MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY

Department of Medical and Biological Physics and Medical Informatics
Academic year: 2021-2022

SYLLABUS OF THE EDUCATIONAL COMPONENT
«MODERN PROBLEMS OF BIOPHYSICS»

Normative or selective educational component: selective

Form of education: full-time
(full-time, part-time, remote)

Field of knowledge 22 "Health care"
(code and name of the direction of training)

Major field 221 "Dentistry"
(code and name of the specialty)

Specialization (if present): _____

Educational professional program (educational scientific program): "Dentistry"

The second (master's) level of higher education

Year: 2

This syllabus was approved at the meeting of the department of medical and biological physics and medical informatics

Record № 7 dated
27 August 2021,

Acting Head of Department

_____ prof. O.V. Zaytseva

Approved by the methodological committee on international students training (KhNMU)

Record № 1 dated
31 August 2021,

Head

_____ S.O.Krasnikova

SYLLABUS DEVELOPERS

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

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

3. Chovpan Ganna, associate professor, PhD (Physics and Mathematics).

4. Rukin Oleksiy, senior lecturer, PhD (Physics and Mathematics).

INFORMATION ABOUT TEACHERS TEACHING THE EDUCATIONAL COMPONENT

Surname, name, position, academic title, scientific degree:
Rukin Oleksiy, senior lecturer, PhD (Physics and Mathematics).

Professional interests, link to the teacher's profile (on the website of the university, department, in the Moodle system, etc.):
mathematical modeling in biology and medicine
http://distance.knmu.edu.ua/user/profile.php?id=803

Contact phone: (057) 707-73-67
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Consultations (face-to-face consultations: schedule and venue; online consultations: schedule, links to electronic resources): face-to-face and online consultations are 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 room No. 1

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" are 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.

Interdisciplinary connections

Course "Modern problems of biophysics":

- is based on the study of disciplines: medical biology, morphological disciplines and integrates with these disciplines;
- lays the foundations for the study of disciplines: social medicine, hygiene and ecology, physiotherapy, radiology (radiation diagnostics and radiation therapy);
- 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 Biology", "Medical Chemistry".

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 "Social Medicine", "Hygiene and Ecology", "Normal Physiology", "Physiotherapy", "Medical Radiology (radiation diagnostics and radiation therapy)", "Biological Chemistry", "Ophthalmology".

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	Integral competence	Ability to solve typical and complex specialized problems and practical problems in professional activities in the field of health care and / or in the process of further training using modern physical theories and methods of research of living organisms, biological objects and processes. in nature using a set of interdisciplinary knowledge and in the absence of information.
2	General competencies	1. Ability to apply knowledge of medical and biological physics in practical situations; 2. Knowledge and understanding in the field of sciences that form the basis of biological and medical physics; 3. Ability to communicate on topics related to the problems of biophysics in the native language both orally and in writing; 4. Ability to understand the principles and methods of graphical and analytical presentation of scientific information; 5. Ability to use information technology to study medical and biological processes; 6. Ability to acquire new knowledge and be modernly educated, aware of the possibility of lifelong learning; 7. Ability to work both independently and in a team; 8. Life safety skills; 9. Tendency to preserve the natural environment and ensure sustainable development of society; 10. Recognition of moral and bioethical aspects of research and the need for intellectual integrity, as well as professional codes of conduct.
3	Special (professional) competencies	1. Ability to replenish knowledge and understanding of the basic physical characteristics of medical and biological systems, the physical basis of the processes occurring in living organisms;

		2. Ability to integrate basic knowledge of physics, chemistry, biology, mathematics, information technology to create a foundation of professional competencies; 3. Ability to collect, record and analyze data from biomedical research using appropriate methods and technological means; 4. Ability to apply quantitative methods in the study of medical and biological processes; 5. Ability to interpret the general physical and biophysical patterns that underlie the functioning of the human body; 6. Ability to explain the physical basis and biophysical mechanisms and effects of the interaction of physical fields with the human body; 7. Ability to explain the physical foundations of the operation and use of modern (electronic) medical devices; 8. Ability to analyze the composition and physical principles of operation of medical devices and equipment; 9. Ability to conduct laboratory tests and observations; 10. Knowledge of modern methods of mathematical modeling and the possibility of their use in the study of medical and biological processes; 11. Knowledge and use of theories, paradigms, concepts and principles, specific for biological and medical physics; 12. Ability to plan, organize and conduct medical and biological research and reporting.

1.3.2. The study of the discipline provides students with the acquisition of the following **program learning outcomes**:

1) knowledge and understanding of the general physical and biophysical laws that underlie the processes occurring in the human body;
2) knowledge and understanding of the characteristics of external physical factors that may influence the human body and the biophysical mechanisms of their effects;
3) knowledge and understanding of the physical foundations, principles of operation, basic characteristics and purpose of medical electronic equipment, safety when working with it.

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

1) ability to analyze and apply in medical practice the basic concepts, laws of biophysics;
2) ability to explain the physical basis and biophysical mechanisms and effects of the interaction of electric currents and electromagnetic fields with the human body;
3) ability to correctly explain the physical basis of operation and use of modern electronic medical devices used in medical diagnostics and therapy (in particular, in electrocardiography, rheography, impedance plethysmography, audiometry, optical and quantum mechanical devices and systems, radiometric and dosimetric devices).

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>selective</td></tr>
<tr><td rowspan="9">Total hours: 90

Hours for full-time (or evening) form of study:
classes: 30
self-study: 60</td><td rowspan="9">Specialty:
221 “Dentistry”

Educational degree:
the second (master's) level of higher education

Educational professional program:
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>Lectures</td></tr>
<tr><td>–</td></tr>
<tr><td>Practical classes, seminars</td></tr>
<tr><td>30 hours</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. Practical 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,	Oral questioning, written (or computerized) test, individual tasks, portfolio method (abstracts, essays,
2	Diagnostics and monitoring of hemodynamics in human organs and systems	2		
3	Physical characteristics of modern dental materials,	2		

	their influence on the organism		webinar, virtual consultation and tutorial, briefing	abstracts, workbooks, etc.)
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 diagnostics	2		
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 dental 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 mechanical phenomena in medicine. (For topic No. 13)	5		
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", approved by the Order of KhNMU from 21.08.2021 No. 181.

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 test 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:

- the student can use his "Workbook";
- using mobile phones is strictly prohibited.

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	Insufficient

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	Not sufficient

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. 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 dental materials. Properties, physical characteristics and requirements for construction materials. Clinical materials and their properties. Auxiliary dental materials and their properties. The effect of dental 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.
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 (electrosurgery), its varieties (diathermotomy and diathermocoagulation); local darsonvalization).
16. 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).
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.
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. 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.
26. 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 action of laser radiation. Types of lasers. The use of lasers in medicine.
29. The phenomenon of electronic paramagnetic resonance (EPR). Information carried by EPR spectra. Spin marks and spin probes.
30. The phenomenon of 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.
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 lesson 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 dental materials. Properties, physical characteristics and requirements for construction materials. Clinical materials and their properties. Auxiliary dental materials and their properties. The effect of dental materials on the human body.

Assessment questions to the final lesson 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 lesson 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

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: Kh. N. M. U., 2018. - Lectures. – 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, Volodymyr; Zaytseva, Olga; Bondarenko, Maryna; Batyuk, Liliya. http://repo.knmu.edu.ua/handle/123456789/21258
4. L. Ridgway Scott, Ariel Fernandez. A Mathematical Approach to Protein Biophysics (Biological and Medical Physics, Biomedical Engineering). – Springer Publishing AG, 2017. – 290 p.
5. Tennille D. Presley. Biophysics of the Senses. – 2016. – 72 p.

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

Useful links:

1. Regulations on prevention, prevention and settlement of cases related to sexual harassment and discrimination in KhNMU http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog-sex.doc
2. Regulations on academic integrity and ethics of academic relations at Kharkiv National Medical University http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_ad_etyka_text.pdf
3. The procedure for conducting classes on in-depth study by students of Kharkiv National Medical University of certain disciplines beyond the scope of the curriculum http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/nak-poriad-pogl-vyv-dysc.docx
4. Regulations on the Commission on Academic Integrity, Ethics and Conflict Management of KhNMU http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_komis_ad_text.pdf
5. Regulations on recognition of results of non-formal education in Kharkiv National Medical University http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_neform_osv.pdf
6. Inclusive education: http://www.knmu.kharkov.ua/index.php?option=com_content&view=article&id=7108
7. Academic integrity: http://www.knmu.kharkov.ua/index.php?option=com_content&view=article&id=2520 http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/kodex_AD.docx