

Curriculum for entrance exam (pre-medical)

BIOLOGY

I. Chemical structure of living organisms

- 1 General information
 - a) organic and inorganic components of organisms
 - b) biogenic elements (C, H, O, N, P, S) and their role
 - c) macro- and microelements and their role
 - d) role of water for living organisms
- 2 Carbohydrates
 - a) mono-, di-, and polysaccharides – examples
 - b) role of given carbohydrates (glucose, fructose, ribose, deoxyribose, sucrose, starch, glycogen, cellulose) for living organisms
- 3 Lipids
 - a) structure and role of lipids
 - b) characteristics of basic lipids (phospholipids, glycolipids, wax, steroids)
- 4 Proteins
 - a) structure of amino acids (general formula)
 - b) peptide bond
 - c) biological role of proteins
 - d) structure of proteins – primary, secondary, tertiary, and quaternary
 - e) characteristics of some proteins (albumins, globulins, histones, metalloproteins)

II. Structure and function of the cell

- a) elements of the cell
- b) comparison of eukaryotic and prokaryotic cell
- c) cell membranes – structure and role
- d) plasmolysis in plant cell
- e) structure and role of cell organelles (nucleus, mitochondria, chloroplasts, vacuole, endoplasmic reticulum, cytoskeleton)
- f) cell movement

III. Metabolism

- 1 Enzymes
 - a) structure of protein enzyme
 - b) route of enzymatic catalysis
 - c) factors influencing enzymatic activity (temperature, pH, salt concentration)
 - d) methods of regulation of enzymatic activity (competitive and non-competitive inhibition, phosphorylation/dephosphorylation, activation of proenzymes)
- 2 General metabolic rules
 - a) comparison of anabolism and catabolism
 - b) ATP as high-energy substrate
 - c) basic metabolic changes in animal and plant cell
- 3 Intracellular respiration
 - a) major energetic compounds in the cell
 - b) comparison of aerobic respiration and fermentation – energetic values
 - c) glycolysis, Krebs cycle– diagrams and placement inside the cell
 - d) respiratory chain and ATP synthesis
- 4 Photosynthesis
 - a) description of photosynthesis
 - b) major pigments involved in photosynthesis

- c) substrates and products of photosynthesis

IV. Diversity of living organisms

- 1 Classification and identification of organisms
 - a) major taxonomic ranks and their hierarchy
 - b) phylogenetics and taxonomic classification
 - c) example of phylogenetic tree
- 2 Viruses
 - a) basic elements of a virus
 - b) bacteriophage and its life cycle
 - c) major viral diseases in human (flu, measles, chickenpox, AIDS, hepatitis, rabies, rubella, mumps, polio) – pathways of infection and prevention methods
- 3 Bacteria
 - a) diversity of bacteria – structure, mobility, nutrition (phototrophism, chemotrophism, heterotrophism)
 - b) cyanobacteria as example of oxygen assimilating bacteria
 - c) transmission of genetic material in conjugation process
 - d) role of bacteria in human life and in natural world
 - e) major bacterial diseases in humans (tuberculosis, dysentery, typhoid, cholera, anthrax, tetanus, lyme disease)
- 4 Protista and primary water plants
 - a) movement of unicellular protista
 - b) different nutrition ways in protista
 - c) major algae groups (Phaeophyta, Rhodophyta, Chlorophyta, diatoms) as producers of organic matter
 - d) major protista diseases in humans (malaria, trichomoniasis, giardiasis, toxoplasmosis, amoebiasis)
- 5 Land plants
 - a) characteristics of land plants enabling their life on land
 - b) characteristics of major plant groups (mosses, ferns, horsetails, lycopods, gymnosperms, angiosperms)
 - c) alternation of generations in various plant groups
 - d) role of plants in human life
- 6 Structure of plant tissues and organs
 - a) major plant tissues (parenchyma, cambium, floem, xylem)
 - b) plant organs (root, stem, leaves) and their modifications
- 7 Plant nutrition
 - a) mechanism of water and minerals transport in plants
 - b) gas exchange in plants
 - c) routes for photosynthesis substrates and products transport
- 8 Plant reproduction
 - a) basic characteristics of ovule and seed
 - b) structure of flower in angiosperms
 - c) origin of male and female gametophyte, fertilization, seed development and germination
 - d) vegetative reproduction
- 9 Plant reactions to stimuli
 - a) tropic and nastic movements (phototropism, geotropism, geonasty, nyctinasty)
 - b) plant hormones
 - c) photoperiodism
- 10 Fungi

- a) basic characteristic of fungi differentiating them from other organisms
 - b) symbiotic connections of fungi (including micorrhiza)
 - c) lichens as examples of symbiosis and indicator organisms
 - d) role of fungi in the industry (positive and negative)
- 11 Invertebrates
- a) structure and lifestyle of sponges
 - b) characteristics specific for cnidaria, flatworms, roundworms, annelids, arthropods, mollusks, and echinoderms
 - c) parasite flatworms and roundworms – examples of their life cycle
 - d) arthropods and their evolutionary success
 - e) incomplete and complete metamorphosis of insects
- 12 Vertebrates
- a) characteristics specific for fishes, amphibians, reptiles, birds, and mammals
 - b) reproduction and development of various vertebrate groups
 - c) role of vertebrates in natural world and human life
- V. Structure and function of human body
- 1 Hierarchic structure of human body
- a) tissues, organs, systems
 - b) structural and functional connections between organs and systems
- 2 Skeleto-muscular system – major structures and functions
- 3 Gastrointestinal system – general processes of digestion and absorption
- 4 Respiratory system – gas exchange and transport
- 5 Cardiovascular system
- a) structure and functioning of the heart
 - b) systemic circulation
 - c) pulmonary circulation
- 6 Immune system – general mechanism of immunity
- 7 Urinary tract – structure and mechanism of action
- 8 Nervous system
- a) structure of brain, spinal cord and nerves
 - b) transmission of information in the nervous system
 - c) role of brain in control and integration of body functions
- 9 Senses
- a) types of sensation in humans
 - b) eye structure and function
 - c) ear structure and function
 - d) smell and taste
- 10 Endocrine system
- a) classification of hormones
 - b) endocrine glands
 - c) hierarchy of hormone action (hypothalamus-pituitary-gland)
- 11 Reproductive system
- a) structure of male and female sex organs
 - b) origin and maturation of komórek rozrodczych
 - c) menstrual cycle
 - d) fertilization
- VI. Genetics and biotechnology
- 1 Nucleic acids
- a) structure of nucleotides
 - b) double helix and its role in DNA replication

- c) comparison of DNA and RNA
- d) types of RNA present in cell
- 2 Cell cycle
 - a) DNA organization in genome
 - b) phases of cell cycle
 - c) chromosome and characteristics of diploid organism
 - d) mitosis and meiosis – comparison
 - e) sex inheritance
- 3 Genetic information and its expression
 - a) coding amino acids in DNA
 - b) transcription and translation
 - c) posttranslational modification of proteins
 - d) prokaryotic and eukaryotic genome - comparison
- 4 Regulation of gene action
 - a) theory of operon
 - b) regulation of gene action in eukaryotics
- 5 Mendel's genetics
 - a) basic terminology of classic genetics (allele, recessive, dominant, locus, homozygote, heterozygote, genotype, phenotype)
 - b) Mendel's laws of inheritance (dominance, segregation, independent assortment)
 - c) Punnet square for on- and two-gene crossings
 - d) sex-conjugated genes
 - e) sex heritage in humans
- 6 Genetic variability
 - a) origin of variability (mutations, recombinations)
 - b) pleiotropy
 - c) mutations (point, insertion, deletion)
- 7 Genetic-based diseases in humans
 - a) gene-mutation based diseases (cystic fibrosis, phenylketonuria, hemophilia, daltonism)
 - b) chromosome-mutation based diseases (Down, Turner, Klinefelter)
- VII. Ecology
 - 1 Ecological niche
 - a) basic elements of ecological niche
 - b) organism tolerance for environmental factors changes
 - 2 Population – basic characteristics
 - 3 Interspecific interactions
 - a) competition
 - b) predation
 - c) parasitism
 - d) mutualism
 - e) comensalism
 - 4 Ecosystem
 - a) different ecosystems (terrestrial, water)
 - b) food chains and webs, examples
 - 5 Energy and matter flow in nature
 - a) trophic levels (producers, consumers – herbivores and carnivores, destruent)
 - b) examples of food chain
 - c) carbon circulation in nature
 - d) nitrogen circulation in nature

VIII. Evolution

- 1 Natural selection
 - a) sources of genetic diversity
 - b) mechanisms of action of natural selection
 - c) examples of adaptation of selected species to its living environment
- 2 Speciation
 - a) definition of species
 - b) mechanism of species origins
- 3 Anthropogenesis
 - a) similarities and differences between humans and apes
 - b) changes of humans during evolution
 - c) major fossil anthropoids

CHEMISTRY

1. Atoms, particles, and stoichiometry
 1. mole and Avogadro number
 2. chemical reactions – products and substrates stoichiometry
2. Atom structure – nucleus and electrons
 1. atomic orbital model (electron cloud)
 2. order of orbital (s, p, and d) and shell (K, L, M) occupation
 3. configurations of valence electrons
3. Chemical bonds
 1. stable electron configurations (ions)
 2. types of bonds (ionic, covalent – polar and nonpolar, coordinate)
 3. hybridization types (sp, sp², sp³)
4. Chemical kinetics and statics
 1. basic definitions: exothermic, endothermic, activation energy
 2. factors influencing reaction rate (temperature, substrate concentration and granularity, catalyst)
 3. dynamic equilibrium and equilibrium constant
 4. Brönsted-Lowry theory of acids and bases
 5. pH, dissociation constant
5. Solutions and reactions in water solutions
 1. solution, colloid, and suspension – definitions
 2. solution concentration – molar and percent
 3. electrolytic dissociation
 4. pH indicators
 5. reactions of neutralization and hydrolysis
6. Oxidation and reduction reactions
 1. definitions: oxidation number, oxidizer, reducer, oxidation, reduction
 2. electron balance – redox stoichiometry
7. Metals
 1. basic characteristics of metals
 2. example reaction with oxygen and acids
 3. hydroxides
 4. amphoteric characteristics of aluminium oxide and hydroxide
 5. comparison of chemical activity of various metals
8. Nonmetals

1. chemical characteristics of nonmetals – reactions with oxygen, hydrogen, and metals
 2. acidic, basic, and neutral examples of oxides
 3. acids – comparison of oxoacids and anoxoacids
 4. characteristics of acids – reactions with metals, metal oxides, hydroxides, and weaker acid salts
 5. oxidizing characteristics of acids
 6. obtaining of salts
9. Hydrocarbons
1. structure of hydrocarbons – aliphatic and aromatic, saturated and unsaturated
 2. basic terms: homologous series, functional group, isomerism
 3. nomenclature of hydrocarbons
 4. chemical characteristics of aliphatic hydrocarbons – burning, substitution, addition, elimination, polymerization
 5. chemical characteristics of aromatic hydrocarbons – burning, reactions with halogens, nitration
10. Hydroxyl derivatives of hydrocarbons – alcohols and phenols
1. structure of alcohol and phenol
 2. alcoholic fermentation
 3. mono- and polyhydroxyl alcohols (polyols) - examples
 4. characteristics of alcohols – burning, oxidizing, dehydration, reactions with inorganic acids and carboxylic acids
 5. primary and secondary alcohols – examples
 6. differentiation between alcohols and phenols
11. Carbonyl compounds – aldehydes and ketones
1. differences between aldehydes and ketones
 2. obtaining of aldehydes and ketones
 3. Tollens and Trommer reactions for carbonyl compound determination
12. Carboxylic acids
1. obtaining of carboxylic acids from alcohols and aldehydes
 2. oxidative and anaerobic fermentation
 3. reactions of carboxylic acids – obtaining of salts and esters
 4. saturated and unsaturated fatty acids
13. Esters and fats
1. structure of ester and ester bond
 2. reaction of esterification
 3. solid and liquid fats
 4. saponification of fats
14. Nitrogen containing organic compounds
1. basic characteristics of ammonia and amines
 2. reactions of obtaining aliphatic and aromatic amines
 3. condensation of amino acids, and peptide bond
 4. hydrolysis of peptides
15. Proteins
1. structure of proteins
 2. secondary structure (α -, β -) of proteins and hydrogen bonds importance
 3. tertiary structure of proteins and its stabilization by R- groups
 4. protein denaturation by temperature, acids, salts
16. Sugars
1. mono- and polysaccharides

2. origin of monosaccharides
3. glucose and fructose – comparison
4. comparison of starch and cellulose
5. hydrolysis of polysaccharides

PHYSICS

1. Linear motion and forces
 1. velocity
 2. force – definition
 3. Newton's laws of motion
 4. gravity
 5. simple machines: lever, pulley, wheel and axle
 6. inertia and resistance
2. Energy
 1. different forms of mechanical energy
 2. work and power
 3. kinetic and potential energy
 4. law of conservation of energy
 5. connection between kinetic energy and temperature
 6. melting, solidification, condensation, sublimation, resublimation
 7. specific heat, melting point, and heat of vaporization
 8. convection of liquids and gases
3. Matter characteristics.
 1. differences in structure of solids, liquids, and gases
 2. crystal structure
 3. density
 4. surface tension
 5. pressure and hydrostatic pressure
 6. Pascal's law
 7. Archimedes' principle
4. Electricity.
 1. triboelectric effect (electrification by friction)
 2. electric charge and interactions of charges
 3. conductors and insulators
 4. flow of current
 5. voltage and amperage
 6. resistance and Ohm's law
5. Magnetism.
 1. permanent magnets and their poles
 2. electromagnet – solenoid and core
 3. mechanism of action of electric engine
6. Oscillating motion and waves.
 1. pendulum – movement and energy transition
 2. amplitude, period, equilibrium position of oscillating body
 3. waves – amplitude, period and frequency, velocity and length
 4. sound as a wave, its velocity of traveling in different media
 5. factors determining loudness and pitch
7. Electromagnetic waves and optics.

1. spreading of electromagnetic waves – comparison with mechanical waves
 2. reflection, dispersion, and refraction of light
 3. concentration and dispersion of light rays in convex and concave lenses
 4. focus, focal length
 5. images: real, virtual, upright, inverted, magnified, reduced
 6. velocity of light
 7. types of electromagnetic waves (radio, micro, infrared, visible light, ultraviolet, X-rays), examples of applications
8. Thermodynamics
1. isobaric, isochoric, and isothermal processes
 2. first law of thermodynamics (adiabatic process)
 3. second law of thermodynamics (entropy)
 4. phase transition on the example of water
9. Atomic physics
1. radiation of bodies
 2. structure of atom
 3. transition of electron between energy levels – conservation of energy
 4. quantum number and Pauli exclusion principle
 5. Heisenberg uncertainty principle