipline, and make **up to 10 points**.

The total amount of points for CLA and IST may not exceed 200 points.

3.1.3. Assessment of the discipline.

The grade in the discipline is determined as the sum of points for current learning activities and individual tasks and may be from 120 to 200 points.

The correspondence of the scores on the 200-point scale to the ECTS scale and to the four-point (national) scale is given in Table 2.

Table 2

Correspondence of grades on 200-point scale to the ECTS scale and to the 4-point national scale

200-point grade	ECTS	National grade
180–200	A	Excellent
160–179	B	Good
150–159	C	Good
130–149	D	Satisfactory
120–129	E	Satisfactory
Less than 120	F, Fx	Not satisfactory

The student receives a **"Credit"** mark into the credit book if he scored from 120 to 200 points.

3.2. Questions for the Credit

1. Acoustics, acoustic waves. Physical (objective) characteristics of sound. Physiological (subjective) characteristics of sound. Weber-Fechner law. Equal loudness curves, audibility threshold and pain threshold.
2. Acoustical research methods (audiometry, auscultation, percussion, phonocardiography and ultrasound diagnostics). Ultrasound and its use in medicine.
3. Infrasound and its impact on biological objects.
4. Biophysical bases of human perception of sound.
5. Ideal and real fluid. Bernoulli's equation, the equation of continuity of the jet. Liquid viscosity. Newton's formula for the force of viscous friction. Newtonian and non-Newtonian fluids. Reynolds number. Laminar and turbulent fluid flows. Poiseuille's formula. Hydraulic resistance. Newton's formula for the force of viscous friction in rheological characteristics. Flow curves. Shvedov-Bingham model. Caisson model.
6. The work and power of the human heart. Pulse wave.
7. Classification of medical and dental materials. Properties, physical characteristics and requirements for construction materials. Clinical materials and their properties. The effect of medical materials on the human body.
8. Mechanisms (types) of transport of substances across biological membranes. Diffusion, types of diffusion in biological cells. Substance flow, substance flow density. Fick's equation. Nernst-Planck equation. Ion pumps. Membrane potentials: rest potential, action potential. Goldman-Hodgkin-Katz equation.
9. Electric and current dipoles. Dipole moments of electric and current dipoles.
10. The main postulates of Einthoven's theory of electrocardiography. The concept of electrocardiogram. Electrocardiographic leads. Analysis of a normal electrocardiogram in the second standard lead. The concept of vector cardiography.
11. Electrographic diagnostic methods (electroencephalography, electromyography, electroretinography).
12. Electric properties of biological tissues for alternating current, their impedance and its components. Dependence of the tissue impedance modulus on the frequency of alternating current. The electrical equivalent of biological tissue. Dispersion coefficient.

13. The main mechanism of action of direct electric current on biological tissues. Physiotherapeutic methods using electric direct current (galvanization, medical electrophoresis).
14. Pulsed electric current, its characteristics. The main mechanism of action of pulsed electric current on biological tissues. Dubois-Reymond's law. Electrodiagnostics in medicine. Hoorweg-Weiss-Lapicque equation, the concept of rheobase and chronaxie. Therapeutic techniques based on the use of pulsed current (pacing, electrosleep, electrogymnastics, defibrillation)
15. Alternating electric current, its characteristics. Mechanisms of action of alternating current on biological tissues depending on its frequency. Nernst's law. Therapeutic techniques based on the use of alternating current: rheography (impedance plethysmography); diathermy (electric surgery), its varieties (diathermotomy and diathermocoagulation); local darsonvalization.
16. The main mechanism of action of alternating electromagnetic fields on biological tissues. Physiotherapeutic methods using the alternating electromagnetic field (inductothermy, UHF therapy, microwave therapy).
17. The main mechanism of action of a constant electric field on biological tissues. Physiotherapeutic methods using a constant electric field (aeroionotherapy, franklinization).
18. Hygienic rationing of electromagnetic field levels.
19. Laws of reflection and refraction of light. Absolute and relative refractive indices. The limiting angle of refraction. The phenomenon of total internal reflection, the limiting angle of total internal reflection. Refractometry.
20. Fiber optics, endoscopes and laparoscopes, their use in medicine.
21. Lenses and their characteristics. Construction of images of the object in the converging and diverging lenses. The formula of a thin lens and the linear magnification of the object in the lens. Types of lens aberrations (spherical aberration, chromatic aberration, astigmatism, distortion)
22. Optical microscope, the course of rays in it. Angular magnification of the optical system. Microscope magnification. Microscope resolution. The limit of resolution of the microscope (with normal and oblique incidence of rays on the object). Ways to reduce the resolution limit of an optical microscope.
23. Ultraviolet microscope, features of the principle of action.
24. Special methods of microscopy: microprojection and microphotography; dark field method; phase contrast method; polarization and fluorescence microscopy.
25. Optical system of the human eye: light-conducting and light-perceiving systems. Optical power of the human eye. The process of accommodation, the distance of the best vision. Formation of the image of an object in the optical system of the human eye. Photoreceptors, their types. The process of adaptation, its mechanisms. Angle of view, the smallest angle of view, the limit of resolution of the human eye. Visual acuity. Defects of light-conducting and light-perceiving systems of the human eye, their correction.
26. Polarization of light. The method of polarimetry and its use in medicine. Polarizing microscope.
27. Luminescence and its types. The mechanism of photoluminescence, its types (fluorescence and phosphorescence). Stokes' law and deviations from it (anti-Stokes luminescence). Luminescence spectra. Luminescent analysis and its use in biomedical research.
28. Induced radiation. Biological effects of laser radiation. Types of lasers. Applications of lasers in medicine.
29. Electron paramagnetic resonance (EPR). Information carried by EPR spectra. Spin marks and spin probes.
30. Nuclear magnetic resonance (NMR). NMR introscopy (magnetic resonance imaging, MRI).

31. Electron microscope, the resolution of the electron microscope.
32. Ionizing radiation, the main types of ionizing radiation.
33. X-radiation, its nature. Bremsstrahlung (braking) and characteristic X-rays. The mechanism of occurrence of bremsstrahlung X-rays. The minimum wavelength in the spectrum of bremsstrahlung X-rays.
34. The mechanism of characteristic X-radiation. Spectrum of characteristic X-radiation. Moseley's law.
35. X-ray tube. X-ray flux generated by an X-ray tube, its properties.
36. Attenuation of the flux of monochromatic X-radiation by matter, Bouguer's law. Mechanisms of interaction of X-radiation with matter: coherent scattering, incoherent scattering (Compton effect), photoeffect.
37. The total attenuation factor of X-rays, its components.
38. Mass attenuation factor of X-rays.
39. X-ray protection.
40. X-ray diagnostics (digital radiography, X-ray computed tomography (CT)) and radiotherapy.
41. Radioactivity. Types of radioactive decay: α-decay, β^--decay, β^+-decay, e-capture.
42. The law of radioactive decay. The half-life of the substance. Substance activity, units of measurement.
43. Interaction of different types of ionizing radiation with matter.
44. Mechanisms of interaction of γ-radiation with matter: incoherent scattering (Compton effect), photoeffect, formation of electron-positron pairs.
45. Attenuation of the flow of monochromatic γ-radiation of matter, Bouguer's law.
46. Characteristics of the interaction of corpuscular ionizing radiation with matter: linear ionization density, linear energy transfer, average linear path. Penetrating ability of ionizing radiation.
47. The negative nature of the impact of ionizing radiation on biological objects.
48. Methods of protection against ionizing radiation.
49. Radiation doses (absorbed dose, exposure dose, equivalent dose), units of measurement. Effective equivalent dose.
50. Radiation dose rate, exposure dose rate, units of measurement.
51. Hygienic rationing of radiation loads. Internal exposure.
52. Detectors and dosimeters of ionizing radiation.
53. Radionuclide diagnostics: dynamic and static methods.
54. Single photon emission computed tomography (SPECT). Positron emission tomography (PET).
55. Radiation therapy and its methods.
56. Modern devices for radiosurgical treatment using ionizing radiation.
57. Direct and indirect effects of ionizing radiation on DNA and other biomacromolecules.
58. Oxygen effect. Oxygen enhancement factor (OEF).
59. Types of radiation damage to cell DNA.
60. Reproductive and interphase death of irradiated cells.
61. Survival rate of irradiated cells, survival curve, its analysis.

3.3. Assessment questions

Assessment questions to the final control No. 1

1. Acoustics, acoustic waves. Physical (objective) characteristics of sound. Physiological (subjective) characteristics of sound. Weber-Fechner law. Equal loudness curves, audibility threshold and pain threshold.
2. Sound research methods (audiometry, auscultation, percussion, phonocardiography and ultrasound diagnostics). Ultrasound and its use in medicine.
3. Infrasound and its impact on biological objects.
4. Biophysical bases of human perception of sound.
5. Ideal and real fluid. Bernoulli's equation, the equation of continuity of the jet. Liquid viscosity. Newton's formula for the force of viscous friction. Newtonian and non-Newtonian fluids. Reynolds number. Laminar and turbulent fluid flows. Poiseuille's formula. Hydraulic resistance. Newton's formula for the force of viscous friction in rheological characteristics. Flow curves. Shvedov-Bingham model. Caisson model.
6. The work and power of the human heart. Pulse wave.
7. Classification of medical and dental materials. Properties, physical characteristics and requirements for construction materials. Clinical materials and their properties. The effect of medical materials on the human body.

Assessment questions to the final control No. 2

1. Mechanisms (types) of transport of substances across biological membranes. Diffusion, types of diffusion in biological cells. Substance flow, substance flow density. Fick's equation. Nernst-Planck equation. Ion pumps. Membrane potentials: rest potential, action potential. Goldman-Hodgkin-Katz equation.
2. Electric and current dipoles. Dipole moments of electric and current dipoles.
3. The main postulates of Einthoven's theory of electrocardiography. The concept of electrocardiogram. Electrocardiographic leads. Analysis of a normal electrocardiogram in the second standard lead. The concept of vector cardiography.
4. Electrographic diagnostic methods.
5. Electric properties of biological tissues for alternating current, their impedance and its components. Dependence of the tissue impedance modulus on the frequency of alternating current. The electrical equivalent of biological tissue. Dispersion coefficient.
6. The main mechanism of action of direct electric current on biological tissues. Physiotherapeutic methods using electric direct current (galvanization, medical electrophoresis).
7. Pulsed electric current, its characteristics. The main mechanism of action of pulsed electric current on biological tissues. Dubois-Reymond's law. Electrodiagnostics in medicine. Hoorweg-Weiss-Lapicque equation, the concept of rheobase and chronaxie. Therapeutic techniques based on the use of pulsed current (pacing, electrosleep, electrogymnastics, defibrillation)
8. Alternating electric current, its characteristics. Mechanisms of action of alternating current on biological tissues depending on its frequency. Nernst's law. Therapeutic techniques based on the use of alternating current (rheography (impedance plethysmography); diathermy (electrosurgery), its varieties (diathermotomy and diathermocoagulation); local darsonvalization).

9. The main mechanism of action of an alternating electromagnetic field on biological tissues. Physiotherapeutic methods using an alternating electromagnetic field (inductothermy, UHF therapy, microwave therapy).
10. The main mechanism of action of a constant electric field on biological tissues. Physiotherapeutic methods using a constant electric field (aeroionotherapy, franklinization).
11. Hygienic rationing of electromagnetic field levels.

Assessment questions to the final control No. 3

1. Laws of reflection and refraction of light. Absolute and relative refractive indices. The limiting angle of refraction. The phenomenon of total internal reflection, the limiting angle of total internal reflection.
2. Fiber optics, endoscopes and laparoscopes, their use in medicine.
3. Lenses and their characteristics. Construction of images of the object in the converging and diverging lenses. The formula of a thin lens and the linear magnification of the object in the lens. Types of lens aberrations (spherical aberration, chromatic aberration, astigmatism, distortion)
4. Optical microscope, the course of rays in it. Angular magnification of the optical system. Microscope magnification. Microscope resolution. The limit of resolution of the microscope (with normal and oblique incidence of rays on the object). Ways to reduce the resolution limit of an optical microscope.
5. Ultraviolet microscope, features of the principle of action.
6. Special methods of microscopy: microprojection and microphotography; dark field method; phase contrast method; polarization and fluorescence microscopy.
7. Optical system of the human eye: light-conducting and light-perceiving systems. Optical power of the human eye. The process of accommodation, the distance of the best vision. Formation of the image of an object in the optical system of the human eye. Defects of light-conducting and light-perceiving systems of the human eye, their correction. Photoreceptors, their types. The process of adaptation, its mechanisms. Angle of view, the smallest angle of view, the limit of resolution of the human eye. Visual acuity.
8. The method of polarimetry and its use in medicine. Polarizing microscope.
9. Luminescence and its types. The mechanism of photoluminescence, its types (fluorescence and phosphorescence). Stokes' law and deviations from it (anti-Stokes luminescence). Luminescence spectra. Luminescent analysis and its use in biomedical research.
10. Induced radiation. Biological action of laser radiation. Types of lasers. The use of lasers in medicine.
11. The phenomenon of electronic paramagnetic resonance (EPR). Information carried by EPR spectra. Spin marks and spin probes.
12. The phenomenon of nuclear magnetic resonance (NMR). NMR introscopy (magnetic resonance imaging (MRI)).
13. Electron microscope, the resolution of the electron microscope.
14. Ionizing radiation, the main types of ionizing radiation.
15. X-radiation, its nature. Bremsstrahlung (braking) and characteristic X-rays. The mechanism of occurrence of bremsstrahlung X-rays. The minimum wavelength in the spectrum of bremsstrahlung X-rays.
16. The mechanism of characteristic X-radiation. Spectrum of characteristic X-radiation. Moseley's law.

17. X-ray tube. X-ray flux generated by an X-ray tube.
18. Attenuation of the flux of monochromatic X-radiation by matter, Bouguer's law. Mechanisms of interaction of X-radiation with matter: coherent scattering, incoherent scattering (Compton effect), photoeffect.
19. The total attenuation factor of X-rays, its components.
20. Mass attenuation factor of X-rays.
21. X-ray protection.
22. X-ray diagnostics (digital radiography, X-ray computed tomography (CT)) and radiotherapy.
23. Radioactivity. Types of radioactive decay: α-decay, β^--decay, β^+-decay, e-capture.
24. The law of radioactive decay. The half-life of the substance. Substance activity, units of measurement.
25. Interaction of different types of ionizing radiation with matter.
26. Mechanisms of interaction of γ-radiation with matter: incoherent scattering (Compton effect), photoeffect, formation of electron-positron pairs.
27. Attenuation of the flow of monochromatic γ-radiation of matter, Bouguer's law.
28. Characteristics of the interaction of corpuscular ionizing radiation with matter: linear ionization density, linear energy transfer, average linear path. Penetrating ability of ionizing radiation.
29. The negative nature of the impact of ionizing radiation on biological objects.
30. Methods of protection against ionizing radiation.
31. Radiation doses (absorbed dose, exposure dose, equivalent dose), units of measurement. Effective equivalent dose.
32. Radiation dose rate, exposure dose rate, units of measurement.
33. Hygienic rationing of radiation loads. Internal exposure.
34. Detectors and dosimeters of ionizing radiation.
35. Radionuclide diagnostics: dynamic and static methods.
36. Single photon emission computed tomography (SPECT). Positron emission tomography (PET).
37. Radiation therapy and its methods.
38. Modern devices for radiosurgical treatment using ionizing radiation.
39. Direct and indirect effects of ionizing radiation on DNA and other biomacromolecules.
40. Oxygen effect. Oxygen enhancement factor (OEF).
41. Types of radiation damage to cell DNA.
42. Reproductive and interphase death of irradiated cells.
43. Survival rate of irradiated cells, survival curve, its analysis.

3.4. Individual tasks (the list approved at the meeting of the department with the determination of the number of points for their performance, which can be added as incentives):

The individual tasks of the student (IST) are evaluated in points (not more than 10), which are added to the points scored for the current learning activity (CLA) at the end of the course. Points for individual work are awarded if the student has completely and thoroughly filled in his Workbook or performed other tasks proposed by the teacher in the discipline, and make **up to 10 points**.

3.5. Rules for appealing the assessment

If the student does not agree with the grade obtained at a class, he can appeal it. In this case, the student's knowledge will be assessed by a commission consisting of the head of the department, an

independent teacher and the teacher of the group in which the student is studying. To increase the grade, the group teacher may also ask the student to choose a topic for writing an essay.

4. DISCIPLINE POLICY

(the system of requirements and rules of conduct for higher education students in the discipline, including the teacher's reaction to late tasks, missed classes, behavior in the classroom, requirements for medical clothing, etc., separately indicate the availability and conditions of training for people with special educational needs).

Discipline requirements (system of requirements and rules that the teacher imposes on students of higher education when studying the discipline)

For successful mastering of the discipline, it is necessary that the student of higher education systematically prepares for practical classes, performs the tasks offered for mastering the topics recommended for independent study, reads the recommended literature, takes an active part in discussing the topic in class.

Attendance and behavior (inadmissibility of absences, delays, clothing requirements, medical examination, etc.).

Attendance at practical classes in the discipline is mandatory (except for valid reasons). A class missed by a student for any reason must be worked off. It is unacceptable to be late for class. By the time the class begins, the student must be dressed in a medical gown. During the lesson the students are not allowed to eat or drink, chew gum, contaminate the surfaces of classrooms. When communicating with the teacher and others, the student must be polite, talk quietly and behave calmly.

Use of electronic gadgets. The use of any electronic gadgets (smartphones, watches, tablets, laptops, etc.) throughout the lesson is strictly prohibited unless the teacher separately allows their use. If the teacher sees that the student is violating this requirement, he can remove the student from the classroom.

Policy for people with special educational needs. For persons with special needs, the requirement of academic integrity is applied taking into account their individual needs and capabilities.

Recommendations for successful completion of the discipline (activity of higher education students during practical classes, fulfillment of the required minimum of educational work)

To successfully complete the discipline, the applicant must complete the required minimum of educational (classroom and self-study) work specified in the curriculum. The grade for the lesson also takes into account diligence, thoroughness of the student, activity in discussing the topic, speed and creativity of thinking, perseverance in learning.

Encouragement and penalties (additional points for conferences, research, edits, advice, participation in surveys)

To encourage students who are particularly active and persistent in their studies, they are awarded additional points for participating in scientific conferences, research, surveys, etc. For violation of discipline (rules of conduct, uniforms, etc.) and academic integrity during classes, the student may be subject to penalties - removal from the class, re-assessment (test, exam, test, etc.); re-taking the training course; expulsion from the educational institution.

Safety precautions

During the lesson, the student must follow the rules of life safety.

When conducting laboratory work or practical classes, it is necessary to follow the rules of fire safety, students need to know the location of the primary means of fire extinguishing (fire extinguisher, capes made of fire-proof fabric, sand).

In the event of an accident, the victim or eyewitness must immediately notify the teacher. If equipment, computers, fixtures and tools malfunction, the student should stop working and also notify the teacher.

During the class, students must follow the order of laboratory work and practical classes, the rules of personal hygiene, remove foreign objects from the workplace and ensure its cleanness.

It is not recommended to leave unattended electrical appliances and devices, including computers. If malfunctions are found in the operation of electrical devices that are under voltage, their increased heating, sparks, the smell of burnt insulation, smoke, immediately stop work, turn off the power supply and notify the teacher.

5. ACADEMIC INTEGRITY

Adherence to academic integrity by the student provides: independent performance of educational tasks, tasks of current and final control of learning outcomes; references to sources of information in the case of the use of ideas, statements, information; compliance with copyright law; providing reliable information about the results of their own educational (scientific, creative) activities.

Academic plagiarism, copying off, deception, falsification, etc. are considered violations of academic integrity. For violation of academic integrity, students may be held subject to the following academic liability: re-assessment (test, exam, test, etc.); re-taking the training course; expulsion from the educational institution.

6. RECOMMENDED LITERATURE

Basic

1. Encyclopedia of Medical Physics: Two Volume Set (2nd Edition). Slavik Tabakov , Franco Milano, Magdalena S. Stoeva, Tennille D. Presley. IOP Publishing, 2021. 101 p.
2. Introduction to Medical Physics / Ed. by S. Keevil, R. Padovani, S. Tabakov, T. Greener, C. Lewis. CRC Press, 2022. 500 p.
3. S. A. Kane, B. A. Gelman. Introduction to Physics in Modern Medicine. CRC Press, 2020. 450 p.
4. Stoumpos AI, Kitsios F, Talias MA. Digital Transformation in Healthcare: Technology Acceptance and Its Applications. Int J Environ Res Public Health. 2023 Feb 15;20(4):3407. doi: 10.3390/ijerph20043407. PMID: 36834105; PMCID: PMC9963556.
5. Information Technology for Healthcare Managers, 9th ed. / G. L. Glandon, D. J. Slovensky, D. H. Smaltz. AUPHA/HAP Book, 2020. 539 p.
6. Bollmann S, Küstner T, Tao Q, Zöllner FG. Artificial intelligence in medical physics. // Med Phys. 2024. May; 34(2):177-178. doi: 10.1016/j.zemedi.2024.03.002.
7. Yaghy A. Medicine's digital revolution. // Can Med Educ J. 2024 May 1;15(2):113-114. doi: 10.36834/cmej.79045.
8. Boone JM, Benedict SH, Labby ZE, Armato SG. Medical Physics ends print. // Med Phys. 2023 Oct;50(10):5933-5934. doi: 10.1002/mp.16766.

Additional

1. Medical and biological physics: textbook for students studying the subject in English: In 2 parts/ V. G. Knigavko, O. V. Zaytseva, M. A. Bondarenko. Kharkiv: KhNMU, 2019. 556 p.
2. Glossary of terms on medical and biological physics / V. G. Knigavko, O. V. Zaitseva, M. A. Bondarenko, L. V. Batyuk. Kharkiv: KhNMU, 2018. 100 p.
3. Medical and Biological Physics: lectures, 2018. Knigavko V., Zaytseva O., Bondarenko M. http://repo.knmu.edu.ua/handle/123456789/21258

7. INFORMATION RESOURCES

1. Link to the page of the discipline in the MOODLE system: http://distance.knmu.edu.ua/course/view.php?id=4004.
2. Page of the Department of Medical and Biological Physics and Medical Informatics on the University website: http://www.knmu.kharkov.ua/index.php?option=com_content&view=article&id=214.
3. Section of the Department of Medical and Biological Physics and Medical Informatics in the Repository of KhNMU: http://repo.knmu.edu.ua/handle/123456789/162.

8. OTHER

Regulations on the prevention, warning and resolution of cases related to sexual harassment and discrimination at KhNMU
https://knmu.edu.ua/wp-content/uploads/2021/05/polog_sex.pdf

Regulations on academic integrity and ethics of academic relations at Kharkiv National Medical University
https://knmu.edu.ua/wp-content/uploads/2021/05/polog_ad-1.pdf

Procedure for conducting classes for in-depth study by students of Kharkiv National Medical University of individual disciplines beyond the scope of the curriculum
https://knmu.edu.ua/wp-content/uploads/2021/05/poriad_pogl-vyv_dysc.pdf

Regulations on the Commission on Academic Integrity, Ethics and Conflict Management of KhNMU
https://knmu.edu.ua/wp-content/uploads/2021/05/polog_komis_ad.pdf

INCLUSIVE EDUCATION:
https://knmu.edu.ua/wp-content/uploads/2021/12/proekt_polog_inkl_navch.pdf

ACADEMIC INTEGRITY:
https://knmu.edu.ua/akademichna-dobrochesnist/
https://knmu.edu.ua/wp-content/uploads/2021/05/polog_ad-1.pdf