

BIOPHYSICS

MSc in Molecular Biology

Division of Biophysics

Subject: BIOPHYSICS

Year, Semester: 1st year/1st semester

Number of teaching hours:

Lecture: 28

Seminar: 9

Week 1

Lecture: 1. Introduction. Electromagnetic waves, the properties of light (interference, photoelectric effect, photon theory). Matter waves. Thermal radiation.

2. Generation and absorption of X-ray. Introduction to X-ray crystallography.

Week 2

Lecture: 3. Molecule spectra, Jablonski diagram, fluorescence, fluorescence applications.

4. Sedimentation and electrophoresis. Mass spectrometry.

Week 3

Lecture: 5. Basic principles of lasers, special fluorescence methods (FRET, anisotropy, quenching, bleaching).

6. Optics, optical microscopy, introduction to electron microscopy.

Week 4

Lecture: 7. Advanced concepts of electron microscopy.

8. Nuclear physics. Nuclear binding energy, radioactivity, law of radioactive decay, radioactive series.

Week 5

Lecture: 9. Features of nuclear radiation and its interaction with absorbing material. Detection of radiation.

10. Radiation biophysics: target theory, direct and indirect action of radiation. Dosimetry. Biological effects of radiation.

Week 6

Lecture: 11. Experimental, diagnostic and

therapeutic application of isotopes. Accelerators.

12. Basic principles of nuclear magnetic resonance, NMR spectroscopy in biology and medicine.

Seminar: From the 6th week onwards, there is a 1-hour seminar per week, where the topics of the lectures are discussed in the form of a consultation.

Week 7

Lecture: 13. Advanced concepts of NMR spectroscopy.

14. Advanced concepts of X-ray crystallography

Seminar: Consultation.

Week 8

Lecture: 15. Chemical potential. Brownian motion. Diffusion at the molecular level, statistical interpretation. Fick's laws. Osmosis. 16. The structure of biological membranes. Membrane transport.

Seminar: Consultation.

Week 9

Lecture: 17. Thermodynamic equilibrium potentials (Nernst, Donnan). Diffusion potential, Goldman-Hodgkin-Katz equation.

18. Ion channels (gating, selectivity), the "patch clamp" technique.

Seminar: Consultation.

Week 10

Lecture: 19. Resting potential, action potential, and electrical excitability. Measurement of membrane potential.

20. Advanced concepts of electrophysiology

Seminar: Consultation.

Week 11

Lecture: 21. CD and Raman spectroscopy
22. Advanced microscopy techniques I.: 3D imaging and dynamical studies of cells (confocal microscopy, FRAP, FCS).

Seminar: Consultation.

Week 12

Lecture: 23. Flow cytometry and cell sorting I.
24. Flow cytometry and cell sorting II.

Seminar: Consultation.

Week 13

Lecture: 25. Advanced microscopy techniques

II.: high-resolution microscopies (AFM, STED, STORM, TIRF).

26. Basic principles of structural biology and molecular dynamics simulations

Seminar: Consultation.

Week 14

Lecture: 27. Problem-oriented, integrative lecture

28. Research in the Institute.

Seminar: Consultation.

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Subject code: AO_MBE_BIF01

ECTS Credit: 3

Department: Department of Biophysics and Cell Biology, Biophysics Division

Semester in which the course is recommended to be taken: 1st year, 1st semester.

Semester for the regular course: 1st.

Prerequisites of the course: No prerequisites.

Course coordinator: Dr. Andrea Dóczy-Bodnár

Teaching staff: Prof. Dr. Péter Nagy and the members of the Department of Biophysics and Cell Biology

Educational manager: Enikő Nizsalóczki (The location and time of office hours are posted on the website.)

E-mail: biophysedu@med.unideb.hu

Aim of the course: To provide the necessary theoretical background for the understanding the physical principles applied in molecular biology and cell biology, and for the description of the role of physical processes in living organisms (e.g. diffusion, electric properties of cells, etc.).

Introduction to (bio)physical methods used in molecular and cell biology, e.g. flow cytometry, microscopy methods.

Short description of the course: Students will be introduced to the quantitative description of the physical basis of selected topics in biology.

Structure of the course:

- Introduction to natural sciences (e.g. basic principles of atomic and nuclear physics)
- Physical principles of methods applied in molecular and cell biology (e.g. electrophoresis, sedimentation, mass spectrometry, microscopy, etc.)
- Molecular biophysics (e.g. diffusion, membrane biophysics)

Compulsory reading:

- Educational material (lecture slides, textual explanations of lectures (“booklet”) and exercises) uploaded to the educational website (e-Learning site) of the Department;
- Medical Biophysics textbook (3rd revised edition. Editors: S. Damjanovich, J. Fidy, J. Szöllősi, Medicina, Budapest, 2019, ISBN: 978-963-226-127-0).

Web page of the Department: <https://biophys.unideb.hu/en> and the link to the e-Learning site there.

Exam: Written exam during the exam period after the 1st semester. Students who attended the course and were granted with signature in a previous semester can take the exam in the 2nd semester as well in an exam course (see Requirements, point 9).

Requirements

1. Lectures: Attendance to lectures is not compulsory, but emphatically recommended. All material covered in lectures is an integral part of the subject, and therefore included in the self-control tests and the final exam. Some new concepts and ideas are discussed in the lectures only and are not present in the textbook.
2. Seminars: From the 6th week onwards, there is a 1-hour seminar per week, where the topics of the lectures are discussed in the form of consultation. Students are encouraged to ask questions related to the topics of the lectures discussed.
Attendance to seminars is compulsory, however, a student may miss maximum four classes. Based on demand, the seminars can be held in 3-hour blocks (two of the blocks scheduled for the weeks preceding the mid-semester SCTs (see point 5) and one block scheduled for the last week of the semester). If the seminars are held in blocks, a student may miss only one block.
3. Exemptions: In order to get an exemption from the biophysics course the student has to write an application to the Educational Office. The Department of Biophysics and Cell Biology does not accept such applications.
4. Conditions for the signature: the student missed four or fewer classes (if there is a one-hour seminar per week) OR maximum one block (if the seminar is held in 3-hour blocks).
5. Self-control tests: There will be 2 self-control tests (SCT) during the semester. None of the SCTs are obligatory. Each SCT will be graded (0-100 %, 0% for absence) and the results of the two SCTs will be averaged (Xave). Missed SCTs cannot be made up at a later time.

Based on the written tests, students may be offered the following final grades:

55-64.99: pass (2)

65-74.99: satisfactory (3)

75-84.99: good (4)

85-100: excellent (5)

Only those students are eligible for the offered grade, who completed both SCTs and achieved at least 50% in each case.

Those students who achieved at least 40% in both SCTs are exempted from Part I (minimum requirement questions) of the Final Examination (see point 6). In addition up to 10 points will be added to the result of the exam test as bonus points (SP: percentage average of the SCTs, BP: bonus points):

$40 \leq SP < 50$ – 6 BP

$50 \leq SP < 60$ – 7 BP

$60 \leq SP < 70$ – 8 BP

$70 \leq SP < 80$ – 9 BP

$80 \leq SP$ – 10 BP

6. Final Examination (FE): Students have three chances (A, B, C) for passing the biophysics final exam in the winter exam period after the semester in which the course was taken (or in the summer exam period for students registered for the exam course, see point 9). Students are exempted from the FE exam if the grade offered based on the self-control tests is accepted by the student (see point 5).

The FE consists of two parts:

Part I. Minimum requirement questions. It consists of a written quiz of 20 minimum requirement

questions. One must pass this part so that part II of the exam is scored. Minimum requirement questions and the answers thereto are provided on the eLearning site of the department. 14 out of the 20 questions have to be answered correctly in order to pass this part. This part of the FE is evaluated as pass or fail, once passed it is valid for further exam chances (B- or C-chance) in the same exam period or in the exam course in the same academic year.

Those students who achieved at least 40% in both SCTs are exempted from Part I of the Final Examination (see point 5).

Based on the result of Part I, a maximum of 5 points will be added to the result of the exam test as follows (MS: minimum score, BP: exam points):

$14 < MS \leq 15 - 1 \text{ BP}$

$15 < MS \leq 16 - 2 \text{ BP}$

$16 < MS \leq 17 - 3 \text{ BP}$

$17 < MS \leq 18 - 4 \text{ BP}$

$18 < MP - 5 \text{ BP}$

For students who are exempted from Part I, the bonus point offered to them based on the SCTs already includes the 5 points for minimum questions (see point 5).

Part II. Written exam. It consists of open-ended questions, fill-in-the-missing-phrase type questions, relation analysis and various simple test and multiple-choice questions, etc. Part II will only be evaluated if part I is passed.

Evaluation of the final exam: the score of part II is expressed on a percentile scale, and grades are offered according to the following scheme:

Grade	Percent
fail (1)	0 - 49.99
pass (2)	50 - 59.99
satisfactory (3)	60 - 69.99
good (4)	70 - 79.99
excellent (5)	80 -

7. Rules for the usage of calculators during self-control tests and the final examination: In order to ensure a fair evaluation, to avoid disturbances in the testing room, and to protect the security of the test material the following types of calculators are NOT permitted:

- calculators with built-in computer algebra systems (capable of simplifying algebraic expressions)
- pocket organizers, handheld or laptop computers
- any device capable of storing text. Calculators with a typewriter keypad (so-called QWERTY devices), electronic writing pads and pen-input devices are not allowed either. Calculators with letters on the keys (e.g. for entering hexadecimal numbers or variable names) are permitted as long as the keys are not arranged in QWERTY format.
- Calculators or other devices capable of communicating with other devices
- Calculators built into wireless phones
- Calculators with paper tape or models that make noise

In general, students may use any four-function, scientific or graphing calculator except as specified above. However, we reserve the right to prohibit the usage of ANY type of calculator, computer and data storage and retrieval device during some tests if no calculations or only very simple calculations are necessary. Sharing calculators during tests is not allowed, and the test proctor will not provide a calculator.

8. Information for repeaters

- students repeating the course are subject to the same regulations as those taking it for the first time

regarding attending the lectures and the seminars (see points 1 and 2);

- according to the relevant rules (point 5) self-control tests may be written and a grade may be offered again;
- the results of the self-control tests written in the failed semester are lost;
- exemptions/bonus points obtained in the failed semester or the exam period of the failed semester are lost.

9. Information for Exam Course students

Only those students may register for the exam course who attended the Biophysics Lecture course in a previous semester and obtained a signature. Points 1-5 and 8 are irrelevant. Points 6 and 7 apply fully. An exemption from writing part I of the Biophysics final exam (minimum requirement questions) based on the averages of SCTs in the 1st semester or by passing this exam part in the winter exam period is only valid for the exam course taken in the same academic year. The same applies for the bonus points. Every other student must write the minimum requirement questions, even those who passed this part of the exam in a previous exam period in another academic year. If a student passes the minimum requirement questions in the exam course, he/she will be exempted from taking this part again in the same exam period. The grade offered on the basis of SCT results could only be accepted in the 1st semester, it cannot be used in the exam course. Exam topics: all the material covered in the semester immediately preceding the semester in which the exam course is taken independent of when the student took the course previously.

10. Rules for C chance exams

Evaluation of C-chance exams is performed according to the following table:

	If result of part II is a fail	If result of part II is above the passing level
If result of the minimum requirement questions is a pass (≥ 14)	final exam grade: FAIL	exam grade is according to the result of part II as described in point 6
If result of the minimum requirement questions is a fail, but at least 12.	final exam grade: FAIL	oral exam
If result of the minimum requirement questions is less than 12.	Part II is not scored, final exam grade: FAIL	

For further information and news, check the web site of the department (biophys.unideb.hu) and the link to the e-Learning site there. The actual information for the semester (topics, dates of SCTs, etc.) will be published on the website during the first week of the semester. Any other changes during the semester (e.g. class rearrangements, etc.) will be published on the website and students will be informed during the lectures as well.