EXAMINATION SYNOPSIS

IN

„BIOPHYSICS”

FOR CONDUCTING SEMESTER EXAMINATION IN ACADEMIC YEAR 2015/2016

WITH STUDENTS FROM MU - PLEVEN SPECIALTY:

„MEDICINE“

1. Nature and subject of biophysics.
2. Molecular structure of biological systems. Intramolecular bonds, covalent bond, molecular orbitals, ionic bonds, coordinative bonds, metalloorganic complexes, hydrogen bonds.
3. Thermodynamics. Subject of thermodynamics, basic thermodynamic terms: thermodynamic system, thermodynamic variables, thermodynamic state, thermodynamic equilibrium, thermodynamic process.
4. Equilibrium thermodynamics. First law of thermodynamics. Mathematical formulation of the first law. Limitations of the first law.

5. Equilibrium thermodynamics. Second law of thermodynamics. Second law of thermodynamics. Phenomenological definition of entropy.
6. Order and probability. Thermodynamic probability and entropy. Boltzmann equation of entropy.
7. Information and entropy. Statistical definition of entropy. Shannon relation of information content. Maxwell's demon.
8. Thermodynamic potentials. Internal energy. Enthalpy. Helmholtz free energy. Gibbs free energy. Chemical and electrochemical potentials.
9. Non-equilibrium thermodynamics. Linear non-equilibrium thermodynamics Definition and basic terms. Force and motion. Phenomenological coefficients. Conjugated fluxes.
10. Non-equilibrium thermodynamics. Stationary state. Dissipative function. Entropy and stability. Stationary state.
11. Biological structures: general aspects.
12. Bioenergetics. Energy. Metabolism. Stages to catabolism/anabolism. Oxidation as a source of metabolic energy. ATP and energy transduction. Mechanism of coupling the oxidative – phosphorylation reactions.
13. Molecular separation procedures: size exclusion and thin-layer chromatography.
14. Cell membranes. Plasma membrane. Internal membranes. Lipid bilayer – unit membrane. Membrane functions.
15. Biological Membranes. Membrane lipids: the supporting structure. Phospholipids, glycolipids and cholesterol. Membrane proteins – categories. Protein functions. Membrane dynamics. Cholesterol effects on membrane fluidity.
16. Model membranes: preparation of hemosomes.
17. Paper electrophoresis: separation of proteins.
18. Transport of matter across cell membranes - classification. Classification on the basis of transport mechanism, energy supply, number of transported species and direction of their translocation, trans-membrane potential changes.
19. Passive transport. Free diffusion of non-charged and charged particles. Free diffusion of non-charged particles. Fick's law. Free diffusion of charged particles. Nernst-Planck molar flux equation.
20. Simple diffusion through membranes. Permeability. Transport of water through membranes. Filtration and osmosis.

21. Biophysics of hemodialysis: transport of urea across a semipermeable membrane.
22. Facilitated diffusion. Transport by carrier proteins. Saturability and specificity - important characteristics of the membrane transport systems. Transport by channels and pores. Three examples of pores important for cellular physiology. Ionophores.
23. Primary active transport. Sodium-potassium ATP-ase. Putative structure of sodium-potassium pump. Basic steps of ion transport process.
24. Primary active transport. Calcium ATP-ase. Putative structure of calcium pump. Basic steps of ion transport process.
25. Secondary (ion gradient-driven) active transport. Lactose permease requires a proton gradient. Putative mechanism of lactose transport in E. coli.
26. Microelectrophoresis: determination of electrokinetic (zeta) potential.
27. Diffusion potential. The Henderson equation. Time dependence of diffusion potential
28. Membrane (equilibrium) potential. The Nernst equation.
29. Donnan potential. Approach to electrical and chemical equilibrium. Gibbs-Donnan equation. Osmotic consequences of the Gibbs-Donnan equilibrium.
30. Generation of resting membrane potential. The Goldman and Thomas equations. Factors contributing to the resting potential.
31. Generation of action potential. Voltage-gated channels. Saltatory conduction.
32. Free radical biology – basic terms. Free radical reactions. Classification. Chemical reactivity of free radicals.
33. Sources of free radical generation in human body.
34. Lipid peroxidation. Basic stages. Initiation and Propagation of lipid peroxidation.
35. Lipid peroxidation. Decomposition stage Metal ions and the peroxidation processes.
36. Copper-induced superoxide production in erythrocytes.
37. Lipid peroxidation: measuring malonedialdehyde concentration.
38. Singlet oxygen – generation and role in living systems.
39. Consequences of free-radical processes in living systems.
40. Antioxidant defense system. Enzymatic antioxidants.
41. Antioxidant defense system. Non enzymatic antioxidants.

42. Lipid peroxidation and toxicology. Contribution of oxidative stress to atherosclerosis.
43. Lipid peroxidation and toxicology. The importance of oxidative stress in the development of nervous system injury.

REFERENCES:

- Alexandrova M, Lecture course, MU-Pleven
- Glaser R, Biophysics. Springer Science & Business Media, 2001 - Science - 361 pages
- Davidovits P. Physics in Biology and Medicine. 3rd Edition, © 2008, Elsevier Inc.
- An Introduction to Biophysics with Medical Orientation, ed. G. Ronto and I. Tarjan, Budapest, 1994

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