

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

**Syllabus course**  
**Modern problems of biophysics**

<b>Amount</b>	90 hours, 3 credits
<b>Semester, year of study</b>	3rd semester, 2nd year
<b>Days, time, place</b>	The time and place (number of the lecture hall, auditorium, laboratory, studio, etc.) of the discipline is determined in accordance with the approved schedule.
<b>Teacher (s)</b>	Full Prof. Godlevsky LS, M.D., Head of Departm Assoc. Prof.Mandel OV, Ph.Dent Assoc. Prof.Zhumatiy PG, Ph.D Assoc. Prof.Matsko OM, Ph.D. Senior Lecturer Marchenko SV Senior Lecturer Pribolovets TV Senior Lecturer Tatarchuk TV Senior Lecturer Bidnyuk KA, Candidate of Medical Sciences
<b>Contact phone</b>	(048) 717-89-16; (048) 712-31-02
<b>E- mail</b>	medphys@onmedu.edu.ua
<b>Workplace</b>	Department of Biophysics, Informatics and Medical Equipment, Olgivska Str 2
<b>Consultations</b>	<i>Face-to-face consultations</i> : Thursday from 15:00 to 17:00; Saturday from 9:00 to 12:00 <i>Online consultations</i> : By prior arrangement with the teacher.

## 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 "Modern problems of biophysics" is the study of physical properties of macromolecules, methods of studying cells and intercellular interactions, as well as the physical foundations of modern methods of studying substances.

### **Prerequisites and postrequisites of lecture course are :**

"Modern problems of biophysics" as a discipline: integrates with such disciplines as medical chemistry, biochemistry, medical biology, biopharmacy , pharmacotherapy, pharmaceutical and industrial technology of medicines, etc .; lays the foundations for the study of special disciplines with students.

**The purpose of** studying the course is to master the main tasks, problems and achievements of the main directions of modern biophysics, as well as the analysis of prospects for its development.

**The main task of the** course is to present modern problems of biophysics based on the methodological value of the course and its close links with other disciplines: biology, physiology, biochemistry, cycle of chemical disciplines, biopharmacy , pharmacotherapy , pharmaceutical and industrial technology of medicines, medical equipment. , computer technology, etc. The program presents medical applications of modern advances in biophysics.

### **Elective objectives of the elective course:**

a) explain the physical foundations of modern methods of studying biological systems and imaging methods in medical diagnostics;

b ) analyze the informativeness of the considered methods and conduct a comparative analysis of their effectiveness;

c) to interpret modern principles of synergetics and general integration processes in scientific research.

Achieving these goals will allow students to master the physical and biophysical, physical, technical and mathematical knowledge and skills

necessary for the study of other theoretical and clinical disciplines. As a result of studying "Modern problems of biophysics" the student has

**Know:**

physical bases and biophysical mechanisms of action of external factors on the systems of the human body;

general physical and biophysical laws that underlie human life;

physical bases of diagnostic and physiotherapeutic (therapeutic) methods used in medical equipment.

**Be able:**

explain the physical basis of modern methods of research of pharmaceutical substances;

perform statistical processing of experimental results; to model simple biological systems;

analyze physical processes in the body, using physical laws and phenomena.

## **COURSE DESCRIPTION**

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

The course will be presented in the form of lectures (10 hours), seminars (30 hours) and independent student work (50 hours).

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

#### **Thematic plan of lectures**

1. Biological macromolecules in solutions.
2. Biophysics of proteins and nucleic acids.
3. Biophysics of proteins and nucleic acids.
4. Physical bases of visualization methods in medical diagnostics.
5. Physical bases of modern methods of research of substances.

Only 10

#### **Thematic plan of seminars**

1. Electrophoresis of macromolecules.
2. Structural models of water.

3. Modern methods of water purification.
4. Absorption and differential spectrophotometry of proteins.
5. The mechanism of action of biologically active compounds on ion channels.
6. Factors that have a detrimental effect on the cell.
7. Modeling of intercellular contacts.
8. Bifurcations and catastrophes in open medical and biological systems.
9. Method of ultrasound Doppler .
10. Methods of preparation of samples and obtaining contrast images in electron microscopy.
11. Electron microscopy of viruses and microbes.
12. Mechanisms of interaction of X-rays with matter.
13. General theory of optical rotation dispersion and circular dichroism.
14. Rayleigh spectroscopy, picosecond spectroscopy.
15. Synergetic principles of biophysics.

Total 30

### **Thematic plan of independent work of students**

1. The subject and main tasks of biophysics. Relationship between physical and biological processes in living organisms. History of development and modern directions of biophysics development. Using the results of biophysical research in practice.
2. Objects of research in molecular biophysics. Features of the chemical composition of living matter. The main types of biomolecules , differences in their structure and functions.
3. Intermolecular interactions and forces that stabilize the structure of biological macromolecules: Coulomb interaction forces Van der Waals , water hydrogen communication and its basic properties, hydrophobic interaction.
4. The method of atomic-atomic potentials and methods of studying intermolecular interactions, empirical potentials of interparticle interaction.
5. Basic physical properties of macromolecules, molecular weight, chain structure, flexibility. Internal rotation and rotary isometry.

6. Conformations of macromolecules, Gaussian balls, persistent chains, spiral configurations, the relationship between the parameters of real and model chains.

7. Conformational transformations: conformations and statistical sum; theories of cooperative transitions, the width of the temperature interval of transitions, the effect of ionization of macromolecules.

8. Macromolecules in solutions - expression of thermodynamic functions through the statistical sum, equations of state of macromolecular solutions ( lattice model), virial coefficients, theta point, excluded volume, swelling of macromolecules, macroions , equations of state in case of macromolecule ionization.

9. Methods for determining the density and volume of biomolecules

10. Optical methods for the study of biological molecules. Low-angle X-ray scattering.

11. X-ray scattering by atoms, molecules, crystal lattice . BraggWulf diffraction condition . The concept of the inverse lattice . Laue diffraction condition . Structural Equation factor  $a$  . The problem of phases in X-ray diffraction analysis and methods of its solution.

Total 50

## **11. 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 set by the dean's office.

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

In the absence of the student in class or when he is late, the student receives a mark n / b (was not), which requires further practice in the prescribed manner.

### **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 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.