PÁZMÁNY PÉTER CATHOLIC UNIVERSITY
FACULTY OF INFORMATION TECHNOLOGY AND BIONICS
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Entrance examination topics

Info-Bionics Engineering MSc

Biology

1. Origin of life on Earth. Organization of cells. Chemo- and photosynthesis, respiration.

2. DNA, gene, chromosomes, genome. Replication and cell division.

3. Genetics of prokaryotes. Mendel's laws, gene linkage, genetic maps. Transcription in pro- and eukaryotes

4. Translation and the genetic code. The ribosome. Mutation and repair. Mutagens and carcinogens.

5. Regulation of gene expression in pro- and eukaryotes. Genetic engineering.

6. Cytoskeleton and cellular movements, intracellular transport. Structure and function of biological membranes.

7. Outline of the nervous system and its function in living organisms.

8. Cellular information uptake, processing, storing and response

9. Characterization of the cell types found in nervous tissue, common and distinctive traits compared to the structure and function of other somatic cells

10. The electrical activity of neurons, action potential, EPSP and IPSP

11. Types of nerve fibers, conduction of nerve impulses in the central and peripheral nervous system

12. Types and functions of glial cells

13. Morphological and functional description of neuron-neuron interactions. Comparison of chemical and electric synapses.

14. Morphological and functional description of neuron-glia interactions. Role of glial cells in synaptic transmission

15. Types of neurotransmitters, their synthesis, use and degradation, amines and peptide type neurotransmitters

16. Non-synaptic interneuronal contacts and retrograde signal transmission

17. Types and function of receptors. The structure and role of the muscle spindle.

18. Types and mechanisms of effectors, structure and role of the motor endplate

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Recommended literature:
Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick: *Lewin's genes X*. Jones & Bartlett Learning, 2011.
Eric R. Kandel et al. (eds): *Principles of Neural Science*. Fifth edition, McGraw-Hill, 2013.

Chemistry

1. The periodic table of the elements. Properties of nuclei, isotopes, electronic structure, quantum numbers, the Bohr-Sommerfeld model

2. Properties of atoms, electonegativity, atomic radius, ionization energy, formation of bonds, bonding models, valence, molecular orbital theory, hybridization, VSEPR theory, features of chemical bonds, primary and secondary bonds

3. Compounds, stoichiometry, classification of compounds, important compounds of the abundant elements, case studies

4. States of matter, gases, kinetic gas theory, gas laws, fluids, surface tension, cohesive forces. Solid state, crystal structures, changes in states, phase diagrams

5. Chemical equilibria, acid-base reactions and theories: Arrhenius-Ostwald, Bønsted-Lowry, Lewis, HSAB

6. Solutions and mixtures. Mixtures of gases, fluids, mixing, phase equilibria in mixtures: fluid-gas, solid-fluid. Colligative properties of dilute solutions

7. Thermodynamics: main laws, heat, entropy, enthalpy (reaction enthalpy), Gibbs free energy (equilibrium processes), electrochemistry (reactions on a boundary surface)

8. Classification and nomenclature of organic compounds

9. Aliphatic hydrocarbons: alkanes and derivatives, stereoisomers, the Cahn-Ingold-Prelog convention. Newman- and Fischer-projection, aromatic hydrocarbons, aromaticity

10. Classification of organic reactions, acidity and basicity of organic compounds, nucleophilicity and electrophilicity, energy profile of reactions, kinetic and thermodynamic control. Factors determining reactivity: inductive, steric and mesomeric effects

11. Mechanisms of reactions: kinetic overview, first and second-order reactions, parallel reactions, nucleophilic and electrophilic substitutions, radicals. Additions and eliminations.

12. Oxo compounds: aldehydes and ketones, tautomerism, carboxylic acids and their derivatives, carbohydrates and heterocyclic compounds.

13. Amino acids and proteins, protein folding, primary, secondary and tertiary structure, cooperativity

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14. Nucleosides, nucleotides and nucleic acids, their structure and biological function

15. Enzymes: fundamentals of enzyme catalysis, basic mechanisms, examples

16. Bioenergetics: role and production of ATP, completion of energetically unfavorable reactions in the cells

17. Lipids, biological membranes and transport mechanisms

Recommended literature:
James E. House: *Inorganic chemistry*. Elsevier, 2008.
Leroy G. Wade, Jan W. Simek: *Organic Chemistry*. Pearson, 2016.
Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr., Lubert Stryer: *Biochemistry*. MacMillan, 2015.

Physics

1. Inductive way to Maxwell equation sand the Maxwell equations

2. Kirchhoff equations

3. Transmission lines

4. Linear antennas and antenna arrays

5. Motion of charge carriers in electromagnetic

6. Basics of quantum mechanics

7. Quantum statistics

8. Elements of solid state physics

9. Basics of semiconductor physics

10. Quantum optics and quantum electronics

Recommended literature:
N. Gershenfeld, *The Physics of Information Technology*. Cambridge University Press, 2000.
J. D. Jackson, *Classical Electrodynamics*. J. Wiley, 1998.

Electronics

1. Concentrated parameter circuits, building block of an electrical circuits: linear and non-linear building blocks. Kirchhoff equations; network specification by graphs and by incidence matrix, Telligent theorem.

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2. Generation of circuit equations, the solution of the DC equation. Thévenin and Norton theorems

3. Solution of the circuit equations in time domain, circuit simulator programs.

4. Application of Laplace transformation in time domain Impulse response calculation of linear circuits.

5. Analysis of linear circuits in frequency domain, Bode diagrams.

6. Basics of nonlinear circuits, Boolean circuit, amplifiers and chaotic circuits

7. Some problems of Boolean circuit design, speed, power, area, low power systems, DeMorgan-theorem, disjoint normal form.

Recommended literature:
Leon O. Chua – Pen-Min Lin, *Computer-aided Analysis of Electronic Circuits*. Prentice Hall, Englewood Cliffs, 1975.
Daniel Menge, *Analysis and Synthesis of Logic Systems.* Artech House, 1986, p. 1-48.

Computer Science

1. Representation of information

2. ALU (its components, functions)

3. Arithmetic operational units

4. Digital building blocks (register, ALU, MUX, encoders)

5. Process of instruction execution

6. Control units

7. Memories (types, properties)

8. Input / Output units, buses

9. RISC and CISC computer architectures

10. Basic data types (Stack (LIFO), Queue (FIFO), Priority Queue, Lists). Representation, implementation and operations.

11. Data storage and retrieving (Heap, Binary search tree, B-tree, Hash table)

12. Sorting algorithms (comparison based): Bubble sort, Insertion sort, Quicksort. Algorithms and their computational complexity

13. Basic components of programming languages: data types, control statements, function calls, and parameters. Support of parallel programming.

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14. Object oriented programming: Class, Object. Creating objects, initialization, inheritance, polymorphism, dynamic binding, abstract class.

15. Software development methodologies. Design and quality aspects. The role of the UML in software design. Testing software.

16. Components and tasks of database management systems

17. Basics of relational database management systems: Concepts: entity, relationship, relational model and relational algebra.

Recommended literature:

- Topics 1-9
  - L. Howard Pollard, Computer design, and architecture, Prentice Hall; 1st edition (July 1, 1997) , ISBN: 9780131672550
- Topics 10-12
  - Cormen, T. H.–Leiserson, C. E.–Rivest, R. L.–Stein,C.: Introduction to Algorithms, MIT Press, 2009 ISBN: 9780262033848
- Topics 13-14
  - Michael L. Scott: Programming Language Pragmatics, Morgan Kaufmann; 4 edition (December 25, 2015); ISBN: 9780124104099
  - Ian Sommerville: Software Engineering (10th Edition), Pearson; 10 edition (April 3, 2015), ISBN: 9780133943030;
- Topics 15-17
  - Avi Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts, McGraw-Hill Education; 6 edition (January 27, 2010), ISBN: 9780073523323