Division of Biophysics

Subject: **BIOPHYSICS LECTURE**
Year, Semester: 1st year/1st semester
Number of teaching hours:
Lecture: **24**
Seminar: **26**

1st week:
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, X-ray crystallography.
Seminar: Introduction.

2nd week:
Lecture: 3. Molecular spectra, Jablonski diagram, fluorescence, fluorescence applications.
4. Sedimentation and electrophoresis. Mass spectrometry.
Seminar: Material related to lectures 1 and 2.

3rd week:
Lecture: 5. Optics, optical microscopy, electron microscopy.
6. Lasers and their application in biology and medicine.
Seminar: Material related to lectures 3-4.

4th week:
Lecture: 7. Physical properties of sound, ultrasound, Doppler effect. Medical and biological applications of ultrasound.
8. Nuclear physics. Nuclear binding energy, radioactivity, law of radioactive decay, radioactive series.
Seminar: Material related to lectures 5 and 6.

5th week:
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.
Seminar: Material related to lectures 7 and 8.

6th week:
Lecture: 11. Experimental, diagnostic and therapeutic application of isotopes. Accelerators.
12. Basic principles of nuclear magnetic resonance, NMR spectroscopy in biology and medicine.
Seminar: Material related to lectures 9 and 10.

7th week:
Lecture: 13. Principles of tomographic methods. X-ray absorption CT. PET.
14. Magnetic resonance imaging (MRI). Gamma camera, SPECT.
Seminar: Material related to lectures 11 and 12

8th week:
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: Material related to lectures 13 and 14.

9th week:
Lecture: 17. Thermodynamic equilibrium potentials (Nernst, Donnan). Diffusion potential, Goldman-Hodgkin-Katz equation.
18. Resting potential, action potential, and electrical excitability. Measurement of membrane potential.
Seminar: Material related to lectures 15 and 16.

10th week:
Lecture: 19. Ion channels (gating, selectivity), the "patch clamp" technique.
20. The physical background of ECG and EEG.
Seminar: Material related to lectures 17 and 18

11th week:
Lecture: 21. The human ear. Mechanism of hearing. The Weber-Fechner law.
22. The human eye. Photoreceptors. The

molecular mechanism of vision.
Seminar: Material related to lectures 19 and 20.

12th week:
Lecture: 23. Biomechanics.
24. Fluid mechanics, blood circulation.
Seminar: Material related to lectures 21 and 22.

13th week:
Lecture: 25. Biophysics of respiration. (not compulsory)
26. Flow cytometry. Confocal laser scanning microscopy. (not compulsory)
Seminar: Material related to lectures 23 and 24.

14th week:
Lecture: 27. Modern microscopic techniques (atomic force microscopy, super resolution microscopy). (not compulsory)
28. Research in the Institute. (not compulsory)

Requirements

Description of the course

Subject: BIOPHYSICS LECTURE
Year, Semester: 1st year/1st semester
Number of teaching hours:
Lecture: 24
Seminar: 26
Subject code: FOBIF05T1
ECTS Credit: 3
Department: Department of Biophysics and Cell Biology, Biophysics Division
Semester recommended to take: 1st year 1st semester.
Semester for the regular course: 1st.
Prerequisites of the course: No prerequisites.
Course coordinator: Prof. Dr. Péter Nagy
Study advisor: Dr. Tamás Kovács
Teaching staff: Prof. Dr. Péter Nagy and the members of the Department
Educational manager: Dr. Enikő Nizsalóczki
E-mail: biophysedu@med.unideb.hu
Office hours: The location and time of office hours are posted on the website.

Aim of the course:
The course is aimed at providing the necessary theoretical background for the understanding the physical principles applied in biology and medicine, and for the description of the physical processes in living organisms. The course introduces students to biophysical techniques facilitating (1) the understanding of the pathomechanism of diseases; (2) understanding the physical background of diagnostic tools (e.g. ECG, MRI, PET) and therapeutic approaches; (3) development of novel diagnostic and therapeutic tools: (4) understanding the functioning of cells, tissues and organs at the molecular level in order to provide a solid background for Physiology, Clinical Physiology and Radiology.

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

Structure of the course:
Introduction to natural sciences (e.g. basic principles of atomic and nuclear physics)
Medical physics (e.g. physical principles of diagnostic and therapeutic procedures)

Molecular biophysics (e.g. diffusion, membrane biophysics)
Organ biophysics (e.g. vision, hearing, circulation)

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: http://biophys.med.unideb.hu/en and the link to the Moodle (e-Learning) within.

Exam: Written exam during the exam period after the 1st semester of the academic year. 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 the frame of the exam course (see Requirements, point 9).

Requirements

1. Lectures: Attendance to lectures is 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: Attendance to seminars is compulsory, however, a student may miss maximum 7 (seven) seminars. Students may attend the seminars according to their group assignment only. In the seminars, students are encouraged to ask questions related to the topic of the lectures discussed (see timetable of lectures and seminars). Students can earn bonus points on the seminars, counted into the result of the final exam, in the following two ways:

- Students may sign up for one short interactive presentation during the semester about the topic of the seminar (5-10 minutes; max. 2 students/seminar). The talks are graded on a scale of 0-3. This grade counts toward the bonus points earned during the semester. One student may sign up for one presentation. The grade of the presentation cannot be improved. The topic list, the requirements and the criteria for evaluation are posted on the web page of the Department on the first week of the semester.

- On each seminar (except for the 1st one) students will write a short electronic test about the topic of the seminar. Taking this electronic test is only possible with the installed tablets available in the seminar room, i.e., students cannot take the test with their own devices. The test on a certain week can only be taken once. During the semester, 13 such tests will be written, and the average of the best 10 quizzes will be calculated (Qave), based on which students will be given bonus points according to the following:
  - 6p – Qave $\geq$ 95%
  - 5p – 95% > Qave $\geq$ 90%
  - 4p – 90% > Qave $\geq$ 80%

- 3p – 80% > Qave ≥ 70%
- 2p – 70% > Qave ≥ 60%
- 1p – 60% > Qave ≥ 40%

If a student makes up for a missed seminar with another group, taking the seminar quiz is not guaranteed, it is subject to the availability of tablets installed in the seminar room.

3. Exemptions: Requests for exemptions must be turned in to the Educational Office. The Department of Biophysics and Cell Biology does not accept such applications.

4. Conditions for the signature:
- 7 or fewer absences from seminars
- Biophysics Practical course is completed successfully (i.e. the student passed the course).

5. Self-control tests: There will be 2 self-control tests (SCTs) during the semester. Topics and dates of the SCTs are provided on the departmental web site in the first week of the semester. None of the SCTs is obligatory. The type of the questions will be similar to those on the final exam (FE). The SCTs will include five minimum requirement questions as well corresponding to the SCT topics plus the physics background questions. Each SCT will be graded (0-100 %, 0% for absence) and the results of the two SCTs will be averaged (Xave). The missed test is counted as 0% in the calculation of the average. Missed SCTs cannot be made up at a later time.

Based on the written self-control tests students may obtain the following bonus points and exceptions from the final exam:
(i) if Xave is at least 66 points, the student is exempted from part I of the Biophysics final exam (minimum requirement questions, see point 6);
(ii) according to Xave students may earn SCT bonus points counted to the FE result are as follows:
Xave – SCT bonus points
0-34.99 – 0p
35-49.99 – 5p
50-54.99 – 6p
55-60.99 – 7p
61-65.99 – 8p
66-72.99 – 9p
73-78.99 – 10p
79 and above – 11p
85 and above – see point iii below

(iii) if Xave is at least 85, the student is eligible for a grade-offering oral exam conducted at the end of the semester, where – based on his/her performance – grades 4 or 5 can be offered. Topics of the oral exam only include the lectures that were not included in the two SCTs. If the student does not show up in the oral exam or his/her performance is not sufficient on the grade-offering exam, no grades are offered and the student should take the regular written FE during the exam period.

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).

The FE consists of 2 parts:

Part I – Minimum requirement questions. It consists of a written quiz of 20 minimum requirement questions. One must pass this part to have the written test (part II) evaluated. Minimum requirement questions and the answers thereto are provided on the website of the Department in the 1st week of the semester. 16 out of 20 have to be answered correctly in order to pass this part. Exemption from this part of the FE is discussed in point 5. This part is evaluated as pass or fail, once passed it is valid for further exam chances (B- or C-chance) of the FE. The result of the minimum requirement questions is not counted into the result of the written test (part II of the FE).

Part II – Written exam. It consists of essays, 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. The total bonus points for the semester are calculated in the following way:

- T: SCT bonus points (0-11)
- Q: bonus points based on the average of the 10 best seminar quizzes (0-6)
- P: seminar presentation bonus points (0-3)

The total number of bonus points (T+Q+P) will be added to the score of the written exam ONLY IF a minimum score of 45% is achieved in part II of the FE. Additional exemptions are in point 5.

Evaluation of the FE: Grade is calculated based on the sum of written exam score + bonus points (T+Q+P; see conditions for the bonus points above)

Grade	
fail (1)	0 - 54.99
pass (2)	55 - 64.99
satisfactory (3)	65 - 74.99
good (4)	75 - 84.99
excellent (5)	85 -

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:
-attendance to seminars is compulsory (see point 2)
-all exemptions and bonuses obtained during the failed semester (self-control tests, exemption from minimals) are lost
-according to the relevant rules (point 5) self-control tests may be written and exemptions may be obtained again
-in the case of schedule collisions with 2nd year classes we ask students to choose the 2nd year groups such that conflicts with the 1st year subjects can be avoided.

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 were granted with signature (for conditions of the signature, see point 4);
* OR – in the case of students who took Biophysics before the academic year of 2018/19 – completed the practical part of the unified Biophysics course successfully (i.e. completed all the labs and passed the practical exam).

Exam topics: all the material covered in the semester immediately preceding the semester in which the exam course is taken.

Bonus points collected for SCTs, seminar quizzes and seminar presentations are valid for the exam course taken **in the same academic year**. If an exemption from writing part I of the Biophysics final exam (minimum requirement questions) has been obtained based on the SCT averages, this exemption is also valid for the exam course taken in the same academic year. Every other student must write the minimum requirement questions, even those who passed this part of the exam in a previous exam period. 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. Otherwise, the structure of the final exam and its evaluation are the same as described in point 6. Rules for calculator usage, described in point 7, also apply.

10. Rules for C chance exams
Evaluation of C chance exams is conducted according to the following table:

<table>
<tr><td></td><td>Result of part II is a fail</td><td>Result of part II is at least a pass</td></tr>
<tr><td>If result of the minimum requirement questions is a pass (≥16)</td><td>Oral exam</td><td>Result of the exam is according to the rules pertaining to A and B chance exams</td></tr>
<tr><td>If result of the minimum requirement questions is a fail (<16)</td><td colspan="2">Oral exam</td></tr>
</table>