

**ANDREI KRUPYNSKYI LVIV MEDICAL ACADEMY**

**Faculty № 1**

*Department of Fundamental Disciplines*

**APPROVED**

**Vice-Rector for Educational Work**

\_\_\_\_\_ **Ph.D. in Chemistry Soika L.D.**

« \_\_\_ » \_\_\_\_\_ **2021**

**SYLLABUS**

**of the discipline**

**“MEDICAL AND BIOLOGICAL PHYSICS”**

**for training of specialists for the Bachelor degree of higher education**

**branch of knowledge: 22 “Health care”**

**Specialty: 223 “Nursing”**

**Discussed and approved at the meeting of Department of Fundamental Disciplines**

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Protocol № \_\_\_ from « \_\_\_ » August, 2021

Head of the Department \_\_\_\_\_ assoc. professor Sopneva N.B., Ph.D. in Pedagogy



## Syllabus of the discipline

### “Medical and Biological Physics”

<b>Branch of knowledge</b>	22 “Health care”
<b>Specialty</b>	223 “Nursing”
<b>Specialization</b>	Nursing
<b>Academic degree</b>	Bachelor
<b>Discipline status</b>	<b>Normative</b>
<b>Group</b>	<b>I MCI-21, I MCI-22</b>
<b>The language of instruction</b>	English
<b>The department to which the discipline is assigned</b>	Department of Fundamental Disciplines
<b>Teacher of the discipline</b>	Sushko Olha, Ph.D. in Biology
<b>Teacher’s contact information</b>	E-mail: <a href="mailto:o.sushko@lma.edu.ua">o.sushko@lma.edu.ua</a> The presence of the group in the Telegram and Hangouts ( <a href="mailto:o.sushko@lma.edu.ua">o.sushko@lma.edu.ua</a> )
<b>Consultations</b>	According to the consultation schedule. Online consultations are possible through ZOOM, Meet, or similar resources. To agree on the time of online consultations students should write to the teacher's e-mail or call.
<b>Discipline page</b>	<a href="https://vl.lma.edu.ua/course/view.php?id=237">https://vl.lma.edu.ua/course/view.php?id=237</a>
<b>Information scope of academic discipline</b>	The amount of credits – 2.5 credits The amount of total hours – 75 hours Modules –2 The year of training – 1st Semester – 2nd Lectures – 14 hours Laboratory works/ Practical classes – 26 hours Self-study – 50 hours.
<b>Short annotation of the discipline</b>	<p>Syllabus of the discipline “Medical and Biological Physics” is developed according to the requirements of the Academic Standard of Bachelor of Science in Nursing (branch of knowledge: 22 “Health care”, 223 “Nursing”).</p> <p>Syllabus of a discipline “Medical and Biological Physics” in terms of its content is a document that defines the amount of knowledge that a student should master in accordance with the requirements of the educational and professional characteristics of future specialist; algorithm for studying of the educational material of the discipline taking into account the interdisciplinary relations that eliminates duplication of educational material in studying general problems of different courses; necessary methodological support, components and technology of assessment of student learning.</p>
<b>Purpose and goals of the discipline</b>	The <i>purpose</i> of the discipline "Medical and Biological Physics" is to enhance and improve students’ 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

	<p>human body in treatment; physical properties of materials used in medicine and pharmacy; physical properties and characteristics of the environment.</p> <p>The <b>goals</b> of the discipline “Medical and biological physics” are to study:</p> <ul style="list-style-type: none"> <li>✓ the physical bases and biophysical mechanisms of external factors (fields) effects on the human body systems;</li> <li>✓ the physical phenomena underlying diagnostic and physiotherapy (curative) methods used in medical equipment;</li> <li>✓ the general physical and biophysical regularities that underlie human life.</li> </ul> <p>As a result of learning "Medical and Biological Physics" student have to <b>know</b>:</p> <ul style="list-style-type: none"> <li>✓ physical bases and biophysical mechanisms of external factors effects on the human body systems;</li> <li>✓ fundamental physical and biophysical laws that underlie the human life;</li> <li>✓ physical bases of diagnostics and physiotherapy (curative) methods used in medical equipment.</li> </ul> <p><b>be able to</b>:</p> <ul style="list-style-type: none"> <li>✓ perform a statistical analysis of experimental results;</li> <li>✓ model a simple biological systems;</li> <li>✓ analyze the physical processes in the body using physical laws and phenomena.</li> </ul>
<b>Program learning outcomes</b>	<p>Use computer and communication technologies to search for information and document performance.</p> <p>Adhere to the principles of professional ethics, tolerant and unwise behavior.</p> <p>Adhere to the principles of universal morality and respect for human dignity.</p>
<b>Course police</b>	<p><b>Adherence to the principles of academic integrity.</b> No forms of violation of academic integrity are tolerated. It is expected that students' works should be independent, with their own original research or thinking. For people with special educational needs, this requirement is applied to their individual needs and abilities. The use of external sources is prohibited during the performance of written tests, module works, testing, during preparation for the answer at the exam. Detection of signs of violation of academic integrity in student's written work is the basis for its non-enrollment by the teacher.</p> <p><b>Adherence to the principles and norms of ethics and professional deontology.</b> During classes students of higher education act from the positions of academic integrity, professional ethics and deontology, follow the rules of internal regulations of the Academy. During the fight against the COVID-19 pandemic students should follow all the guidelines of the anti-epidemiological regime: wear masks, adhere to social distance, use antiseptics. Students should behave tolerantly and friendly in communication between themselves and teachers.</p> <p><b>Attending classes.</b> Students should attend all lectures, practical classes and laboratory works of the course and inform the teacher about the inability to attend classes.</p> <p><b>Deadline policy.</b> Students are required to adhere to the deadlines determined by the course in general and all types of work in particular.</p> <p><b>The procedure of working off missed classes.</b> Students can work off classes which were missed without a significant reason in accordance with the schedule of working off and consultations. Classes which were missed for a significant reason can be worked out at any time convenient for the teacher.</p> <p>Reassignment of the final grade in order to increase it is not allowed, except situations provided by the regulations of the Academy, or non-appearance for the final control for a significant reason.</p>
<p><b>Structure of the discipline</b></p> <p><b>TOPICS OF LECTURES</b></p>	

<b>№</b>	<b>Name topics</b>	<b>Number of hours</b>
1.	Introduction. Basic principles of biomechanics and bioacoustics	2
2.	Physical bases of biorheology and hemodynamics	2
3.	Electrical properties of cells, tissues and organs. Methods of registration of medical and biological information	2
4.	Basic principle of electrotherapy	2
5.	Thermal radiation. Basic provisions of quantum mechanics	2
6.	Optical phenomena, their use in biology and medicine	2
7.	X-rays. Radioactivity. Radiology	2
	<b>Total:</b>	<b>14</b>

### TOPICS OF LABORATORY WORKS

<b>№</b>	<b>Name topics</b>	<b>Number of hours</b>
1.	Measurement of hearing threshold by audiometric method	2
2.	Study of elastic properties of biological tissues	2
3.	Determination of dependence of liquid's surface tension coefficient on temperature and surface-active substance	2
4.	Measurement of coefficient of viscosity	2
5.	Determination of rheological properties of blood, blood flow velocity	2
	<b>Total:</b>	<b>10</b>

### TOPICS OF PRACTICAL CLASSES

<b>№</b>	<b>Name topics</b>	<b>Number of hours</b>
1.	Study of equipment (electrodes and sensors) for the collection of medical and biological information from the studied organism. Work with an electrocardiograph	2
2.	Work with physiotherapy equipment	2
3.	<b>Control work on Sections 1 and 2.</b> Basic principles of biomechanics, bioacoustics, biorheology, hemodynamics and electrodynamics	2
4.	Study of physical characteristics of thermal radiation of the human body, its thermoregulation	2
5.	Study of the functional features of the human eye	2
6.	Microscope study and measurement of micro-objects	2
7.	Physical bases of radiodiagnostics and radiotherapy. Working with the dosimeter	2
8.	<b>Control work on Sections 3 and 4.</b> Quantum-mechanical, optical methods and basics of radiation physics	2
	<b>Total:</b>	<b>16</b>

### TOPICS FOR STUDENT'S SELF-STUDY

<b>№</b>	<b>Name topics</b>	<b>Number of hours</b>
1.	Anthropometric and mass-inertial characteristics of man	2
2.	Muscles. Muscle work	2
3.	Infrasound and its effects on the human body	2
4.	Rheography is a method of examining the general and organ circulation	2
5.	General concepts of thermodynamics	2

6.	Structure and physical properties of biological membranes and their functions	4
7.	Equipment (electrodes and sensors) for registration of medical and biological information	4
8.	Application of modern medical equipment in diagnostic, medical and rehabilitation institutions	4
9.	Preparation for control work 1	4
10.	Modern views on the mechanism of action of the magnetic field on the human body	2
11.	Luminescent methods in medical and biological research	2
12.	The role of microwave resonance therapy in the treatment of diseases	2
13.	Laser acupuncture	2
14.	Nanotechnologies and prospects of their application in medicine	2
15.	Cryomedicine and directions of its development	2
16.	The use of fiber optics in practical medicine	2
	<b>Total:</b>	<b>50</b>

<b>List of recommended literature</b>	<p><b>Basic sources:</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>Davidovits P. Physics in Biology and Medicine. Elsevier, 2001. – 303 p.</li> <li>Newman J. Physics of the Life Sciences. Springer, 2008. – 718 p.</li> <li>Herman I.P. Physics of the Human Body. Springer, 2008. – 860 p.</li> <li>Hobie R.K., Roth B.J. Intermediate Physics for Medicine and Biology. Springer, 2007. – 616 p.</li> </ol> <p><b>Additional sources:</b></p> <ol style="list-style-type: none"> <li>Cotterill R. Biophysics. An introduction. J.Wiley&amp;Sons, 2004.</li> <li>Glaser R., Biophysics, Springer, 2004.</li> <li>Ronto G., Tarjan I. (Eds.): An Introduction to Biophysics with Medical Orientation, (3rd ed.), Akadémiai Publishing Company, Budapest, 1999.</li> <li>Hendee W., Ritenour R. Medical imaging physics. J.Wiley&amp;Sons, 2002.</li> </ol>
<b>Control methods</b>	<p><b>Current control</b> is realized on the basis of the control of theoretical knowledge, skills and abilities.</p> <p><i>Forms of current control.</i></p> <ol style="list-style-type: none"> <li>Oral survey (frontal, individual, combined survey);</li> <li>Practical test of formed professional skills;</li> <li>Test control (open and closed tests).</li> </ol> <p><b>Individual work</b> of students is evaluated on practical classes and is part of the final grade of the student.</p> <p><b>Final control</b> is carried out in the form of a written exam.</p>
<b>Teaching methods</b>	<ul style="list-style-type: none"> <li>✓ verbal methods (lectures, discussion);</li> <li>✓ visual methods (illustration, demonstration, frontal experiment);</li> <li>✓ practical methods (laboratory work and solving of problems with professional content);</li> <li>✓ individual work of students with comprehension and learning of material;</li> <li>✓ use of control and training computer software in the discipline;</li> <li>✓ use of project method for interdisciplinary integration.</li> </ul>
<b>Necessary equipment</b>	<p><b>In normal training mode.</b> Studying the course involves joining each student to the learning environment MOODLE, or Google Classroom.</p> <p><b>In the distance learning mode during quarantine,</b> the study of the course additionally involves joining each student to the programs ZOOM, or Meet (for classes in video conferencing). In this case, the student must take care of the quality of Internet access.</p>

**List of questions for final module control**

1. Acoustics. Physical characteristics of sound. Physics of hearing, the characteristics of acoustical sensation. Weber-Fechner law.
2. Audiometry. The scale of intensity and scale of loudness of sound, units. Thresholds of audibility and painful sensation. Audiogram.
3. Ultrasound. The basic properties of propagation of ultrasound. Infrasound, physical characteristics of an infrasound. Action of ultrasound and infrasound on biological tissues and organs of a human body.
4. Deformations, their kinds. Elasticity and plasticity. Hooke's law. Young's modulus. Poisson's coefficient. Deformation properties of biological tissue.
5. Nature of surface tension. Coefficient of surface tension and methods of its determination.
6. What substances are named the surface-active? Their influence on the coefficient of surface tension.
7. Laminar and turbulent flow. Reynolds number. Bernoulli equation. Flow of viscous liquids. Poiseuille formula. Hydraulic resistance.
8. The structural organization of biological membranes. Physical properties of membranes. A liquid crystal state of biomembranes. Dynamic properties of membranes.
9. Passive transport of substances through membrane structures. Fick's equation. Speed of diffusion. Nernst-Planck's equation. Electrochemical gradient and potential. Theorell's equation.
10. Active transport, the main kinds. The molecular organization of active transport using the example of work K-Na pump. Conjugation of flows.
11. The nature of membrane potential of rest (equilibrium Nernst's potentials for different ions, diffusion, Donnan's potential).
12. Potential of action (PA). Hypothesis of occurrence of PA. The equivalent electric circuit of a membrane. Phenomenological equations of Hodgkin-Haksley. Concept about goal ionic currents.
13. Electric characteristics of biological tissues. The Ohm's law in the differential form. Conductivity of biological tissues. Capacitance properties. The equivalent electric schemes.
14. Biophysical bases of electrography. Concept of the equivalent electric generator. Einthoven conception about electrocardiogram (an integrated electric vector of heart, dipole potential, system of leads).
15. Magnetic field and its characteristics. Biot-Savart-Laplace law. Magnetic properties of substances. Physical bases of magnetobiology.
16. Physical bases of therapeutic methods (galvanization, franklinization, diathermy, inductothermy, d'arsonvalisation, UHF- and SHF- therapy, microwave resonant therapy). Thermal and specific action.
17. Quantum mechanical model of hydrogen atom. The Schrodinger's equation. Quantum numbers. Energy levels. Pauli's principle.
18. Radiation and absorption of light by atoms and molecules. Spectra of radiation and absorption. Spectrophotometry.
19. Thermal radiation of bodies, its characteristics. Absolute black and grey bodies. Kirchhoff's law. Thermal radiation of a human body. Thermography.
20. Luminescence: types, the basic regularities, properties. Stoke's law. Application of luminescence in medicine.
21. Stimulated radiation. Equilibrium and inverse population of energy levels. Lasers, a principle of action and applications in medicine.
22. Elements of geometrical optics. Centred optical system. Optical microscopy. Characteristics of a microscope.
23. Polarization of light. Ways of obtaining of polarized light. Double refraction. Nicol's prism. Malus' law.
24. Optically active substances. Angle of rotation of the plane of polarization. Biot law. Concentration polarization.
25. Absorption of light. Bouguer's law. Absorption of light by solutions.

	<p>Bouguer-Lambert-Beer's law. Concentration colorimetry.</p> <p>26. Scattering of light in disperse mediums. Molecular scattering of light. Rayleigh's law. Nephelometry.</p> <p>27. Thermal radiation of bodies, its characteristics. Absolute black and grey bodies. Kirchhoff's law. Thermal radiation of a human body. Thermography.</p> <p>28. The law of radiation of absolute black body: the law of radiation of Planck, Stephan-Boltzmann's law, Wien displacement law.</p> <p>29. Luminescence: types, the basic regularities, properties. Stoke's law. Application of luminescence in medicine.</p> <p>30. X-ray radiation, a spectrum and characteristics, application in medicine. Interaction of X-ray radiation with substance. The law of damping of X-ray radiation.</p> <p>31. Radioactivity. Kinds of a radioactivity. The main law of radioactive decay. A half-life time. Activity, units of activity.</p> <p>32. Ionizing radiation and its kinds. Interaction of ionizing radiation with substance. Protection against action of ionizing radiation. Biophysical bases of interaction of ionizing radiation.</p> <p>33. Dosimetry of ionizing radiation. The exposure and absorbed dozes. Biological action of radiation, biological equivalent doze. Power of doze. Units of dozes and powers of dozes.</p>
<b>Survey</b>	A questionnaire to assess the quality of the course will be provided upon completion of the course