DETAILED SYLLABUS FOR THE POST OF SCIENTIFIC ASSISTANT (PATHOLOGY) IN MEDICAL EDUCATION DEPARTMENT

(CAT.NO.: 279/2024)

(Total Marks – 100)

PART I : Zoology - (50 Marks)

Module I: Animal Diversity and Evolution (5 marks)

Animal Diversity: Lower Metazoans: Porifera, Cnidaria-Polymorphism, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudo-coelomata, Echinoderms: Classification Hemichordates: Position in the animal kingdom, Chordates: Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostraco derms and Gnathostomes Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes. Terrestrial Vertebrates: Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats. Reptiles- diversity, Birds and Mammals: diversity. Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders. Scientific names and common names of organisms under all phylums.

Evolution: The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Geological Timescale. Major events in evolutionary timescale. Anthropocene. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significance, Types of fossilization. Population Genetics. Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Cytogenetic and molecular basis of origin of Man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam

Module II: Biophysics (3 marks)

Microarrays-significance of proteomics and drug design, Systems Biology, metabolomics, gene network, synthetic biology, Radiation Biophysics: Ionizing radiation, units of radioactivity, exposure and dose. Interaction of radiation with matter – effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation: somatic and genetic. Radiation dosimetry, radioactive isotopes, auto radiography, Cerenkov radiation, liquid scintillation techniques, Flow cytometry and fluorescence.

Module III: Animal Physiology (12 marks)

Nutrition: Constituents of normal diet and their daily requirements. Physiological calorie value of food stuffs. Antioxidant nutrients. Movements of GI tract, deglutition, gastric motility and emptying, intestinal motility and defecation. Mechanism of absorption of monosaccarides, amino acids and lipids and vitamins. The role of hormones and

neurotransmitters in the control of gastrointestinal Motility. Energy balance and obesity-causes and consequences. BMR and its significance.

Excretory System: Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules). Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus- structure, parts and function. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion) Regulation of water balance -Mechanism of concentration of urine – Counter Current system. Renal regulation of acid- base balance & electrolyte balance. Structure of urinary bladder, micturition reflex and micturition. Renal clearance – definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium.

Respiratory system: Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia). Physiological anatomy and histology of respiratory passage and lungs. Mechanism of pulmonary ventilation (inspiration & expiration). Alveolar ventilation, dead space and its effect on alveolar ventilation. Role of surfactant in alveolar expansion. Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity). Exchange of gases- partial pressures involved-lung and tissues. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO_2, PCO_2, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin). Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

Nervous system: Organisation of human brain. Cerebrum and cerebral lobe. Cerebral cortex and its functional areas- Motor cortex, Broca's area, cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick's area, Brodman map, cerebral dominance. Cortical white matter- commissures, association fibers, projection fibers, corpus callosum and fornix, basal nuclei, Brain stem, Cerebellum, Diencephalon. Functional brain systems - Limbic system and reticular formation. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function. Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease. Memory- types of memory- somatosensory, short term, intermediate long term and Long term memory, consolidation of memory. PNS and Autonomic nervous system. Spinal cord – structure. Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and Golgi tendon organ. Special senses Vision: Structure of eyeball Fluid systems of the eye Layers of Retina and photoreceptors (rods & cones) Neuronal cell types and neural circuitry of the retina and visual pathways from retina to visual cortex Image formation Taste: Primary sensations of taste. Taste buds, Physiology of taste, Smell: Olfactory membrane and receptor cells Physiology of olfaction, Tactile response: Mechanoreceptor, Pain receptors, Thermal receptors, Formation of image on the retina. A brief general account of electrophysiology of vision Photochemistry of vision and colour vision

Cardiovascular system: Structural organization of myogenic heart (in human beings). Physiological anatomy of cardiac muscle – specialized tissue. Cardiac cycle. Neural and chemical regulation of heart function. Blood volume and blood pressure. Physiological anatomy of coronary blood flow, Ischemic heart disease. Lymphatic System. Lymph channels of the body. Composition and formation of lymph. Functions of lymph and lymphatic system including. Muscle physiology, Skeletal, Smooth and Cardiac muscles, physiology of muscle contraction, muscle proteins, molecular mechanism of muscle contraction, muscle twitch, rigor mortis, summation.

Endocrinology: Invertebrate and vertebrate endocrine system. Endocrine glands. Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine regulation of hormone action. Disorders of hormonal imbalance in Man. Reproductive physiology: Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control. Physiology of implantation, pregnancy, parturition, and lactation. Environmental Physiology: Thermoregulation. Comfort zone, normal body temperatures (oral, skin & core). Temperature regulating mechanism (hot & cold), role of hypothalamus, thyroid and adrenal glands.

Module IV: Immunology (10 marks)

Hematopoiesis – Lymphoid and myeloid lineages. Hematopoieti c growth factors. Genes that regulate hematopoiesis. Regulation of hematopoiesis. B- Lymphocytes, T-lymphocytes and Antigen presenting cells. Antigens Immunogenicity, Antigenicity. Factors that influence immunogenicity. Adjuvants. Haptens. Epitopes. Properties of B-cell and T- cell epitopes. Immunoglobulins (Antibodies) Structure and function of Antibody molecules. Generation of Antibody diversity. Immunoglobulin gene. Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype. B-cell receptor (BCR). Monoclonal Antibodies. Production of Monoclonal Antibodies (Hybridoma technology). Clinical uses of Monoclonal Antibodies. Antibody Engineering. Antigen-Antibody Interactions Strength of antigen – antibody interactions. (a) Antibody affinity (b) Antibody avidity. Cross- reactivity. Precipitation reactions. Humoral immunity. Cellular immunity. T- Cell receptor, TCR- CD3 complex. Activation, maturation and differentiation of B-Cells and T-Cells. Immune effector mechanism. Cytokines. Cytokine antagonists. Cytokine secretion by TH1 and TH2- cells. Cytokine related diseases. (a) Bacterial septic- shock (b) chaga‟s disease) (c) lymphoid and myeloid cancers. Therapeutic uses of cytokines. Toll- like receptors. The Complement system. The functions of complement components. Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway. Regulation of complement system. Biological consequences of complement activation. Complement deficiencies. Major Histocompatibility Complex (MHC) General organization and inheritance of MHC. MHC molecules and genes. Cellular distribution of MHC. Antigen-processing and presentation- Exogenous and Endogenous pathways. Presentation of non- peptide antigens.

Transplantation immunology: Auto graft, Allograft, Isograft and xenograft Immunological basis of graft rejection. Role of cell- mediated responses. Bone marrow

transplantation, Transplantation antigens. General immune suppressive therapy. Hypersensitivity Reactions. Allergens IgE- mediated (type- I) hypersensitivity. Antibody-mediated cytotoxic (type- II) hypersensitivity. Immune complex- mediated (type- III) hypersensitivity. TDTH- mediated (type- IV) hypersensitivity Vaccines.: Active and passive immunization. Whole organism vaccines. Recombinant vector vaccines. DNA vaccines. Synthetic peptide vaccines. Multivalent vaccines.

Module V: Animal Biotechnology (8 marks)

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics. Transfection Methods: CaPO4 precipitation, Short Gun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knocking technology. Applications of transgenic animals. Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine. Biotechnology in Healthcare: Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non-medical. Biochips and their application. Biotechnology in Industry and Agriculture: Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstream processing. Microbial enzymes and bio-transformation- Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life. Bio-fertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, bio-pesticides, bio-insecticides, Terminator gene technology

Module VI: Developmental Biology and Human Genetics (10 Marks)

Developmental Biology (8 marks)

Basic concepts of development Cell fate, potency, determination and differentiation. Commitment, Specification- autonomous, conditional, syncytial. Genomic equivalence and cytoplasmic determinants, Morphogenetic gradients, Genomic Imprinting, The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent

adult stem cells, Pluripotent Embryonic stem cells, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages. Genomic equivalence and Cytoplasmic determinants. Gametogenesis, fertilization and early development: Production of gametes- Spermatogenesis and Oogenesis, Ultrastructure of gametes, Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals) Zygote formation-Encounter of sperm and egg, Capacitation, Acrosome reaction, Activation of ovum, Amphimixis, Prevention of Polyspermy Cleavage and blastula formation, Gastrulation in humans.

Transcription factors induced in the organizer. Neural induction, Regional specificity of induction, Genetic specificity of induction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP). Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and cell death pathway. Differential gene transcription - exons and introns, promotors, silencers, enhancers, transcription factors, DNA methylation, genomic imprinting, dosage compensation, differential RNA processing; Control of gene expression: translational and post translational control of gene expression. Teratogenesis, Malformations and disruptions, Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals). Infertility-Test tube babies (In vitro fertilization and embryo transfer). Cloning experiments- (Mammals and Human).

Human Genetics: **(2marks)**

Karyotype, pedigree analysis, Chromosome anomalies: autosomal and sex chromosomal disorders. Lod score for linkage testing, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping. Blood group systems - ABO, Rh and MN blood groups, Bombay Blood Group, other types, human karyotype and syndromes caused by its aberrations, genetic counselling, pedigree analysis.

Module – VII (2marks)

Recent Development In Zoology

PART II – CHEMISTRY – 50 MARKS

Module 1 - Inorganic Chemistry-1 - 05 MARKS

Structure and bonding in molecules- Chemical periodicity- Chemistry of Hydrogen and s block elements- Chemistry of p block elements and d block elements- Extractive chemistry of various metals of commercial importance- Chemistry of Nontransition elements like Glass

Theories of acids and bases- HSAB concept- solvent effects, linear free energy relationship – mechanism and methods of determination, super acids - Reactions in Non-aqueous solvents- Protic and Aprotic solvents- Chemistry of Isopoly and Heteropoly acids ;

Silicon-Oxygen compounds; Zeolites ; Xenon and Krypton compounds including their organic and coordination compounds

Synthesis, reactions, structure and bonding in Sulphur-Nitrogen compounds ; Sulphur-Phosphorus compounds ; Phosphorous-Nitrogen compounds ; Boron - Nitrogen compounds ; Boron hydrides; Organoboranes; Carboranes and metallocarboranes- STYX and WADE rules

Chemistry of Lanthanides and Actinides including their extraction and applications as well as their coordination complexes and spectral behaviour

Theories of Coordination Chemistry in detail: Werner's theory - Crystal field theory – Ligand field theory – Molecular orbital theory- Stereochemistry of coordination compounds- Jahn Teller distortion- Detailed study of Stability and reactions of metal complexes- Electron transfer, Substitution and Photochemical reactions and their kinetics

Module 2 - Inorganic Chemistry-2 - 05 MARKS

Construction of energy level diagrams. Correlation diagram. Method of descending symmetry. Term symbols; Correlation diagrams for d^n and d^{10} ions in octahedral and tetrahedral fields ; Orgel and Tanabe-Sugano diagrams. Symmetry and Selection rules for electronic spectra , IR and Raman Theory of Electronic, IR, NMR, ESR and Mossbaur spectra of complexes. Different aspects of magnetic properties of complexes and their determination.

Spectroscopic Methods in Inorganic Chemistry- Structural elucidation of coordination compounds containing the following molecules/ ions as ligands- NH_3, H_2O, CO, NO, OH^-, SO_2^- , CN^- , SCN^- , NO^-, NO^-, CH_3COO^- and X^- (X=halogen). changes in ligand vibration on coordination with metal ions.- CD and ORD spectra of metal complexes- NMR of metal nuclides with emphasis on ^{11}B, ^{31}P and ^{19}F NMR.- ESR spectra: Application to Cu(II) complexes and inorganic free radicals such as PH_4, F^- and $[BH]^-$. Mossbauer Spectroscopy: Application of the technique to the studies of iron and tin complexes

Nomenclature, synthesis, structure, properties and bonding of organo-metallic compounds - metal carbonyls and cyanides – Complexes with linear π donor ligands: Olefins, acetylenes, dienes and allyl complexes. Complexes with cyclic π donors: Cyclopentadiene, benzene complexes. Structure and bonding of ferrocene and dibenzenechromium complexes - Metal –Metal bonds and metal atom clusters. Tri , Tetra and hexa nuclear clusters, Isoelectronic and isolobal relationships, Low nuclearity and High nuclearity carbonyl clusters (LNCCs and HNCCs). Cubane Clusters, Chalcogenide Clusters, Chevrel Phases. Zintl Anions and Cations – Capping Rule Catalysis by organo metallic compounds and metal clusters- hydrogenation, hydroformylation and polymerization.

Essential and trace metal elements in biological systems, . Role of Iron,Calcium, Copper, Lithium, Aluminium, Magnesium and other metals in biological systems structure and functions of biological membranes, mechanism of ion transport across membranes, sodium- potassium pump. - Role and effects : Coenzymes, Cytochromes, chlorophylls and hormones. Photosynthesis, porphyrin ring system, chlorophyll, PS I and PS II. Synthetic model for photosynthesis. Inorganic medicinal chemistry. Metals in medicine.

Module 3 - Inorganic Chemistry-3 - 05 MARKS

Nuclear reactions - structure and stability- Magic numbers – Detailed study of different nuclear models- radio active equilibria and equations of radioactive decay and growth - Nuclear reactions: Direct nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions. Neutron captures cross section and critical size -Applications of nuclear reactions- fission and fusion; neutron activation analysis – counting techniques.

Solid State Chemistry: Crystal symmetry- Point groups and space groups. Miller indices and Bravais Lattices- Close packed structures: BCC, FCC and HCP. Voids. Coordination number.

X-ray diffraction by crystals: Applications and calculations using Bragg's equation and indexing methods. Different types of Crystal defects and consequences

Electronic structure of solids. Different theories about conductors, insulators and semiconductors and their applications. Doping and band gap adjustments. AX, AX_2, A_mX_2, ABX_3, Spinels and Inverse spinel structures. Structure and theories of Liquids- Liquid crystals and their applications.

Temperature dependence of conductivity, carrier density and carrier mobility in semiconductors - Superconductivity, Photoconductivity Photovoltaic effect.

Colour in inorganic solids. - Dielectric properties. Dielectric materials. Ferroelectricity, pyroelectricity, piezoelectricity and ionic conductivity. Applications of ferro, piezo and pyroelectrics.

Inorganic Advanced materials : Solid Electrolytes: Mixed oxides, cationic, anionic solid electrolytes, mixed ionic-electronic conductors- Solid Oxide Fuel Cells (SOFC), Rechargeable battery materials- Solid state chemistry of metal nitrides and fluorides, chalcogenides, intercalation chemistry and metal-rich phases.- Inorganic pigments, Inorganic phosphors- Molecular materials and fullerides, basic idea of molecular materials chemistry like One dimensional metals, Molecular magnets and Inorganic liquid crystals.

Module 4 - Organic Chemistry-1 - 05 MARKS

Nomenclature of organic compounds - Cyclic, fused polycyclic and bridged polycyclic hydrocarbons, bridged and fused hydrocarbon systems, Spirocyclic hydrocarbon systems, Heterocyclic systems containing Nitrogen and Oxygen.

Molecular symmetry and chirality, axial chirality, planar chirality and helicity, relative configuration, stereochemical nomenclature, R and S, E and Z. Stereo chemistry of biphenyl and allenes - Topicity and prostereo isomerism -asymmetric synthesis. Axial stereochemistry: atropisomerism and its designation - biphenyls, allenes, spiranes- M and P configurations. Stereoselectivity: enantioselectivity, diastereoselectivity & stereoconvergence. Stereospecific and stereoselective synthesis. stereotopicity & stereoprojections. Prochiral centre and prochiral faces- Pro R and Pro S, Re face and Si face, Importance of prochirality in biological systems. Geometrical isomerism . , Conformational analysis in acyclic and cyclic systems , Application of Cram's rule, Felkin–Ahn model

Basic concepts of Organic reactions - Electron displacement effects –Aromaticity and antiaromaticity. Non aromatic, homoaromatic, hetero and non–benzenoid aromatic systems. Aromaticity of annulenes, mesoionic compounds, metallocenes, cyclic carbocations and carbanions.

Mechanism and applications of common substitution, addition, elimination and rearrangement reactions. Stereochemistry and factors affecting Aliphatic and Aromatic SN1 and SN2 reactions. S_N1', S_N2', S_Ni S_NAr and benzyne mechanisms – NGP and Nonclassical carbocations- Generation and reactions of Nitrenes, Carbenes and free radicals like Triphenyl methyl, TEMPO, Dibenzoyl peroxide, NBS , Tributyl Tinhydride and AIBN. - Chlorination of alkane, addition of HX, S_RN1 mechanism- Acyloin condensation, Alkyne coupling reactions- Reimer-Tiemann, Vilsmeier-Haack reactions. Mitsunobu reaction and Chichibabin reactions.

Mechanism of Addition of H_2O, X_2, HX, and boranes to C=C systems- Cis and trans hydroxylation of cycloalkenes- Mechanism and applications of Michael addition and Robinson Annulation- Aldol condensation- Stork enamine, Cannizzaro, Perkin, Ritter, Stobbe, Knoevenagel, Darzen, Reformatsky and benzoin condensations- Grignard, Mannich, Thorpe reactions and Dieckmann condensation

Mechanism and regio and stereo aspects of E1, E2 and E1cb reactions in cyclic and acyclic systems. Hoffmann and Saytzeff elimination- Elimination Vs substitution- Mechanism and applications of Shapiro reaction, Peterson and Julia olefination, Wittig and Wittig - Horner reactions; Chugaev reaction and Cope eliminations- Sodium in liquid ammonia and Lindlars catalyst in conversion of alkynes to alkenes

Module 5 - Organic Chemistry-2 - 05 MARKS

Mechanism with evidence of Wagner – Meerwein, Pinacol, Demjanov, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Fries, Hofmann–Martius, Dienone–phenol, Benzilic acid, Benzidine, Favorskii, Stevens and Wolf rearrangement.

Oxidation and Reduction reactions in organic synthesis- Reduction using boranes, hindered boranes and derivatives- $NaBH_4$, and $LiAlH_4$, DIBAL-H, tri-n-butyltin hydride, diimide, and aluminium alkoxide. Birch reduction, Clemmensen reduction and Wolff - Kishner reduction, Huang - Minlon modification, Rosenmund reduction - allylic and benzylic oxidation, Sharpless epoxidation, oxidation using SeO_2, manganese (IV) oxide, lead tetraacetate, ozone, peracids, DDQ, silver carbonate and Cr(VI) reagents. Jones oxidation, Swern oxidation, Moffatt oxidation, Sommelet reaction. Applications of HIO_4, OsO_4 and mCPBA

Linear Free Energy Relations, The Hammett equation and its applications. Significance of sigma (σ) and rho (ρ) reactions with negative and positive ρ, low and high ρ, abnormal Hammet plot, Taft equation. Hammet plot and applications- Primary, secondary, inverse kinetic isotope effects. Salt effects and special salt effects in SN reactions

Retrosynthetic analysis and disconnection approach in organic synthesis- Olefin metathesis- Grubbs' catalysts. Umpolung concept-1,3-Dithiane, benzoin condensation. Heck, Negishi, Sonagashira, Kumada, Stille coupling and Suzuki coupling

Use of various organic, inorganic and organometallic reagents in organic synthesis- Grignard reagents, Alkyl lithiums, Lithium Dialkylcuprates, Alkynyl copper reagents, Tebbe reagent etc. Use of various protecting groups in peptide synthesis. Phase transfer catalysis and its applications.

Module 6 - Organic Chemistry-3 - 05 MARKS

Photochemical processes. Singlet and triplet states and their reactivity, Jablonski diagram, Energy transfer, sensitization and quenching. Photoreactions of carbonyl compounds, enes, dienes and arenes. Patterno-Buchi and Barton reactions, Hofmann-Löffler- Freytag reaction, photo-Fries and Di-π methane, di- π methane rearrangements. Applications of photochemistry.

Classification of pericyclic reactions, FMO, Correlation diagram, Mobius and Huckel theory of electrocyclic and cyclo addition reactions- Stereo and region selectivity and industrial applications of Diels Alder reaction, 1,3–Dipolar cycloaddition and Sigmatropic rearrangements

Chemistry of Natural Products : Terpenes, steroids, alakaloids, carbohydrates, proteins, nucleic acids, vitamins, prostoglandins, hormones and enzymes.

Combinatorial organic synthesis, introduction, methodology, automation, solid supported and solution phase synthesis, study of targeted or focused libraries and small molecule libraries. Application of Drug design and development- various steps

Fundamentals of polymerization - structure - property relationship of polymers and polynucleotides- Protein sequencing by Edmans method.

Protein denaturation - Synthesis of stereo regular polymers. Ziegler-Natta catalyst. Polymers in organic synthesis - supports, reagents and catalysts. Biodegradable polymers biopolymers

Spectrocopic methods in Organic chemistry- Applications of UV, IR, H^1NMR, C^{13}NMR and Mass Spectroscopy - 2D NMR techniques - NOE, DEPT, and 2D techniques such as COSY-HSQC, HMQC and HMBC. Spectral interpretation and structural elucidation. Solving of structural problems on the basis of numerical and spectrum based data. ORD and CD - theory and applications

Module 7 - Physical Chemistry-1 - 05 MARKS

Gaseous State- Maxwell's distribution and equation- Transport phenomena- Chapman equation- Equations of state of real gases- vander Waals, Virial and other equations- Inter molecular forces and consequences.

Electronic Structure of Solids - Crystal Symmetry - Theories of Solids - Properties of Solids : Electrical, Magnetical and Optical - Crystal defects. Structure and Theories of Liquids- XRD of liquids- Theories and calculation of Surface tension and Viscosity - Liquid Crystals and their applications

Laws of Thermodynamics - Entropy and its dependence on variables of a system- Equations of state- Euler's relation, Gibbs and Helmholtz equations and energies. Maxwells relations- Gibbs Duhem equation- Partial Molar Quantities- Chemical potential- Fugacity- Activity coefficients. Thermodynamics of Solutions – Duhem Marghules equation- vant Hoff's equations, isochore and isotherm. Thermodynamics of irreversible process – Fundamentals and advances in the study of Phase Equilibria - Two and Three Component Systems

Statistical thermodynamics - Molecular Partition Function - Quantum Statistics - Heat capacities of Solids and Gases- Relationship between partition functions and thermodynamic properties, Sackur-Tetrode equation. The principle of equi-partition of energy

Chemical equilibrium, Law of mass action, Transformation of the equilibrium expressions. Statistical derivation.

Module 8 - Physical Chemistry-2 - 05 MARKS

The gas-solid interphase, types of adsorption. Monolayer and multilayer adsorption - Adsorption Isotherms Heat of adsorption and its determination .-Adsorption from solutions -Determination of surface area of solids-Harkins–Jura absolute method, point B method, Langmuir method and BET method- - Principles of LEED, SEM, TEM, ECSA, Photoelectron spectroscopy, scanning probe microscopy, Auger electron spectroscopy

Electrochemistry and Ionics: Activity and activity coefficient of electrolytes, determination of activity coefficient.- Electrodes and Electrochemical Cells - Nernst, Debye-Huckel, Omsager Equations - Over potentials: Butler-Volmer equation. Tafel and Nernst equation, Tafel plot and its significance - Electrolytic Polarization- Fuel cells: H2-O2, zinc-air and solid oxide fuel cells- Theory and applications of electro Analytical Methods : Potentiometry, Polarography , Coulometry, Conductometry, Cyclic Voltametry, Stripping Voltametry and Amperometry- Colloids - Zeta Potential - Electrokinetic Phenomena

Basic principles of Kinetics - Kinetics of Complex reactions - steady state approximation -Theories of Reaction Rates - Arrhenius equation - fast reactions and methods of study. Reactions in solution: Factors affecting reaction rates in solutions, effect of dielectric constant and ionic strength, cage effect, Bronsted-Bjerrum equation - Kinetic effects: Primary and secondary kinetic salt effect, influence of solvent on reaction rates, significance of volume of activation, linear free energy relationship. Hammet equation and Taft equation.

Catalysis: Mechanism and theories of homogeneous and heterogeneous catalysis. Bimolecular surface reactions. Langmuir–Hinshelwood mechanism. Enzyme catalysis.

Module 9 - Physical Chemistry-3 - 05 MARKS

Classical mechanics and its limitations –need of quantum mechanics, de Broglie relation and its experimental proof, uncertainty principle and its consequences- Formulation of Quantum Mechanics - Postulates of quantum mechanics- Application of Quantum mechanics to Exactly Solvable Model Problems- Translational motion- Quantum mechanical tunnelling- Vibrational motion- and Rotational motion –SHO, Rigid Rotor- Legendre polynomials and associated Legendre functions Approximation Methods and Chemical Bonding - Hydrogen like Atoms -Multi Electron Systems - Angular Momentum – SCF and variation method - MO diagram of homo nuclear diatomic molecules Li_2, Be_2, B_2, C_2, O_2 and F_2 and hetero nuclear diatomic molecules LiH CO, NO and HF-

Wave functions for multi electron systems, wave equation for multi electron systems, symmetric and anti- symmetric wave functions, Pauli’s anti-symmetry principle, and the

postulate of spin- Spin orbitals. Spin- orbit coupling. Vector atom model-Term symbols, selection rules and exp anation of spectral lines of hydrogen atom- Applications- Chemical Bonding in Diatomic and Polyatomic Molecules

Computational Chemistry - Computational methods : ab initio, Semi Empirical methods - Molecular Mechanics

Quantum statistics- Bose-Einstein statistics, Thermodynamic probability- Maxwell Boltzmann, Bose Einstein and Fermi-Dirac statistics- Quantum theory of heat capacity - calculation of heat capacity of gases- Dulong and Petit's law, Kopp's law; limitations.- Einstein theory and Debye theory of heat capacity

Symmetry elements and symmetry operation. Basic principles of Group Theory - Character Tables - . Point groups and their systematic identification.- Multiplication of operations - Setting up of character table of C_{2v}, C_{3v} and C_{2h} groups –Applications to MO Theory, Chemical Bonding and Spectroscopy

Electronic Spectroscopy of Atoms – Basic principles of Molecular spectroscopy: Microwave, Infrared, Raman, Electronic, NMR, ESR, Raman and Mossbaur

Module 10 - Analytical, Environmental, Material and Supramolecular chemistry - 05 MARKS

Evaluation of analytical data: Accuracy and precision. Standard deviation, variance and coefficient of variation. Student 't' test, 'Q' test, and 'F' test. Confidence limits- Errors and their minimisation- Significant figures- Correlation analysis- Calculation of R by method of least squares

Theory and practice of : Quantitative and Qualitative analysis- Inorganic analysis- Organic analysis and preparations - physical chemistry experiments (Post graduate level)

Applications of TG, DTA and DSC in the study of metal complexes, ceramics and polymers.

Theory of chromatographic techniques -Column, TLC, Paper, GC, HPLC and ion exchange chromatographic techniques. Solvent extraction. Extraction using supercritical liquid CO_2, Craig's technique of liquid-liquid extraction

Twelve principles of green chemistry and issues in sustainable chemistry - Green synthesis - Application of Phase Transfer Catalysts -Green Reactions- Applications of Microwave and sonication in the synthesis of organic compounds.

Chemistry of Atmosphere, Hydrosphere and Lithosphere.

Nanostructures - ID, 2D and 3D structures - Synthesis and applications of nanomaterials..

Chemistry behind Piezoelectric, magnetostrictive, halochromic, chromogenic, electrochromic, thermochromic, magnetocaloric and thermoelectric materials

Supramolecular chemistry - Molecular recognition : Synthetic Receptors, Cyclodextrin, Calixiranes, Cyclophanes, Crown Ethers- Drug design and Drug action.