

# 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.  
2. Electromagnetic waves. Atomic and molecular spectra, basic principles of fluorescence.

#### Week 2

**Lecture:** 3-4. Selected fluorescence phenomena and applications. Lasers.

#### Week 3

**Lecture:** 5-6. Basic principles of optical geometry. Optical microscopy. Fluorescence microscopy.

#### Week 4

**Lecture:** 7-8. Modern microscopy techniques: confocal microscopy, STED, STORM.

#### Week 5

**Lecture:** 9-10. Chemical potential. Brownian motion. Diffusion at the molecular level. Fick's first law. Osmosis.

#### Week 6

**Lecture:** 11-12. Membrane structure, membrane transport. FRAP, FCS.  
**Seminar:** From the 6th week onwards, the course includes a weekly 1-hour seminar, providing an opportunity to discuss the lecture material in a consultation-based format.

#### Week 7

**Lecture:** 13-14. Electrophysiology I: Thermodynamic equilibrium potentials (Nernst, Donnan), diffusion potential. Resting membrane potential, action potential.  
**Seminar:** Consultation.

#### Week 8

**Lecture:** 15-16. Electrophysiology II: Ion channels, the patch-clamp technique.  
**Seminar:** Consultation.

#### Week 9

**Lecture:** 17-18. Flow cytometry and cell sorting.  
**Seminar:** Consultation.

#### Week 10

**Lecture:** 19-20. Structural biology I: basic principles, molecular dynamics simulations, docking, structure prediction.  
**Seminar:** Consultation.

#### Week 11

**Lecture:** 21-22. Structural biology II: Raman scattering, Raman spectroscopy, special Raman applications.  
**Seminar:** Consultation.

#### Week 12

**Lecture:** 23-24. Structural biology III: Nuclear magnetic resonance (NMR) phenomenon, basics of NMR spectroscopy.  
**Seminar:** Consultation.

#### Week 13

**Lecture:** 25-26. Electron microscopy. X-ray crystallography.  
**Seminar:** Consultation.

#### Week 14

**Lecture:** 27-28. Sedimentation methods, electrophoresis, mass spectrometry.  
**Seminar:** Consultation.

## Requirements

Subject: BIOPHYSICS

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Number of teaching hours:

Lecture: 28

Seminar: 9

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: Dr. Enikő Nizsalóczy (The location and time of office hours are posted on the website.)

E-mail: biophysedu@med.unideb.hu

**Aim of the course:** Providing the theoretical background necessary for understanding the physical and biophysical principles applied in molecular and cell biology, as well as the physical processes occurring in living systems and their biological significance. Introduction to the basic principles of biophysical methods and techniques used in modern molecular and cell biology research, with special emphasis on optical and electron microscopy methods, membrane and electrophysiological studies, flow cytometry, structural biology approaches, and separation and spectroscopic techniques used for biomolecular analysis.

**Short description of the course:** The aim of the course is to provide a quantitative approach to the physical and biophysical principles relevant to molecular and cell biology, and to introduce the theoretical foundations of modern biophysical and biomolecular research methods.

### Structure of the course:

Physical and biophysical principles in molecular and cell biology.

Theoretical background and applications of modern biophysical research methods (e.g. microscopy techniques, flow cytometry, structural biology methods).

Biophysics of biological systems at the molecular and cellular level (e.g. diffusion, membrane processes, electrophysiology).

### 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 at the lectures is not compulsory, but emphatically recommended, as the material presented during the lectures is included in the midterm tests and examinations, regardless of whether it is covered in the textbook. Some concepts and ideas are discussed in the lectures only and are not present in the textbook. The lectures are held in an interactive format, providing students with continuous opportunities to ask questions and discuss the material. At the end of three randomly selected lectures, a short test will be written on the given topic. Based on the test results, students may earn a maximum of 6 bonus points (BP) in total, which will be added to the score of the written examination (see point 6). Participation in the tests is optional, and missed tests cannot be retaken.

**2. Seminars:** From the 6th week onwards, the course includes a weekly 1-hour seminar, providing the opportunity to review and discuss the material covered in the biophysics lectures in a consultation-based format. Accordingly, students are expected to attend the seminars prepared and with questions related to the lecture material. Depending on demand, the seminars may also be organized in a block format consisting of 3×3-hour sessions, scheduled for the week preceding the mid-semester tests and for the final week of the semester. Students may miss a maximum of 4 seminar hours; in the case of block seminars, absence from a maximum of one session is permitted.

**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. Missed SCTs cannot be made up at a later time.

Based on the written tests, students may be offered the following final examination 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 BP

$15 < MS \leq 16$  – 2 BP

$16 < MS \leq 17$  – 3 BP

$17 < MS \leq 18$  – 4 BP

$18 < MP$  – 5 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 the SCTs in the 1st semester or on passing this part of the exam during the winter examination period, is **valid only for the exam course taken in the same academic year**. The same applies to the bonus points (see points 1, 5 and 6).

Any benefits obtained in previous academic years become invalid, including bonus points earned during the semester, exemption from the minimum requirement questions, and bonus points obtained by completing Part I of the examination (minimum requirement questions) in a previous academic year (i.e. students must complete the minimum requirement questions again).

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 can only be accepted in the 1st semester, it cannot be used in the exam course.

Otherwise, the rules of the examination (see points 6 and 7) are identical for the regular course and 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 ( $\geq 14$ )     | 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](http://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.