PLANT BREEDING: Objective of plant breeding, methods of propagation in relation to breeding methods, methods of plant breeding (selection, hybridization, concept and causes of heterosis). Maintenance of germplasm, Heterosis and hybrid seed production, Molecular Breeding (use of DNA markers in plant breeding). Maintenance of germplasm, Mass selection and pure line selection, Heterosis and hybrid seed production, Molecular Breeding (use of DNA markers in plant breeding).

BIOMETRY: Random sampling, Frequency distribution, Central tendency– Arithmetic Mean, Mode and Median, Measurement of dispersion – Standard Deviation, Standard error of Mean, Test of significance: 't'- test; chi square test for goodness of fit. Probability, Measurement of gene frequency (Hardy-Weinberg equilibrium). Overview of Bioinformatics, nature of biological data, literature databases (searching and downloading), introduction and overview of biological databases, nucleic acid sequence databases, GenBank, Protein sequence databases, introduction to BLAST series.

EVOLUTION BIOLOGY: Concept of biological evolution, evidence of organic evolution (taxonomic, geological, morphological and anatomical); Lamarckism, Darwinism and mutation theories of de Vries.

Physiology and Biochemistry:

Plant-water relations, Stomatal physiology-mechanism of opening and closing, Organic Translocation Photosynthesis, Photochemical reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, photophosphorylation, Z-scheme, Calvin cycle – Biochemical reactions and stoichiometry, Photosynthetic efficiency of C_3 and C_4 plants and crop productivity, Photorespiration, Crassulacean acid metabolism. Respiration- EMP pathway, TCA cycle, ETS and oxidative phosphorylation, Oxidative pentose phosphate pathway and its significance, ß-oxidation of fatty acids and significance. Nitrogen Metabolism (symbiotic and non-symbiotic), structure and function of di-nitrogenase complex, ETS of di-nitrogenase, basic concept of *nif* and *nod* genes. Plant Growth Regulators (Auxin, Gibberellin, Cytokinin, Ethylene and Abscisic Acid). Photoperiodism and plant types, Phytochrome, Vernalisation, Concept of biological clock and biorhythm. Seed dormancy, Physiology of Senescence and Ageing. Stress Physiology.

Biochemistry as the molecular logic of living organisms, axioms of living organisms, the major compounds of living beings; pH, buffers and basic bioenergetics, chemical structure and properties of water molecule, ionization of water, Henderson-Hasselbalch equation, titration curve and the concept of preparation of any buffer solution; biomolecules: general structure, properties, classification and metabolic importance of carbohydrates, proteins, lipids and nucleic acids; enzymes, basic structure (holoenzyme, apoenzyme, cofactor, coenzyme and prosthetic group), nomenclature and classification of enzymes according to IUBMB, mechanism of enzyme action (concept of active site of an enzyme, activation of free energy, principles of enzyme action, Fisher's and Koshland's models), enzyme kinetics (Michaelis-Menten equation and Lineweaver-Burk plot), reversible and irreversible enzyme inhibition, allosteric enzyme regulation and covalently modulated enzyme regulation, basic concept of ribozymes, abzymes and isozymes.

Pharmacognosy :

Pharmacognosy and its importance in modern medicine , Crude drugs, Drug evaluation Secondary metabolites, Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis with special reference to *Cinchona, Ipecac, Adhatoda* and *Curcuma longa.*

Plant Biotechnology & Instrumentation:

Plant tissue culture and Micropropagation. Plant Genetic Engineering: Brief concept of different gene transfer methods. Transgenic plants.

Principles and applications of simple, compound, confocal and electron microscopy, colorimetry, visible and UV-visible spectrophotometry, deferential centrifugation, PCR, RT-PCR, Gel Electrophoresis, Blotting (Southern, Northern and Western) and ELISA.

CHEMISTRY :

Paper – I :

Group A

1. Atomic Structure:

Bohr theory of hydrogen atom, Mosley's experiment. Heisenberg's uncertainty principle; Schrodinger wave equation; Interpretation of wave function, particle in a one-dimensional box; quantum numbers; hydrogen atom wave functions; shapes of s, p and d-orbitals.

2. Chemical Bonding:

Ionic bond: characteristics of ionic compounds, lattice energy, Born-Haber cycle. Covalent bond and its general characteristics: polarities of bonds in molecules and their dipole moments; shapes of molecule, VSEPR theory.

Valence bond theory, concept of resonance and resonance energy; molecular orbital theory (LCAO method); bonding in H_2^+, H_2, He_2^+ to Ne_2, NO, CO, HF, and CN^-, comparison of valence bond and molecular orbital theories, bond order, bond strength and bond length.

3. Acid-Base & Redox Reactions

Theory of acids and bases; pH, buffer solution; solubility product and salt hydrolysis.

Nernst equation (without derivation). Influence of complex formation, precipitation and pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples).

4. Chemical Periodicity:

Periodic table, group trends and periodic trends in physical properties.

Effective nuclear charge, screening effect, Slater's rules, atomic radii, ionic radii (Pauling univalent), covalent radii. Ionization potential, electron affinity and electronegativity (Pauling, Mulliken and Allred-Rochow scales) and factors influencing these properties.

Comparative studies of hydrides, halides, oxides of s- and p- block elements.

Structure and bonding of B_2H_6, $(SN)_x$, Phosphazenes and inter-halogens.

d-block elements; electronic configuration, ionization energies, oxidation states, variation in atomic and ionic radii, magnetic and spectral properties.

Group-B

5. Gaseous State and Transport Phenomenon

Maxwell distribution of molecular speeds, intermolecular collisions, collisions on wall and effusion; thermal conductivity and viscosity of hard sphere gases. van der Waals equation of state, inter-molecular interactions, critical phenomena and liquefaction of gases,

6. Liquid State

Viscosity, Poiseuille equation, temperature dependence.

Surface tension and surface energy, wetting and contact angle, interfacial tension and capillary action; Laplace equation.

7. Solid State

Crystal systems; designation of crystal planes, lattice structure and unit cell; Miller indices, Bragg's law; X-ray diffraction by crystals; close packing, radius- ratio rules, calculation of some limiting radius-ratio values; structures of NaCl, KCl; stoichiometric and non-stoichiometric defects, impurity defects, semi-conductors.

8. Thermodynamics

Work, heat and internal energy; first law of thermodynamics.

Second law of thermodynamics; entropy as a state function, entropy change in various processes, reversibility and irreversibility, free energy functions; thermodynamic equation of state; Maxwell's relations; temperature, volume and pressure dependence of thermodynamic functions; J-T effect and inversion temperature; criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities; Nernst heat theorem.

Definitions and interrelations among K_p, K_c and K_x ; Van't Hoff equation, Le Chatelier principle.

Group - C

9. Aromaticity

Aromaticity and anti-aromaticity; benzene, naphthalene, annulene, azulene, tropolones, fulvenes, sydnones. Electrophilic and nucleophilic substitution. Synthesis and reactions of heteroaromatic compounds (pyrrole, furan, thiophene, pyridine).

10. Study of Mechanisms

General methods (both kinetic and non-kinetic) of study of mechanism of organic reactions: isotopic method, cross-over experiment, intermediate trapping, stereochemistry; energy of activation; thermodynamic control and kinetic control of reactions.

Reactive intermediates: Generation geometry, stability and reactions of carbonium ions and carbanions free radicals, carbenes, benzynes and nitrenes.

11. Organic Reaction Types

Substitution Reactions: S_N1, S_N2 and S_Ni mechanisms; neighbouring group participation.

	Elimination Reactions: E1, E2 and E1cb mechanisms; orientation in E2 reactions-Saytzeff and Hoffmann; pyrolytic *syn* elimination – Chugaev and Cope eliminations. Addition Reactions: Electrophillic addition to C=C and C≡C; nucleophilic addition to C=O, C=N, conjugated olefins and carbonyls. Rearrangements: Pinacol-pinacolone, Hoffmann, Beckmann, Baeyer-Villiger, Favorskii, Fries, Sclaisen, Cope, Stevens and Wagner-Meerwein rearrangements. **12. Organic Spectroscopy:** Principle and applications in structure elucidation: Infra-red: typical functional group identification UV-vis: Singlet and triplet states; n-π* and π-π* transitions; application to conjugated double bonds and conjugated carbonyls - Woodward–Fieser rules; charge-transfer spectra. Nuclear Magnetic Resonance (^{1}H NMR): Basic principle; chemical shift and spin-spin interaction and coupling constants. Mass Spectrometry: Parent peak, base peak metastable peak, McLafferty rearrangement.
Paper – II :	**Group-A** **1. Coordination Chemistry - I** Bonding theories of metal complexes; valence bond theory, crystal field theory and its modifications; application of theories in the explanation of magnetism and electronic spectra of metal complexes. **2. Coordination Chemistry - II** Isomerism in coordination compounds; IUPAC nomenclature of coordination compounds; stereochemistry of complexes with 4 and 6 coordination numbers; chelate effect and polynuclear complexes; trans effect and its theories; kinetics of substitution reactions in square-planer complexes; thermodynamic and kinetic stability of complexes. **3. Bio-Inorganic Chemistry** Metal ion in biological systems and their role in ion transport across the membranes (molecular mechanism), oxygen-transport proteins: hemoglobin, myoglobin, hemerythrin; electron-transport proteins: cytochromes and ferrodoxins. **4. Organometallic Chemistry** EAN rule, synthesis, structure and reactivity of metal carbonyls; carboxylate anions, carbonyl hydrides and metal nitrosyl compounds. Complexes with aromatic systems; synthesis, structure and bonding in metal-olefin, -alkyne and -cyclopentadienyl complexes; coordinative unsaturation, oxidative addition reactions, insertion reactions, fluxional molecules and their characterization; compounds with metal-metal bonds and metal atom clusters. **Group - B** **5. Phase-equilibria and solutions** Gibbs phase rule and its significance. Clapeyron equation; Clausius – Clapeyron equation; phase diagram for a pure substance; phase-equilibria in binary systems, partially miscible liquids, upper and lower critical solution temperatures; properties of dilute solutions; Raoult's and Henry's law. Partial molar quantities, their significance; excess thermodynamic functions. **6. Surface phenomena, catalysis and polymers** Adsorption from gases and solutions on solid adsorbents: Langmuir and B.E.T. adsorption isotherms; determination of surface area, characteristics and mechanism of reactions on heterogeneous catalysts. Number and weight average molecular weight, their determination. Kinetics of polymerization. **7. Chemical Kinetics** Differential and integral rate equation for zeroth, first, second and fractional order reactions; rate equations involving reverse, parallel, consecutive and chain reactions; branching chain and explosion; effect of temperature and pressure on rate constant; collision theory and transition state theory. **8. Photochemistry and spectroscopy :** Fluorescence & phosphorescence, Jablonsky diagram, Franck-Condon principle, Lambert-Beer law. Laws of photochemistry, quantum yield, photo-stationary state, photosensitized reaction. Rotational spectra of diatomic molecules: Rigid rotator model, selection rule, determination of bond length.