

Biophysics final exam questions ED 2014.

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 reflectance
 - 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 grating, dispersion of white 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; Wien'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; isomeric 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. Radiotherapy
 - a) Types of radiation in radiotherapy and their absorption characteristics
 - b) Relative depth-dose
32. Accelerators and therapeutic devices
 - a) Linear accelerator and cyclotron
 - b) Collimators
 - c) Gamma knives, brachytherapy
33. Dosimetry of ionizing radiation
 - a) Absorbed dose (definition, unit, validity)
 - b) Exposure, (definition, unit, validity);
 - c) Measurement of exposure

34. Detection of ionizing radiation
 - a) Devices based ion gas ionization
 - b) Scintillation counter, thermoluminescent dosimeter
35. Ionizing radiation caused damages
 - a) Characteristics of stochastic and deterministic damages; examples
 - b) Radiophysics and radiochemistry of stochastic and deterministic damages.
36. Quantitative characterization of biological effects of ionizing radiation
 - a) Equivalent dose effective dose; waiting factors;
 - b) Origin and biological significance of background radiation
37. Natural and artificial sources of ionizing radiation
 - a) Medical sources of ionizing radiation and natural background radiation
 - b) ALARA principle
 - b) PET
38. Basic principles of medical application of ultrasound
 - a) Sound and ultrasound as mechanical waves; their parameters
 - b) Propagation, absorption and reflection of US; acoustic impedance
39. Generation and detection of ultrasound
 - a) Generation and detection of US
 - b) US techniques, echo principle
40. Ultrasound imaging
 - a) US image and its interpretation
 - b) A-, B- and (T)M images
41. Doppler method; US therapy
 - a) Doppler effect and its medical application
 - b) Biological effects of US; US therapy
 - c) Shock wave therapy
42. Basic principles of electricity
 - a) Elements of electric circuits; properties and parameters
 - b) Electric behavior of biological structures
43. Detection and analysis of electric signals
 - a) Classification of signals
 - a) Electric amplifiers, types and parameters
 - b) Fourier's principle
44. Interpretation of images made by various diagnostic methods
 - a) image, pixel, voxel
 - b) Interpretation and comparison of information held by various diagnostic images
45. Medical imaging methods
 - a) Direct and computed tomographyc methods
 - b) Non-tomographyc images - types and interpretation
46. Volume transport
 - a) General characteristics of volume transport
 - b) Comparison of the flow of ideal and real fluids
47. Flow of fluids and gases; methods for measuring the volumetric flow rate
 - a) Law of continuity and the blood flow
 - b) Bernoulli's law for ideal fluids (an example of its consequences for the blood flow)
48. Flow of real fluids
 - a) Newton's law of friction (explanation and validity); its application for spherical particle
 - b) Comparison of laminar and turbulent flow; critical velocity;
49. Description and modeling of blood flow
 - a) Fluid flow in a tube; Hagen-Poiseuille's law (explanation and validity)
 - b) Application of Hagen-Poiseuille law to blood-circulation; comparison of Hagen-Poiseuille'law and Ohm's law

50. Characteristics of molecular motion
 - a) Qualitative description of molecular motion; thermal motion, Brownian motion, drift speed, mobility
 - b) Visualization and quantitative characterization of molecular motion; mean free path, mobility
51. Diffusion
 - a) Fick's first law; diffusion coefficient
 - b) Generalized continuity-equation; Fick's second law and its meaning
52. Osmosis; osmotic phenomenon
 - a) Explanation of the osmotic pressure; van't Hoff law
 - b) Problems of osmotic pressure in practice; isotonic solutions
53. Thermodynamic aspects of transport processes
 - a) Thermodiffusion; heat conduction
 - b) Extensive and intensive quantities; uniform description of transport processes; Onsager-relation
54. Transport through cell membrane; chemical and electro-chemical potential
 - a) Classification and characterization of transport processes
 - b) Membrane permeability constant; diffusion of molecules; electrodiffusion
55. Interpretation of resting membrane potential
 - a) Equilibrium model and electro-diffusion (transport) model
 - b) Equivalent circuit model of cell membrane
56. Alteration of resting membrane potential I.
 - a) Local changes of membrane potential
 - c) Time constant and space constant of the cell membrane
57. Alteration of resting membrane potential II.
 - a) Action potential; ion transport during action potential
 - b) Depolarization threshold and its changes during action potential
58. Propagation of action potential
 - a) Speed of signal propagation
 - b) Synaptic signal transmission; spatial and temporal summation
59. Basic principles of sensory function I.
 - a) Types of stimuli and modalities
 - b) Types of receptors
 - c) Psycho-physical laws
60. Basic principles of sensory function II.
 - a) receptor potential; Its parameters and role in signal transition
 - b) Connection between stimulus intensity and parameters of receptor potential and action potential
61. Physical principles of functioning of sensory organs
 - a) Biophysical basics of vision
 - b) Biophysical basics of hearing
62. Medical applications of electric pulses I.
 - a) High frequency heat therapy
 - b) Galvan therapy; iontophoresis
63. Medical applications of electric pulses II.
 - a) Stimulus characteristic curves
 - b) Parameters of electric stimuli, pacemaker
64. Basic principles of ECG
 - a) Heart muscle as source of electric signal
 - b) Integral vector
 - c) Electrodes and lead systems in ECG
65. Modern microscopic techniques
 - a) confocal laser-microscopy
 - b) two-photon excitation
66. Scanning techniques in modern microscopy
 - a) Concept of scanning
 - b) Atomic force microscope

- 67. Concept of electron microscopy
 - a) resolution of electron microscope
 - b) TEM, SEM
- 68. Biostatistics I
 - a) Variable and probability distribution
 - b) Normal distribution and its parameters
- 69. Biostatistics II
 - a) Sample and statistical characteristics
 - b) Estimation of the expected value
- 70. Biostatistics III
 - a) linear regression
 - b) correlation
- 71. Hypothesis testing I
 - a) t-distribution; null-hypothesis;
 - b) correlation t-test
- 72. Hypothesis testing II
 - a) t-test for one sample. T-test for two samples
 - β) χ^2 -test