Syllabus of Chemistry for Premedical Course
(entrance exam requirements)

I. General Chemistry

1. Atoms. Atomic number. Mass number. Protons and neutrons. Electron configuration. Orbitals. Pauli exclusion principle. Hund´s rule. Aufbau principle. Chemical symbols.
2. Nomenclature of inorganic compounds.
3. Physical quantities : mass, volume, temperature, time and quantity of chemical substance. Density, specific gravity.
4. Kinetic and Potential energy. (Chemical energy as a form of potential energy. Law of Conversion of Energy). Heat. Specific heat and Heat capacity. Melting point of solids. Boiling point of liquid. Exothermic and endothermic reactions.
5. Periodic Table. Periodic law. Representative elements, transition elements, inner transition elements. Metals and nonmetals. Biologically important elements (macroelements, inorganic ions, trace elements). Ionic compounds. Shapes, sizes and radii of ions. Octet rule.
6. Molecules. Chemical bonds. Covalent, Polar covalent and Ionic bonds, Intermolecular attractive forces. Inorganic Chemical Compounds.
7. States of Matter: Gaseous state. Pressure. The pressure-volume-temperature relationships for a fixed amount of gas. The general gas law. Avogadro´s principle. Dalton´s law of partial pressures.
8. States of Matter : Liquid state. Dynamic equilibrium. Vapor pressure. Water and Hydrogen bonds. Boiling point. Surface pension. Surfactants.
9. Solid state. Melting point. Sublimation.
10. Heterogeneous and homogeneous mixtures (Solutions. Colloidal Dispersions. Suspensions). Aqueous solutions. Product of solubility. Solubilities of Gates. Henry´s law. Gas tension. Diffusion. Osmosis and Dialysis.
11. Quantitative Relationships in Chemical Reactions . Reactions in solution. (the mole concept, percentage concentration, molar concentration, mutual conversion of different concentration, preparing dilute solutions from concentrated solutions). Balanced Chemical Equations and Stoichiometry.
12. Chemical reactions. Equilibrium. Shifting of equilibrium. Le Chatelier ´s principle
13. Electrolytes, Acids and Bases. Arhenius and Brönsted theories, and ionic compounds. Salts. Product of solubility.
14. The pH concept. Ionic product of water. Acid ionization constants. Buffers. Acid-Base titration.
15. Reaction Kinetics and Chemical Equilibria. Guldberg-Waage law. Catalyst. Rate of reaction. Acid-Base Equilibria
16. Oxidation-Reduction Equilibria. The oxidation number. Balancing equations of redox reactions. Reduction potentials.

II. Organic chemistry and biochemistry

1. Classification of Organic Compounds (hydrocarbons, derivatives of hydrocarbons), Physical Properties

2. Important Terms of Organic Chemistry (valence of C, O, H, N, S, halogens; alkyl, aryl, aromatic compound, constitution, conformation, configuration, saturated and unsaturated hydrocarbon, functional group, cyclic hydrocarbon, single and multiple bonds, sigma and pi electrones, primary, secondary, and tertiary carbon)
3. Chemical Formulas (molecular, empirical, and structure formula)
4. Isomerism (structural isomers, stereoisomers: optical and geometrical isomerism)
5. Rection Types (substitution, addition, elimination, rearrangement)
6. Nomenclature of Organic Compounds (important prefixes and suffixes, systematic and common names, general rules of naming compounds, priority of functional groups and their structures
7. Alkanes, Alkenes, and Alkynes (physical and biological properties, occurrence, reactivity: oxidation, halogenation, reduction, addition, polymerization; important common names: ethylene, acetylene, chloroform, vinylchloride)
8. Arenes (structure, physical and biological properties; important common names: benzene, phenyl-, toluene, benzyl-, o-, m-, and p-xylene, naphtalene, anthracene, phenanthrene, pyrene, biphenyl, styrene)
9. Alcohols and Phenols (naming, structure, classification: primary, secondary, and tertiary alcohols, monofunctional and polyfunctional alcohols; physical and biological properties, reactivity: dehydration, oxidation, esterification; important common names: glycerol, phenol, cresols, hydroquinone, pyrocatechol, benzylalcohol)
10. Ethers and Epoxides (naming, structure, physical and biological properties)
11. Thiols, Sulfides, and Disulfides (naming, structure, physical and biological properties)
12. Carbonyl Compounds: Aldehydes and Ketones (naming, structure, physical and biological properties, reactivity: oxidation, reduction, addition of water, alcohol, and nitrogen compounds; keto-enol tautomers, aldol condensation; important common names: formaldehyde, acetaldehyde, benzaldehyde, glyceraldehyde, acetone, dihydroxyacetone, quinones, phenones)
13. Carboxylic Acids (naming, structure, classification: saturated, unsaturated, monocarboxylic, dicarboxylic; terms: acyl, anion, alpha-carbon, omega-carbon; physical and biological properties; important common names: monocarboxylic acids C1-C4, C16, C18, dicarboxylic acids C2-C5, fumaric and maleic acid, oleic, linoleic, linolenic, arachidonic acid, benzoic acid)
14. Derivatives of Carboxylic Acids: Substitutional Derivatives (halogen, hydroxy, oxo = keto, and amino derivatives; naming, structure, important common names: lactic acid, malic acid, pyruvic acid, oxaloacetic acid, 2-oxoglutaric acid, citric acid, salicylic acid), and Functional Derivatives (salts, anhydrides, esters, amides, halides, and nitriles; naming, structure, properties)
15. Sulfonic Acids (naming, structure, properties)
16. Carbonic Acid Derivatives (urea, phosgene, guanidine)
17. Heterocyclic Compounds (structure, pyrrole, indole, pyridine, pyrimidine, purine, imidazole, furan, pyran)
18. Amines (naming, structure, classification: primary, secondary, tertiary amnines, quaternary ammonium; physical and biological properties; reactivity: diazotation; important common names: aniline, choline)
19. Nitrocompounds (naming, structure, properties)
20. Structure of Nucleic Acids (purine and pyrimidine bases, nucleosides, nucleotides; keto-enol tautomerism; complementary base pairing, bonds in nucleic acids: H-bond,

N-glycosidic bond, phospoester bond, phosphodiester bond; structure of DNA and RNA, types of RNA)

21. Proteins (proteinogenic amino acids: classification, properties, isoelectric point; structure of proteins: primary, secondary, tertiary, and quaternary one; bonds in proteins, properties, denaturation, classification, and functions of proteins)
22. Lipids (classification: fatty acids, neutral lipids - triacylglycerols, phospholipids, sfingolipids, steroids - cholesterol; structure, properties, and functions) and Terpenes (structure, classification; isoprene)
23. Saccharides (classification: mono-, oligo-, and polysaccharides; structure: Fischer, Tollens, and Haworth projection, properties; reactivity: oxidation, reduction, esterification, glycosylation, isomerization: ketose-aldose, pyran-furan, alpha-beta anomer, epimers, D- and L- enantiomers; important saccharides: glucose, fructose, galactose, mannose, ribose, deoxyribose, sucrose, lactose, maltose, starch, glycogen, cellulose)

Syllabus of Biology for Premedical course
(Entrance exam requirements)

1. General features and energetics of live systems (second law of thermodynamics, characteristics of the living systems: organization, homeostasis, metabolism, growth, adaptation, response to stimuli, reproduction, bacterial conjugation, parthenogenesis, sexual reproduction, energetics of live system, photosynthesis, cell respiration, glycolysis, Krebs cycle, electron transport chain, oxidative phosphorylation, fermentation)

2. Cellular biology: prokaryotic organisms (phylogenetic division, archaebacteria, genomic organization, shapes of bacteria, cell wall, movement, growth of population, bacterial transformation, endospores, nutritional and metabolic diversity, nitrogen fixation, domain *Bacteria*, symbiosis, pathogenicity, bacteria in technology)

3. Cellular biology: eukaryotic organisms (nucleus, plasma membrane, endomembrane system, mitochondria and chloroplasts, centrosomes, cytoskeleton, flagella, actin filaments, muscle, cell surfaces, intracellular junctions, fluid mosaic model, proteins and carbohydrates in membrane, transports, osmosis)

4. Cellular biology: non-cell organisms (division according to host, icosahedral models, capsids configuration, virus classification, virus evolution, reverse transcription, reproduction, lytic cycle, lysogenic cycle, tumor viruses, prions, heredity, disease, HIV infection)

5. Molecular bases of heredity: DNA (bacterial transformation, informational polymers, pyrimidines, purines, pentose, nucleotide and nucleoside, bonds between nucleotides, replication, DNA polymerase, euchromatin, heterochromatin, ultrastructure of chromosomes, condensation, sister and nonsister chromatids, karyotypes)

6. Molecular bases of gene expression: RNA and proteins (expression of genetic information – transcription and translation, RNA structure and types, RNA processing, genetic code, ribosomes and polyribosomes, aminoacyl-tRNA synthetases, protein structure and synthesis, regulation of expression of genetic information and differences between prokaryotes and eukaryotes)

7. Mitosis (mitosis and cell cycle, cell cycle phases, proliferation and resting cells, phases of mitosis, centrosomes with kinetochores, regulation of cell cycle, check points, cyclins and CDK; protooncogenes, tumor suppressor genes, carcinogenesis, exogene mechanisms of regulation, signal molecules, signal transduction, aging, apoptosis, necrosis)
8. Meiosis (asexual reproduction, sexual reproduction, alternation of haploid and diploid phase, reduction of haploid phase in evolution, meiosis-mitosis differences; first meiotic division: prophase of MI, synapsis, synaptonemal complex, crossing over, phases of MI; second meiotic division and phases, gametogenesis, spermatogenesis, oogenesis, fertilization; consequences of meiosis, errors in meiosis, nondisjunction and anaphase lag in meiosis and in mitosis, errors of fertilization, gynogenesis a androgenesis)
9. Origin of life on the earth (conditions on Earth, evolutional theory of abiotic synthesis, early atmosphere, primordial soup, chemical evolution, Miller and Urey experiment, microspheres, liposomes, protobionts, RNA world, hypothesis of cooperation, time scale of evolution, evolution of prokaryotic metabolism, origin of photosynthesis, endosymbiotic theory, phylogenetic tree, evolution of eukaryotes, evolution of multicellular organisms)
10. Biologic evolution (time scale of life on the Earth, macro and microevolution, Lamarck, Darwin, de Vries, mechanisms of evolution, mutations, recombination, intragene combination, gene duplication, horizontal transfer between species, natural and artificial selection, genetic drift, evolution of chromosomes, sex determination, species, gene pools, phylogeny, geological time scale, radiometric dating, taxonomy, cladistic analyses)
11. Genetics of prokaryotic cell (bacterial chromosome, transformation, transduction, conjugation, F and R plasmids, transposons, operons, negative and positive gene regulations)
12. Genetics of eukaryotic cell (eukaryotic chromosomes and mitochondrial DNA, Gregor Mendel's inheritance: pea plants, character, trait, hybridization, monohybrid and dihybrid crosses, testcross, parental and filial generations, the laws of uniformity, segregation and independent assortment; Thomas Hunt Morgan's gene linkage: fruit flies Drosophila)
13. Genetics in humans (genetics, heredity, variability, gene, gene expression, dominant and recessive alleles, homozygous – heterozygous, genome, gene pool, genotype, phenotype, complete and incomplete dominance, codominance, ABO and Rh blood groups)
14. Cytogenetics in humans (structure and classification of chromosomes, human karyotype, cell cycle, gamete maturation, sex determination in different species, Barr bodies)
15. Single-gene disorders (gene mutations: nucleotide substitution, deletion, insertion; autosomal dominant and recessive traits, X-linked dominant and recessive traits)
16. Chromosome disorders (chromosome mutations: unbalanced rearrangements, deletion and duplication, balanced rearrangements, inversion and translocation; genome mutations: aneuploidy, trisomy and monosomy, polyploidy, triploidy and tetraploidy)
17. Genetic disorders (genetic counseling and testing, carrier recognition, fetal testing: amniocentesis and chorionic villus sampling, newborn screening)
18. DNA technology (DNA diagnosis and therapy, PCR, sequencing, restriction digestion, reverse transcription, blotting, and cloning)

19. Population genetics (modern evolutionary synthesis of Darwinian selection and Mendelian inheritance, genetic structure, Hardy-Weinberg equilibrium)
20. Evolution of populations (five causes of microevolution: genetic drift, gene flow, mutation, nonrandom mating, and natural selection – genetic variation, adaptive evolution)
21. Individual development in humans (human specification, diblastica/triblastica, protostomia/deuterostomia, types of celoms, vertebrates, mammals, genetic bases of development, models, gradients of morphogenes, ontogenesis, ectoderm, endoderm, mesoderm, differentiation)
22. Tissues (epithelial, connective: loose – fibrous – cartilage – bone – adipose – blood, muscle: skeletal or striated – cardiac – smooth, nervous: neurons – glia)
23. Skeletal system (structure, function, shapes of joints, fuselage framework, ribs, skeletons of limbs, arms, legs, pelvis, skeleton of head, frequent diseases)
24. Muscular system (structure, function, muscles of arm, muscles of leg, fuselage muscles, muscles of backpack, frequent diseases)
25. Circulatory system (body fluid, intracellular, extracellular, circulatory system, vessels and heart, blood circulation, heart activity, blood pressure, blood elements, hematopoiesis, blood groups, most frequent diseases, lymphatic system, spleen, nodules)
26. Respiratory system (external and internal respiration, gas exchange, larynx, vocal cords, trachea, two bronchi, lungs, bronchioles and alveoli, positive and negative pressure breathing, tidal volume, vital capacity, residual volume, frequent diseases)
27. Digestive system (oral cavity, tongue - salivary glands - teeth, pharynx, esophagus, stomach, small and large intestine, rectum, anus, pancreas, liver, gallbladder, digestion and absorption of carbohydrates, proteins and fats, frequent diseases - hepatitis)
28. Excretory system (filtration, reabsorption, secretion; kidney, nephron, collecting duct and renal pelvis; ureter, urinary bladder, urethra, frequent diseases)
29. Skin system (epidermis, dermis; nervous endings, pain and touch receptors, sweat glands; body defense and thermoregulation, frequent diseases)
30. Reproductive system (male: testis, epididymis, vas deferens, seminal vesicle, prostate; female: ovary, oviduct, uterus, vagina; embryonic and fetal development; frequent diseases)
31. Substantial control (hormonal) (endocrine glands and their hormones: chemical classes, actions and regulations, homeostasis of blood calcium and blood glucose levels)
32. Nervous control – structure, function (central, brain + spinal cord, and peripheral nervous systems, somatic + autonomic with parasympathetic and sympathetic divisions; neuron structure and supporting cells, sensory and motor neurons, reflexes, ganglia – nuclei; neural signals: membrane and action potential, electrical and chemical synapses)
33. Nervous control – CNS (medulla oblongata, pons, cerebellum, midbrain, diencephalon, thalamus – hypothalamus, cerebrum: cerebral hemispheres with cortex, white matter and basal nuclei, corpus callosum, limbic system, structural and functional areas of cortex)
34. Controlling the internal environment (thermoregulation: conduction, convection, radiation and evaporation; water and mineral balance: diffusion and osmosis, homeostasis of blood osmolarity, pressure and volume; nitrogenous wastes: ammonia, urea, uric acid)

35. Sense organs (mechanoreceptors: muscle spindles and hair cells in ear, pain receptors – nociceptors in skin, thermoreceptors in skin and in hypothalamus, chemoreceptors: gustatory and olfactory receptors for taste and smell, electromagnetic receptors – photoreceptors in eye)
36. Blood (function, plasma and cellular elements: erythrocytes, leucocytes, thrombocytes, hematocrit, serum, hematopoiesis regulation – erythropoietin; blood clotting, hemophilia)
37. Immune system (function, organs of immune system, leucocytes classification; nonspecific and specific defense mechanisms, cellular and humoral components)
38. Nutrition (nutritional requirements: chemical energy, biosynthesis, essential nutrients; homeostatic mechanisms – leptin, overnourishment, undernourishment, malnourishment; metabolism of carbohydrates, proteins and fats, vitamins and minerals)
39. Evolution of humans (the timing of major episodes in the history of life and the timeline of hominid species, important characters of human evolution; Anthropoids, Australopithecus, Homo habilis, Homo ergaster, Homo erectus, Homo neanderthalensis, Homo sapiens; multiregional and monogenesis models for the origin of modern humans, cultural evolution)
40. Man and environment (agricultural effects on nutrient cycling, accelerated eutrophication of lakes, biological magnification of toxins, carbon dioxide emissions and greenhouse effect, depletion of atmospheric ozone)