REQUIREMENTS

Semmelweis University
Host Institute:
Institute of Biophysics and Radiation Biology

Subject in Hungarian: Biofizika I.

Subject in English: Biophysics I.

Subject in German: Biophysik I.

Number of credits: 3

Number of lessons: 56 **lectures:** 21 **practices:** 35 **seminars:-**

Type of the subject: compulsory

Academic year: 2020/2021 1st semester

Lecturer: Dr. Csik Gabriella
Contact: Institute of Biophysics and Radiation Biology, +36 20 663 2124
Disposition: associate professor, habil

The goals of the course in point of view of the education:
Todays students will be the physicians of the oncoming decades. In selecting and highlighting topics of study, the first viewpoint is scientific foresight: the knowledge should be conveyed which must be pertinent to ensure first-class professional competence while keeping abreast of the most recent development in the field of study. Our aim is not only the teaching of a specific body of knowledge but also the development of the exact scientific method and concrete problem-solving abilities.

Location of the course (lectures and practices):
Basic Medical Science Center, 1094 Budapest, Tűzoltó u. 37-47.

Competences acquired by completion of the course: Students must be familiar in the basic principles of physics and mathematics

Pre-study requirements and prerequisites of course registration and completion: -

Number of students required for announcement of course *(min., max.)*: Number of students registered in NEPTUN system

Detailed course/lecture description[i]: *(to facilitate credit recognition in other institutions)*

No of weeks	Lectures - 1,5 h/week	Practices – 2,5 h/week
1	Biostatistics I: Normal distribution, parameters, sample, frequency distribution, statistical properties, estimation of parameters; linear regression	Introduction. Laboratory safety rules. Basic principles of data processing. Basic types of mathematical functions
2	Biostatistics II: Statistical inference, hypothesis testing, statistical tests (t-test for a single sample, t-test for two samples, t-test for correlation, chi-square-probe); contingency tables, applications in clinical studies	Biostatistics I. Average, standard deviation, frequency distribution. Estimation of parameters of normal distribution.
3	Radiation: characteristic parameters; classification, electromagnetic spectrum; dual nature of light, diffraction, interference, monochromators, matter wave.	Biostatistics II. Hypothesis testing
4	Interaction of light I. refraction, lenses, light microscope, electron microscopes.	Refractometry; correlation; linear regrassion
5	Interactions of light II.reflection, scattering, absorption, law of attenuation of intensity, medical applications; color of the objects,	Special microscopes

6	Thermal radiation characteristics and description; emission of the human body, medical applications, infra-diagnostics	Optics of the eye
7	Luminescence: description, characteristics, light sources, medical applications	Light emission. Luminescence spectroscopy
8	Lasers: working principle, types of lasers; fields of medical application	Polarimetry. Transverse waves
9	Special microscopic techniques: fluorescent microscope, confocal microscope, super resolution microscopes	Light absorption. Absorption spectroscopy
10	Biological effects of light, medical applications.	Signal detection in uclear medicine
11	X-radiation 1: production, spectrum, interaction with matter	Skin impedance
12	X-radiation 2: physical bases of X-ray diagnostic methods; dental X-ray, principle of CAT-scan, generations	Resonance. Deformation of elastic materials. AFM microscopy
13	Nuclear radiation: types, characteristics of them, principles of tracing with radioisotopes	Gamma absorption. Basic concepts of radiation protection
14	Nuclear radiation in the clinical practice: isotope diagnostics: bases of radioisotope diagnostic methods, gamma-camera, SPECT, PET; radiotherapy	Summary and repetition

Lecturers: Dr. Balog Erika, Dr. Csik Gabriella, Dr. Haluszka Dóra Dr. Jedlovszky-Hajdú Angéla, Dr. Liliom Károly, Dr. Veres Dániel,

Courses *(obligatory and elective)* which in part or entirely overlap the topics of above course: -

Special academic work required for completion of the course[ii]:-

Attendance on practices and lectures, replacement in case of missed sessions:
Participation in the practical lessons is compulsory. No more than three absences from practices are allowed for any reason, otherwise the semester will not be credited. Missed sessions must be reported to the teacher the week after. The missed measurements should be done with another group if possible. By the end of the practice lessons corresponding electric laboratory reports have to uploaded to the electronic system of the Institute.

Method of checking acquired knowledge during the study period[iii]:
Midterm tests will be written twice during the semester. To pass one has to get at least 50 points from the possible 100 points altogether for the two midterm. Retake will be on the 13th and 14th weeks from the material of both midterms
.

Requirements of an accepted semester *(signature of the lecturer)*: participation on at least 75 % of the practices; at least 50 % of the points possible to get from the two midterm tests are achieved; at least 75 % of uploaded laboratory reports must be confirmed by the practice teacher.

Type of the exam: oral exam/semifinal

Requirements of the exam[5]:
1. Radiation
    a) Properties and types of radiation
    b) Physical parameters of radiation
2. Law of attenuation of radiation
    a) Experimental interpretation of the law
    b) Forms and validity of the law
    c) Application of the law in medical and laboratory practice
3. Basic principles of optics I
    a) refraction of light; Fermat's principle; Snellius-Descartes law
    b) applications: prism, optical fiber
4. Basic principles of optics II

a) Reflection, spectral reflectane
b) Scattering : Rayleigh-, Mie-, Raman-scattering

5. Optics of the human eye
   a) Image formation and power of the eye
   b) Visual acuity, resolution of the eye; accommodation power, eyeglasses
6. Image formation by optical devices and their medical application
   a) Optical lenses, lens systems, microscope
   b) Resolution; Abbe’s principle
7. Light as electromagnetic wave
   a) Parameters of electromagnetic waves
   b) Family of electromagnetic radiation; electromagnetic spectrum
8. Wave nature of light
   a) Superposition, interference
   b) diffraction, optical greating, dispersion of whit light
9. Corpuscular nature of light
   a) photoelectric effect (experiment and its interpretation); the photon concept
   b) application of photoelectric phenomenon
10. Absorption of light
   a) Mechanism of light absorption; the absorption spectrum
   b) Lambert-Beer's law and its medical application
   c) Measuring techniques: light sources, monochromators, detectors
11. Blackbody radiation
   a) absorption coefficient; radiant emittance; Kirchhoff's law
   b) origin of blackbody radiation
   c) Spectrum of blackbody radiation; Wiens's displacement law
12. Basic principles of telethermography
   a) Stefan-Boltzmann law
   b) Thermal radiation of human body
   c) Other application fields of thermal radiation
13. Luminescence
   a) Mechanisms of luminescence; Kasha's rule
   b) Emission spectrum, Stokes shift
   c) Life time of fluorescence and phosphorescence
14. Application fields of luminescence
   a) Light sources based on luminescence
   b) Medical and laboratory use of luminescence
15. Concept of light amplification
   a) Optical pumping and population inversion
   b) Induced emission
16. Production of LASER light
   a) Preconditions for LASER operation
   b) Emission and properties of LASER light
17. Medical application of LASERs
   a) Characteristics of LASER light
   b) Biological effects and medical application of LASER light
18. Generation of X-ray I.
   a) Structure and operation of X-ray tube
   b) Generation and spectrum of Bremsstrahlung
19. Generation of X-ray II.
   a) Power and efficiency of the X-ray tube
   b) Generation and spectrum of characteristic radiation
20. Absorption of X-ray
   a) Attenuation and mass attenuation coefficient
   b) Mechanisms of the absorption
21. Medical application of X-ray absorption
   a) Factors influencing X-ray absorption
   b) Basic principles of X-ray diagnostics and radiation protection
   c) Application of contrast materials
22. X-ray diagnostics I
   a) Summation image; fluoroscopy
   b) X-ray image amplifier; DSA

23. X-ray diagnostics II
    a) Concept of CT; Hounsfield units, spiral CT, spatial and temporal resolution
    b) Generations of CT
24. Nuclear radiation
    a) Composition and stability of the nucleus
    b) Nuclear forces; mass defect
25. Radioactive decay law
    a) Activity; definition and factors influencing its value
    b) Change of activity in time; decay constant, half life
26. α- and β-radiation
    a) α-particle; spectrum of α-radiation; interaction with matter
    b) Types, characteristics and spectrum of β-radiation; interaction with matter; annihilation
27. Gamma-radiation and its interaction with matter
    a) Nature, characteristics and spectrum of gamma-radiation; izomeric transition
    b) Interaction of Gamma-radiation with matter
28. Basic principles of diagnostic application of radioisotopes
    a) Basic principles and information provided by isotope diagnostics
    b) Selection rules for in vivo application of radioisotopes
29. Methods in isotope diagnostics I.
    a) Isotope accumulation curve; effective and biological half life
    b) Gamma camera (structure and operation); static and dynamic pictures
30. Methods in isotope diagnostics II.
    a) SPECT
    b) PET
31. Biostatistics I
    a) Variable and probability distribution
    b) Normal distribution and its parameters
32. Biostatistics II
    a) Sample and statistical characteristics
    b) Estimation of the expected value
33. Biostatistics III
    a) linear regression
    b) correlation
34. Hypothesis testing I
    a) t-distribution; null-hypothesis;
    b) correlation t-test
35. Hypothesis testing II
    a) t-test for one sample. T-test for two samples
    β) χ^2 -test

Grading of courses[7]: The knowledge of students presented during the oral exam will be evaluated by a grade between 1-5. Midterm assessments are not included in the exam grading.

Exam registration: Semmelweis University, Neptun system

Rules of repeating exams: according to the regulation by The Study and Examination Policy

Supporting educational materials (textbooks, notes etc.)
Damjanovich-Fidy-Szöllősi (eds): Medical Biophysics (2009) Medical biophysics practices (Semmelweis Publisher, 2015) Essentials of Dental Radiography and Radiology (Elsevier 2013) Orvosi Biofizika (szerk. Damjanovich S., Fidy J., Szöllősi J.) Medicina Könyvkiadó Rt., Budapest, 2006. Uploaded e-materals

Signature of course lecturer: **Dr. Csik Gabriella**
Signature of head of department: **Dr. Kellermayer Miklós**
Date of submission: 2nd March 2020, Budapest

Opinion of OKB:
Notes from the Dean's Office:
Signature of Dean:

[i] Detailed and numbered for each week of theoretical and practical lessons one by one, indicating the names of lecturers and instructors

[ii] Eg. field practice, medical chart analysis, survey conducting, etc.

[iii] Eg. homework, report, midterm exam etc. Topics, dates, method of retake and replacement.