

**Odessa National Medical University**  
**Faculty of Medicine №2**  
**Department of Biophysics, Informatics and Medical Equipment**

**Syllabus course**  
**Medical and biological physics**

<b>Scope of the educational discipline</b>	90 hours, 3 credits
<b>Days, time, place of the educational discipline</b>	Time and place (number of the lecture hall, classrooms, laboratories, studios, etc.) the conduct of the educational discipline is determined in accordance with the approved schedule of classes.
<b>Teacher(s)</b>	Leonid Godlevskyi, Doctor of Medicine, Professor, Head of Department Oleksandr Mandel, Doctor of Physiology, Associate Professor, Head of Department Andriy Ponomarenko, Doctor of Medicine, Associate Professor Serhii Marchenko, Master , senior lecturer Tetyana Prybolovets, senior lecturer
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### **COMMUNICATION**

Communication with students can be done via e-mail, social networks, telephone, face-to-face meetings.

### **COURSE ANNOTATION**

***The subject of study of the discipline*** "Medical and Biological Physics" are the processes that occur in wildlife, especially in the human body, and which are explained on the basis of fundamental laws and achievements of physics to solve practical problems of dentistry and medicine.

***Prerequisites and postrequisites of the course:***

In accordance with the approved curriculum, the study of the discipline "Medical and Biological Physics" is carried out for two semesters in the first year. Thus medical and biological physics as an academic discipline:

a) integrates with such disciplines as medical and general chemistry, medical biology and others

b) lays the physical and biophysical foundations for students to study clinical disciplines of medical profile, normal and pathological physiology, biological and bioorganic chemistry, biostatistics, histology, radiology and radiation medicine, hygiene and ecology, ophthalmology, otorhinolaryngology and other disciplines.

***The purpose of teaching the discipline "Medical and Biological Physics"*** is: the formation of students' knowledge of basic physical principles and approaches to the study of processes in wildlife, physical and technical principles of medical and technical devices used in practical medicine, the use of mathematical methods biomedical research, which is the basis of subject competencies in medical and biological physics and is an integral part of the professional competence of future physicians and health professionals, as well as the basis for studying professional and clinical natural and clinical disciplines in higher medical institutions of Ukraine.

***Tasks of the discipline :***

**The main tasks of** studying the discipline "Medical and Biological Physics" in accordance with the requirements of the educational and professional program to the knowledge and skills of students are as follows:

***know:***

- basics of mathematical processing of medical and biological data;
- general physical and biophysical patterns that underlie the processes occurring in the human body;
- characteristics of physical external factors affecting the human body and biophysical mechanisms of these influences;
- physical and biophysical bases of medical materials science;
- purpose and principles of electronic medical equipment, safety precautions when working with it.

***be able:***

- to carry out mathematical and computer processing of medical and biological information;
- use medical equipment used in medicine, diagnostics, electrical stimulation and physiotherapy (in particular, in electrocardiography, rheography, impedance plethysmography, audiometry, optical and quantum mechanical devices and systems, radiometric and dosimetric control devices.

***Expected results***

The main tasks of studying the discipline "Medical and Biological Physics" are also the acquisition by students of professionally-oriented subject competencies in medical and biological physics:

**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 occur in wildlife using a set of interdisciplinary knowledge and in the absence of information.

**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. The 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. The desire 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.

### **Special (professional) competencies**

1. The 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. The 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 basis of operation and use of modern (electronic) medical devices.

8. Ability to analyze the composition and physical principles of operation of medical devices and equipment.

6. Ability to conduct laboratory tests and observations.

8. To have an idea of modern methods of mathematical modeling and the possibility of their use in the study of medical and biological processes.

9. Knowledge and use of specific for biological and medical physics theories, paradigms, concepts and principles.

10. Ability to plan, organize and conduct medical and biological research and reporting.

## **COURSE DESCRIPTION**

### ***Forms and methods of teaching***

The course will be presented in the form of lectures (20 hours) and practical (60 hours), organization of independent work of students (40 hours).

### ***The content of the discipline***

Content block 1. Probability theory and mathematical statistics.

Topic 1. Introductory lesson. Fundamentals of probability theory.

Topic 2. Fundamentals of mathematical statistics.

Content block 2. Mathematical processing of medical and biological data.

Topic 3. Mathematical processing of medical and biological data.

Topic 4. Boundary control from the material of content blocks 1 and 2. - to carry out the procedure of mathematical processing of medical and biological data, finding errors

Content block 3. Mechanics of rotational and oscillating motion.

Topic 5. Rotational motion.

Topic 6. Mechanical oscillations

Content block 4. Bioacoustics.

Topic 7. Mechanical waves. Acoustics. Physics of hearing.

Content block 5. Liquids and solids. Fundamentals of rheology and hemodynamics

Topic 8. Mechanical properties of solids and biotissues.

Topic 9. Fundamentals of bioreology.

Topic 10. The system of internal respiration.

Topic 11. Biomechanics of the heart.

Topic 12. Fundamentals of thermodynamics. Thermodynamics of biological systems

Topic 13. Physical foundations of biomembranology.

Topic 15. Bioelectric potentials

Topic 16. Boundary control from the material of content blocks 3 - 7

Content block 8. Electrostatics. Direct current.

Topic 17. Electric field.

Topic 18. Electric current. Electrophoresis.

Content block 9. Electromagnetism.

Topic 19. Magnetic field. Physical foundations of magnetobiology

Topic 20. Electromagnetic oscillations and waves

Content block 10. Fundamentals of electromedical equipment.

Topic 21. Medical electronics. Medical information retrieval system.

Content block 11. Optical methods and their use in biology and medicine

Topic 22. Interference and diffraction of light.

Topic 23. Polarized light in medical research.

Topic 24. Geometric optics. Optical systems of the eye and microscope

Topic 25. Thermal radiation. Thermography

Topic 26. Elements of quantum mechanics. Electron microscope. Quantum-mechanical methods of research of biological objects.

Topic 27. Radiation and energy absorption by atoms and molecules. Photobiological processes.

Content block 12. Ionizing radiation

Topic 28. X-rays. Physical bases of X-ray diagnostics and X-ray therapy.

Topic 29. Radioactivity. Physical bases of radiodiagnostics and radiotherapy.

Topic 30. Elements of dosimetry. Radiation protection

### ***List of recommended literature***

#### ***Basic:***

1. Intermediate Physics for Medicine and Biology / Russell K. Hobbie (Author), Bradley J. Roth. — 5th ed. — Springer Science+Business Media, 2015. — ISBN-13: 978-3319126814, ISBN-10: 3319126814
2. Compendium of Biophysics / Andrey B. Rubin First © 2017 Scrivener Publishing LLC ISBN:9781119160250 |Online ISBN:9781119160281 |DOI:10.1002/9781119160281

#### ***Additional:***

1. Biophysics: An Introduction / Roland Glaser. Springer-Verlag Berlin Heidelberg, 2012. ISBN 978-3-642-25212-9
2. Physics in Biology and Medicine - 5th Edition / Paul Davidovits. Academic Press, 2018. ISBN: 9780128137178
3. Membrane Structural Biology With Biochemical and Biophysical Foundations 2nd Edition / Mary Luckey, San Francisco State University, 2014 ISBN: 9781107030633
4. Biophysics: Tools and Techniques / Betty Karasek. East West Books, 2017. ISBN-13: 978-1632385444. ISBN-10: 1632385449

#### ***Online resources:***

1. <https://info.odmu.edu.ua/chair/biophysics/files/428/en> (Methodic resources of the department)
2. <http://amphu.org> (Medical Physics in Ukraine)
3. <http://uamedphys.blogspot.com> (Books on Medical Physics)
4. <http://iopscience.iop.org/0031-9155> (Journal of Physics in Medicine and Biology)
5. <http://mednavigator.net> (Medical search engine)
6. <https://physicsworld.com/c/medical-physics> (Information resources of medical and biological physics)
7. <http://iomp.org> (International Organization of Medical Physics)

8. <https://aapm.org/default.asp> (Website of the American Association of Physicists in Medicine)
9. <https://aapm.onlinelibrary.wiley.com/journal/24734209> ((Journal «Medical Physics»))
10. <https://efomp.org> (Website of the European Federation of Medical Physicists)
11. <https://www.facebook.com/AmericanMedicalAssociation/> (American Medical Association)

## EVALUATION

The university uses various forms of control of classes in a particular discipline (oral, written, combined, testing, practical skills, etc.). The results of students' academic performance are presented in the form of assessment on the national scale, 200-point and ECTS scale and have standardized generalized criteria for assessing knowledge:

### *National scale:*

- the grade "**excellent**" is given to the student who systematically worked during a semester, showed during examination various and deep knowledge of a program material, is able to successfully carry out tasks which are provided by the program, has mastered the maintenance of the basic and additional literature, has understood interrelation of separate sections of discipline. importance for the future profession, showed creative abilities in understanding and using educational material, showed the ability to independently update and replenish knowledge; level of competence - high (creative);

- a grade of "**good**" is given to a student who has shown full knowledge of the curriculum, successfully completes the tasks provided by the program, mastered the basic literature recommended by the program, showed a sufficient level of knowledge in the discipline and is able to independently update and update during further study and professional activity; level of competence - sufficient (constructive-variable);

- the grade "**satisfactory**" is given to the student who has shown knowledge of the basic educational program material in the volume necessary for the further training and the subsequent work on a profession, copes with performance of the tasks provided by the program, has made separate mistakes in answers on examination and at performance of examination tasks, but has the necessary knowledge to overcome mistakes under the guidance of a researcher; level of competence - average (reproductive);

- the grade **"unsatisfactory" is given** to the student who did not show sufficient knowledge of the basic educational program material, made fundamental mistakes in performance of the tasks provided by the program, cannot without knowledge of the teacher to use knowledge at the further training, failed to master skills of independent work; level of competence - low (receptive-productive).

The final control in the form of tests is evaluated on a two-point scale:

- grade **"credited" is given** to a student who has completed the curriculum of the discipline, has no academic debt; level of competence - high (creative);

- the grade **"not credited" is given** to a student who has not fulfilled the curriculum of the discipline, has an academic debt (average score below 3.0 and / or absences); level of competence - low (receptive-productive).

*The multi-point scale* characterizes the actual success of each student in mastering the discipline. Conversion of the traditional grade from the discipline to 200-point is performed by the information and computer center of the university program "Contingent" according to the formula:

***average grade point average (current / discipline) x 40***

national grade	points
«5»	185 - 200
«4»	151 - 184
«3»	120 - 150

*The ECTS rating scale* evaluates the achievements of students in the discipline who study in one course of one specialty, in accordance with the points obtained by them, by ranking, namely:

ECTS	Statistical indicator
"A"	The best 10% of students

"B"	The next 25% of students
"C"	The next 30% of students
«D»	The next 25% of students
"E"	The last 10% of students

The ECTS scale establishes the student's belonging to the group of the best or worst among the reference group of classmates (faculty, specialty), ie his rating. When converting from a multi-point scale, as a rule, the limits of grades "A", "B", "C", "D", "E" do not coincide with the limits of grades "5", "4", "3" on the traditional scale. Grade "A" on the ECTS scale cannot be equal to grade "excellent", and grade "B" - grade "good" and so on.

Students who have received grades "Fx" and "F" ("2") are not included in the list of ranked students. Such students automatically receive a score of "E" after reassembly.

The grade "Fx" is given to students who scored the minimum number of points for the current educational activity, but who did not pass the final 30 control. Grade "F" is given to students who have attended all classes in the discipline, but did not score a grade point average (3.00) for current educational activities and are not admitted to the final control.

Criteria for assessing the current performance of students should be reflected by the departments in the work programs in the disciplines, indicating a clear structure of student receipt in the assessment class.

## **COURSE POLICY**

### **Deadline and recompilation policy:**

Deadlines and transfers are carried out according to the schedule.

### **Attendance and lateness policy :**

In the absence of a student in class or when he is late, the student receives a mark n / b (was not), which requires further work in accordance with the provisions on the organization of the educational process by applicants for higher education at Odessa National Medical University.

### **Mobile devices**

During practical classes, the use of a smartphone, tablet or other device for storing and processing information is allowed only with the permission of the teacher.

The use of mobile devices and their accessories is strictly prohibited during any form of control.

**Behavior in the audience:** observance of silence among students at lectures, exceptions - students' questions to the teacher regarding the explanation of the material; working discussion atmosphere in practical classes during the survey; adherence to the ethics of academic relations.