



Faculty of Medicine

Department III: Functional Sciences

University Department Sub-Structure of Medical Biophysics

Associate Professor, Position 3

Topics

1. The atomic and molecular structure of matter and the biological roles of interatomic and intermolecular forces. Water: the structure of the water molecule and its electric dipole character, the role of hydrogen bonds in defining the physical properties of water, biological roles of water, hydric equilibrium and the consequences of deviations from the equilibrium between water uptake and elimination.
2. Solubility equilibria: factors that influence the solubility of a substance in a given solvent, medical uses of endothermal and exothermal processes of dissolution, the implications of the solubility product of hardly soluble ionic compounds in the formation of renal calculi, effects of pressure and temperature on gas solubility and the physical basis of the administration of anesthetic gases, the distribution of a solute between two immiscible solvents in contact.
3. Acid-base equilibria: the pH scale, the composition and role of buffer systems in stabilizing the pH of biological media, buffer systems in the blood, the dominant ionic form of a weak electrolyte in a biological fluid, the biological significance of the isoelectric pH of a protein, experimental techniques used in the measurement of the isoelectric pH.
4. Osmosis: the Van't Hoff law, the composition and osmolarity of blood plasma, osmotic fluxes through the membranes of cells in hypotonic and hypertonic solutions, the role of osmosis in the transport of micromolecules through the walls of capillary vessels. Diffusion: Fick's laws, the role of diffusion in the exchange of gases between the lungs, the blood and tissues.
5. Biological membranes and passive membrane transport: the constituents of cell membranes, membrane models, mechanisms of passive transport.
6. Active membrane transport: characteristics, the role of ion pumps and secondary active transporters in setting up and maintaining differences in ionic concentrations between the media separated by a cell membrane, the structure and function of the Na/K pump.
7. Electric properties of cell membranes: causes of bioelectrogenesis, experimental techniques used to measure membrane potentials, biophysical mechanisms involved in the generation of specific and non-specific responses of neurons, types of ion channels that contribute to an action potential and ionic movements during the phases of an action potential, the propagation of a nervous influx.
8. Synaptic transmission: types of synapses, structure and function of an electric synapse, structure of a chemical synapse, the role of Ca^{2+} ions and of the SNARE complex in the exocytosis of the neurotransmitter, transport mechanisms implied in the recycling of lipids and neurotransmitters.
9. The biophysics of vision and hearing: the eye as an optical instrument, the structure of the retina, mechanisms of receptor potential generation in photoreceptor cells, color vision; acoustical waves, the functional anatomy of the human auditory system, biophysical mechanisms of hearing.
10. The origin and recording of biopotentials: operations with vectors, the electric potential of an electric dipole situated in a conductive medium, the physical mechanisms of the generation of biopotentials and the recording of biopotentials with surface electrodes, physical aspects of electrocardiography: the electric dipole moment of the heart, bipolar leads, unipolar leads, precordial leads, the characteristics of a 12 lead ECG recording, finding the electric axis of the heart.
11. Electromagnetic waves and elements of optics: the spectrum of electromagnetic waves (infrared radiations, visible light, ultraviolet radiations, X-rays), wave-particle duality of the electromagnetic field, properties of photons, light sources used in dental practice, refraction and reflection of light, total internal reflection of light, optic fibers and their uses in dental medicine.



12. Lasers and their applications in dental medicine: spontaneous and stimulated emission, metastable states and population inversion, the ruby laser, the He-Ne laser, the Nd-YAG laser, the CO₂ laser, the XeF excimer laser, the european classification of laser devices, applications of lasers in dental medicine (treatment of parodontosis, caries prevention, caries diagnostics, laser drilling, facilitation of teeth whitening procedures, surgery).
13. Elements of optoelectronics: semiconductors of type n and p, the structure of energy bands of semiconductors of type n and p, absorption and emission of light by semiconductors, optoelectronic devices used in dentistry (LEDs and laser diodes).
14. Color in dentistry: the structure of retina and the physiological basis of color perception, colorimetric parameters (hue, saturation and lightness), CIE standard light sources, the CIELAB color space, expressing differences in color in terms of distances between points in the CIELAB color space, color analysis in dental medicine (visual analysis and instrumental analysis by colorimetry and spectrophotometry), color communication in dental medicine.
15. Uses of X-rays in dental imaging: generation of X-rays, bremsstrahlung and characteristic radiation, attenuation of X-rays described in terms of the linear attenuation coefficient and in terms of the radiodensity (expressed in Hounsfield units HU), dental radiography, the physical principle of computed tomography (CT), classical CT, spiral CT, multi-slice spiral CT, cone-beam computed tomography (CBCT) and its uses in oral imaging (orthodontics, implantology and maxillofacial surgery).
16. The laws of classical mechanics and mechanical properties of dental materials: motion, Newton's laws, types of forces acting on hard and soft tissues from the oral environment, deformable solids, Hooke's law, Young's modulus, shear modulus, thermal expansion stress, deformability characteristics of solid dental materials.
17. The biomechanics of the rigid body: torque, the equilibrium of a rigid body, the classification of levers, anatomic levers, biomechanics of mastication, biomechanical aspects of prosthetics and dental implantology.
18. Electrochemistry and oral galvanism: redox reactions, galvanic cells, standard electrode potential, corrosion of metals in the oral environment, oral galvanism.

Bibliography

- [1] Mihalaș Gh. I., Neagu M., Neagu A., *Curs de Biofizică*, Editura Eurobit, Timișoara, 2008.
- [2] Hille B., *Ionic Channels of Excitable Membranes*, Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, 1991.
- [3] Sybesma C., *Biophysics. An Introduction*, Kluwer Academic Publishers, Dordrecht, 1995.
- [4] Bergethon P.R., Simons E.R., *Biophysical Chemistry. Molecules to Membranes*, Springer-Verlag, New York, 1990.
- [5] Kovács Eugenia et al., *Biofizică și biotehnologie celulară. Metode de cercetare. Manual de lucrări practice*, Editura Universitară “Carol Davila”, București, 2002.
- [6] Popescu A., *Fundamentele biofizicii medicale*, Editura ALL, București, 1994.
- [7] Benga G., *Biologia moleculară a membranelor cu aplicații medicale*, Editura Dacia, Cluj-Napoca, 1979.
- [8] Dimoftache C., Herman Sonia, *Biofizica medicală*, Editura Cerma, Bucuresti, 1993.
- [9] Mihăilescu D., Flonta Maria-Luiza, Movileanu L., *Probleme de biofizică*, Editura Universității din București, 1997.
- [10] Eremia, D., *Curs de biofizică medicală*, Lito U.M.F. “Carol Davila”, Bucuresti, 1993.
- [11] Ruch T.C., Fulton J.F., *Fiziologie medicală și biofizică*, Editura Medicală, București, 1963.
- [12] Atkins P.W., *Physical Chemistry*, Fifth Edition, Oxford University Press, Oxford, 1994.
- [13] Starzak M.E., *The Physical Chemistry of Membranes*, Academic Press, New York, 1984.
- [14] Ebbing D.D., Wrigton M.S., *General Chemistry*, Houghton Mifflin Company, Boston, 1990.
- [15] Martini F.H., *Fundamentals of Anatomy and Physiology*, Prentice Hall, New Jersey, 1998.
- [16] Patton H.D., Fuchs A.F., Hille B., Scher A.M., Steiner R. *Textbook of Physiology*, W.B. Saunders



Company, Philadelphia, 1989.

[17] Lehninger A.L., *Biochimie*, Editura Tehnică, București, 1987.

Notă: Titlurile bibliografice recomandate se găsesc în biblioteca Catedrei de Biofizică, Universitatea de Medicină și Farmacie “Victor Babeș” din Timișoara.