Biology

**Cytology:**

**Basic characteristics of the cells.**


Biomembranes: Composition, orientation of membrane macromolecules, characteristics of the cytoplasm membrane, transport of molecules across membranes by diffusion and osmosis, the role of transport proteins in the transfer of metabolites across cell membranes. Endocytosis and exocytosis - the process of phagocytosis and pinocytosis, the role of Golgi complex in exocytosis, the role of cytoskeleton in these processes. Osmosis - transport of the water across semipermeable membrane, hypertonic and hypotonic solutions, plant and animal cell in hypertonic and hypotonic environments.

**Structure of the prokaryotic cell:** Organisation of DNA, membranous and non-membranous structures, composition of the cell wall, ribosome characteristics.

**Structure of the eukaryotic cell:** Membranous structures of the cell - characteristics and function, one- and two-membranous organelles, non-membranous structures of the cell - characteristics and function, composition and function of the cytoskeleton, proteinous cellular structures, characteristics of the nucleus, chromatin - composition, nuclear chromosomes structure and shape, extranuclear DNA in the cell - characteristics and function.

**Metabolism:** Catabolic and anabolic processes, energy exchange in the cell, primary source of energy in the cell, aerobic and anaerobic metabolism, oxidative phosphorylation in the eukaryotic and prokaryotic cells, anaerobic glycolysis in eukaryotic and prokaryotic cells, the use of energy released by oxidative phosphorylation, the use of energy released during anaerobic glycolysis. The cell as an energetically autonomous unit.

Autotrophy and its different types. Heterotrophy and its different types. Characteristics of photosystem I and photosystem II.

**Genetic material and protein synthesis:** replication of DNA, transcription, translation, localisation of transcription and translation in prokaryotic and eukaryotic cells, The role of polymerases in replication and transcription, regulation of proteosynthesis.

**Cell division:** haploid and diploid cells, the process of amitosis and mitosis, the origin and the role of the spindle and centromere of chromosomes. Cell cycle and its phases, processes occurring during individual phases of the cell cycle, regulation of the cell cycle, cells during the phase GO, cells with the failure in the main control point.

**Multicellular organisms:** cell differentiation, tissue types, association of cells in plants, division and characteristics of tissues, regulation of processes in organism.

**Types of reproduction in multicellular organisms:** vegetative reproduction, sexual reproduction, the origin and types of gametes, isogamy and anisogamy.

**Meiotic division:** characteristics of phase I. and II. of meiotic division, homologous chromosomes, synapsis, tetrad, crossing-over, genetic recombination, spermatogenesis, oogenesis, ploidity of gametogonia and of gametes. Copulation, fertilization and origin of the zygote, cleavage, gastrulation, ontogenetic development phases, hermaphroditism and gonochorism, determination of primary and of secondary sex traits, the role of gonosomes in sex determinations. Haploid and diploid parthenogenesis, metagenesis, heterogony.

Reproduction of unicellular organisms: conjugation of prokaryotic and eukaryotic organisms,
hologamy.

**Systematic nomenclature of living systems.**

**Viruses:** division of viruses depending on nucleic acids, characteristics of viruses depending on external coats, shape of virions, reproduction of viruses, (+)RNA viruses and retroviruses, provirus, the process of virogeny, viruses and diseases.

**Bacteria:** the structure of bacterial cell, shape of bacteria, forms of autotrophic nutrition, bacterial plasmids, transformation, conjugation and transduction, the role of prophylaxy.

**Plants:**
Plant cell and its cellular organelles, types of chlorophyles in plant cells, characteristics of plant tissues, active and passive intake of the water, water activity inside the cells, the process of transpiration, gutation, the main characteristics of photosynthesis, saprophytism, semiparasitism and parasitism, mixotrophic nutrition, breathing in plants, divisional and prolongational growth, regulation of tissue differentiation, plant development, plant movement and plant reproduction.

**Algae:** division depending on the type of chlorophyl, body structure and main characteristics, representatives of different classes and their characteristics.

**Land plants:**

**Fungi:**
Characteristics of fungi: hyphae, haustoria, mycelium, mycorrhizae, saprobes. Chytridiomycota - general characterisation, type of reproductions, representative members Endomycota - general characteristics, taxonomic division, representatives and their life cycle. Zygomycota - general characteristics, type of reproduction, representatives Ascomycota - general characteristics representative members Basidiomycota - general characteristics representative members

**Animals:**
**Unicellulars:** general characteristics, taxonomic division, representatives of individual classes with respect to the diseases which they determine, their life cycle and type of reproduction. **Multicellulars:** Origins of multicellularity, taxonomic division - phylum, class, order, family, genus and species. **Protostomes** - taxonomic division, characteristics of phyla, classes and families, body cavities of protostomes and their characteristics, types of nervous, sensory, excretory reproductive, circulatory and respiratory systems, types of blood pigments, ectoparasites and endoparasites of plants, animals and human beings, diseases which are caused by hosts and intermediate hosts of parasites. **Deuterostomes** - characteristics of individual phyla, taxonomic division of Chordata, main characteristics of individual classes of Vertebrates: types of circulatory and transport, respiratory, immune, hormonal, nervous, sensory, excretory and reproductive systems, ontogenetic development, Anamniotes, Amniotes, ectothermy, endothermy, taxonomic division of Mammalia, their characteristics and representatives.
Regulatory mechanisms in animal kingdom: interrelationships between neural and chemical regulation, biorhythms, homeostasis in organisms. Metabolism and energy flow in the organism: mechanisms of nutrition and processes of digestion. Phylogenesis of digestion system. Gas exchange between tissues and the environment. Phylogenesis of respiratory system. Types of body fluids in animals and in humans, composition and function. Systems of open and closed blood circulation, flow of the blood in blood vessels, blood groups and blood clotting in animals and in humans. The heart in vertebrates and in invertebrates, functional characteristics, phylogenesis of the circulatory system. Phylogenesis of the excretory system, structure and function of the nephron, secretion and composition of the urine. Hormonal regulations: mechanisms of direct and indirect effect of hormones, regulation of hormone level in body fluids, hormonal regulation in invertebrates and in vertebrates, species specific regulatory odours. The structure and the function of the neurone. Transfer of neural signal by neurone and on synapses, action potential of neurite, phylogenesis of nervous system, central nervous system in vertebrates. Instincts, conditioned and unconditioned reflexes, origin and stability of conditioned reflexes, memory and memory traces, learning and thinking. Sense organs: chemoreceptors, mechanoreceptors and radioreceptors, their sensitivity and function, phylogenetic development. Muscles: structure and function of muscle fibres, smooth muscle - its characteristics, striated muscle - its characteristics, characteristics of heart muscle and regulation of heart activity, classification of muscles according the content of myoglobin, energy sources for muscle activity, muscle fatigue. Immune reactions of organism: antigens, non-specific and specific immunity, cellular and antibody immunity reaction, response of B and T lymphocytes to antigen, allergy, passive and active immunisation.

eugenics and its aim.

**Human biology:**
- **Bones:** structure, function, connection, scull, permanent and milk teeth, skeleton.
- **Muscles:** types of muscles, muscle systems, muscle innervation.
- **Blood:** composition, function, volume, blood cells - their origin, shape, function, sedimentation, types of haemoglobin, ABO system, Rh factor and its role, defence reactions of organism, blood transfusion.
- **Heart:** structure, activity, innervation, blood supply, minute volume of the heart, heart stroke, regulation of heart activity.
- **Arteries, veins, capillaries:** - their structure and function, blood circulation, blood pressure, regulation of blood circulation, lymph production and function, hemostasis, embolus, trombosis.
- **Respiration:** airways, mechanism of inspiration and expiration, internal and external gas exchange, breathing regulation, respiratory defence reflexes and respiratory diseases.
- **Digestive system:** composition and function, glands of digestive secretion and their products, intestinal juice and its composition, metabolism and energy exchange, digestion of different foods, liver and its function, liver and gall-bladder diseases, defecation reflex, starvation, malnutrition and obesity.
- **Vitamins:** names, their role, deficiency effects, hypovitaminosis and avitaminosis.
- **Excretion:** kidneys - their structure and function, primary and secondary urine - composition and amount, regulation of kidney function. Role of the skin excretion.
- **Regulation of body functions:** neural and chemical regulation, their interrelationship.
- **Endocrine glands** and their hormones, regulation of hormone secretion into blood, most important effects of hormones.
- **Neural system:** neurone, synaptic junction, central nervous system. Brain - its parts and function, head nerves, spinal cord, spinal nerves, reflex circuit, spinal somatic reflexes, sympatic and parasympatic nervous system, higher nervous activity.
- **Receptors:** stimulus, adaptation to stimuli, exteroceptors, interoreceptors and proprioceptors, radioreceptors, chemoreceptors, mechanoreceptors and photoreceptors.
- **Reproductive system** of women and menstruation cycle, pregnancy, prenatal ontogenesis, parturition. Reproductive system in men.

**Ecology:**
Ecology as a science, basic terminology. The relationship between organism and its environment.
- Ecosystem - definition, basic characteristics.
- Nutritionally chains of the ecosystem and nutrial pyramide.
- Flow of foodstuffs and of energy in ecosystem.
- Changes in the ecosystem. Influences on the ecosystem equilibrium.
- Biosphere - basic characteristics.
- Biome - definition and characteristics.
- The human - the active part of the environment. Negative effects of human.
- Human population - growth, differences in the concentration of inhabitants, effects of human activities and their consequences.
- The role of biology - biotechnology, gene engineering. Bionics and biocybernetics.
Theories of the origin of life: Coacervate theory, eobiontes, prokaryotic and eukaryotic cells, Darwin's theory of evolution.

Chemistry

Classification of matter
Physical versus chemical change
Elements, compounds, and mixtures
Unit conversion
Density
Specific gravity
Temperature
Units of energy
Atomic theory
Atomic number
Charged atoms
Isotopes
Mass number
Relative atomic mass
Average atomic weight
Electronic versus nuclear changes
Radioactivity
Properties of (-, (-, and (- radiation
Ionizing radiation
Medical uses of radioisotopes
Electron structure of the atom
Electron configuration notation
Periodic table
How can atoms achieve lower-energy states?
- Metals lose electrons
- Nonmetals gain electrons
Oxidation -reduction
Formulas for ionic compounds
Nomenclature
The nature of the ionic bond
Diatomic molecules
The nature of the covalent bond
Coordinate covalent bonds
Electronegativity and polarity
Recognizing ionic versus molecular compounds
Molecular shape
Molecular polarity
Molecular weight
Individuals versus "packages"
Relative weights
How many particles is in a mole?
Moles of compounds
Gram-mole-particle conversions
Chemical reactions and equations
Balancing equations
Types of reactions
Oxidation-reduction reactions
Molar interpretation of the balanced equation
The mole ratio
Mole-mole, mole-gram, gram-gram conversions
Heat as a reactant or product
Gases, liquids, solids
Characteristics of gases
Intermolecular forces
Physical properties of liquids
Classes of crystalline solids
Properties of solids
Solution terminology
Factors influencing solubility
Electrolytes
Particles in solution
Concentration expressions
Colligative properties of solutions
Osmotic pressure of solutions
Colloids and suspensions
Active transport
Osmotic pressure and fluid transport
Kinetics and equilibrium
The origin of heats of reaction ((H)
Gibbs free energy
Activation energy
Factors influencing reaction rate
Reversible reactions
Equilibrium constant
Acids and bases
The Arrhenius definition
Bronsted-Lowry definition
Acid and base strength
Ionization of water
pH, measurement of pH
Reactions of acids and bases
Acid-base indicators
General properties of organic compounds
Bonding in carbon compounds
Structural formulas for organic molecules
Condensed structural formulas
Functional-group concept
Homologous series
The R-group concept
The "action" is at the functional group
Isomerism
Geometry around carbon atoms
Rotation about single bonds
Isomerism revisited
Nomenclature
Common nomenclature
Writing structures from names
Nomenclature and isomerism
Physical properties of hydrocarbons
Chemical properties of alkanes
Alkanes
Nomenclature of alkenes
Geometric isomerism
Bonding in alkenes - The double bond
Alkene reactions
Polymerization
Alkynes
Cyclic hydrocarbons
Aromatic hydrocarbons
Biologically significant hydrocarbons
Properties of the halogenated hydrocarbons
The alcohol functional group
Hydrogen bonding in alcohols
Nomenclature of alcohols
Industrial source and use of some alcohols
Dehydration of alcohols
Oxidation of alcohols
Ethers
The carbonyl group
Aldehyde and ketone nomenclature
Physical properties of aldehydes and ketones
Oxidation and reduction of aldehydes and ketones
Alcohol addition to aldehydes and ketones
Aldol addition of aldehydes and ketones
Reactions of aldehydes and ketones with nitrogen compounds
The occurrence and use of a few aldehydes and ketones
Phenols
Thiols
Stereoisomerism
Stereoisomerism and glucose
Fischer projections
Multiple chiral centers
Classification: D-family versus L-family
Intramolecular hemiacetals and hemiketals
Haworth projections
Mutarotation
Formation of di- and polysaccharides
Monosaccharides
Classification: Reducing and nonreducing sugars
Disaccharides
Polysaccharides
Classification of amines
Nomenclature
Physical properties of amines
Amine basicity
Nomenclature of carboxylic acids
Physical properties of carboxylic acids
Acidity and salt formation
Fatty acid salts as soap
Esterification
A close examination of the ester functional group
Esters from phosphoric acids
Thioesters
Anhydrides of carboxylic acids
Hydrolysis of esters
Amides: Nomenclature
Properties of amides
Amide formation
Waxes
Fats and oils
Hydrogenation of oils
Hydrolysis of simple lipids and digestion
Compound lipids
Phospholipids
The lipid bilayer of cell membranes
Steroids
Structure of amino acids
Classification of amino acids
Stereoisomerism in amino acids
The peptide bond
Polypeptides
Primary structure of proteins
Secondary structure of proteins
Tertiary structure of proteins
Quaternary structure of proteins
Classification of proteins
Denaturation
Hydrolysis of proteins
Chemical composition of DNA
The primary structure of DNA
The secondary structure of DNA
Ribonucleic acids
The genetic code
Protein biosynthesis I: Transcription
Protein biosynthesis II: Translation
Enzyme composition
Enzyme classification and nomenclature
Mechanism of enzyme activity
Substrate specificity and the enzyme-substrate complex
Factors affecting enzyme catalysis
Enzyme inhibition
Coenzymes and vitamins classification, relationship
Hormones - classification, target effects
Thermodynamic principles
The role of ATP
The roles of eating and breathing