FACULTY OF MEDICINE

STUDY PROGRAM 0912.1 MEDICINE

DEPARTMENT OF HUMAN PHYSIOLOGY AND BIOPHYSICS

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum in Medicine II
Minutes No. 1 of 16.09.21
Chairman Chairman, PHD, professor,
Suman Serghei _____

APPROVED
at the Council meeting of the Faculty Medicine II
Minutes No. 1 of 21.09.21
Dean of the Faculty Medicine 2,
doctor of medicine,assoc. professor,
Mircea Bețiu _____

APPROVED
approved at the meeting of the chair Human Physiology and Biophysics
Minutes No. 3 of 09.09.2021
Head of chair PHD, professor,
Victor Vovc _____

SYLLABUS
DISCIPLINE **BIOPHYSICS**

Integrated studies

Tipe of course: **Compulsory**

Syllabus developed by the team of authors:
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I. INTRODUCTION

II. General presentation of the discipline: place and role of the discipline in the formation of the specific competences of the professional / specialty training program

Biophysics is an interdisciplinary science that studies physical and physico-chemical processes in biological organisms, as well as the influence of physical factors on living organisms. Biophysics is the science that studies the physical properties of molecules, complexes of molecules, cells in complex biological systems, and the physical and physico-chemical processes that take place in them. Biophysical research is widely used to study the mechanisms of disease in humans, to develop new medical devices, new methods of treatment and diagnosis, and to create modern medical techniques. Studies of the physical basis of biological phenomena occurring at the molecular level have become possible due to the successes of physics and physical chemistry. The intense development of science has stipulated the emergence of new physical methods, roentgen-structural analysis, radiospectroscopy, spectrometry, optical measurement methods, nuclear magnetic resonance (NMR) methods. Studies of MRI phenomena and the propagation of ultrasonic waves in tissues have led to the creation of new diagnostic methods - MRI and ultrasonography tomography. Devices for physiotherapy are created based on the influence of ultra-high frequency waves, varied spectrum lasers, UV radiation, etc.

III. Mission of the curriculum (aim) in professional training

The course of "Biophysics" aims to train the students of the General Medicine faculty with a set of skills necessary for the acquisition of the specialized courses as well as the further training of a specialist. The content units of the course "Biophysics" are structured to provide the students with skills training in several fundamental directions: a) physical analysis skills of composition, structure and development of the living matter; b) skills to use physical methods of exploration of the biological structures and the physical principles of operation of apparatus and equipment used in medicine; c) skills to analyze the influence of physical factors (such as the temperature, the electromagnetic radiation of different types, the composition and environmental parameters) on the biological systems.

IV. Language of the discipline: English.

V. Beneficiaries: students of the 1st year, faculty Medicine II.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**F.01.O.003**	
Name of the discipline		**Biophysics**	
Persons in charge of the discipline		**Ciobanu Nellu, Gubceac Natalia**	
Year	**I**	Semester/Semesters	**I**
Total number of hours, including:			**150**

Lectures	**30**	Practical/laboratory hours	**25**
Seminars	**20**	Self-training	**75**
Form of assessment	**E**	Number of credits	**5**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study the student will be able to:

- ***at the level of knowledge and understanding:***

– to distinguish the notions and physical laws that describe the structure and development of the biological systems;
– to expand the approaches used to describe the physical phenomena and the processes to elucidate the nature of the processes in the living organisms and their elements;
– to report on the similarity of the laws of the physical systems in the biological systems;
– to interpret the achievements of the contemporary physics that can be used in the medicine;
– to explain the essence of the physical phenomena and their relationship with processes in the biological organisms;
– to illustrate the analogies between the known physical systems and the biological systems;
– to exemplify the application of the contemporary physics achievements in medical practice.

- ***at the application level:***

– to use the physical facilities for study characteristic of the physical processes and the biological organisms;
– to operate with the physical quantities and their units of measurement that also characterize the biological systems;
– to model the functioning of the biological organisms based on analogy with the physical systems;
– to practice the evaluation of the activity of the living organism based on its physical parameters;
– to simulate the experiments that elucidate the action of the physical factors on the vital functions of the biological organism;
– to perform the measurements of the physical factors parameters affecting living organisms;
– to solve problems related to the parameters of the physical factors that influence the biological systems.

- ***at the integration level:***

– to generalize the basic conclusions regarding the physical phenomena and the processes in the living organism;
– to use the theoretical and practical knowledge obtained in studying of the biophysics course by correlating them with the field of activity;
– to estimate the role of physical and physicochemical processes that ensure the vital activity of the human organism;

– to give assumptions about the importance and the place of biophysics in the system of medical-biological sciences.

IV. PROVISIONAL TERMS AND CONDITIONS

In order to achieve the curriculum, the student of the 1st year must meet the following requirements:

- knowledge of the language of instruction;
- proven skills in biology, chemistry, physics at upper secondary level;
- skills in the field of information technologies (using the Internet, documenting with computer, using graphics software);
- communication skills and teamwork.

V. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/ laboratory hours/seminars and self-training

No. d/o	THEME	Number of hours			
		Lectures	Practical hours	Seminars	Self-training
1.	Introduction. The Biophysics discipline. Classification of the systems.	2			2
2.	Structure of the substance. Bohr model of the atom. Quantum numbers.	2			2
3.	Molecular biophysics. Connecting forces. Phase transformations.	2			2
4.	The water. Structure and properties of the water molecule.	2			2
5.	Biophysics of dispersed systems. The electrical properties of the solutions.	2			2
6.	Introduction to the fluid biomechanics. Dynamics of the fluids.	2			2
7.	Simple diffusion. The diffusion through membranes. The molecular transport phenomena.	2			2
8.	Bioelectrical phenomena. Membrane bio-potential.				
9.	The Electromagnetic radiance. The interaction of the photon with the substance.	2			2
10.	The thermal radiance. The laws of Kirchhoff, Stefan-Boltsmann, Wien.	2			2
11.	The luminescence. The photoluminescence. The Stokes' law.	2			2
12.	The X-radiation. The X-Ray Diffraction. The Radiography	2			2

No. d/o	THEME	Number of hours			
		Lectures	Practical hours	Seminars	Self-training
	and radioscopy.				
13.	The magnetic properties of the substance. The nuclear magnetic resonance.	2			2
14.	Visual apparatus. Reduced Eye system.	2			2
15.	Auditory analyzer. Audible perception.	2			2
16.	Structure of matter. Methods of errors calculation.			3	3
17.	Determination of viscosity of biological liquids.		3		3
18.	Ultrasound effects. Techniques and methods used in medicine.			3	3
19.	Determination of the coefficient of surface tension to liquid-air interface.		3		3
20.	Cell osmotic phenomena		1	2	3
21.	Determination of ion mobility by electrophoretic method.		3		3
22.	The water. Structure and properties of the water molecule.			3	3
23.	Emission and absorption spectra. Spectral analysis.		3		3
24.	Laser radiation. Determination of wavelength and energy of laser radiation.		3		3
25.	Determination of the concentration of solutions by the polarimetrical method.		3		3
26.	Stud Studying of colored solutions by photo-colorimetric method		3		3
27.	Determination of a biological dose with installation B-4.		3		3
28.	Detection of nuclear radiation.			3	3
29.	Magnetic properties of substances.			3	3
30.	Impedance dispersion of biological tissues.			3	3
Total		**30**	**25**	**20**	**75**

VI. PRACTICAL TOOLS PURCHASED AT THE END OF THE COURSE

VII. OBJECTIVES AND CONTENT UNITS

Objectives	Content units
Fluid biophysics	
• To define the notions of atom, viscosity, superficial tension,ultrasound, osmosis and ion mobility; • to know the SI units and medical practice for the above specified quantities; • to know the water disintegration formula as well as all water properties; • to determine the coefficient of viscosity, the surface tension coefficient, the mobility of the ions by the methods specific to each; • to apply the new studied concepts to medical practice.	1. Determination of the viscosity of the liquids. 2. Ultrasonic effects. Techniques and methods used in medicine. 3. Determination of the surface tension coefficient at the liquid-air interface 4. Cell osmotic phenomena. 5. Determination of ion mobility by electrophoretic method. 6. Water. Structure of the water molecule. 7. Fluid biophysics. Statics and Fluid Dynamics. Hemodynamics. 8. Structure of matter. Bohr's atom. Quantum numbers.
Electromagnetic radiation	
• To define the concepts of solution, emission spectra and absorption spectra, laser,impedance,polarimetry; • to know how to express the concentration of solutions; • to determine the energy of a laser quantum; • to determine the concentration of solutions by polarimetric method and photocolorimetric method; • to apply the new studied concepts to medical practice.	1. Emission and absorption spectra. Spectral analysis. 2. Laser radiation. Determination of wavelength and quantum energy. 3. Dispersion of impedance of biological tissues. 4. Determination of solution concentration by polarimetric method. 5. Studying colored solutions by photocolorimetric method. 6. Detection of nuclear radiation. Protection against ionizing radiation.
Lectures	
	1. Molecular biophysics. Connecting forces. Phase transformations.

Objectives	Content units
• To define the concepts of dispersion systems, electromagnetic radiation, thermal radiation, luminescence; • To know the types of transport through membranes; • To explain the phenomena of interaction of electromagnetic radiation with matter and its effects; • To explain the difference between X-ray, computed tomography and magnetic resonance.	2. Biophysics of dispersed systems. Electrical properties of solutions. 3. Molecular transport phenomena. Diffusion through membranes. 4. Electromagnetic radiance. Interaction of the photon with the substance. 5. Thermal radiance. The laws of Kirchhoff, Stefan-Boltzmann, Wien. 6. Luminescence. Photoluminescence. Stokes' law. 7. Radiation X. X-Ray Diffraction. Radiography, radioscopy. 8. Magnetic properties of the substance. Nuclear magnetic resonance.

VIII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY FINALITIES

✓ Professional (specific) (SC) competences

- PC1. Knowledge and understanding of the atomic and the molecular structure of the substance and its relation to the physico-chemical properties of the substance.
- PC1. Measurement and estimation of physical quantities, which characterize the properties of the substance. Performing various practical exercises related to the study of physical and biological systems.
- PC2. Analysis and comparison of different physical methods of study of the biological systems. Solving problems related to the study of physical systems that model the biological systems.
- PC2. Knowledge, understanding of the functioning principles of medical examination devices based on physical phenomena.

✓ Transversal competences (TC)

- TC1. The ability to work in a group to reach the expected goals.
- TC1. Developing auto-teaching capabilities and techniques.
- TC1. Competences to establish the interconnections between physical phenomena and biological phenomena in biological organisms.
- TC1. Competencies to elaborate and elaborate individual study projects.

- TC1. The capabilities to use the mathematical apparatus to study the physical properties of physical and biological systems.
- TC1. Ability to use different physical devices to measure physical and biological system parameters.
- TC1. Effective use of language skills, knowledge in information technologies, research and communication skills.

✓ Study finalities

Note. Discipline finatities (are deduced from the professional competences and the formative valences of the informational content of the discipline).

- Knowledge, understanding and correct use of the terminology of the Biophysics.
- Knowledge and understanding of atomic and the molecular structure of the substance and its relationship to the physico-chemical properties of the substance.
- Measurement and estimation of physical quantities, which characterize the properties of the substance.
- Solving problems related to the study of physical systems that model the biological systems.
- Analysis and comparison of different physical methods of study of the biological systems.
- Performing various practical exercises related to the study of physical and biological systems.

IX. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with information sources	Reading the lecture or the material in the manual carefully; To get acquainted with the list of additional information sources on the topic; Select the source of additional information on the topic; Reading the text entirely, carefully and writing the essential content; Formulate conclusions about the importance of the topic / subject.	• Ability to extract the essentials; interpretative skills;	During the semester
2.	Working with the notebook of	Until the presentation of the practical notebook, it is necessary to study the material	Presentation of the report, with the conclusions and the error	During the semester

	Practical Lesson	for each paper, to prepare the notebook according to the unique requirements. After the experiment, it is necessary to calculate the errors, interpret them and formulate the conclusions.	calculation.	
3.	Preparation of presentations, posters and papers	Selection of the research theme, setting the plan and the deadline. Determining the components of the PowerPoint presentation, poster or report - theme, purpose, results, conclusions, practical applications, bibliography.	The volume of work, the degree of penetration in the essence of the project theme, the level of scientific argumentation, the quality of the conclusions, the elements of creativity, the formation of the personal attitude, the coherence of the exposure and the scientific correctness, the presentation,	During the semester

X. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

✓ *Teaching and learning methods used*

Lecture lessons are held for students of the General Medicine II faculty. Seminar and laboratory lessons are held in groups. Laboratory work is performed individually by each student and ends with the teacher's assessment of the report. Seminars are used to listen to and discuss the papers prepared by the students. The assessment of the students' knowledge and skills in the Biophysics discipline takes place in the form of three evaluations/tests according to the USMF curriculum. A grade for the average assessment is made up of the current grades of each student in performing the laboratory work and the individual work of each student.

✓ ***Applied*** *(specific to the discipline)* ***teaching strategies / technologies***

Biophysics is a compulsory discipline and teaches according to the classical university standard: lectures and practical papers. The theoretical course at lectures is held by the course holders. At the initial practical work, the basic theoretical notions are discussed using modern techniques applied to the subject, followed by the laboratory work. Experiences happen with demonstration medical devices. They allow the student to practice under their own coordination. Following the experiments, the data obtained is recorded. These data are entered in the work notebook. The paper finishes with the completion of the

minutes.

✓ ***Methods of assessment*** *(including the method of final mark calculation)*

Current: frontal and / or individual control through:

- applying computerized tests,
- solving problems / exercises,
- control work.

Final: Exam.

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-9,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all stages of final examination (computer assisted, test, oral) - are expressed in numbers according to the mark scale (according to the table), and the final mark obtained is expressed in number with two decimals, which is transferred to student's record-book.

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations in the failed exam.

XI. RECOMMENDED LITERATURE:

A. Compulsory :

1. D. Croitoru, V.Vovc, N. Gubceac, V. Tonu, I. Cojocaru, Practical Papers of Medical Biophysics, 2015.

2. D. Croitoru, V. Vovc, I. Cojocaru, Lectures, Exercices, Medical Biophysics, 2014.

B. Additional

1. Philip Nelson, Biological Physics: Energy, Information, Life 2010.
2. *2.* Richard Berry, Biophysics of Molecular Motors, Oxford 2010.