

BSc Chemistry Syllabus

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications, the syllabus pertaining to B.Sc. (3 Year Degree Course) in the subject of Chemistry has been prepared as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills. This B.Sc course of Chemistry consists of 3 year-course with semester system - in all six semesters (two semesters in a year). Total marks: 1500 (500 per year and 250 per semester) of core discipline.

BSc Sem I

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry	BCH101	80	20
2	Organic Chemistry/Physical Chemistry	BCH102	80	20
5	Lab Course I	BCH10P	40	10

BSc Sem II

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry	BCH201	80	20
2	Organic Chemistry/Physical Chemistry	BCH202	80	20
5	Lab Course II	BCH20P	40	10

BSc Sem III

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry/ Physical Chemistry	BCH301	80	20
2	Organic Chemistry	BCH302	80	20
5	Lab Course III	BCH30P	40	10

BSc Sem IV

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry/ Physical Chemistry	BCH401	80	20
2	Organic Chemistry	BCH402	80	20
5	Lab Course IV	BCH40P	40	10

BSc Sem V

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Physical Chemistry	BCH501	80	20

2	Organic Chemistry/ Inorganic Chemistry	BCH502	80	20
5	Lab Course V	BCH50P	40	10

BSe Sem VI

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Physical Chemistry	BCH601	80	20
2	Organic Chemistry/ Inorganic Chemistry	BCH602	80	20
5	Lab Course VI	BCH60P	40	10

Semester I (90 lectures)

Paper I: Inorganic Chemistry

1. Atomic Structure and Periodic Properties

(16 Lecture)

Bohr's model, Sommerfeld's extension, de Broglie's wave particle duality; Heisenberg's uncertainty principle and Schrödinger's equation (qualitative); significance of ψ and ψ^2 , radial density, angular probability, Quantum numbers and their significance, Aufbau principle, Pauli's exclusion/ant symmetry principle (statement and implication), Hund's rules, Slater's rules, quantum defect; Brief discussion of the following properties of the elements, with reference to s & p-block and the trends shown:

- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
- Atomic and ionic radii
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
- Electron gain enthalpy and trends in groups and periods.
- Electro negativity, Pauling's scale. Variation of electro negativity with bond order, partial charge.

2. Chemical Bonding & Ionic Solids

(14 Lecture)

Covalent bond: Valence Bond theory (Heitler-London approach). Concept of hybridization; Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O , NH_3 , PCl_3 , PCl_5 , SF_6 , ClF_3 , I_3^- , BrF_2^+ , PCl_6^- , ICl_2^- , ICl_4^- and SO_4^{2-} .

Molecular orbitals (MO) approach of bonding (LCAO Method). Symmetry and overlap, symmetry of molecular orbitals, Bonding in Homonuclear molecules (H_2 to Ne_2) and NO , CO , CN^+ , CO^+ , CN^- , HF , HCl , CO_2 , Comparison of VB and MO theories.

Covalent character in ionic compounds, Fajan's rules and consequences of polarization; Percentage Ionic character in covalent compounds, Dipole moment

Handwritten signatures and marks at the bottom of the page.

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals: Lattice defects, semiconductors, lattice energy and Born-Haber cycle. Solvation energy and solubility of ionic solids

Weak interactions-hydrogen bonding and Van der Waals forces

3. s-block elements

(5 Lecture)

General discussion with respect to all periodic and chemical properties, diagonal relationship, chemical reactivity and trends in alkali and alkaline earth metals: structure and properties of Hydrides, oxides, halides and hydroxides, coordination complexes, Organometallic compounds of alkali metals, Crown and Crypts, Role of alkali and alkaline earth metal ions in bio-systems

4. p-block elements & Chemistry of Noble gases

(10 Lecture)

General discussion and comparative study (all periodic and chemical properties) including diagonal relationship, of groups 13 to 17 elements; chemistry of elements-hydrides, oxides & oxy-acids, and halides (including inter-halogen compounds), Diborane-properties & structure, borohydrides, carbides, fluorocarbons, basic properties of iodine and polyhalides, Inert-pair effect: in heavier elements of 13, 14 & 15 group elements; its consequences in redox properties of their halides. Chemistry of noble gasses.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.
6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi. I.L. Finar, Organic Chemistry, Pearson.

Paper II: Organic Chemistry/Physical Chemistry

1. Structure and Bonding in organic compounds, and Mechanism of Organic Reactions (9 Lectures)

Hybridization, Shapes of molecules bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes resonance, aromaticity, Inductive, electromeric, resonance and mesomeric effects, hyperconjugation, dipole moment; hydrogen bonding (Applications to be discussed with relevant topics).

Homolytic and Heterolytic fission with suitable examples. Curved arrow notation, drawing electron movements with arrows, half headed and double headed arrows, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations,

Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions: Addition, Elimination and Substitution reactions. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

2. Stereochemistry of Organic Compounds

(12 Lectures)

Concept of isomerism, Types of isomerism

Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds

Conformational isomerism – conformational analysis of ethane and n-butane; conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.

Difference between configuration and conformation

3. Gaseous, Liquid and Solid States

(18 Lecture)

Kinetic theory of gases, Deviation of real gases from ideal behaviour, compressibility factor; van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomenon, critical constants and their calculation from van der Waals' equation; Laws of corresponding states.

Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance., collision number, mean free path and collision diameter, liquefaction of gases (based on Joule-Thomson effect);

Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity and refractive index. Liquid crystals, Difference between liquid crystal, solids and liquids.

Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry; Symmetry elements in crystals, X-ray diffraction by crystals., Derivation of Bragg's equation; Determination of crystal structure of NaCl, KCl and CsCl by Laue's method and powder methods.

4. Colloidal State

(6 Lecture)

Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optional and electrical; stability of colloids, protective action, Hardy-Schulze law, gold



number. Liquids in liquids (emulsions): types of emulsions, preparation, emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Physical Chemistry:

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S, Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tull, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Lab Course B.Sc. Ist semester (4hours)

1. Mixture analysis for six radicals including interfering radicals and combination tests.
Cations : NH_4^+ , Pb^{2+} , Ag^+ , Bi^{3+} , Cu^{2+} , Cd^{2+} , Sn^{2+} , Fe^{3+} , Al^{3+} , Co^{2+} , Cr^{3+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , K^+ Anions : CO_3^{2-} , S^{2-} , NO_3^- , CH_3COO^- , Cl^- , Br^- , I^- , SO_4^{2-} , PO_4^{3-} , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$ 12 marks
2. (i) Detection of extra element (N, S, X) in the organic compounds (containing two elements). 4×2 marks
(ii) Detection of functional groups in the organic compounds (containing two functional groups).
3. (i) Determination of relative surface tension of a liquid and its parachor value. 10 marks
(ii) Determination of relative coefficient of viscosity of a liquid and its Rheochor value.
4. Viva 5 marks
5. Record 5 marks

Semester II (90 lectures)

Paper I: Inorganic Chemistry

1. Chemistry of Transition Elements (First Transition Series) (8 Lecture)

Characteristic properties of the elements; ionic radii, oxidation states, complex compound formation and magnetic properties. Their binary compounds, illustrating relative stability of their oxidation states, coordination number and geometry.

2. Chemistry of Transition Elements (Second and Third Series) (6 Lecture)

General characteristics, comparative treatment with their analogues in respect of ionic radii, oxidation state, magnetic behaviour and stereochemistry.

3. Chemistry of Lanthanides and Actinides (10 Lecture)

Electronic structure, oxidation states, ionic radii, lanthanide contraction and its consequences, complex formation, methods of separation of lanthanides-fractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods. General features of actinides-electronic configuration, atomic and ionic radii, ionization potential, oxidation states and complex formation.

4. Metal Carbonyls and Nitrosyls (10 Lecture)

Definition, nomenclature and classification based on nature of metal-carbon bond. Metal carbonyls. Mononuclear carbonyls, nature of bonding, structure and preparation. EAN and 18-electron rule. Definition, nomenclature, classification, general methods of preparation of organometallic compounds and a brief account of metal-ethylene complexes. Applications of organometallic compounds-Ziegler-Natta catalyst, Wilkinson catalyst (No mechanism). Metal nitrosyl compounds, nitrosyl carbonyls. Dinitrogen and dioxygen complexes, tertiary phosphines as ligand.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand & Company, New Delhi.
5. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi. I.L. Finar, Organic Chemistry, Pearson.

Paper II: Organic Chemistry/Physical Chemistry

1. Alkanes, alkenes, alkynes and dienes (20 Lecture)

Nomenclature, classification and isomerism in alkanes, methods of preparations physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. Cycloalkanes- nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations; Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-bent or banana bonds.

Nomenclature of alkenes, methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff Rule, Hoffmann Elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes -mechanisms involved in electrophilic and free radical additions.

Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO_4 . Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes.

Methods of formation, and chemical reactions of cycloalkenes.

Nomenclature and classification of dienes; isolated, conjugated and cumulative dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions. Diels-Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reduction, oxidation and polymerization.

2. Arenes and Aromaticity; Alkyl and Aryl Halides

(12 Lecture)

Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond length of benzene, resonance structure, MO picture. Aromaticity—the Hückel rule. Aromatic electrophilic substitution—general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

Methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, $\text{S}_{\text{N}}2$ and $\text{S}_{\text{N}}1$ reactions with energy profile diagrams. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.

3. Thermodynamics (Second and Third Law)

(14 Lecture)

Brief introduction of First Law of Thermodynamics and related topics;

Second law of thermodynamics, need of the law, different statements of the law; Carnot cycle and its efficiency, Carnot theorem; Thermodynamic scale of temperature; Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical and chemical processes, entropy change in reversible and irreversible processes. Clausius inequality, entropy as criteria of spontaneity and equilibrium; Entropy change in ideal gases and mixing of gases;

Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A and G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T; Gibbs-Helmholtz equation, Clapeyron equation, Clausius-Clapeyron equation, reaction isotherm and reaction isochore;

Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data

4. Chemical Kinetics

(10 Lecture)

Rates of reactions, rate constant, order and molecularity of reactions. Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-life time of a reaction. Methods for determining order of reaction. Effect of temperature on reaction rate and the concept of activation energy. Reaction mechanism. Steady state hypothesis. Homogeneous catalysis, Acid-base catalysis and enzyme catalysis (Michaelis-Menten equation). Heterogeneous catalysis. Unimolecular surface reactions.

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Wiley.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh, Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand.
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan

Physical Chemistry:

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Lab Course B.Sc. IInd semester (4 hours)

1. (a) Redox titration: (i) Iodometry (ii) $\text{Fe}^{2+}/\text{K}_2\text{Cr}_2\text{O}_7$ 12 marks
(b) Hardness of water by EDTA methods.
2. Organic synthesis involving nitration, halogenations, sulphonation, oxidation and benzoylation. 8 marks
3. (i) Determination of transition temperature of inorganic substances. 10 marks
(ii) Construction of phase diagram of a two component system.
(iii) Determination of heat capacity of calorimeter for different volumes.
4. Viva 5 marks
5. Record 5 marks

Semester III (90 lectures)

Paper I: Inorganic Chemistry/Physical Chemistry

1. Coordination Chemistry-I

(10 Lecture)

Werner's theory for coordination compounds; its experimental verification, effective atomic number (EAN) concept, chelates. Nomenclature of coordination compounds (IUPAC system), isomerism in coordination compounds, stability of complexes and factors contributing to the stability; Valence Bond Theory (VBT) for coordination compounds, magnetic properties of complex compounds.

2. Coordination Chemistry-II: Metal-Ligand Bonding in transition Metal Complexes (8 Lecture)

Limitations of valence bond theory, an elementary idea about crystal field theory; crystal field splitting octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters. Jahn Teller Distortion in complexes.

3. Chemical and Ionic Equilibrium (14 Lecture)

General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and G° ; Relation between K_p , K_c and K_x . Temperature dependence of equilibrium constant-Van't Hoff equation, homogeneous & heterogeneous equilibria, Le Chatelier's principle.

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

4. Electrochemistry (10 Lecture)

Specific conductance, molar conductance and their dependence on electrolyte concentration. Ionic Equilibria and conductance, Essential postulates of the Debye-Huckel theory of strong electrolytes. Mean ionic activity coefficient and ionic strength. Transport number and its relation to ionic conductance and ionic mobility.

Conductometric titrations. pH scale. Buffer solutions, salt hydrolysis. Acid-base indicators.

Distinction between electrolytic and electrochemical cells. Standard EMF and electrode potential. Types of electrodes Reference electrode. Calculation of ΔG , ΔH , ΔS and equilibrium constant from EMF data. Potentiometric determination of pH. Potentiometric titrations.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kalia, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand & Company, New Delhi.
5. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi. I.L. Finar, Organic Chemistry, Pearson.

Physical Chemistry:

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.

3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Paper II: Organic Chemistry

1. Alcohols and Phenols

(16 Lecture)

Alcohols: Classification and nomenclature, Monohydric alcohols-methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [$\text{Pb}(\text{OAc})_4$ and HIO_4], esterification, oxidation (with PCC, alk. KMnO_4 , acidic dichromate, conc. HNO_3). Oppenauer oxidation and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.

Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Electrophilic substitution: Nitration, halogenation and sulphonation, acylation and carboxylation, Mechanism of Fries rearrangement, Reimer-Tiemann Reaction, Claisen condensation, Lederer-Manasse reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten - Baumann Reaction.

2. Ethers and Epoxides

(6 Lecture)

Ethers: Structure, Physical properties, preparation (Williamson synthesis). Reactions: Cleavage by acids, Electrophilic substitution in ethers.

Epoxides: Preparation: From Halohydrins, Peroxidation of Carbon-carbon double bonds. Reactions with acid, base and Grignard reagents.

3. Chemistry of Carbonyl compounds (aldehydes and Ketones) Lecture)

(12

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis from acid chlorides, synthesis using 1,3-dithianes, from nitriles and carboxylic acids. Physical properties. Mechanism of nucleophile additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH_4 and NaBH_4 reductions. Halogenation of enolizable ketones. An introduction to α -, β -unsaturated aldehyde and ketones.

4. Carboxylic Acids and derivatives Lecture)

(14

Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids.

Hydroxy acids: maleic, tartaric and citric acids. Methods of formation and chemical reactions of unsaturated monocarboxylic acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

Carboxylic acid derivatives: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of esterification and hydrolysis (acidic and basic).

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Wiley.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh, Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand.
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan

Lab Course B.Sc. III semester (4 hour)

- | | |
|--|----------|
| 1. Inorganic preparations: | 8 marks |
| (i) Cuprous chloride | |
| (ii) Potash alum | |
| (iii) Chrome alum | |
| (iv) Ammonium ferric sulphate | |
| (v) Ferrous oxalate | |
| 3. Identification of simple organic compounds (formation of derivatives not included). | 12 marks |
| 3. (i) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. | 10 marks |
| (ii) Determination of enthalpy of solutions (NH_4NO_3 & CaCl_2). | |
| (iii) Separation of amino acids and sugars by paper / TLC chromatography. | |
| 4. Viva | 5 marks |
| 5. Record | 5 marks |

Semester IV (90 lectures)

Paper I: Inorganic Chemistry/Physical Chemistry

1. Thermodynamic and Kinetic Aspects of Coordination Compounds (8 Lecture)

A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability of coordination compounds. Substitution reactions in square planar complexes.

2. Magnetic Properties of Transition Metal Complexes

(8 Lecture)

Types of magnetic behaviour, methods of determining magnetic susceptibility; Gouy's and Quincke's methods, spin only formula, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

3. Physical Properties and Molecular Structure

(8 Lecture)

Optical properties and their relation with chemical constitution, polarization, Clausius-mossotti equation, orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and its application in determining the structure of molecules.

4. Surface Chemistry, Catalysis and Phase Equilibrium

(16 lecture)

Bulk phases and interfacial region, types of interfaces; Surface tension and interfacial tension. Adsorption of gases on solids, chemisorption and physisorption, desorption. Adsorption isotherms; theories of adsorption, Langmuir isotherm, Freundlich isotherm, Adsorption and catalysis; Catalysis, characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.

Statement and meaning of the terms: phase, component and degree of freedom, derivation of Gibbs phase rule, One component systems-water, sulphur, carbon dioxide, helium. Phase equilibria of two component systems: solid-liquid equilibria, simple eutectic; Bi-Cd, Pb-Ag systems, desilverisation of lead; construction and interpretation of general phase diagrams for liquid vapour, liquid-liquid and liquid-solid systems.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand & Company, New Delhi.
5. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi, I.L. Finar, Organic Chemistry, Pearson.

Physical Chemistry:

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathuniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Paper II: Organic Chemistry

1. Nitrogen Containing Organic Compounds

(14 Lecture)

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Picric acid. Halonitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabrielphthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

2. Chemistry of Carbohydrates

(10 Lecture)

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides (structure determination not required). General introduction of structure of ribose and deoxyribose.

3. Amino Acids, Peptides, Proteins and Nucleic Acids

(14 Lecture)

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α -amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solidphase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation.

Nucleic acids : Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

4. Heterocyclic Compounds

(12 Lecture)

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction of condensed five- and six membered heterocycles. Preparation and reactions of quinolene and isoquinolene with special reference to Fischer-Indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of quinolene and isoquinolene.

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Wiley.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.

3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan

Lab B.Sc. IV semester (4 hour)

- | | |
|---|----------|
| 1. Preparation of inorganic complex compounds : | 8 marks |
| (i) Tetraammine copper sulphate (ii) Prussian blue (iii) Hexammine nickel (II) chloride
(iv) Potassium trioxalato chromate (III) (v) Hexaammine cobalt (III) chloride. | |
| 2. Estimation of functional groups such as -OH, -NH ₂ , -CHO, -COOH etc. | 12 marks |
| 3. (i) Kinetics of First order reaction. | 10 marks |
| (ii) Viscosity-composition curve for a binary mixture. | |
| (iii) Determination of strength of unknown acids or bases by using pHmetry. | |
| 5. Viva | 5 marks |
| 6. Record | 5 marks |

Semester V (90 lectures)

Paper II: Physical Chemistry

1. Elementary Quantum Mechanics

(14 Lecture)

Quantum mechanics of simple systems: Schrodinger's wave equation, and time dependent Schrodinger's wave equation, postulates of quantum mechanics, Eigen functions and eigen values and quantum mechanical operators. Expectation value of a physical quantity, Orthogonality of wave functions. The particle in a one dimensional box problem and its solutions, Particle in three dimensional box, Degeneracy, rigid rotor and harmonic oscillator.

2. Molecular Spectroscopy

(14 Lecture)

Region of electromagnetic spectrum, emission and absorption spectra, signal to noise ratio and resolving power, width and intensity of spectral transitions, pure rotational spectra, diatomic rigid rotor molecules, effect of isotope substitution, vibrational and vibration-rotational spectra of diatomic molecules, harmonic oscillator-rigid rotor approximation, anharmonicity effect, normal modes of vibration, infrared spectra of linear and bent AB₂ molecules, electronic spectra of diatomic molecules, vibrational structure, Franck-Condon principle.

3. Photochemistry

(12 Lecture)

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Draper law, Lambert's law, Lambert-Beer's law, Stark-

Paul
W.R. *Jaw*

Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

4. Energy and Distribution Law

(6 Lecture)

Degrees of freedom, types of energies in linear and non-linear molecules, derivation and applications of Maxwell-Boltzmann distribution law.

Books Suggested:

Physical Chemistry

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.
6. G Joshi, R Verma, R Bahuguna and S Kothiyal, Integrated Instrumental methods in spectroscopic and separation techniques Pragati Publication Meerut

Paper II: Inorganic Chemistry/Organic Chemistry

1. Basics of Bioinorganic Chemistry

(10 Lecture)

Introduction of bioinorganic chemistry; General properties of biological molecules, physical methods in bio-inorganic chemistry, Binding of metal ions and complexes with biomolecule active centers, Atoms and group transfer chemistry, Electron transfer in Proteins

2. Inorganic Polymers of Silicones and Phosphates

(8 Lecture)

Silicones; siloxanes, silicone rubber, polymethylhydrosiloxanes, applications. Phosphazenes, nature of bonding in triphosphazenes. Zeolites.

3. Organo-Metallic Compounds & Organic Synthesis via Enolates

(16 Lecture)

Organic derivatives of lithium and magnesium – their preparation, properties and reactions. Organocopper intermediates; Organozinc compounds; formation and chemical reactions. Synthetic applications of other transition metals; Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acid, sulphonamides and sulphaguanidine.

Acidity of methylene hydrogen, alkylation of diethylmalonate and ethylacetoacetate. Synthesis of ethylacetoacetate, the Claisen condensation, Keto-enol tautomerism of ethylacetoacetate. Synthetic uses of ethylacetoacetate and diethylmalonate.

4. Synthetic Polymers and Synthetic dyes

(10 Lecture)

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubber.

Colour and constitution (electronic concept), classification of dyes. Synthesis and uses of Methyl orange, Malachite green, Phenolphthalein, Fluorescein, Alizarin and Indigo.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand & Company, New Delhi.
5. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi, LL.
6. Finar, Organic Chemistry, Pearson.

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Lab Course B.Sc. V semester (6 hour)

1. Gravimetric estimations of copper-zinc, copper-nickel and silver-copper in their respective solutions 12 marks
2. Separation of binary mixture of organic compounds (solid-solid). 10 marks
3. (i) Determination of equilibrium constant of methyl acetate hydrolysis reaction. 8 mark
(ii) Potentiometric titration: Acid-base.
(iii) Order of reaction of I_2 /Acetate/ H^+ .
4. Viva 5 marks
5. Record 5 marks

Semester VI (90 lectures)

Paper I: Physical Chemistry

1. Basics of NMR and Mass Spectrometry

(10 Lecture)

Principle and Instrumentation of NMR spectroscopy, nuclear shielding and deshielding, Factors affecting chemical shift, Spin coupling, Applications of NMR spectroscopy, Applications of NMR spectroscopy. Introduction and Principle of Mass Spectrometry; Instrumentation of Mass Spectrometer Ion Source or Ionization Chamber Electron-Impact ionisation (EI-MS) Chemical Ionisation (CI-MS); m/z peak; Applications of mass spectroscopy.

2. Introduction to Nuclear Chemistry

(14 Lecture)

Nuclear Chemistry: Classification of nuclides, nuclear stability and binding energy, atomic energy. Radioactivity: general characteristics of radioactive decay kinetics, artificial radioactivity, detection and measurement of radioactivity: GM counter.

Nuclear Reactions: Types of nuclear reactions, conservation of linear momentum and mass-energy in nuclear reactions, nuclear reaction cross section, Compound nucleus theory and its experimental verification; nuclear fission process, fission energy;

Interaction of nuclear radiations with matter- charged particle, neutrons and gamma rays.

Radiolysis of water and aqueous solutions, radiation dosimetry.

3. Solutions and Colligative Properties

(12 Lecture)

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

4. Separation Techniques

(10 Lecture)

Introduction to Analytical Chemistry and its interdisciplinary nature; Concept of sampling; Importance of accuracy, precision and sources of error in analytical measurements; Presentation of experimental data and results, from the point of view of significant figures; Definition, general introduction on principles of chromatography, Qualitative and quantitative aspects of chromatographic methods of analysis: paper chromatography, TLC etc. IC, GLC, GPC, and HPLC. Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.

Books Suggested:

Physical Chemistry

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.
6. Essentials of Nuclear Chemistry, H.J. Arnikar, 4th Edition, (2003) New Age International Publishers, New Delhi
7. G Joshi, R Verma, R Bahuguna and S Kothiyal, Integrated Instrumental methods in spectroscopic and separation techniques Pragati Publication Meerut

Paper II: Inorganic Chemistry/Organic Chemistry

1. Introduction of Supramolecular, Nano & Green Chemistry

(10 Lecture)

Definition, molecule to supramolecule, molecular aggregate to crystalline aggregate; synthetic methods: choice of building units, reaction condition, design of structures: nano and mega carbon tubes, meso structures, nanoclusters and nanowires; applications. Principles and concepts of green chemistry, Need for Green Chemistry. Goals of Green Chemistry: Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents,

2. Acids and Bases, Hard soft acids and bases & Non aqueous Solvents (14 Lecture)

Various definitions of acids and bases, A generalized acid-base concept, Measurement of acid-base strength, Lewis interactions in non-polar solvents, Systematics of Lewis acid-base interactions, Bond energies, steric effects, solvation effects and acid-base anomalies, Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness,

Classification of solvents, their general characteristics, physical properties of the solvents, reaction in nonaqueous solvents-liquid NH_3 and SO_2 (auto-ionization, precipitation reactions, acid-base reaction, oxidation-reduction reactions, solvation and solvolysis, complex formation), merits and demerits;

3. Spectroscopy and It's use in structure determination of organic molecules

(12 Lecture)

Infrared Spectroscopy, Principle of IR: fundamental vibrational modes; factors affecting vibrational frequencies; energy, selection rules, and transition frequency for harmonic and an-harmonic diatomic oscillator; Instrumentation of IR; Introduction and principle of Ultraviolet and Visible spectroscopy; Beer Lambert Law; energy, selection rules, and transition frequency for diatomic molecule; Instrumentation of UV spectrophotometer; Applications of UV-Vis, IR and NMR in the structure determination of simple organic molecules.

4. Introduction to Medicinal Chemistry

(8 Lecture)

Introduction to medicinal chemistry, Drug discovery, design and development; Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim).

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.

6. Sarya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi. I.L. Finar, Organic Chemistry, Pearson.
7. J.M. Lehn, Supramolecular Chemistry, VCH
8. Geoffrey A. Ozin, and Andre Arsenite, Neno Chemistry, RSC Publishing
9. Green Chemistry: Environmentally benign reactions V K Ahluvalia 2007

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh, Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand.
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. New Trends in Green Chemistry, V K Ahluvalia and M Kidvai, Anamaya Publication New Delhi 2004

Lab Course B.Sc. VI semester (6 hour)

- | | |
|--|----------|
| 1. Volumetric and gravimetric analysis of inorganic elements. | 12 marks |
| 2. Two step organic synthesis : | 10 marks |
| a) Nitrobenzene to metadinotroaniline | |
| b) Benzaldehyde to banzamide | |
| c) Benzaldehyde to Benzil | |
| d) Aniline to p-Bromobenzanilide | |
| 3.(i) Conductometric titrations: Acid-base. | 8 marks |
| (ii) Kinetics of catalytic decomposition of H_2O_2 . | |
| (iii) Determination of PH of the given solution using glass electrods. | |
| (iv) Surface tension-composition curve for a binary liquid mixture. | |
| 4. Viva | 5 marks |
| 5. Record | 5 marks |

Sri Dev Suman Uttarakhand University Badshahithaul Tehri Garhwal
Syllabus of Botany Course for B.Sc. (6 Semesters)

B.Sc. Botany Syllabus

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Botany and their applications, the syllabus pertaining to B.Sc. (3 Year Degree Course) in the subject of Botany has been proposed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit-wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

B.Sc. Semester I

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Microbiology	BBO101	80	20
II	Fungi, Elementary Plant Pathology and Lichens	BBO102	80	20
	Lab Course I	BBO10P	40	10

B.Sc. Semester II

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Algae and Bryophyta	BBO201	80	20
II	Pteridophyta, Gymnosperm and Elementary Palaeobotany	BBO202	80	20
	Lab Course II	BBO20P	40	10

B.Sc. Semester III

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Taxonomy of Angiosperms	BBO301	80	20
II	Anatomy and Embryology	BBO302	80	20
	Lab Course III	BBO30P	40	10

B.Sc. Semester IV

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Cytology and Genetics	BBO401	80	20
II	Plant Ecology	BBO402	80	20
	Lab Course IV	BBO40P	40	10



B.Sc. Semester V

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Molecular Biology and Biotechnology	BBO501	80	20
II	Plant Breeding and Biostatistics	BBO502	80	20
	Lab Course V	BBO50P	40	10

B.Sc. Semester VI

Paper No.	Title	Paper Code	Max. Marks (100)	
			Ext.	Int.
I	Plant Physiology, Elementary Morphogenesis and Biochemistry	BBO601	80	20
II	Economic Botany and Biodiversity	BBO602	80	20
	Lab Course VI	BBO60P	40	10

Semester I (90 Lectures)

Paper I (BBO 101): Microbiology

UNIT-I

10 Lectures

1. History and scope of Microbiology.
2. A brief idea of microbial diversity and distribution, position of microorganisms in the living world
3. Classification of microorganisms.

UNIT-II

08 Lectures

1. Elementary principles and methods of isolation, purification and culture of microorganisms (bacteria and Fungi)
2. Role of microorganisms in biogeochemical cycles in nature.
3. Bacteria: Structure, reproduction, nutrition, plasmids, economic importance.

UNIT-III

08 Lectures

1. Virus: general characteristics, structure, replication, transmission.
2. A brief idea of bacteriophages, cyanophages

UNIT-IV

06 Lectures

1. Viroids and prions.
2. Mycoplasma: a general account.



Paper II (BBO 102): Fungi, Elementary Plant Pathology and Lichens

UNIT-I:

14 Lectures

1. Brief history and salient features of fungi
2. Outline of classification of Alexopoulos & Mims and salient features of important groups.
3. Habit, habitat, structure and methods of reproduction of fungi based on the following representatives: *Albugo*, *Mucor*, *Saccharomyces*, *Puccinia* and *Alternaria*.

UNIT-II:

16 Lectures

1. Lichens: Occurrence, General structure, types and physiology (symbiotic relationship) of Lichens.
2. Morphology and microscopic structure of crustose, fruticose and foliose lichens
3. Economic importance of Lichens in general.

UNIT-III:

12 Lectures

1. General symptoms of plant diseases.
2. General principles of infection and resistance.

UNIT-IV:

16 Lectures

1. General methods of chemical and biological control of the plant diseases.
2. The symptoms, morphology of the causal organism, disease cycle and control measures of the following disease: White rust of crucifers, Loose smut of wheat, Wart disease of potato, Red rot of sugarcane.

Lab Course (BBO 10P):

1. Study of various equipments, glasswares and accessories used in microbiological experiments.
2. Preparation of bacterial and fungal culture media.
3. Negative staining and Staining of bacteria with Gram stain.
4. A study of the following types: *Albugo*, *Mucor*, *Agaricus*, *Alternaria*, *Ustilago* and *Puccinia*
5. Study of morphology and structure of different types of lichens
6. Symptoms and morphology of diseases, as mentioned in theory syllabus.

Books recommended:

Gangulee, H.C. and Kar, A.K. 1992. College Botany, Vol II. Calcutta
Panley, B.P. 1999. Simplified Course in Botany, B.Sc. I S. Chand & Co. Ltd. New Delhi
Singh, V., Pande, P.C. and Jain, D.K. 1998. A Text Book of Botany, Rastogi Publ, Meerut
Singh, R.S. 1992. Principles of Plant Pathology. Oxford and IBH Publ. Co., New Delhi.
Vashlatha, B.R. 1998. A Textbook of Fungi. S. Chand & Co. New Delhi
Sharma, P.D. Microbiology. Rastogi Publications, Meerut, India



Two handwritten signatures are present at the bottom of the page. The one on the left is a cursive signature, and the one on the right consists of a circled 'A' followed by a signature.

- Dubey, R.C., & D.K. Maheshwari. A textbook of Microbiology, A.Chand & Company, New Delhi
- Clifton, A. 1958. Introduction to the Bacteria, McGraw-Hill book Co., New York.
- Mandahar, C.L. 1978. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi.
- Dubey, R.C. & D.K. Maheshwari. Practical Microbiology. S.Chand, New Delhi
- Aneja, A.R. Experiments in Microbiology Plant Pathology and Biotechnology, New Age International Publishers
- Kaushik, P 2009. Introductory Microbiology. Emkay Publication, Delhi. 110051.

Semester II : 90 Lectures

PAPER I (BBO 201): Algae and Bryophytes

UNIT-I:

12 Lectures

1. General Characteristics of Algae
2. Classification of algae, basic outline of Fritsch's classification
3. Organization of thallus, pigmentation and mode of reproduction in Algae

UNIT-II:

12 Lectures

1. Occurrence, structure of thallus and mode of reproduction in the following genera: *Chlamydomonas*, *Cladophora*, *Vaucheria* and *Chara*
2. General account of the Bacillariophyceae

UNIT-III:

10 Lectures

1. Occurrence, structure and mode of reproduction of the *Polysiphonia*.
2. Cyanobacteria- A general account and nitrogen fixation by cyanobacteria
3. Economic importance of algae as food and fodder, in agriculture, industry and in public health

UNIT-IV:

12 Lectures

1. Outline and basic principles of classification of the Bryophytes
2. Comparative account of the gross morphology, vegetative and sexual reproduction, structure and evolution of the sporophytes of *Marchantia*, *Anthoceros* and *Funaria*
3. Origin, habitat, distribution and economic importance of Bryophytes

PAPER II (BBO 202) : Pteridophyta, Gymnosperm and Elementary Palaeobotany

UNIT-I:

18 Lectures

1. General characters of the Pteridophytes and classification as proposed by Sporne.
2. A comparative study of *Rhynia*, *Selaginella*, *Equisetum* & *Martilia* on the basis of following features:

[Handwritten signatures]

Morphology and anatomy of the vegetative plant body and spore producing organ (strobilus, sporophyll, sporangium and spores), sexual reproduction, male and female gametophytes, fertilization.

UNIT-II: 8 Lectures

1. A brief account of Telome theory, Stear system and its evolution.
2. Heterospory and seed habit in Pteridophytes.

UNIT-III: 12 Lectures

1. Outlines of classifications as proposed by D.D. Pant and distinguishing features of Gymnosperms. Distribution of Gymnosperms in India.
2. Comparative account of the structure, life history and evolutionary trends and economic importance based on *Cycas* and *Pinus* and *Ephedra*.

UNIT-IV: 6 Lectures

1. Process of fossilization
2. Types of fossils
3. Living and pseudo-fossils.

Lab Course (BBO 20P)

Study of the following types by preparing temporary slides: *Nostoc*, *Chlamydomonas*, *Cladophora*, *Vaucheria*, *Chara*, *Sargassum* and *Polysiphonia*

Study of the external features and internal structures with the help of permanent and/or temporary preparation of scales, rhizoids, gemma cups, archegoniophores, antheridiophores and sporophytes of the following: *Riccia*, *Marchantia*, *Anthoceros* and *Fumarica*.

Study of the external features and internal structures of rhizome, leaves, roots, and reproductive structure of *Seleginella*, *Equisetum* and *Marsilea* (Specimen and Permanent Slides only)

Study of the morphological features and anatomical structures of vegetative and reproductive parts of *Cycas*, *Pinus* (Specimen and Permanent Slides only).

Study of fossil specimens.

Books recommended:

Algae and Bryophyta

Khan, M. 1983. Fundamentals of Phycology. Bishen Singh Mahendra Pal Singh, Dehradun.
Parihar, N.S. 1976. The Biology and Morphology of Bryophytes. Central Book Depot, Allahabad.

Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi.

Sharma, O.P. 1998. A Text Book of Bryophyta. Pragati Prakashan, Meerut.

Singh, V., Pandey, P.C. and Jain, D.K. 1996. A Textbook of Botany, Rastogi Publ, Meerut.

Vasishta, B.R. 2001. Text Book of Algae. S. Chand & Co. New Delhi.

Rashid. 1996. Pteridophyta

Parihar, N.S. 1996. Biology & Morphology of Pteridophytes. Central Book Depot, Allahabad.

Pandey, S.N. A Textbook of Pteridophyta.

Singh, V., Pandey, P.C. and Jain, D.K. 1996. A Textbook of Botany, Rastogi Publ, Meerut.

Pandey, B.P. 2001. Gymnosperms and Palaeobotany. S. Chand & Co. Ltd., New Delhi



Sharma, O.P. 1998. An Introduction to Gymnosperms, Pragati Prakashan, Meerut.
Vashistha, P.C. 2001. A Textbook of Pteridophyta, S. Chand & Co. Ltd., New Delhi
Vashistha, P.C. 2001. A Textbook of Gymnosperm, S. Chand & Co. Ltd., New Delhi

Semester III : 90 Lectures

Paper I(BBO 301) : Taxonomy of Angiosperms

UNIT-I:

14 Lectures

1. Origin of Angiosperms: Vavilov's concept, some examples of primitive angiosperms. Angiosperm taxonomy- fundamental taxonomical characteristics.
2. Historical development in plant taxonomy in pre- Linnaeus and post Linnaeus periods.
3. Comparison and evolution of the systems of classification as proposed by Linnaeus, Bentham and Hooker and Hutchinson

UNIT-II:

12 Lectures

1. Nomenclature: International Code of Nomenclature for Algae, Fungi and Plants (ICN), scientific naming of plants, priority, types, validity, *nomina conservanda*
2. Collection and preservation techniques of specimens for herbarium and museums.
3. Botanical Gardens and Herbaria. A brief idea of Botanical Survey of India (BSI)

UNIT-III:

10 Lectures

1. Taxonomy, important distinguishing characters, classification and economic importance of the following families:
 - a. *A. Dicotyledonae*
Polypetalae: Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Rutaceae, Fabaceae, Rosaceae, Cucurbitaceae, Apiaceae.

UNIT-IV:

10 Lectures

1. *Gamopetalae*: Solanaceae, Apocynaceae, Asclepiadaceae, Acanthaceae, Lamiaceae
2. *Monochlamydae*: Euphorbiaceae, Moraceae
3. *Monocotyledonae*: Orchidaceae, Poaceae

Paper II(BBO 302) : Anatomy and Embryology

UNIT-I:

8 Lectures

1. The techniques for the study of plant anatomy
2. Meristems- Primary and Secondary meristems, characteristics and functions. Various types of permanent tissues
3. Anatomy of stem, root, leaf (Dicot & monocot)

UNIT-II:

12 Lectures

1. Secretory structures
2. Structure of xylem and phloem including cork cambium, its activity and products.
3. Origin, structure and function of vascular cambium, anomalous secondary growth with special reference to the following taxa: *Salvadora*, *Dracaena*, and *Tinospora* and



Velamen in Orchid and Ficus

UNIT-III:

12 Lectures

1. Structure of anther, microsporogenesis and development of male gametophytes in angiosperms
2. Structure of ovule, megasporogenesis and development of different types of female gametophytes.
3. Mode of different types of Pollination, double fertilization and triple fusion,

UNIT-IV:

12 Lectures

1. Types of endosperm and embryo development in dicots.
2. Polyembryony and apomixis
3. Seed germination and dormancy

Lab Course (BBO 30P)

Identification of locally available plants belonging to the families mentioned in the syllabus, their description in semi technical language

Collection of the plant specimens-herbarium and/or live specimen. Excursion should be organized by the department to acquaint the students with the local flora.

Demonstration of usual techniques of plant anatomy, section cutting, TS, LS of leaf, stem and root.

Normal and abnormal secondary growth in *Boerhavia*, *Salvadora*, *Dracaena*, *Ficus*, and *Tinospora*

T.S. of Anther

Study of various types of pollen grains, placentations, embryosacs, ovules and stages of embryo development using permanent preparations.

Demonstration of pollen germination experiment using hanging drop or other method.

Books recommended:

Agrawal, K.C. 1999. Biodiversity. Agrobotanica, Bikaner.

Gupta, R.K. 1989. Text Book of Systematic Botany. Atma Ram & Sons, New Delhi.

Pandey, B.P. 2001. a Text Book of Angiosperms. S. Chand & Co. Ltd., New Delhi.

Sexena, N.B. 1997. Plant Taxonomy. Pragati Prakashan, Meerut.

Singh, V. and Jain, D.K. 1998. Taxonomy of Angiosperms, Rastogi Publ., Meerut.

Tyagi, Y.D. & Kabherpal, S. 1996. An Introduction to the Taxonomy of Angiosperms. Ramesh Book Depot, Jaipur.

Vasudeven, R. Taxonomy of Angiosperms

Bhojwani, S.S. and S.P. Bhatnagar. 1994. Embryology of Angiosperms

Maheshwari, P. An Introduction to Embryology of Angiosperms

Singh, S.P. A Textbook of Plant Anatomy

Tayal, M.S. 1996. Plant Anatomy. Rastogi Publ. Meerut.



Handwritten signatures and initials at the bottom of the page, including a large signature and several smaller initials.

Semester IV : 90 Lectures

Paper I (BBO 401) : Cytology and Genetics

UNIT-I

10 Lectures

1. Cell structure: Prokaryotic and eukaryotic cells: ultrastructure of eukaryotic cell,
2. Cell wall and plasma membrane (ultrastructure, chemical composition and models of plasma membrane)
3. Structure and Function of Nucleus: Ultrastructure, Nuclear membrane, Nucleolus

UNIT II

8 Lectures

1. Structure and Function of cell Organelles: Vacuoles, Lysosomes, Mitochondria, Chloroplasts.
2. Cell cycle and Cell Division (Mitosis and Meiosis), Their comparison
3. Linkage and Crossing over

UNIT-III

10 Lectures

1. Mendel's Laws of inheritance (Law of dominance, Law of segregation and Independent assortment, Incomplete dominance)
2. Cytoplasmic inheritance
3. Interaction of Genes

UNIT-IV

10 Lectures

1. Sex-linked inheritance, Haemophilia, Colour Blindness,
2. Determination of sex
3. Mutation

Paper II (BBO 402) : Plant Ecology

UNIT-I:

12 Lectures

1. Definition and scope of Ecology
2. Ecosystem: Types, abiotic and biotic components, food chain, food web and ecological pyramids,
3. Energy flow and ecological energetics, Lindemann's Concept of energy flow.

UNIT-II:

12 Lectures

1. Biogeochemical cycles: A brief discussion of concept by giving examples of carbon and nitrogen cycles.
2. Population ecology: Definition, population characters




3. Community ecology: Community characteristics, structure and composition, quantitative, qualitative and synthetic features, life forms and biological spectrum.

UNIT-III:**14 Lectures**

1. Productivity, type, measurement of primary productivity, turn over,
2. ecological succession
3. Bio-geographical regions of India; vegetation types in Uttarakhand.

UNIT-IV:**14 Lectures**

1. Applied ecology : Soil erosion and soil conservation,
2. Pollution of air and water, Thermal and radioactive pollution, Prevention and control of pollution.
3. Global warming, ozone depletion and climate change.

Lab Course (BBO 40P):

Study of Cell division Mitosis and Meiosis using smear and squash technique

Problems based on mendel's law and incomplete dominance

To determine the minimum size of quadrat by species area curve method

To determine the minimum number of quadrat to be laid down for the vegetational analysis of the given area

To determine frequency, density and abundance of each species in a community by quadrat method

To prepare frequency diagram and compare it with that of the Raunkiaer's normal frequency diagram

To determine the mean basal cover and total basal cover.

To study the physical character of the soil in terms of temperature, colour texture and pH

To find out the bulk density and porosity of different soil samples.

To estimate the moisture percentage of various soil samples

Books recommended:

Gupta, P.K. 2000. Cytology, Genetics and Evolution, Rastogi Publications, Meerut.

Gupta, P.K. 2000. Genetics, Rastogi Publications, Meerut.

Gupta, P.K. 2001. Elements of Biotechnology, Rastogi Publication, Meerut.

Power, C.B. 1994. Cell Biology, Himalaya Publishing House, Delhi.

Veerbala Rastogi Introductory Cytology, Meerut. Ambastit, R.S. 1992. A Text Book of Plant

Ecology, Students Friends & Co. Varanasi.

Jasra, P.K. and Gurudeep Raj. 2000 Biostatistics, Krishna Prakashan Media (P) Ltd. Meerut.

Misra, K.C. 1980. Manual of Plant Ecology. Oxford and IBH Publ. Co. New Delhi.

Odum, E.P. 1983. Basic Ecology. Saunders College Publ, New York.

Ray, M. & Sharma, H.S. 2000. Mathematical Statistics, Ram Prasad & Sons. Agra.

Sharma, P.D. 2001. Ecology and Environment, New Delhi.




Semester V : 90 Lectures

Paper I (BBO 501): Molecular Biology and Biotechnology

UNIT I

14 Lectures

1. DNA as genetic material : Griffith and Avery Transformation experiment, Hershey and Chase bacteriophage experiment
2. Watson and Crick Model of DNA, Replication of DNA (Semi conservative)
3. Types of RNA (tRNA, rRNA and mRNA) their structure and function.

UNIT II

14 Lectures

1. Eukaryotic chromosome: structure, chemical composition, Karyotype analysis.
2. Ideogram; structure and functions of Polytene and Lampbrush chromosomes

UNIT-III

12 Lectures

1. Definition and scope of biotechnology
2. Theory and techniques of plant tissue culture, storage of germplasm (cryopreservation)
3. Biology of *Agrobacterium*, vectors for gene delivery and marker genes.

UNIT-IV

14 Lectures

1. Genetic Engineering: Tools and techniques of recombinant DNA technology, cloning vectors, genome and cDNA libraries, transposable elements.
2. Techniques of gene mapping and chromosome walking.
3. Gene Sequencing

Paper II (BBO 502): Plant Breeding and Biostatistics

UNIT-I:

12 Lectures

1. Plant breeding : Aims and objectives, basic techniques of plant breeding
2. Crop improvement method- Plant introduction, selection, acclimatization and hybridization.
3. Mutational breeding and breeding for disease resistance

UNIT-II:

6 Lectures

1. Improved seeds – production, multiplication and distribution.
2. Maintenance and seed testing
3. National Seeds Corporation and Seed Testing Laboratories.

UNIT-III:

10 Lectures

1. Methods of representation of statistical data diagrams.
2. Measurements of central tendencies – Mean, Median, Mode.

Handwritten signatures and initials at the bottom of the page, including a large signature on the left and a circular stamp with initials in the center.

3. Measures of dispersion – range, mean deviation and standard deviation.

UNIT-IV:

8 Lectures

1. Coefficient of correlation.
2. Test of significance-Chi-square test.

Lab Course (BBO 50P):

Study of biotechnological tools and equipments.
Preparation of culture media for plant tissue culture.
Isolation, surface sterilization and inoculation of explants.
Isolation of plant protoplasts.
Preparation of artificial seeds.
Perform the Emasculation in the plant provided.
Determine the Dockage percentage
Determination of Moisture percentage in the soil samples provided.
Study of the Floral Biology of some important plants
Statistical problems of central tendencies, standard deviation, correlation and chi-square test

Books recommended:

Gupta, P.K. 2000. Genetics, Rastogi Publications, Meerut.
Gupta, P.K. 2001. Elements of Biotechnology. Rastogi Publication, Meerut.
Dubey, R.C. 2000. A Text Book of Biotechnology. S.Chand & Company, New Delhi
Anuja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age Publication, New Delhi
Chaudhary, H.K. Plant Breeding
Bhandari, M.M. 1979. Practicals in Plant Breeding. Oxford and IBH Publ.Co.-New Delhi.
Kapoor, R.L. Plant Breeding and Crop Improvement
Kochhar, S.L. Economic Botany in the Tropics.
Simmonds, N.W. 1988. Evolution of Crop Plants.
Singh, B.D. 2001. Plant Breeding-Principles and Methods. Kalyani Publ. New Delhi.

Semester VI : 90 Lectures

Paper I(BBO 601) : Plant Physiology, Elementary Morphogenesis and Biochemistry

UNIT-I

8 Lectures

1. Cell Physiology, diffusion, permeability, plasmolysis, imbibition, water potential and osmotic potential
2. Active and passive absorption, anatomical features of xylem in relation to path of water transport, ascent of sap.
3. Loss of water from plants, transpiration, factors affecting transpiration, guttation, anatomy of leaf with special reference to loss of water

UNIT-II

12 Lectures

[Handwritten signatures]

1. Translocation of solutes, theories and mechanism of translocation, anatomical features of the phloem tissue with reference to the translocation of solutes.
2. Elementary knowledge of the macro and micronutrients.
3. Symptoms of mineral deficiency, techniques of water and sand culture

UNIT-III

14 Lectures

1. Photosynthesis, historical background and importance of the process, role of primary pigments, Concept of two photosystems, Z-scheme, Photophosphorylation, calvin cycle, Factors affecting photosynthesis, chemosynthesis.
2. Respiration, glycolysis, Kreb's cycle, Electron transport mechanism (Chemiosmotic theory), ATP the biological energy currency, Redox potential, oxidative phosphorylation, pentose phosphate pathways, CAM plant, factors affecting respiration, fermentation.

UNIT-IV

14 Lectures

1. Carbohydrates- properties, structures and biological role.
2. Structures and properties of Proteins.
3. Plant growth regulators, Auxin, cytokinins and Abscisic acid
4. Morphogenesis: basic concept of differentiation, morphogenesis, polarity and totipotency. Elementary Plant Movements

Paper II(BBO 602): Economic Botany and Biodiversity

UNIT-I

4 Lectures

1. Importance of plants to mankind
2. Origin of cultivated plants, centres of origin of some important crop plants.

UNIT-II

12 Lectures

1. Origin, history, botanical features and cultivation of wheat, maize and one millet.
2. Legumes- an introduction to the economically important legumes.
3. Oils- Castor oil, linseed oil, mustard oil and mint oil.
4. Sugar and starches (sugar cane)

UNIT-III

14 Lectures

1. General account of fruit (apple, banana, citrus, litchi and mango) and vegetable (root, stem, leaf and fruit vegetable) plants
2. Fibers (Coir, cotton, flax, hemp) and medicinal plants (*Aconitum*, *Atrropa*, *Cinchona*, *Ephedra* and *Rauwolfia*) plants
3. Common timber yielding plants (*Chir*, *deodar*, *sal*, *shisham* and *teak*) of western Himalaya
4. Beverages – Tea, coffee and alcohol beverages

UNIT-IV:

12 Lectures

[Handwritten signatures]

1. Biodiversity: Basic concept, biodiversity at global and National level, causes of loss of Biodiversity
2. Biodiversity conservation action plan: In-situ and Ex-situ conservation, gene bank, introductory account of Biosphere Reserves, national Parks and sanctuaries.

Lab Course (BBO 60P) :

1. Study the path of conduction of water by eosin method
2. Respiratory quotient by Respirometer
3. Estimation of Rate of photosynthesis
4. Rate of transpiration by Ganong's potometer
5. Perform the experiments on Osmosis & plasmolysis
6. Comparison of stomatal & cuticular transpiration
7. Experiments on Paper chromatography, Separation of pigments.
8. Experiments based on use of growth regulators in plants
9. Study of economic importance of Food Crops, Legumes, Oil yielding plants, fruits and vegetable plants.
10. Study of Timber & fire wood yielding plants
11. Study of Fibre yielding & Medicinal Plants
12. Plant based Beverages & Sugars

Recommended Books:

- Devlin, R.M. 1996. Plant Physiology. Indian Print, New Delhi
- Kochhar, P.L. and H.B. Krishnamourthy. 1998. Plant Physiology.
- Pandey, S.N. 2000. Plant Physiology.
- Srivastva, H.S. 2001. Plant Physiology. Rastogi Publications, Meerut.
- Verma, S.K. 1996. A Textbook of Plant Physiology.
- Zeiger and Tez. 2010. Plant Physiology and Biochemistry
- Plant Wealth of India 1997. Special Issue of Proceedings Indian National science Academy 8-63.
- Plucknett, D.L., Smith, N.J.H., William, J.T. and Murti Amishetty, N. 1987. Gene Banks and worlds Food. Princeton University Press, Princeton, New Jersey, USA.
- Rodgers, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. 1. The Report. Wildlife Institute of India, Dehradun.
- Sahni, K.C. 2000. The Book of Indian Trees, 2nd edition. Oxford University Press Mumbai.
- Schery, R.W. 1972. Plants for Man. 2nd ed. Englewood Cliffs, New Jersey. Prentice Hall.
- Sharma, O.P. 1996. Hill's economic Botany (Lata Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., new Delhi.
- Swaminathan, M.S. and Kocchar, S.L. (Eds) 1989. Plants and Society. Macmillan Publication Ltd., London.
- Thakur, R.S., Puri, H.S. and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

[Handwritten signature]

[Handwritten signature]

[Handwritten signature]

04-07-2018

Department of Zoology

Sri Dev Suman Uttarakhand University, Badshaithaul

New Tehri



Course Contents & Syllabus

Based on

Annual System

for

Undergraduate Course

BOS held on 7th February 2020

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. (Zoology)
(All affiliated colleges)

The BSc examination will be spread over three years. There will be three theory papers and one practical examination every year. Each theory paper has been divided into five units. There will be 12 objective questions (1 mark each) (Multiple choice/true & false, fill in the blanks); Six short answer questions type (3 marks each) and four long answer type (5 marks each). There will be internal choice in short and long answer questions. The total duration of paper will be 2.30 hours.

Course Content and Teaching Schedule:

Class		No of lecture/periods 45 minutes, 25 weeks	Teaching hours		
			Weekly	Total	MM
B.Sc. 1st Year			Weekly	Total	MM
Paper-1 st	Non-Chordata (Animal Diversity)	50	1.5	37.5	50
Paper 2 nd	Cell Biology and Genetics	50	1.5	37.5	50
Paper 3 rd	Taxonomy, Evolution, Biostats & Computer	50	1.5	37.5	50
Practical based on paper 1,2 &3		100	03	75	50
B.Sc. 2nd Year			Weekly	Total	MM
Paper 4 th	Chordata	50	1.5	37.5	50
Paper 5 th	Animal Physiology and Biochemistry	50	1.5	37.5	50
Paper 6 th	Molecular Biology, Microbiology and Biotechnology	50	1.5	37.5	50
Practical based on paper 4,5 &6		100	03	75	50
B.Sc. 3rd Year			Weekly	Total	MM
Paper-7 th	Endocrinology and Applied Zoology	50	1.5	37.5	50
Paper 8 th	Ecology, Conservation biology and Animal Behaviour	50	1.5	37.5	50
Paper 9 th	Developmental Biology and Toxicology	50	1.5	37.5	50
Practical based on paper 7,8 &9		100	03	75	50

20% marks will be on the basis of internal assessment (10% for attendance + 10% for performance in the practical).

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 1st Year (Zoology)
Paper I: Animal Diversity (Non-Chordata)

UNIT-I

Protozoa: General characters and classification up to classes; locomotion and nutrition in Protozoa.

Porifera: General characters and classification up to classes; Canal system in sponges

UNIT-II

Coelenterata: General characters and classification up to classes; Polymorphism in Coelenterates; Corals and coral reefs.

Helminthes: General characters of Nematelminthes and Platyhelminthes; Life history of *Ascaris lumbricoides* and *Taenia solium* and their parasitic adaptations

UNIT-III

Annelida: General characters and classification up to classes; Metamerism in Trochophore larva and its significance.

Arthropoda: General characters and classification up to classes; Zoological importance of *Peripatus* and *Limulus*. Metamorphosis in Insects.

UNIT-IV

Mollusca: General characters and classification up to classes; Torsion in Gastropoda; Pearl formation.

UNIT-V

Echinodermata: General characters and classification up to classes; Water vascular system in star fish; Echinoderm larvae and their significance.

Books Recommended:

1. Kotpal, Agrawal & Khetrapal: Modern Text-book of Zoology, Invertebrates.11/E. Rastogi publication.
2. Nigam: Biology of Non-Chordates, Nagin Chand,.
4. B.Sc. Zoology Series -Animal Diversity ,Tata McGraw Hill Edu Pvt. Ltd. N.Delhi
5. Jordan E.L. et al.: Invertebrate Zoology. S.Chand & Company Ltd.
6. Barnes: Invertebrate Zoology (4th ed.), Holt-Saunders.
7. Barrington: Invertebrate Structure and Function, Nelson.
8. Iyer: A Manual of Zoology, Part I. Visawanathan

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 1st Year (Zoology)
Paper 2: Cell Biology and Genetics

Unit -I

Introduction to Cell biology; Cell theory
Comparative study of the Prokaryotic and Eukaryotic Cell.

Unit -II

Elementary knowledge of the structure & functions of plasma membrane;
Introduction to the organelles constituting endomembrane system (Endoplasmic reticulum, Golgi complex, Lysosome & Peroxisome).

Unit -III Nucleus & nucleolus; Ribosome; Mitochondria. Introduction to cytoskeleton.

Cell Division-Mitosis & Meiosis. Basic features of Cell cycle;
Elementary idea of cell transformation and cancer

Unit-IV

Mendel's law; Exceptions to Mendel's law. Incomplete dominance and Co-dominance, Multiple alleles, Lethal alleles, Epistasis.
Sex-linked inheritance; Extra chromosomal inheritance

Unit-V

Linkage & Crossing over. Sex determination.
Chromosome structure; Euchromatin; Heterochromatin; Histones.
Polytene & lampbrush chromosomes, Eugenesis

Books Recommended:

1. Alberts et al.: Molecular Biology of the Cell, Garland Publ., New York, 1989.
2. Strickberger: Genetics, Prentice Hall, 1996.
3. DeRobertis & DeRobertis: Cell & Molecular Biology, 1996
4. Verma, P.S. and Agrwal, V. K. Cell Biology, Genetics, Molecular biology and Evolution (S. Chand & Co.)

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 1st Year (Zoology)
Paper 3rd: Taxonomy and Evolution, Biostat & Ccomputer

Unit -I

Taxonomy: Definition & scope; relationship with Systematic, Zoological nomenclature: Binominal & Trinominal; ICZN.

Components of classification: Linnaean hierarchy. Concepts of species: Typological, Nomenclastic & Biological

Unit -II

Geological distribution of animals, period of evolution and extinction of major groups. Direct Evidences of Evolution: Type of Fossils & fossilization. Dating of fossils. Significance of fossil record.

Unit - III

Evolutionary theories: Lamarckism, Darwinism, Neo-Darwinism;

Processes of Evolutionary Change: Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive). Evolution of Horse

Unit -IV

Biostatistics as a tool in research. Data collection: Random & non-random sampling. Data tabulation; Data presentation (Graph, Frequency Polygon, Histogram, Bar diagram, Scatter diagram).

Measures of central tendency- Calculation of Mean, Mode, Median

Unit -V

Introduction to computers types; Components of computer (Input unit, Memory, Central Processing Unit, Output unit). Problem solving with computers. Elementary idea of memory (RAM, ROM). Uses of computers in different fields. e.g. Biology, Medical, Environment etc.

Books Recommended:

1. Ashok Verma - Animal Taxonomy
2. Ernst Mayr- Principals of Systematic
3. Simpson- Principals and Practices of Animal Taxonomy
4. Kapoor- Theory and Practices of Animal Taxonomy, Oxford & Ibh
5. Strickberger: Evolution, CBS Publ. 1994.
6. Douglas, J. Futuyma. *Evolutionary Biology*. Sinauer Associate (1997)
7. Jain P.C. : Paleontology, Vishal Publ. Co.
8. Arora M.P.: Organic Evolution, Himalaya Publ
9. Rajaraman & V. Rajaraman: Computer Primer (2nd ed.) Prentice Hall of India, New Delhi.
10. Mahajan: Methods in Biostatistics, (4th ed.) Jaypee Bros. 1984

PRACTICAL SYLLABUS B.Sc. First Year (Zoology)

A. Non-Chordata:

Kingdom Protista: Amoeba, Euglena, Plasmodium, Paramecium

Phylum Porifera: Sycon (including T.S. and L.S.), Hyalonema, and Euplectella

Phylum Cnidaria: Obelia, Physalia, Aurelia, Tubipora, Metridium

Phylum Platyhelminthes: Liver Fluke, Taenia solium and Study of its life history stages (*Liver Fluke, Taenia solium*)

Phylum Nematelminthes: Male and female Ascaris lumbricoides

Phylum Annelida: Aphrodite, Nereis, Pheretima, Hirudinaria

Phylum Arthropoda: Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Apis, Peripatus

Phylum Mollusca: Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus

Phylum Echinodermata: Pentaceros, Ophiura, Echinus, Cucumaria and Antedon

An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa.

B. Cell Biology and Genetics:

1. Cell Structure and Cell Division- Prepared slides/photographs

2. Preparation of giant chromosome

3. Preparation of onion root tip for the stage of mitosis

4. Using suitable examples of Mendelian Inheritance and gene interactions verify the results through Chi-square test.

5. Study of Human Karyotypes (normal and abnormal).

C. Evolution:

1. Study of fossil evidences from plaster cast models and pictures

2. Study of homology and analogy from suitable specimens/ pictures and charts:

3. Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors

4. Darwin’s Finches with diagrams/ cut outs of beaks of different species

5. Visit to Museums, National parks and sanctuaries and submission of report.

B. Biostatistics

Practical application of statistics- Data presentation (Bar diagram, Histogram, Frequency distribution curve and scattered diagram), Measures of central tendency (Calculation of Mean, Mode, Median).

C. Computer application

Practical demonstration –preparation of Power Point presentation, Spread sheet, Chart and Design etc.

Distribution of marks: Duration 4 hrs.

1. Spotting (10) (Protozoa to Echinodermata)

2. Exercise on Cell Biology

3. Exercise on Genetics

4. Record and Collection

5. Viva Voice

6. Sessional Marks

Total 50

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 2nd Year (Zoology)
Paper 4th: Chordata

Unit- I

Protochordates: General features and Phylogeny of Protochordates. Body organization of *Balanoglossus*, *Herdmania* and *Amphioxus*.

Unit - II

Agnatha: General features of Agnatha and classification of cyclostomes up to Classes, Comparison between Lampreys and Hagfishes.

Pisces: General features and Classification up to orders; Scales and fins of fishes, Hill stream adaptations

Unit - III

Amphibia: General features and Classification up to orders; Parental care; Neoteny

Reptiles: General features and Classification up to orders; Poisonous and non-poisonous snakes; Biting mechanism in snakes; Venum and antivenum.

Unit - IV

Aves: General features and Classification up to orders; Feathers in Birds; Adaptations for aerial mode of life;

Unit - V

Mammalia: General features; Origin of mammals; distribution and affinities of Prototheria, Metatheria and Eutheria; Aerial and aquatic adaptations in mammals.

Books Recommended:

1. Pandey B.N. and Mathur V. Biology of Chordates, PHI Learning, 2018
2. R.L. Kotpal: Modern Text-book of Zoology, Vertebrates. Rastogi Publication.
3. E.L. Jordan and P.S. Verma: Chordate Zoology. S. Chand & Co. Ltd.
4. Hildebrand: Analysis of Vertebrate structure.
5. Romer & Parsons: The Vertebrate Body, Saunders.

Sri Dev Suman University, Badshahithaul, Tehri Garhwal

B.Sc. 2nd Year (Zoology)

Paper 5th: Animal Physiology & Biochemistry

Unit - I

Digestion: Intracellular and Extracellular digestion. Digestion and absorption of Carbohydrates, Lipids and Proteins.

Respiration: Pulmonary ventilation, Respiratory volumes and capacities,. Transport of Oxygen and Carbon dioxide in Blood. Dissociation of oxyhaemoglobin

Unit - II

Circulation: Composition of blood; Blood coagulation; Structure of Heart; Origin and conduction of the cardiac impulse, Cardiac cycle.

Excretion: Structure of nephron; Physiology of urine formation

Unit - III

Nervous system: Types of neurons; Myelinated and non-myelinated nerve fibres. Initiation and conduction of nerve impulse; Resting and action potential; Synapse and chemical transmission.

Muscles: Types of muscles; Ultrastructure of skeletal muscles; Molecular and Chemical basis of muscle contraction; Brief idea of tetanus and fatigue

Unit – IV

Carbohydrates Metabolism: Glycolysis, Kreb's Cycle, Gluconeogenesis, Glycogenesis and Glycogenolysis; Lipids: Biological significance, structure and classification.

Unit-V

Proteins: structure and classification; Transamination and Deamination

Enzymes: types and properties, factors affecting their functions. Mechanism of enzyme Action,

Books recommended:

1. Singh & Neeraj: Graduate Animal Physiology & Biochemistry, Vishal Publ
2. Prosser and Brown: Comparative Animal Physiology, Wiley.
3. Nielson: Animal Physiology, Cambridge.
4. Jain A.K: Textbook Of Physiology 6/E, Avichal Publishing Company
5. Conn and Stumpf: Outlines of Biochemistry. John Wiley.
6. Pandey B N: B.Sc. Zoology Series-Biochemistry, Physiology, Endocrinology; Tata McGraw Hill Edu Pvt. Ltd. N. Delhi

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 2nd Year (Zoology)
Paper 6th: Molecular Biology, Biotechnology and Microbiology

Unit I

Structure of DNA: nucleosides, nucleotides, polynucleotide chain, Watson and Crick DNA double helix model. DNA as genetic material, Packaging of DNA, Types of DNA

Unit II

Enzymes involved in prokaryotic and eukaryotic DNA replication; Mechanism & Type of replication.

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair:

Unit III

RNA: Structure and types of RNA, Clover leaf model of tRNA,

Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains.

Processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit IV

Biotechnology: Definition and scopes; Enzyme used in genetic engineering, Recombinant DNA technology, DNA fingerprinting. A Brief knowledge of PCR and its significance.

Biotechnological innovations in the area of medical, agriculture, industrial and forensic sciences

Unit V

General account of Cyanobacteria, fungi, yeast and viruses,

Bacteria: Structure, classification, nutrition and reproduction.

Books recommended:

1. Alberts et al.: Molecular Biology of the cell. Garland Publ., New York.
2. De Robertis- Cell and Molecular Biology
3. Friefelder: Molecular Biology. Narosa Publ. House.
4. Smith: Biotechnology. Cambridge.
5. Verma, P.S. and Agrwal, V. K. Cell Biology, Genetics, Molecular biology, Evolution and Ecology (S. Chand & Co.)
6. Tortora- Microbiology: an Introduction

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
PRACTICAL SYLLABUS of B.Sc. 2nd year (Zoology)

A. Chordata:

Protochordata: *Balanoglossus, Herdmania, Branchiostoma, Agnatha: Petromyzon*
Pisces: *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Tor putitora*, Hill stream fishes

Amphibia: *Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Axolotal larva*

Reptilia: *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*

Key for Identification of poisonous and non-poisonous snakes

Aves: Study of six common birds from different orders

Mammalia: *Sorex, Bat, Funambulus, Loris,*

An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa.

B. Physiology

Preparation of hemin crystals, Estimation of Haemoglobin percentage, Blood group test

Examination of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage etc.

C. Biochemistry

Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose)

Colour reactions to identify functional group in the given solution of proteins

Study of activity of salivary amylase under optimum conditions

D. Molecular biology and Biotechnology:

Study of Watson & Crick Model of DNA through model/photographs

Study of Clover leaf structure of tRNA through model/photographs

Agarose gel electrophoresis of genomic DNA & plasmid DNA

Preparation of restriction enzyme digests of DNA samples

E. Microbiology

Media preparation and sterilization, Gram’s staining of Bacterial Cell

Distribution of marks: Duration 4 hrs.

1. Spotting (05) 15
2. Exercise on Molecular Biology/Biotechnology 05
3. Exercise on Immunology 05
4. Exercise on Microbiology 05
5. Record and Collection 05
6. Viva Voice 05
7. Sessional Marks 10

Total 50

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 3rd Year (Zoology)
Paper 7th: Endocrinology and Applied Zoology

UNIT I

Basic idea of endocrine, paracrine & autocrine secretion. Mechanism of action of hormones. Structure and function of Pituitary, Thyroid, Adrenal, Pancreas, Testes and ovary. Hormonal control of menstrual cycle

Unit II

Structure and function of Pituitary, Thyroid, Adrenal, Pancreas, Testes and ovary. Hormonal control of menstrual cycle.

Unit III

Sericulture: Types of silk worms (Mulberry & Nonmulberry), Rearing of Mulberry Silkworm

Lac culture: cultivation practices of host plants, extraction and uses of lac

Unit IV

Medicinal Pests: Identification, Characteristics of Mosquitoes, Housefly, Bedbug, Sand Medicinal Pests fly, Human lice, Tse Tse fly, Rat flea

Unit V

Aquaculture (Fish Culture): Monoculture and composite culture.

Hatchery management – development of fish hatcheries, types of hatcheries, production of spawn, fry and fingerlings, Pond management and fertilization - pre and post stocking management.

Induced breeding with special reference to Indian major carps.

Suggested Readings

Hadley, M.E.: Endocrinology. Pearson Education Pvt. Ltd. Singapore.

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 3rd Year (Zoology)
Paper 8th: Ecology, Conservation Biology and Animal Behaviour

Unit -I

Ecology: Definition, scope and importance,
Introduction to laws of Limiting factors: Liebig's law of the minimum, Shelford's law of tolerance. Factor interaction

Unit -II

Biogeochemical cycles: Concept and types of biogeochemical cycle (Water, Carbon, Nitrogen and Phosphorus cycle)

Unit -III

Ecosystem concept: Component & types (Grassland, Forest, Pond, River); Abiotic, biotic & edaphic factors and their interdependence,
Energy flow in ecosystem. Primary and secondary productivity. Food chains, food web and ecological pyramids

Unit -IV

Conservation Biology: Definition & scope. Concept of biodiversity; Biodiversity as a resource; Biodiversity loss and its Causes.
Conservation & Management of Biodiversity. Concept of Protected Areas: *Ex-situ* & *In-situ* Conservation. Biodiversity hot spots.
India's wildlife: Habitats & Distribution; Protected areas: National Parks & Sanctuaries.

Unit-III

The science of behaviour: History, scope and terminology. Biological rhythms. Biological Clock. Circadian rhythms and their synchronisation seasonal rhythms. Photoperiodism

Recommended Books:

1. Alcock : Animal behaviour Sinaur Associates, Inc. 1989.
2. Drickamer & Vessey: Animal Behaviour: Concepts, Processes and Methods (2nd ed.)1986
3. Goodenough et al.: Perspectives on animal behaviour. Wiley & Sons, New Youk. 1993.
4. Grier : Biology of animal behaviour, Mosby 1984.
5. M P Arora. Anilam behaviour. Himalayan Publishing house
6. Negi: An introduction to Wildlife Management, 1983.
7. Negi: Himalayan Wildlife: Habitat and Conservation. 1992. Indus Publ. Com., New Delhi.
8. Pullin: Conservation Biology, Cambridge, 2002.
9. Rawat & Agarwal : Biodiversity: Concept, threats and conservation.
10. Sharma, High Altitude Wildlife of India. Oxford 7 IBH Publ. Co. Pvt. Ltd. 1994.

Sri Dev Suman University, Badshahithaul, Tehri Garhwal
B.Sc. 3rd Year (Zoology)
Paper 9th: Developmental Biology and Toxicology

Unit - I

Gametogenesis: Spermatogenesis in mammals, Morphology of mature mammalian spermatozoon: Oogenesis in mammals, Vitellogenesis in birds.
Fertilization: external (amphibian), Internal (mammals), Block to polyspermy

Unit - II

Early Development of Frog and Human: types of egg; patterns of cleavage; role of yolk during cleavage; Morphogenetic movements; Development up to formation of gastrula.

Neurulation in frog embryo, Extra embryonic membranes.

Unit - III

Implantation of embryo in human; Types of placenta on the basis of histology; Formation of human placenta and its functions.

Elementary concept of primary organizer; Induction. Differentiation and organogenesis of vertebrate eye.

Unit - IV

Definition, history, scope of toxicology.

Classification of toxic agents, natural toxins, food toxins, and chemical toxins

Environmental toxicology of heavy metal (lead)

Unit - V

Air pollution-types of air pollutants, their effects and remedial measures.

Water pollution- types of water pollutants, their effects and remedial measures.

General introduction to pesticides;, herbicides, fungicides, and insecticides

Books recommended:

1. Jain P C . Development Biology.
2. Gilbert, Developmental Biology. 3rd ed. Sinauer, 1991.
3. Berril: Developmental Biology, McGraw-Hill. Indian ed. 1974.
4. Laycock, J.F. and Wise, P.H.: Essential Endocrinology. Oxford University Press.
5. Hadley, M.E.: Endocrinology. Pearson Education Pvt. Ltd. Singapore

PRACTICAL SYLLABUS of B.Sc. 3rd Year (Zoology)

A. Endocrinology

Study of slides; pituitary, adrenal gland, thymus, testes, ovary

B. Ecology

Models Based on different aspects of ecology.

Population study of available terrestrial and aquatic animals

Physico-chemical study of soil and water (pH, DO, Free CO₂, Turbidity etc)

Study of an ecosystem, its biotic components and food chains

C. Animal Behavior &

Models Based on different aspects of animal behavior.

Study of Birds Nest showing Nesting Behaviour

Experiments related to learning behaviour/conditional learning.

Conservation Biology: Definition & scope. Concept of biodiversity; Biodiversity as a resource; Biodiversity loss and its Causes.

D. Conservation Biology

Study of Biodiversity hot spots with the help of maps..

Study of Protected areas: National Parks & Sanctuaries with the help of maps.

D. Developmental Biology

Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole-external and internal gill stages.

Study of the different types of placentae- histological sections through permanent slides or photomicrographs.

E. Toxicology

Distribution of marks: Duration 4 hrs.

Spotting (05) 15

(Ecological adaptation, Wildlife, Animal behaviour)

Exercise on Ecology/ Conservation Biology 10

Exercise on Animal Behaviour 05

Record and Collection 05

Viva Voice 05

Sessional Marks 10

Total: 50