

Questions for doctoral students for the state doctoral examination in Medical Biophysics

General Biophysics

1. Structure of electron shells in atom
2. Magnetic moment of an electron
3. Magnetic properties of the atomic nucleus
4. Principle of mass spectrometry
5. Forces acting between molecules
6. Gibbs phase rule, phase diagram
7. Electrical properties of colloids
8. Colligative properties of solutions
9. Importance of osmotic pressure for water exchange in capillaries
10. Physical laws important for the dynamics of blood circulation
11. Thermodynamic state functions
12. Chemical potential
13. Extinction, Lambert-Beer's law
14. Emission and absorption spectral analysis
15. Magnification and resolution of an optical microscope
16. Principle of electron microscope
17. Principles of ionizing radiation detection, selective and integral radiation detection of γ
18. Principle of radiation spectrometry γ
19. Methods of personal dosimetry, exposure and radiation dose
20. Measurement errors, interpolation of discrete measured values by a continuous function, least squares method
21. Physical properties of ultrasonic waves
22. Physical principles of ultrasound using in diagnostics
23. NMR principle
24. Osmotic pressure, osmotic work of kidneys
25. Diffusion
26. Active and passive transport through the cell membrane
27. Donnan's equilibrium on the cell membran
28. Principle of laser
29. Electrochemical potential, resting membrane potential 30. Effects of electric current
31. Electrodiagnostic methods
32. X-ray radiation and its absorption.
33. Principle of computer tomography CT
34. Biological effects of X-rays and γ -radiation, radiation dose, dose equivalent
35. Radioactive decay, physical, biological and effective half-life
36. Deterministic effects of ionizing radiation
37. Stochastic effects of ionizing radiation
38. Diagnosis of acute radiation disease
39. Treatment of acute radiation disease
40. Relation of physical properties of light radiation on its biological effect

Recommended literature:

- **Jiráček Daniel - Vítek František: Basics of Medical Physics. Karolinum** 2019, paperback, 226 pp.
ISBN 9788024638102
- **Jiráček Daniel - Vítek František: Basics of Medical Physics. Karolinum** 2018, published: March 2018,
e-book, ISBN 9788024638843 (PDF)
- Ivo Hrazdira, Vojtěch Mornstein: Lékařská biofyzika a přístrojová technika. Neptun 2004, ISBN-10: 80-902896-1-4
- Vojtěch Mornstein, Ivo Hrazdira, Aleš Bourek: Lékařská fyzika a informatika. Neptun 2007, ISBN-13: 978-80-86850-02-3
- Ivo Hrazdira, Vojtěch Mornstein, Jiřina Škorpíková: Základy biofyziky a zdravotnické techniky. Neptun 2006, ISBN-10: 80-86850-01-3
- Navrátil, Leoš; Rosina, Jozef a kolektiv: Medicínská biofyzika, Grada, 2005, s. 524, ISBN: 978-80-247-1152-2

Physiology

1. Cell - composition
2. Ion channels
3. Body fluids
4. Nervous system - structure, function
5. Rest and action potential
6. Synapsis
7. Muscles - structure, function
8. Skeletal muscles
9. Smooth muscles
10. Functional anatomy of the heart
11. Heart activity, ECG curve
12. Cardiac management
13. Blood circulation - functional anatomy
14. Blood composition
15. Haemoglobin
16. Red blood cells
17. Trombocytes
18. Blood groups
19. Lymphatic system
20. Leucocytes, white cells
21. Immune system
22. Respiratory system
23. Gas transport
24. Respiratory regulation
25. Kidneys
26. Acid-base balance
27. Internal CNS environment

28. Blood-brain barrier
29. Functional states of the CNS and bioelectrical activity
30. CNS integration functions

Recommended literature:

- Otomar Kittnar a kolektiv: **Lékařská fyziologie**. (Grada, 2011)
- **Elektronická učebnici Fyziologie**
- **Lékařská fyziologie**. Grada-Avicenum, Praha 1994, reedice 1996,1999,2003
- M. Langmeier a kol.: **Základy lékařské fyziologie**. Grada 2009
- O. Kittnar, M. Mlček: **Atlas fyziologických regulací**. Grada Publishing,2009
- S.Silbernagl, A. Despopoulos: **Atlas fyziologie člověka**. Grada 1993
- J. Mysliveček a kolektiv: **Základy neurověd**. Triton 2009, 2. Opravené a přepracované vydání

Biochemistry

1. Glycolysis
2. Gluconeogenesis
3. Pentose cycle
4. Citric acid cycle
5. Respiratory chain
6. β - oxidation of fatty acids
7. Amino acid conversion
8. Energy metabolism of muscle
9. Membranes
10. Transport of substances (water, ions, organic molecules)
11. Metabolism of N-acetylsparatate
12. Metabolism of creatine and phosphocreatine
13. Metabolism of choline compounds, the most important choline compounds
14. Metabolism of inositols
15. Metabolism of the most important neurotransmitters
16. Lactate metabolism
17. Glucose metabolism
18. Phenylalanine metabolism
19. Metabolism of ATP, ADP, AMP
20. The role of inorganic phosphate in metabolism

Recommended literature:

- MATOUŠ, Bohuslav. **Základy lékařské chemie a biochemie**. 1. vyd. Praha: Galén, c2010, xv, 540 s. ISBN 978-80-7262-702-8.
- PRŮŠA, Richard a kol. Errata k učebnici Matouš, B: **Základy lékařské chemie a biochemie**.
- MURRAY, Robert K. **Harperova biochemie**. 4. čes. vyd. Jinočany: Nakladatelství a vydavatelství H&H, c2002, 872 s. ISBN 80-731-9013-3.
- ALBERTS, Bruce. **Základy buněčné biologie: úvod do molekulární biologie buňky**. 2. vyd. Překlad Arnošt Kotyk, Bohumil Bouzek, Pavel Hozák. Ústí nad Labem: Espero Publishing, c1998, 630 s. ISBN 80-902-9062-0.

- KOOLMAN, Jan a Klaus-Heinrich RÖHM. **Barevný atlas biochemie**. 1. české vyd. Praha: Grada, 2012, 498 s. ISBN 978-802-4729-770.

Magnetic Resonance

1. Resonance condition, magnetic moment, gyromagnetic ratio
2. Bloch equations, signal shape
3. Signal strength
4. Pulse NMR spectroscopy
5. Fourier transform
6. Definition of chemical shift, standardization
7. Relaxation time T1
8. Additivity of relaxation times and basic contributions to relaxation mechanisms
9. Relaxation time T2
10. NOE: The nuclear Overhauser effect
11. MR tomograph and MR spectrometer, differences in construction, basic construction scheme
12. Coils used in MR spectroscopy
13. Sensitivity of NMR measurements, signal-to-noise ratio and possibilities of its increasing
14. NMR spectrometer resolution
15. Principle of MR imaging, comparison of MR imaging and MR spectroscopy
16. K-space in MR imaging and MR spectroscopy
17. In vivo MR spectroscopy-its difference from high resolution NMR
18. Methods of spin and stimulated echo in in vivo MR spectroscopy
19. Basic imaging MR sequences
20. „single voxel“ method
21. „Spectroscopic imaging“ method
22. Water signal suppression methods(T1, selective pulses, postprocessing)
23. Spectrum processing methods
24. Methods of MR spectrum processing in frequency and time domain
25. Basic metabolites monitored by ¹H MR spectroscopy
26. Basic metabolites monitored by ³¹P MR spectroscopy
27. Basic metabolites monitored by ¹³C
28. Methods for determining absolute concentrations of metabolites measured by MRS
29. Examination protocol of in vivo MR spectroscopy

Recommended literature:

- LIANG, Z. **Principles of Magnetic Resonance Imaging: A Signal Processing Perspective**. New York: IEEE Press, 2000.
- BERGER, S., BRAUN, S. **200 and More NMR Experiments: Practical Course**. Wiley-VCH, 2002.
- HUETTEL, S. A., SONG, A. W., MCCARTHY, G. **Functional Magnetic Resonance Imaging**, Second Edition, Sinauer Associates, Inc., 2009. ISBN 978-0-87893-286-3.
- KUPKA K, a kol. **Nukleární medicína, učební text, P3K, Příbram 2007**, ISBN 978-80-903584- 9-2
- www.sweb.cz/AstroNuklFyzika