

TOPICS FOR THE ENTRANCE EXAMINATION AND RECOMMENDED LITERATURE

BIOLOGY

Literature:

Neil A. Campbell, Jane B. Reece: Biology

Mike Boyle, Kathryn Senior: Biology

Topics:

GENERAL CHARACTERISTICS OF LIVING ORGANISMS

Individual and species. General properties of organisms. Hierarchy of organisms according to their complexity (viruses, prokaryotes, eukaryotes).

CELL

Chemical constitution of a cell, importance of chemical compounds in cells. General structure of prokaryotic and eukaryotic cells. Cell division. Structure and number of chromosomes. Mitosis and meiosis. Regulation of cell division.

VITAL FUNCTIONS AT THE CELLULAR LEVEL

Cell metabolism - enzymatic catalysis, regulation of enzymatic reactions. Input and output of compounds by a cell - diffusion, transport, endocytosis, exocytosis, osmotic processes.

Energy transformations in a cell - heterotrophy, autotrophy, mixotrophy.

Photosynthesis, anaerobic glycolysis, oxidative phosphorylation, ATP metabolism.

Synthesis of nucleic acids, synthesis of polysaccharides, course and regulation of proteosynthesis.

Cell reproduction. Course and regulation of cell cycle.

VITAL FUNCTIONS AT THE LEVEL OF HIGHER ORGANISMS

Animals. Sexual and asexual reproduction. Physiology of reproduction, functional principle of ontogenetic development.

Individual development.

Vital functions of animals and human beings - phylogenesis of the body fluids, of digestive events, of the circulation system, phylogenesis of respiration, of excretion, hormonal regulation of invertebrates and vertebrates, phylogenesis of the nervous system. Ways of movement of animals.

ORIGIN AND EVOLUTION OF SPECIES. Darwinian evolution theory.

HISTORICAL EVOLUTION OF ORGANISMS. Evolution of animals.

GENETICS

Basic terms of genetics. Genes of high and small effect.

Molecular basis of heredity. Nucleic acids, genetic information and genetic code. Gene, its transfer and expression.

Cell and heredity. Gene arrangement in chromosomes, genetics of a prokaryotic cell - prokaryotic chromosome, plasmids. Genetics of a eukaryotic cell - nuclear genome, karyotype. Chromosomes - diploid and haploid number, segregation and combination, sex determination. Extranuclear DNA molecules.

Heredity of a multicellular organism. Ways of reproduction, crossing, heredity of quantitative traits. Inherited and non-inherited variability, heritability.

Genetic variability. Classification of mutations. Mutagenic factors in the environment, importance of mutations.

Heredity in the population of organisms. Genetic structure of a population, genetic equilibrium in a population and processes responsible for its modifications, genetic aspects of ecology.

Importance of genetics. Breeding of microorganisms, plants and animals. Medical importance and ethical aspects of genetics. Social perspectives of genetics.

HUMAN ORGANISM WITH REGARD TO THE STRUCTURE AND FUNCTION

Locomotor system. Skeleton of the human body. Skeletal muscles. Internal milieu - blood.

Blood cells. Haemostasis. Organism's defensive reactions. Blood groups. Transfusion.

Circulatory system. Function of heart, blood pressure, pulse, capillaries, tissue fluid, blood circulation, vascular diseases, regulation of blood circulation. Lymph and lymphatic circulation.

Respiratory system. Respiration mechanism, lung ventilation, exchange of respiratory gases in lungs and in tissues, regulation of respiratory movements, defensive respiratory reflexes, diseases of the respiratory tract.

Digestive system. Function of the oral cavity and oesophagus, function of stomach, of small and large intestines. Transformation of compounds and energy, metabolism of individual nutrients. Importance of the liver for metabolism.

Importance of nutrition, composition of food, vitamins. Hypoalimentionation, undernutrition, obesity.

Body temperature and its maintenance. Regulation of body temperature.

Excretion. Function of the kidney, urinary tract. Function of the skin.

REGULATION OF THE FUNCTION OF HUMAN ORGANISM

Metabolic regulation of an organism. Insulin, adrenal hormones, thyroid gland hormones, parathyroids, pituitary.

Nervous regulation of an organism. Structure of human nervous system. Reflexes. Function of sense organs.

Functions of the nervous system. Function of the spinal cord, hindbrain, midbrain, reticular formation, diencephalon, cortex.

Regulated function of internal organs. Sleep and vigilance. Higher nervous activity.

Conditioned and unconditioned reflexes.

Reproduction systems of woman and man.

Development of an individual. Intrauterine development, uterus, placenta, pregnancy and mother's organism, care of pregnant women and mothers.

Human genetics. Methods, hereditary diseases and disposition, genetic counselling.

Phases of the human life. Human health. Healthy nutrition, work and rest regime, drug dependence.

Human parasitology - the main human parasites - protozoa, worms, mites, insecta.

ECOLOGY

Basic ecological terms. Relationship between organism and environment.

Abiotic components of the environment. Sun, atmosphere, hydrosphere, lithosphere, pedosphere.

Biotic components of the environment. Population, interrelations between populations, communities.

Ecosystem. Changes of ecosystem. Biosphere.

Man and environment. Human population, present problems associated with the environment - atmosphere, water pollution, pollution of soil. Chemicals in the environment. Increased radioactivity. Noise. Increased amount of waste. Influence of the environment of man, environmental protection.

Importance of biology on the present development of sciences and technology.

CHEMISTRY

Literature:

Chang R. and Overby J. General Chemistry - the essential concepts. 6th edition, McGraw-Hill, 2011.

Topics:

GENERAL CHEMISTRY

The structure of the atom, elements, atoms and the periodic table; structure and properties of ionic and covalent compounds; bonds in chemistry; fundamental laws of chemistry, composition, chemical equation and stoichiometry; states of matter - gases, liquids and solids; energy of chemical and biochemical processes, thermochemistry; reaction rates and equilibria, Le Chatelier's principle; solutions; acids and bases, Brønsted-Lowry theory, hydrolysis; oxidation and reduction;

BASIC CALCULATIONS IN CHEMISTRY

The concentration in mol dm⁻³ and in percentage by mass; calculations based on chemical equations; stoichiometry involving gases; mass fractions; empirical formulae; pH, pOH and concentrations of H⁺ and OH⁻ of strong acids and bases; balancing of oxidation-reduction reactions.

INORGANIC CHEMISTRY

Nomenclature of inorganic compounds. Trends across the periodic table. Hydrogen, water; s block metals and their compounds; p block elements and their compounds; transition metals and their compounds.

ORGANIC CHEMISTRY

Isomerism, functional groups, basic reaction mechanisms in organic chemistry, organic nomenclature.

Nomenclature, properties and reactivity of: alkanes, alkenes, alkynes, aromatic hydrocarbons ; halogenoalkanes and halogenoarenes; alcohols, phenols and ethers; aldehydes and ketones; amines; carboxylic acids and their derivatives - halogenoacids, aminoacids, hydroxyacids; acid halogenides, esters, amides, anhydrides; carbonic acid derivatives.

Simple five membered and six membered heterocycles.

BIOCHEMISTRY

Saccharides: structure - linear and cyclic formulae, monosaccharides, disaccharides, polysaccharides, importance in biochemistry. Lipids: classification, composition, properties, importance in biochemistry. Proteins: basic amino acids (formulae), peptide bonds, composition and function of proteins. Nucleic acids: composition, nucleosides, nucleotides, base pairing, structure and function. Enzymes: characteristics, classification, digestive enzymes. Basic metabolic pathway of saccharides, triacylglycerols and proteins. Energy production.

PHYSICS

Literature:

Miriam Lazar. Let's Review Physics. Publisher: Barron's Educational Series, 2009.

Greg Curran. Homework Helpers: Physics. Publisher: Career Press, 2012.

Jonathan Orsay. Examcrackers: 1001 Questions in MCAT in Physics. Publisher: Osote Publishing, 2001.

Topics:

PHYSICAL QUANTITIES AND THEIR UNITS

SI - basic units, complementary, derived. Formation of parts and multiples. Conversions of units, determination of unit dimensions.

MECHANICS

Types of motions and their classification. Uniformly rectilinear motion. Uniformly accelerated and decelerated motion. Uniform circle motion.

Newton's law of motion. Mass and weight of a body. Quantity of motion of a body. Effect of force - work, impulse of force, moment of force with regard to the axis, pressure, mechanical stress.

Energy and work. Power and efficiency.

Gravitational field, Newton's gravitational law.

Mechanics of liquids, the term "ideal liquid".

Pressure in the liquid induced by external force. Pascal's law and its application. Hydrostatic pressure. Archimedes' law. Flow of liquids. Equation of continuity and Bernouille's equation.

MOLECULAR PHYSICS AND THERMODYNAMICS

Quantity of compounds.

Interactions inside molecules, intermolecular interactions.

Heat and temperature and their measurement.

Molecular properties of gases. Events in gases. Equation of state of an ideal gas. Dalton's and Avogadro's laws.

Molecular properties of liquids. Surface tension and its biological importance.

Diffusion, osmosis. Viscosity of liquids and its importance.

Molecular properties of solids. Changes of state.

MECHANICAL WAVE MOTION AND ACOUSTICS

Harmonic motion.

Types of wave motion and their properties.

Sound properties with regard to sound source and propagation.

Sound pitch, timbre, intensity. Ear as a biological detector of sound. Sound field. Intensity level and loudness level of sound.

ELECTRICITY AND MAGNETISM

Electric charge and electric field. Classification of atmosphere from the electrical point of view. Potential of electric field. Voltage.

Capacity, capacitor, arrangement of capacitors.

Metal conductivity. Electric current, simple circuit.

Operation and output of electric current.

Electric resistance. Ohm's law. Branched electric circuit.

Kirchhoff's laws. Assembly of resistors.

Semiconductors and their application.

Electric current in electrolytes. Faraday's law.

Electric current conduction in gases and in vacuum.

Magnetic field.

Alternating current. Electromagnetic induction.

Induction coil.

Transformers.

Electric oscillating circuit.

OPTICS

Electromagnetic spectrum - survey and properties.

Light as an electromagnetic wave motion.

Wave properties of light, interference, light polarization. Quantum properties of light , photoelectric phenomenon.

Geometric optics, Fermat's principle. Reflection, refraction.

Picture formation by mirrors and lenses.

Optical instruments, magnifying glass, microscope. Eye as an optical system.

Eye as a biological detector of light. Eye defects. Photometric quantities and their units.

X-ray radiation and its biological importance.

ATOMICS

Structure of atom, atom and its characteristics.

Electron shell.

Atomic nucleus. Natural and artificial radioactivity.

Nuclear reactions and their power utilization.

PHYSICAL MEASUREMENT METHODS

Balances and weighing. Density and its measurement. Temperature and thermometers.

Measurement of electrical quantities - current, voltage, resistance.

Optical measurement - refractometry, polarimetry, photolorimetry.

GENERAL REQUIREMENTS

- ability to perform simple numerical calculations related to solution of a given problem (percentage, conversion of units, conversion of angles),

- knowledge of basic mathematical functions and their physical applications (linear, quadratic,

refracted, exponential, logarithmic, goniometric functions),
- knowledge of basic geometrical formulas,
- knowledge of basic physical constants.

MATHEMATICS

Literature:

J. K. Backhouse and S. P. T. Houldsworth - PURE MATHEMATICS 1 and 2

For all subjects:

General knowledge such as basic mathematical operations, unit conversions etc. is required.