

SYLLABUS

INTERNATIONAL EUROPEAN
UNIVERSITY



**SCHOOL OF
MEDICINE**

Medical and Biological Physics

2021



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Discipline

 Medical and Biological Physics

Lecturer

 Gennadiy Taranyuk

Lecturer's profile


 <https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin>

Consultations

On-campus consultations

 Fourth Tuesday of the month from 3 p.m. till 4 p.m.

Online consultations

 Second and fourth Friday of the month from 3 p.m. till 4 p.m.

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Discipline page



Form of final control

Final test

Diff.credit

Exam



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1 Discipline annotation

Medical and Biological Physics is a fundamental medical and biological discipline that studies living objects and the human body in particular, based on physical phenomena and processes that determine their functioning, and underlie diagnostic, therapeutic and preventive methods of medicine.

The discipline comprises three main sections:

Fundamentals of mathematical modeling of living systems and mathematical processing of medical and biological data

Fundamentals of Biological Physics

Fundamentals of Medical Physics

The discipline is taught in the first year of study within the 1st semester.

2 Background of the discipline

The given course on Medical and Biological Physics is based on knowledge of physics, mathematics, chemistry, and biology in accordance with the secondary school program.

3 Goal and objectives of the discipline

The goal of the Medical and Biological Physics is to provide students with a comprehensive set of general scientific, fundamental physical and biophysical knowledge required to understand medical and biological phenomena and to acquire corresponding **specialized expertise in practical medicine.**

Key objectives of the Medical and Biological Physics are:

to learn methods of mathematical modeling and statistical processing of medical and biological information;

to explore biophysical basics of human body systems functioning in norm and pathology;

to study the mechanisms of influence of physical environmental factors on the human body at the micro and macro levels of living organization;

to learn physical and technical basics of diagnostic, treatment and preventive methods of medicine, medical equipment operations.

4 Learning outcomes

Expected results of learning Medical and Biological Physics include:

- provision of students with a comprehensive system of physical and biophysical knowledge in order to understand phenomena and regularities of vital activities of the living organisms and the human body at all levels of their organization;

- proficiency in methods of mathematical modeling and statistical processing of medical and biological information;

- knowledge of mechanisms of influence of physical environmental factors on the human body;

- knowledge of physical and technical basics of diagnostic, treatment, and preventive methods of medicine;

- skills in medical equipment operations;

- ability to conduct theoretical and practical research based on the synthesis of mathematical and fundamental natural medical and biological knowledge;

- ability to solve common and specialized complex biomedical problems.

As well as:

Knowledge:

- of biophysical factors and mechanisms of human body systems functioning in norm and pathology, biophysical factors and mechanisms of etiology and pathogenesis of certain diseases;



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4 Learning outcomes

Ability:

- to apply acquired physical and biophysical knowledge
- to model problem situations based on the systematic analysis and mathematical processing of medical and biological data

5 ECTS credits

4 credits / 120 hours

6 Structure of the Discipline

Topics	Type of classes / hours				
	Lecture	Practice	Laboratory	Individual	Self-study
Section 1. Fundamentals of mathematical modeling of living systems and mathematical processing of medical and biological data					
1. Fundamentals of Calculus	2	6			2
2. Fundamentals of the Theory of Differential Equations	2	3			2
3. Modelling of dynamic processes with the use of Differential Equations	2	3			2
4. Fundamentals of Probability Theory and Mathematical Statistics	2	3			2
Total of section 1	8	15			8
Section 2. Fundamentals of Biological Physics					
5. Fundamentals of Molecular Biophysics	2	3			2
6. Fundamentals of Biological Thermodynamics	2	3			2
7. Biophysics of membrane processes	2				4
8. Membrane Potentials. Action Potential	2	3			2
Total of section 2	8	9			10
Section 3. Fundamentals of Medical Physics					
9. Bioacoustics. Biophysics of Hearing	2	3			2
10. Fundamentals of Biorheology	2	3			2
11. Fundamentals of Hemodynamics	2	3			4



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Structure of the Discipline

Topics	Type of classes / hours				
	Lecture	Practice	Laboratory	Individual	Self-study
12. Fundamentals of Biological Electrodynamics. Electrography	2	3			2
13. Fundamentals of Rheography	2				4
14. Physical bases of Physiotherapy	2	3			2
15. Biological optics. Optical methods in Medicine	2	3			2
16. Physical bases of Radiology. Radiation safety	2	3			4
Total of section 3	16	21			22
Graded Test		3			
Total	32	48			40

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Mandatory tasks

1. Application of the differential to approximate calculations and measurement error evaluation.
2. Application of the definite integral to calculate areas and volumes of figures, and estimation of averages.
3. Application of the theory of differential equations to describe vibration and wave processes.
4. Modeling of population dynamics, epidemiology, and pharmacokinetics models.
5. Application of probability theory methods and statistical analysis of medical and biological data.
6. Surface tension and its biological importance.
7. Modeling and calculation of membrane potentials.
8. Modeling of elastic properties of biological tissues.
9. Modeling and calculation of hemodynamics parameters.
10. Determining of liquid viscosity.
11. Determining of blood viscosity in clinic.
12. Calculation of hemodynamic parameters on the base of rheogram data.
13. Modeling of biological tissues impedance.
14. Processing of cardiogram data.
15. Determining of the threshold of hearing with the use of audiometric method.
16. Determining of physical effects of physiotherapy.
17. Optical methods of determining of biological liquid properties.
18. Biological effect of ionizing radiation.

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Elective tasks

1. Calculation of errors of indirect measurements.
2. Calculation of the mean arterial pressure.
3. Diffusion and heat conductivity equations, their physical and biological nature.



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Elective tasks

4. Wave processes in living systems.
5. Predator-prey population dynamics model.
6. Mathematical models in epidemiology.
7. Pharmacokinetics models.
8. Bayes' Theorem and its clinical applications.
9. Normal law of random distribution.
10. Evaluation and calculation of thermodynamic potentials.
11. The first law of Thermodynamics and its biological meaning. Calculation of body energy balance.
12. Neurotransmission.
13. Biophysical models of muscular contraction.
14. Biophysics of cardiac muscle.
15. Modeling of hemodynamic processes.
16. Ultrasonic methods of diagnostics.
17. Blood viscosity and its clinical meaning.
18. Physical principles of electrocardiography.
19. Electrography of organs and body tissues.
20. Magnetocardiography.
21. Eye as an optical system. Biophysics of vision.
22. Radiography methods.
23. Magnetic resonance imaging.
24. Calculation of radiation safety parameters.

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Signs of the Discipline

Period of teaching	Semester	International discipline integration	Year of study	Courses: general training/ professional training/elective
One semester, 16 weeks	I	available	1st year	General training course

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Assessment system and requirements

General system of discipline assessment

Overall discipline assessment:

Current student performance is assessed due to the 4-point grading scale (2; 3; 4; 5) at each practical (seminar, laboratory) class.

The final test on the discipline "Medical and Biological Physics" is carried out in the form of a graded test.

The graded test on the discipline is conducted in the form of a written test on individual variants, each of which contains 3 theoretical questions and one problem.

Written work requirements

Practical tasks and homework assignments should be prepared in a written form and provided to the lecturer for checking and assessment.

Students are admitted sitting the final graded test if they do not have missed or undone practical classes, and if their average current grade is at least 3 points due to the 4-point scale \ 120 points due to the 200-point scale.

<https://ieu.edu.ua/docs/rate-of-study.pdf>



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Discipline policy

The learning process on Medical and Biological Physics is supposed compliance with the rules that ensure effective mastery of the subject, both in theory and on practice, namely:

- lecturer and students are present in the classroom in accordance with the schedule, and the established time mode
- students attend classes regularly without missing
- lecturer and students are neatly dressed in appropriate clothing, namely in a white lab coat while the class time
- lecturer lays out the course fully in the line with the curriculum of the discipline
- students lead notes of lectures and practices
- the learning of the discipline is based on a team spirit, cooperation, and solidarity of the lecturer with the students
- subject issues are discussed in the form of free discussion between lecturer and students, and among students themselves
- lectures and practical classes conducting, except for the final test, involves independent work of students with use of information technology, and respective means of processing, storage and transmission of information, including computers, personal gadgets, and other electronic devices, as well as textbooks, manuals, methodical developments, etc.
- scientific research work of students is welcome
- essay writing is essential, and obligatory part of the learning process, and self-study
- topics of the subject matter is considered in terms of their practical importance and bioethical consistency
- mutual behavior of lecturer and students in classroom and in extracurricular time has to follow the generally accepted norms and patterns of behavior, which provide mutual respect, collegial way of relationships, and excludes religious, racial, ethnic, cultural, age, gender, social, political, and other prejudices, as well as bullying, sexual harassment, and other manifestations and forms of intolerance, and humiliation of human dignity
- any signs of corruption in the learning process, made by lecturer or by students are unacceptable

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Policy of absence and late task performance

Students who miss current control for valid reasons confirmed by documents have the right to take current control within two weeks after returning to studying.

Students who have missed classes without valid reasons, have not participated in current control activities, have not liquidated academic failure are not admitted to final semester control of this discipline. In this case, an academic staff member puts a mark 'non-admission' in the exam record.

Repeated taking of the grading exam of the discipline is appointed in case of accomplishing all types of educational, individual work stipulated by the working program of the academic discipline and is carried out according to the approved schedule of academic failure liquidation.

<https://ie.u.edu.ua/docs/050.pdf>

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Academic integrity policy

Participants of the educational process rely on the academic integrity principles

<https://ie.u.edu.ua/docs/011.pdf>



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Recommended sources of information

- Medical and Biological Physics. Part I / [V.I. Fediv, O.I. Olar, O.Y. Mykytiuk and others]. Textbook for students of higher medical education institutions – Chernivtsi: BSMU Publishing House, 2016. - 205 p.
- Medical and Biological Physics. Part II / [V.I. Fediv, O.I. Olar, O.Y. Mykytiuk, V.F. Boiechko]. Textbook for students of higher medical education institutions – Chernivtsi: BSMU Publishing House, 2017. - 235 p.
- Medical and Biological Physics. Textbook for students of higher medical education institutions / V.I. Fediv, O.I. Olar, V.V. Kulchynskyi, H. Y. Rudko. – Chernivtsi: BSMU Publishing House, 2017. - 342 p. – English.
- Irving P. Herman. Physics of the Human Body. / Springer – Verlag. Berlin, Heidelberg 2007.
- Medical and Biological Physics. MODULE 1. Mathematical processing of medical and biological data. Basic of regularities of biomechanics and electricity and their use for diagnosis and treatment. Educational-methodical textbook / ed. by V.I. Fediv // Chernivtsi, Higher State Educational Establishment of Ukraine "Bukovinian State Medical University", 2019. - 146 pp.
- Medical and Biological Physics. MODULE 2. Basic concepts and laws of electromagnetism, optics, quantum and nuclear physics. Educational-methodical textbook / ed. by V.I. Fediv // Chernivtsi, Bukovinian State Medical University, 2020. - 151pp
- Medical and Biological Physics. / edited by prof. A.V. Chalyi. – 2nd ed. – Vinnytsia, Nova Knyha, 2013. – 480 p.

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Tips on successful study during the course

- Class attendance
- Dialogue with the lecturer regarding the educational program issues
- Accomplishment of tasks according to the program
- Essay writing on program topics
- Discussion of topics and tasks in groups in the out-of-class time
- Usage of online resources