

## Biochemistry

### Macromolecules.

Proteins. Amino acids. General properties and functions of amino acids, classification, acid-base properties, isoelectric point. Structure and function of proteins. The peptide bond. Levels of structural organization of proteins. The alpha-helix. The beta sheets. Fibrous proteins, collagen. Protein folding and stability.

Myoglobin and hemoglobin. Enzymes. General properties. Classification. Active site. Substrate specificity.

Cofactors and coenzymes. Activation energy. Transition state and effects of the enzyme on the substrate.

Outline of the mechanisms of catalysis. Thermodynamic aspects of catalysis. Michaelis-Menten equation.

$K_m$ ,  $V_{max}$  and  $K_{cat}$ . Enzyme inhibition. Regulation of enzymatic activity.

Carbohydrates. Monosaccharides and polysaccharides. Reserve and structural polysaccharides.

Glycoproteins. Proteoglycans.

Lipids. Fatty acids. Triacylglycerols. Phosphoglycerolipids and sphingolipids. Cholesterol. Double lipid layers.

Biological membranes. Fluid mosaic pattern. Endocytosis. Transport across membranes.

The metabolism. Generality; hints of energetics and mechanisms of regulation of metabolic pathways;

intermediates that conserve energy; redox reactions; enzymatic cofactors. Metabolism of hexoses.

Glycolysis and its regulation; homolactic fermentation and alcoholic fermentation; pentose phosphate

pathway; gluconeogenesis and its regulation; synthesis of glycogen and its regulation; glycogen degradation

and its regulation. Energetics of the metabolism of hexoses. Metabolism of AcetylCoA. The citric acid cycle

and its regulation. Utilization energetics of AcetylCoA. Mitochondrial energy metabolism. The shuttle

systems; the electron transport chain; the cytochromes; oxidative phosphorylation; chemiosmotic theory;

breathing energy. Lipid metabolism. Digestion and absorption. Catabolism of fatty acids. Biosynthesis of

acids fats, biosynthesis and cholesterol transport. Amino acid metabolism. Metabolism of the amino group.

Protein degradation, transamination, deamination and urea cycle. General information on the degradation pathways of amino acids.

### Biochemical methodologies

Protein extraction; Uv / vis spectrophotometry; Protein Assay Techniques; Electrophoresis of proteins and DNA; Chromatography and applications to the study of proteins; Centrifugation techniques, ultrafiltration, dialysis; Antibody production and methods using antibodies (Western blot, ELISA, RIA, immunocytochemistry); genomics and proteomics techniques; production and characterization of recombinant proteins.

## Cell Biology

What are Cytology and Histology. Prokaryotic and eukaryotic cells. The Cell Theory. Exceptions to theory. Properties of cells.

Study Methods. Optical and Electronic Microscopy. Prepared colors and preparation.

Structure of Biological Membranes. Plasma membrane and its specializations. Cell junctions and

membrane transport. Cellular Endo-Membrane System and Protein Synthesis: Lattice Wrinkled

Endoplasmic, Ribosomes, Smooth Endoplasmic Reticule, Golgi Apparatus. Mitochondria: structure and

function, energy production. Cytoskeleton: Microfilaments, Intermediate Filaments and Microtubules.

Vesicular transport, mechanisms of exo- and endo-cytosis, lysosomes and peroxisomes. Nucleus:

nuclear envelope, chromatin, nucleolus. Structure of chromosomes. Cell cycle. Mitosis and meiosis.

Cellular signaling.

Principles of histology. EPITHELIAL TISSUES. Coating epithelia: Simple (cubic and cylindrical paving)

Stratified (keratinized and not). Transitional. Glandular epithelia. Exocrine glands: classification and

morphology. Endocrine glands. CONNECTIVE TISSUES. The connectives proper (loose and dense) Adipose

tissue. Supportive connective tissue: Cartilage tissue (elastic, fibrous and growth hyaline cartilage). Bone

tissue (compact and spongy and the process of direct and indirect ossification).

Connective tissues with trophic function: Blood: generality and composition. Hemopoiesis: general

information. Immune reaction. MUSCLE TISSUE. Striated skeletal muscle tissue and the process of

contraction. Cardiac striated muscle tissue. Smooth muscle tissue. NERVOUS TISSUE

The structure of the neuron. The nerve fiber. The dendrite. The synapse

**Genetics:**

Genetics and the organism. Mendel's experiments. Chromosomal theory of heredity. Segregations. abnormal phenotypes. Association. Extrachromosomal inheritance. Gene Mutations. Alterations of structure of chromosomes. Alterations in the number of chromosomes. The structure of DNA. Such as genes work. Bacterial genetics. Outline of recombinant DNA techniques. Control of gene expression in prokaryotes. Outline of gene expression control in eukaryotes

**Molecular Biology**

History, X-ray DNA structure, nucleotides, genetic code, DNA structures. Topology, enzymes of restriction. Genomes, C value. Exons-introns. Gene organization, gene families. Repeated DNA, retrotransposons. Chromosomes and chromatin. Replicon and replication. Transcription and regulation transcriptional prokaryotes. Eukaryotic transcription and transcriptional regulation. Termination and antitermination in prokaryotes. Maturation rRNA, eukaryotic mRNA. RNA splicing modifications, editing. tRNA, ribosome mRNA. Translation and translation regulation. MRNA localization. Protein localization. Nucleus-cytoplasmic transport. Post-translational modifications. Techniques of Molecular Biology: screening, blotting of expression systems.

**General Physiology**

The plasma membrane and the exchanges of matter and energy between inside and outside. Transport mechanisms of neutral and charged molecules: ion channels and carriers. Active and passive transport. Flows of water. Osmotic pressure. Absorbing and secreting epithelia. Transepithelial transports. Intercellular communication: communicating junctions, paracrine and autocrine signals. Signal reception pathways: types of membrane receptors and related intracellular transduction pathways. Electrical properties of the membrane and physiology of neurons. Ionic gradients at the ends of the plasma membrane and origin of bioelectric phenomena. Ionic selectivity of biological membranes. Equivalent circuit of the plasma membrane. Transient changes in membrane potential, generation of electrical signals and regulation of cellular functions. Cell electrophysiology. Resting membrane potential and action potential. Channels and ionic currents. Transmission of signals in axons. Chemical and electrical synapses. Neuromuscular synapse. Synapses between nerve cells and integration of signals. Electrical synapses. Sensory physiology: general principles of sensory transduction. Receptor potential and adaptation. Mechanoreception: auditory system and organ of balance, proprioceptors, baroreceptors. Sensory transduction in retinal photoreceptors. Chemical senses: taste and smell. visceral receptors. Thermoreceptors and nociceptors. Muscle: classification and general properties of muscles. Microscopic aspects of the contraction. Excitation-contraction coupling. Control of strength development. Type of muscle fibers and muscle metabolism. Smooth and cardiac muscle. Nervous system. Movement control on an involuntary basis: spinal reflexes. Voluntary movement: cortical areas, basal nuclei and cerebellum. Higher functions of the brain: EEG, sleep and wakefulness, memory and language. Limbic areas, instincts and emotions. Hypothalamus and vegetative functions. Autonomic nervous system Circulating liquids: functions of the liquid and cellular part of the blood Circulatory system: structure and function of the cardiovascular system in vertebrates (notes on invertebrates); the heart as a pump (electrical and mechanical activity of the heart), blood vessels and circulation: blood pressure and speed, capillaries and exchanges with tissues. Regulation and adaptations of the cardiovascular system. Respiratory system: general principles. Mechanics of respiration and diffusion of gases through the respiratory surfaces. Respiratory function of the blood: transport of oxygen and carbon dioxide, buffer function of the blood. Nervous and chemical regulation of respiration, respiratory adjustments and muscular activity. Digestive system: functional anatomy of the alimentary canal, control of gastrointestinal function, motility, secretion and absorption in the different districts of the digestive system, concepts of energy balance and metabolism, evolution of the digestive system. Renal function: morphofunctional organization, processes of filtration, absorption and secretion in the nephron, variety of tubular structures. Water and saline balance.

## **Plant Physiology**

Plant cell. Cell wall. Plasma membrane and endomembrane system. Cytoskeletal and cell cycle. Vacuole. Plastids. Peroxisomes. Mitochondria. Plant nucleus and genomes. Polyploidy.

Plant tissues: primary and secondary meristems, parenchyma, integumental tissues, conducting tissues, conducting bundles, xylem and phloem, secretory tissues. Plant organs: stem, leaf, root.

Plant biodiversity. Classification: concept of species, taxonomic ranks and nomenclature.

Functions of the cell, tissues and plant organs. Energy flow in plant systems. Thermodynamics and modes of transport in plant cells. Electrochemical potential. Transport of water and transpiration. Plant metabolism: photosynthesis, photorespiration, C4 and CAM plants. Synthesis of sucrose and starch. Translocation of photoassimilates. Plant growth and development: plant hormones - structure, biosynthesis, physiological effects and mechanism of action of auxin, cytokinins, gibberellins, abscisic acid and ethylene; photomorphogenesis and phototropism.

## **Microbiology**

Microbial Diversity: Bacteria, Archea and Eukarya; The prokaryotic cell structure and organization. The eukaryotic microbes cell structure and life cycles; Microbial Nutrition, Growth and Metabolism; Environmental factors affecting microbial growth Chemoorganotrophy; Chemolithotrophy and Nitrogen Metabolism; Phototrophy; Bacterial Genetics, Regulation of gene expression, The molecular basis of mutations, Genetic transfer in microorganisms, Genetic Engineering and bacterial genomics, Basic principles of cloning. Microbial Associations and Microorganisms in the Environment. Bacterial Pathogenicity. Control of Microorganisms and Antimicrobial Agents