

Syllabus of biophysics and medical physics lecture  
First year – Specialization on General Medicine

1. Biophysics. Medical Physics. Substance structure. Definition. Brief history. Role in medical sciences. The atom. The molecule. Ionic bond. Covalent bond.
2. Elements of thermodynamic and statistical physics. General elements of electricity and magnetism. Thermodynamic parameters. Entropy. Enthalpy. Thermodynamic steady state. Non-equilibrium processes. Scientific observation and experiment. Physical methods and biophysical techniques used in medical application.
3. General elements of electricity and magnetism. Electromagnetic interaction. Types of interactions: dipole-dipole interaction; induced dipole-dipole interaction.
4. Mathematical modeling in research. Hodgkin-Huxley model. Models classification and their medical applications. Bionics and cybernetics. Protein model. Actual trends in biophysics. Biotechnologies. Biosensors. Nanotechnologies. Nanomedicine.
5. Introduction in molecular biophysics. Atoms and biomolecules in Biosystems: physical characteristics of molecular structures, interatomic forces and intramolecular forces; magnetic and electric properties of molecules. Molecular biophysics of water: structure of water molecule and relationship with their particular properties; biophysical properties of water; water in organisms, the role in thermoregulation; biophysical methods of liquids determination in different organism structure. Water and solutions.
6. Biophysics of the cell. Macromolecule biophysics (proteins and nucleic acids). Segregation steps in living tissues (ultracentrifugation) and biophysical methods of study (X-ray diffraction and NMR). Biophysical elements of primary and conformational structures of the biopolymers. Biological liquids macromolecules (biocolloids): biophysical properties. Macromolecules in biological structures. General biophysical characteristics of the cell; shape and size of the cell from biophysics point of view.
7. Human biomechanics (at microscopic level). Bio-membranes: biophysical methods of study of the bio-membranes and their component elements. Phospholipids and membrane proteins properties. Membrane fluidity (micro-viscosity). Fluid mosaic model. Biophysical processes of bio-membrane transport: classification, biophysical bases. Ionic channels: patch-clamp technique, molecular information, channel proteins. Intercellular communication theory. Classification of cell receivers. Main ways of information transmission: secondary messengers system. Intracellular receivers. Medical applications.
8. Elements of biomechanics at molecular and cell level. Fundamentals of biophysical in electrophysiology: Bio-potential of resting state – causes, computations and measurements. Action bio-potential; bio-electro-genesis at tissue and organs level. Medical applications.
9. Biophysics of blood flow. Physical-chemical phenomena in transduction of information at the cell level. Mechanical deformations at cell and tissue level. Long-term effects of pressure and some physical factors on cells and tissues. Biophysical and mechanical mechanisms of muscle contraction.
10. Biophysical elements of respiration. Physical factors in pulmonary ventilation. Biophysical parameters of pulmonary elasticity. Pulmonary surfactant.

11. Elements of sensorial biophysics. Physical signals and sensorial messages. Biophysics of hearing. Ocular diopter properties. Biophysical mechanisms of visual reception. Olfactory reception. Psychophysics; Weber-Fechner law.
12. Elements of radiobiology. Physical bases of radioactivity. Physical mechanisms of radiation matter interaction. Characteristics of radiation interaction with living structures. Ionizing radiation detection. Dose-effect relationship. Dosimetry. Radio-pathology. Radioprotection. Applications of radioisotopes in biology and medicine.
13. Effects of some physical factors on Biosystems. Temperature variation effects. Organism in hyperbaric and hypobaric medium. Effects of acceleration and imponderability on human body. Biological effects of visible radiation. Laser principles and their application. Effects of UV radiations. Magnetic field interaction with Biosystems. Elements of bio-magnetism. Ultrasounds and their effects. Biological effects of electricity.
14. Physical and biophysical bases of medical imaging. Medical imaging classification from physics point of view. Clinical scintigraphy: radioactive markers, radiopharmaceuticals. Devices of external detection of radiation. Informatics system of scintigraphy images. Ultrasound in medicine: medical applications. X-rays in medicine: physical basis of radiology, standard radiography, classical tomography, thermos-densitometry. X-ray fluorescence. Medical Resonance Imaging.

Syllabus of biophysics and medical physics practical works and seminars  
First year – Specialization on General Medicine

1. Mathematical processing of data. Average, geometric mean, harmonic mean, confidence interval. Graphical representation of experimental data.
2. Transmission microscopy and reflection microscopy. The path of light rays in the optical microscope. Physical characteristics of the microscope. Erythrocytes diameter measurements.
3. Special microscopy techniques. Immersion microscopy. Dark field microscopy. Phase contrast microscopy. Polarization microscopy. UV microscopy.
4. Traube stalagmometer. Measurements of surface tension coefficient for biological fluids. Comparative study.
5. Measurements of viscosity coefficient of biological fluids. Ostwald viscometer.
6. Transport phenomena. Measurements of diffusion coefficient. Osmosis.
7. Blood sedimentation and centrifugation. Blood sedimentation velocity. Measurements of blood centrifugation time.
8. Chromatography and electrophoresis. Column chromatography. Paper chromatography.
9. Action potentials. Action potentials study. Rheobase. Chronaxie. Refractory period. TTX and Cs effect. Simulation of membrane functioning: computer application.
10. Absorption spectrophotometry in visible and UV. Applications of visible and UV spectrophotometry. Buggier-Lambert-Beer Law. Transmittance. Absorbance. Drawing different absorption spectra for hemoglobin.

11. Refraction index. Measurements of solutions concentrations based refraction index. Variation of refraction index with concentration. Molecular agglutination. Measurements of biological fluid concentrations.
12. Optical active substances. Measurements of optical active substances. Polarization. Qualitative and quantitative determination of optical active substances.
13. Determination of the density of biological liquids with densimeter and pycnometer. Definition of mass, density, concentration of a substance.
14. Telecobaltotherapy. Practical application. Measurements of irradiation time. Calculation of absorbed dose in therapeutically gamma irradiation. Elements of radiobiology. Types of matter interaction with electromagnetic radiation. Photoelectric effect. Compton Effect. Pair production. Attenuation of X-rays and gamma rays with substance. Röntgenological and radiobiological system of units and measurements.

### Bibliography

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