

B.Sc. (Bio)

Combination Of Chemistry-Botany-Zoology

- **Subject-1 Chemistry**
- **Subject-2 Botany**
- **Subject-3 Zoology**

B.Sc. Chemistry

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Chemistry
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: BCHE 101	
Course Title: Basics of Chemistry	
Credits: 2+0	
Unit	Topics
I	Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology

Course Code: BCHE 102 (B020101T)	
Course Title: Fundamentals of Chemistry	
Credits: 4+0	
Unit	Topics
I	Molecular polarity and Weak Chemical Forces: Resonance and resonance energy, formal charge, hydrogen bonding, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability.
II	Simple Bonding theories of Molecules: Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H ₂ O, NH ₃ , PCl ₅ , SF ₆ , SF ₄ , ClF ₃ , I ₂ , ClF ⁻ and SO ²⁻ and H ₃ O ⁺ . Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions (N ₂ , O ₂ , C ₂ , B ₂ , F ₂ , CO, NO, and their ions)
III	A. Periodic properties of Atoms (with reference to s & p-block): Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, electronegativity, Pauling's/Allred Rochow's scales, Ionization enthalpy, electron gain enthalpy. B. Acid-Base concept Lewis concept, concept and classification of Hard and Soft Acids and Bases. Applications of HSAB Principle.
IV	Recapitulation of basics of Organic Chemistry: Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications
V	Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates Carbocations, carbanions, free radicals, Assigning formal charges on intermediates and other ionic species.
VI	Stereochemistry: 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 enantiomer, 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, Conformational isomerism conformational analysis of ethane and n-butane;
VII	Basic Computer system (in brief) -Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System)
VIII	Environmental Chemistry : The earth's atmosphere and its components., Types of pollutants and their sources. Green house effect and global warming. Acid rains, Ozone layer (Importance and its protection)

Course Code: BCHE 103 (B020102P)	
Course Title: Quantitative Analysis	
Credits: 0+ 2	
Unit	Topics
I	Water Quality analysis 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).
II	Estimation of Metals ions 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.
III	Estimation of acids and alkali contents 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with KMnO ₄ .
IV	Estimation of inorganic salts and hydrated water 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Redox titrations e.g. titration of ferrous ion with permanganate and dichromate using internal and external indicators 3. Iodometric Estimation of Copper Sulphate and Potassium dichromate 4. Estimation of water of crystallization of mohar's salt by titrating with KMnO ₄ .

Course Code: BCHE 104 (B020201T)	
Course Title: Bioorganic and Medicinal Chemistry	
Credits: 4+0	
Unit	Topics
I	Chemistry of Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses).
II	Chemistry of Proteins: Classification of amino acids, zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary, and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C terminal amino, Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis.
III	Chemistry of Nucleic Acids: Constituents of Nucleic acids: Adenine, guanine, thymine, and Cytosine (Structure only), Nucleosides and nucleotides (nomenclature), Synthesis of nucleic acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation
IV	Introductory Medicinal Chemistry: Drug discovery, design, and development; Basic Retrosynthetic approach. Drug action-receptor theory. Structure activity relationships of drug molecules, binding role of OH group, -NH ₂ group, double bond and aromatic ring.
V	Solid State Definition of space lattice, unit cell. Laws of crystallography (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and (iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl and KCl.
VI	Introduction to Polymer Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibers, Homopolymers and Co-polymers, Bonding in polymers : Primary and secondary bond forces in polymers ; cohesive energy, and decomposition of polymers. Silicones and Phosphazenes Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.
VII	Synthetic Dyes: Color and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green

Course Code: BCHE 105 (B020202P)	
Course Title: Biochemical Analysis	
Credits: 0+2	
Unit	Topics
I	Qualitative and quantitative analysis of Carbohydrates: . 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ non reducing sugar 3. Synthesis of Osazones.
II	Qualitative and quantitative analysis of Proteins, amino acids, and Fats 1. Isolation of protein. 2. Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of an oil/fat. 8. To determine the iodine value of an oil/fat
III	Determination and identification of Nucleic Acids 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauliflower
IV	Synthesis of Simple drug molecules 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid 3. Synthesis of propanol

Course Code: BCHE 201 (B020301T)	
Course Title: Chemical Dynamics & Coordination Chemistry	
Credits: 4+0	
Unit	Topics
I	Chemical Kinetics: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction differential method, method of integration, half-life method and isolation method. Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).
II	Phase Equilibrium: Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system water, S, He and Diamond, graphite. Phase equilibria of two component systems Solid - liquid equilibria , simple eutectic. Pb-Ag systems.
III	Kinetic theories of gases Gaseous State: Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. Critical phenomena: PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state.
IV	Liquid State Liquid State: Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Thermography and seven segmentcell.
V	Coordination Chemistry Coordinate bonding, double complex salts, Werner's theory of coordination complexes classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.
VI	Theories of Coordination Chemistry I. Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting

	<p>in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.</p> <p>II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes</p>
VII	<p>Inorganic Spectroscopy and Magnetism</p> <p>I. Electronic spectra of Transition Metal Complexes, Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.</p> <p>II. Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes. General description of magnetic properties :Paramagnetism, diamagnetism, ferromagnetism and magnetic susceptibility</p>

Course Code: BCHE 202 (B020302P)	
Course Title: Physical Analysis	
Credits: 0+2	
Unit	Topics
I	<p>Strengths of Solution</p> <p>Calibration of fractional weights, pipettes, and burettes. Preparation of standards solutions. Dilution 0.1M to 0.001M solutions</p> <p>Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles</p>
II	<p>Surface Tension and Viscosity</p> <ol style="list-style-type: none"> 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution
III	<p>Boiling point and Transition Temperature</p> <ol style="list-style-type: none"> 1. Boiling point of common organic liquid compounds ANY FIVE: <i>n</i>-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180⁰C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dialometric method (e.g. MnCl₂.4H₂O/SrBr₂.2H₂O)
IV	<p>Phase Equilibrium</p> <ol style="list-style-type: none"> 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol water system) and to determine the concentration of that solute in the given phenol-water system 2. To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.

Course Code: BCHE 203 (B020401T)	
Course Title: Quantum Mechanics and Analytical Techniques	
Credits: 4+0	
Unit	Topics
I	Atomic Structure: Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψ and ψ^2 quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule
II	Elementary Quantum Mechanics: de-Broglie hypothesis. Heisenberg uncertainty principle, Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, Schrödinger wave equation for H-atom, separation into three equations (without derivation), bonding wave function, concept of σ , σ^* , π , π^*
III	Molecular Spectroscopy: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom Rotational Spectrum: Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell- Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect . Vibrational Spectrum: Infrared spectrum : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability , pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules.
IV	UV-Visible Spectroscopy : Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, types of electronic transitions, λ_{max} , chromophore and auxochromes, nBathochromic and Hypsochromic shifts, Intensity of absorption, application of Woodward Rules for calculation of λ_{max} for the conjugated dienes, alicyclic, homoannular and heteroannular; extended conjugated systems, distinction between cis and trans isomers.
V	Infrared Spectroscopy: IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Hooke's law, selection rule, IR absorption positions of various functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance, application in functional group analysis and interpretation of I.R. spectra of simple organic compounds.
VI	A. Volumetric Analysis General principle of acid-base titrations, precipitation titrations, oxidation-reduction titrations, iodimetry and complexometric titrations, use of EDTA for the determination of Ca^{2+} and Mg^{2+} , Hardness of water, types of EDTA titrations and metal ion indicators. B. Gravimetric Analysis Precipitation from homogenous medium, purity of precipitates, coprecipitation,

	post-precipitation, washing and ignition of precipitates, contamination and their removal.
VII	Errors and Evaluation Definition of terms, mean and median, precision, standard deviation, relative standard deviation, accuracy- absolute error, types of error in experimental data determination (systematic), intermediate (or random) and gross, sources of errors and the effects upon the analytical results, methods for reporting analytical data, statistical evaluation and data -indeterminate errors, use of statistics
VIII	Separation Techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution, and displacement methods.

Course Code: BCHE 204 (B020402P)	
Course Title: Instrumental Analysis	
Credits: 0+2	
Unit	Topics
I	<p>Molecular Weight Determination</p> <ol style="list-style-type: none"> 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy
II	<p>Spectrophotometry</p> <ol style="list-style-type: none"> 1. To verify Beer Lambert Law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD). 4. Determination of Biological oxygen demand (BOD).
III	<p>Spectroscopy</p> <ol style="list-style-type: none"> 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C---C, stretching frequencies, characteristic bending vibrations are included. Spectra to be provided).
IV	<p>Chromatographic Separations</p> <ol style="list-style-type: none"> 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the R_f values TLC separation of a mixture of dyes (fluorescein and methylene blue)

Course Code: BCHE 301 (B020501T)	
Course Title: Organic Synthesis A	
Credits: 4+0	
Unit	Topics
I	<p>Chemistry of Alkanes and Cycloalkanes</p> <p>A) Alkanes :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity</p> <p>B) Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.</p>
II	<p>Chemistry of Alkenes</p> <p>Methods of formation of alkenes, Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, <i>syn</i> and <i>anti</i>-hydroxylation, ozonolysis, radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; <i>E</i>- and <i>Z</i>- alkenes;</p>
III	<p>Chemistry of Alkynes</p> <p>Methods of formation of alkynes, Addition of C triple bond C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration</p>
IV	<p>Aromaticity and Chemistry of Arenes</p> <p>Nomenclature of benzene derivatives, MO picture of benzene, Character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution - halogenation, nitration, sulphonation and Friedel- Craft's Alkylation with their mechanism, Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.</p>
V	<p>Chemistry of Alcohols</p> <p>Classification and nomenclature, Monohydric alcohols nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols, Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.</p>
VI	<p>Chemistry of 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. Reactions of phenols electrophilic aromatic substitution, acylation and carboxylation.</p>

VII	Chemistry of Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions cleavage and autoxidation,—Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides,
VIII	Chemistry of Organic Halides Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams; Polyhalogencompounds : Chloroform, carbon tetrachloride; 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,

Course Code: BCHE 302 (B020502T)	
Course Title: Rearrangement and Chemistry of group elements	
Credits: 4+0	
Unit	Topics
I	Rearrangements A detailed study of the following rearrangements: Pinacol-pinacolone, BenzilBenzilic acid, and Fries rearrangement
II	Catalysis General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation, or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis: Michaelis-Menten equation, Lineweaver-Burkplot, turn-over number.
III	Chemistry of Main Group Elements s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. p-Block Elements: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. Chemistry of Noble Gasses: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.
IV	Chemistry of Transition Elements Chemistry of Elements of First Transition Series -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. Chemistry of Elements of Second and Third Transition Series- General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.
V	Chemistry of Lanthanides Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.
VI	Chemistry of Actinides Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

VII	Metal Carbonyls and Nitrosyls 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclear carbonyls and nitrosyls.
VIII	Bioinorganic Chemistry Essential and trace elements in biological processes, metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} and Mg^{2+} . Cu in plastocyanin and hemocyanin, Zn in carboxypeptidase and carbonic anhydrase.

Course Code: BCHE 303 (B020503P)	
Course Title: Qualitative Analysis	
Credits: 0+ 2	
Unit	Topics
I	Inorganic Qualitative Analysis Semimicro Analysis cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion and interfering anion analysis. Mixture containing 6 radicals- 2+4 or 4+ or 3+3
II	Elemental analysis and identification of functional groups Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.
III	Separation of Organic Mixture Analysis of an organic mixture containing two solid components using water, NaHCO_3 , NaOH for separation and preparation of suitable derivatives
IV	Identification of organic compounds Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Course Code: BCHE 304 (B020601T)	
Course Title: Organic Synthesis B	
Credits: 4+0	
Unit	Topics
I	Reagents in Organic Synthesis A detailed study of the following reagents in organic transformations, Oxidation with SeO ₂ , Jones Oxidation, PCC, PDC, NaBH ₄ , LiAlH ₄ , DIBAL-H
II	Organometallic Compounds- Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organolithium compounds: formation and chemical reactions.
III	Chemistry of Aldehydes and ketones: Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Wittig reaction Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, An introduction to α,β – unsaturated aldehyde and ketones.
IV	Carboxylic acids and their Functional Derivatives Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.
V	Organic Synthesis via Enolates Acidity of α - hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate.
VI	Organic Compounds of Nitrogen- Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Gabriel- phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in arylamines, reactions of amines with nitrous acid.
VII	Heterocyclic Chemistry 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 reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Course Code: BCHE 305 (B020602T)	
Course Title: Chemical Energetics and Radiochemistry	
Credits: 4+0	
Unit	Topics
I	<p>Thermodynamics-1 :</p> <p>First Law of Thermodynamics : Statement , definition of internal energy and enthalpy. Heat capacity ,heat capacities at constant volume and pressure and their relationship. Joule's law Joule- Thomson coefficient and inversion temperature .</p> <p>Thermochemistry: Standard state, standard enthalpy of formation Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume . Enthalpy of neutralization . Bond dissociation energy and its calculation from thermo-chemical data , Kirchoff's equation.</p>
II	<p>Thermodynamics II</p> <p>Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature.</p> <p>Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P&T, Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions</p> <p>Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A &G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change,</p>
III	<p>Electrochemistry: specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, , Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations .</p>
IV	<p>Colligative Properties-Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.</p>

Course Code: BCHE 306 (B020603P)	
Course Title: Analytical Methods	
Credits: 0+2	
Unit	Topics
I	Gravimetric Analysis <ol style="list-style-type: none"> 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni(dimethylgloxime) 3. Analysis of Ba as BaSO₄.
II	Paper Chromatography Ascending and Circular Rf of organic compounds, Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent ninhydrin. Separation of a mixture of D, L alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent ninhydrin. Separation of monosaccharides a mixture of D- galactose and D –fructose using n- butanol: acetone: water (4:5:1). Spray reagent aniline hydrogen phthalate
III	Thin Layer Chromatography Determination of Rf values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- dinitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60), Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)
IV	Thermochemistry <ol style="list-style-type: none"> 1. To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolution process 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle

B.Sc. Botany

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Department of Botany
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: BOT 101	
Course Title: Basics of Botany	
Credits: 2+0	
Unit	Topic
I	Plant diversity: Study of lower plants Study of general characteristics features of Algae, Fungi, Bryophyta, Pteridophyte and Gymnosperms.
II	Morphology of angiosperms with general account of types of habit, root, leaf, shoot, inflorescence, flower and fruit. Adaptation in plants.
III	Basic concepts of ecology and environment, components of ecosystem, Environmental Pollution, its types and mitigation.
IV	Plant physiology and Biochemistry; basic concept of photosynthesis, respiration; mineral nutrition in plants; Plant Growth hormone: Auxin, Gibberellin and Ethylene.

Course Code: BOT102 (B040101T)	
Course Title: Microbiology & Plant Pathology	
Credits: 4+0	
Unit	Topic
I	A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/ assignments / self-study mentioned under Continuous Internal Evaluation (CIE). B. Microbial Techniques & instrumentation Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.
II	Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; Bacterial Chemotaxis, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria. Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes & plasmids and their economic uses.
III	Phycology Range of thallus organization in Algae, Pigments, Reserve food-Reproduction-Classification and life cycle of– <i>Nostoc</i> , <i>Chlorella</i> , <i>Volvox</i> , <i>Hydrodictyon</i> , <i>Oedogonium</i> , <i>Chara</i> ; <i>Sargassum</i> , <i>Ectocarpus</i> . Economic importance of algae-Role of algae in soil fertility- biofertilizer – Nitrogen fixation- Symbiosis; Commercial products of algae –biofuel, Agar.
IV	Mycology General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: <i>Rhizopus</i> , Ascomycota: <i>Saccharomyces</i> , <i>Penicillium</i> , <i>Peziza</i> . Basidiomycotina: <i>Puccinia</i> , <i>Agaricus</i> ; Deuteromycotina: <i>Fusarium</i> , <i>Alternaria</i> . Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality.
	Mushroom Cultivation, Lichenology & Mycorrhiza

V	Mushroom cultivation. General account of lichens, reproduction and significance; <i>Mycorrhiza: ectomycorrhiza</i> and <i>endomycorrhiza</i> and their significance.
VI	Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and induced systemic fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil
VII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of –Late Blight of Potato, False Smut of Rice/ Brown spot of rice and 'White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management
VIII	Applied Microbiology Food fermentations and food produced by microbes, amino acids, Production of antibiotics, enzymes, alcoholic beverages, organic acid. Mass production of bacterial biofertilizers, blue green algae, <i>Azolla</i> and <i>mycorrhiza</i> . Plant growth promoting rhizobacteria & biopesticides— <i>Trichoderma sp.</i> and <i>Pseudomonas</i> , Single cell proteins, Organic farming inputs, Microbiology of water, Bioremediation, Production of biofuels, and biodeterioration of materials.

Course Code: BOT 103 (B040102P)	
Course Title: Techniques in Microbiology & Plant Pathology	
Credits: 0+2	
Unit	Topic * (Minimum Any three from each unit depending on facilities)
I	INSTRUMENTS & TECHNIQUES <ol style="list-style-type: none"> Laboratory safety and good laboratory practices Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. Buffer preparation & titration Cleaning and Sterilization of glassware Preparation of media- Nutrient Agar and Broth Inoculation and culturing of bacteria in Nutrient agar and nutrient broth Preparation of agar slant, stab, agar plate Phenol Coefficient method to test the efficacy of disinfectants
II	BACTERIAL IDENTIFICATION <ol style="list-style-type: none"> Isolation of bacteria. Identification of bacteria. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. Cultural characteristics of bacteria on NA. Pure culture techniques (Types of streaking). Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.
III	MYCOLOGICAL STUDY: <ol style="list-style-type: none"> Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. Identification of fungi by lactophenol cotton blue method. <i>Rhizopus</i>, <i>Saccharomyces</i>, <i>Penicillium</i>, <i>Peziza</i>, <i>Ustilago</i>, <i>Puccinia</i>; <i>Fusarium</i>, <i>Curvularia</i>, <i>Alternaria</i>.

	<p>3. <i>Agaricus</i>: Specimens of button stage and fullgrown mushroom; Sectioning of gills of <i>Agaricus</i>.</p> <p>4. Lichens: crustose, foliose and fruticose specimens.</p>
IV	<p>PHYCOLOGY:</p> <p>1. Type study of algae and Cyanobacteria –<i>Spirullina</i>, <i>Nostoc</i>. Chlorophyceae - <i>Chlorella</i>, <i>Volvox</i>, <i>Oedogonium</i>, <i>Cladophora</i>, and <i>Chara</i>; Xanthophyceae – <i>Vaucheria</i>; Bacillariophyceae – <i>Pinnularia</i> Phaeophyceae – <i>Sargassum</i> Rhodophyceae - <i>Polysiphonia</i></p>
V	<p>EXPERIMENTAL PLANT PATHOLOGY</p> <ol style="list-style-type: none"> 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. 3. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of <i>Puccinia</i>, Few viral and bacterial plant diseases.
VI	<p>PRACTICALS IN APPLIED MICROBIOLOGY-1</p> <ol style="list-style-type: none"> 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic <i>Pseudomonas</i> from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of <i>Azospirillum</i> sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms.
VII	<p>PRACTICALS IN APPLIED MICROBIOLOGY-2</p> <ol style="list-style-type: none"> 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.
VIII	<ol style="list-style-type: none"> 1. Cultivation of <i>Spirulina</i>, & <i>Chlorella</i> in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/ IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures 4. Mushroom cultivation for Protein 5. Alcohol production. from Sugarcane Juice.

Course Code: BOT 104 (B040201T)	
Course Title: Archegoniates and Plant Architecture	
Credits: 4+0	
Unit	Topic
I	Introduction to Archegoniates & Bryophytes Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Sphagnum</i> . (Developmental details not to be included). economic importance of bryophytes.
II	Pteridophytes General characteristics, Early land plants (<i>Rhynia</i>). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.
III	Gymnosperms Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance
IV	Palaeobotany General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Birbal Sahni
V	Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence) Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.
VI	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica -Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - <i>Bignonia</i> , <i>Boerhaavia</i> , <i>Dracaena</i> , <i>Nyctanthes</i>
VII	Reproductive Botany Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.
VIII	Palynology: Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.

Course Code: BOT 105 (B040202P)	
Course Title: Land Plants Architecture	
Credits: 0+2	
Unit	Topic
I	Bryophytes: Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). <i>Sphagnum</i> - morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.
II	Pteridophytes: <i>Lycopodium</i> : Habit, stem T. S. stobilus V. S., <i>Selaginella</i> : Habit, rhizophore T. S, stem T. S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. <i>Equisetum</i> - Habit, rhizome and stem T.S. and V. S. of strobilus. <i>Azolla</i> – Habitat & its structure
III	Gymnosperms 1. <i>Cycas</i> – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule. <i>Pinus</i> - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. <i>Ephedra</i> & <i>Thuja</i> : Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed.
IV	Palaeobotany & Palynology 1. Morphology of <i>Rhynia</i> and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.
V	Angiosperm Morphology 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences
VI	Plant Anatomy: Normal & Anomalous secondary thickening - <i>Bignonia</i> , <i>Dracaena</i> , <i>Boerhaaviadiffusa</i> , <i>Nyctanthes</i> Study of primary and secondary growth in the root and stem of monocots and dicots by section cutting and permanent slides. Study of internal structure of dicot and monocot leaves. Study of structure of stomata.
VII	Reproductive Botany 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule and embryo sac development (through slides). 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants – <i>Hibiscus</i> , <i>Vinca</i> , <i>Balsam</i> , <i>Ixora</i> , <i>Crotalaria</i> , <i>Bougainvillea</i> by microscopic observation.

	7. Calculation of pollen viability percentage using in vitro pollen germination techniques.
VIII	Commercial Uses and Production technology 1. <i>Azolla</i> production 2. Production technology of Resins 3. Production and propagation of Ornamental <i>Pteris</i> , Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and <i>Thuja</i> oil.

Course Code: BOT 201 (B040301T)	
Course Title: Flowering Plants Identification & Aesthetic Characteristics	
Credits: 4+0	
Unit	Topic
I	Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification) ; Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication).
II	Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification.
III	Identification of Angiospermic families -I: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae.
IV	Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)- Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae.
V	Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy).
VI	TOOLS & SOFTWARES IN PLANT IDENTIFICATION- GIS (i) Patterns(ii) Features (iii) Quantities Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for botany.
VII	Computer usage & Android Applications MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps.
VIII	Aesthetic Characteristics of Plants: Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden, Trees, shrubs and shrubberies, climbers and creepers. Some Famous gardens of India.

Course Code: BOT 202 (B040302P)	
Course Title: Plant Identification technology	
Credits: 0+2	
Unit	Topic*
*(Perform Any three experiments from each unit as per facility)	
I	Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number
II	Taxonomic Identification using plant structure a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.
III	Identification during excursions a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.
IV	COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGI BRYOPHYTES, PTERIDOPHYTES (Two each)
V	Botanical Nomenclature & reporting Method: a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI b. Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal
VI	COMPUTERS 1. Learning to use EXCEL Microsoft PowerPoint and Word., WORKING WITH FOLDER AND WINDOWS UTILITY., CREATE AND MANAGE FILES AND FOLDER TREE, 2. Practice browsing different sites using search engines. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails. 3. Create and Participate in virtual conferencing in an interactive Zoom Meeting
VII	Computer Application in taxonomy 1. Use Taxonomic Softwares (Dichotomous Key) 2. Practicals on Phylogenetic analysis 3. Make line drawing of Plants for description 4. Using of plant identification apps on android phones
VIII	1. Create a Bonsai of any plant 2. Develop a miniature garden 3. Draw Layouts of various types of gardens 4. Plant Propagation methods practice

Course Code: BOT 203 (B040401T)	
Course Title: Economic Botany, Ethnomedicine and Phytochemistry	
Credits: 4+0	
Unit	Topic
I	Origin and domestication of cultivated plants Centers of diversity of plants, origin of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes.
II	Botany of oils, Fibers, timber yielding plants & dyes Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.
III	Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise) Commercial greenhouse cultivation of rose, tomato, bell pepper, cucumber, strawberry using Hydroponics.
IV	IPR & Traditional Knowledge IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge
V	Ethnobotany Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP
VI	Medicinal aspects Study of common plants used by tribes (<i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Eclipta alba</i> , <i>Ocimum sanctum</i> and <i>Trichopuszeylanicus</i>) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics. Plants in primary health care: common medicinal plants: <i>Tinospora</i> , <i>Acorus</i> ,
VII	Pharmacognosy Preparation of drugs for commercial market - Organoleptic evaluation of drugs - Microscopic evaluation of drugs - Physical evaluation of drugs - Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds ; organoleptic study of <i>Adhatodavasica</i> , <i>Andrographis paniculata</i> , <i>Azadirachta indica</i> , <i>Datura metel</i> , <i>Emblica officinalis</i> , <i>Vinca rosea</i> and <i>Zingiber officinale</i> .
VIII	Herbal Preparations & Phytochemistry : Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Volatile oils and Alkaloids and pharmacological activities.

Course Code: BOT 204 (B040402P)	
Course Title: Commercial Botany & Phytochemical Analysis	
Credits: 0+2	
Unit	Topic (Perform minimum any three experiments from each unit)
I	<p>Economic Botany & Microtechnique: Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea- tea leaves, tests for tannin Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance mentioned in Unit I-& II</p>
II	<p>Commercial Cultivation Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrient solutions & running models for cultivation of vegetables Development of hydroponics nutrient solutions & running models for cultivation of fodder</p>
III	<p>Cultivating Medicinal and aromatic plants & Essential oil extraction a. Lemon grass/ Neem/ Zinger /Rose/Mint</p>
IV	<p>Documentation from Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand –NakshtraVatika, Navgrahvatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi</p>
V	<p>Ethnobotany Study of common plants used by tribes. <i>Aegle marmelos</i>, <i>Ficus religiosa</i>, <i>Cynodon dactylon</i>. Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital</p>
VI	<p>Instrumentation and herbal Preparations Develop Capsules of herbs/ Develop Herbal oils/ Develop Poulitice/cream Analyse some active ingredients using chromatography /Spectrophotometry</p>
VII	<p>Pharmacognosy Organoleptic studies of plants mentioned in the theory : 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test</p>

	8. Proteins and lipid test
VIII	<p>Phytochemistry: Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.</p>

Course Code: BOT 301 (B040501T)	
Course Title: Plant Physiology, Metabolism & Biochemistry	
Credits: 4+0	
Unit	Topic
I	<p>Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.</p>
II	<p>Carbon Oxidation Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.</p>
III	<p>Nitrogen Metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.</p>
IV	<p>Lipid Metabolism & Photosynthesis Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation. ; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance</p>
V	<p>Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.), Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization</p>
VI	<p>Biomolecules <i>Carbohydrates</i>: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol); Disaccharides(sucrose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin,; storage – starch, inulin). <i>Lipids</i>: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Introduction of lipid micelles, monolayers, bilayers</p>
VII	<p>Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary,</p>

	secondary, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Re-naturation.
VIII	Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes Introductory concept of -Phytonutrients, Nutraceuticals, dietary supplements and antioxidants

Course Code: BOT 302 (B040502T)	
Course Title: Molecular Biology & Bioinformatics	
Credits: 4+0	
Unit	Topic
I	Genetic material Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi-conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes.
II	Transcription & Regulation of gene expression Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon; and in Eukaryotes
III	Principles & Techniques of genetic engineering Blotting techniques: Northern, Southern and DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Introductory concepts of -Hybridoma and monoclonal antibodies, ELISA and Immunodetection.
IV	Applications of Genetic engineering Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase,); Biosafety concerns..
V	Bioinformatics & its applications Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.
VI	Biological databases : Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)
VII	Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file

	format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)
VIII	Phylogenetic analysis Introductory concepts of -Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.

Course Code: BOT 303 (B040503P)	
Course Title: Experiments in Physiology, Biochemistry & Molecular Biology	
Credits: 0+2	
Unit	Topic* <i>*(Perform any three from each unit based on facility)</i>
I	Plant water relation, Mineral Nutrition and translocation in phloem 1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoec / Tradescantia. 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q ₁₀ . 4. Experiment to demonstrate the transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of stomata (dicot & monocot) 7. Determination of rate of transpiration using cobalt chloride method. 8. Experiment to measure the rate of transpiration by using Farmer's Potometer 9. Experiment to measure the rate of transpiration by using Ganong's potometer 10. Effect of Temperature on membrane permeability by colorimetric method. 11. Study of mineral deficiency symptoms using plant material/photographs.
II	Nitrogen Metabolism, Photo Synthesis & Respiration 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO ₃ concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble
III	Plant Development, Movements, Dormancy & Responses 1. Geotropism and phototropism — Klinostat 2. Hydrotropism a. Measurement of growth — Arc and Liver Auxonometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains. 5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on <i>Avena</i> coleoptile elongation (IAA bioassay)
IV	Techniques for biochemical analysis 1. Weighing and Preparation of solutions -percentage, molar & normal solutions,

	<p>dilution from stock solution etc.</p> <ol style="list-style-type: none"> 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items.
V	<p>Genetic material</p> <ol style="list-style-type: none"> 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating E.coli on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method.
VI	<p>Preparation of models/ charts:</p> <ol style="list-style-type: none"> 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous ; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA 4. Study of structures of : tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs
VII	<p>Genetic Engineering</p> <ol style="list-style-type: none"> 1. Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR
VIII	<p>Applications of Genetic engineering</p> <ol style="list-style-type: none"> 1. ELISA Test, 2. Viability tests of cells

	<p>3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.</p> <p>4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.</p>
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Course Code: BOT 304 (B040504R)	
Course Title: Project in Botany for Pre-graduation	
Credits: 0+4	
Suggestive List Of PROJECTS	
	<ol style="list-style-type: none"> 1. Rural Areas: Flora of a city/ village, Biodiversity of Village, Soil & seed testing service provision to farmers, 2. Industrial waste management 3. water pollution status of rural water & promotion of WASH in villages 4. Plant Disease identification in farms, nurseries and orchards. 5. Digital portal for plants: Campus, city or particular area 6. Rare and endangered plants & their conservation & domestication 7. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area 8. Science Communication by Creating science documentaries of innovators , Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.) 9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public. 10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties 11. Study of pollen grains in different flowers 12. Study of stomata in different plants 13. Study of various types of secretory and special tissues in plants.

Course Code: BOT 305 (B040601T)	
Course Title: Cytogenetics, Plant Breeding & Nanotechnology	
Credits: 4+0	
Unit	Topic
I	<p>Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: G₀, G₁, S and G₂ phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical aberrations)- aneuploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.</p>
II	<p>Genetics Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants</p>
III	<p>Plant breeding</p>

	Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Introductory concepts of -Breeding for pest, pathogenic diseases and stress resistance.
IV	Biostatistics: Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi- square test for goodness of fit.
V	Plant tissue culture Principles, components and techniques of <i>in vitro</i> plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.
VI	Nanotechnology Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Advantages and applications of biologically synthesized nanomaterials.
VII	Artificial Intelligence in Plant Sciences Introductory concepts of -Big Data Analytics, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic.
VIII	Introduction to use of Digital technologies – AI& ICT in Botany Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository- google scholar, science direct. resource management, weather forecasting. ICT Applications for different crops and horticulture.

Course Code: BOT 306 (B040602T)	
Course Title: Ecology & Environment	
Credits: 4+0	
Unit	Topic
I	Natural resources & Sustainable utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water , Wetlands; Threats and management strategies, Ramsar sites ,Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy , Contemporary practices in resource management.
II	Ecology & Ecosystem Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic com-Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes.
	Soil Formation, Properties & Conservation

III	Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles of carbon, water, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Soil reclamation.
IV	Biodiversity and its conservation: Definition -genetic, species and ecosystem diversity. Value of biodiversity: hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. <i>Conservation of Biodiversity:</i> Ex-situ and in-situ conservation, Introduction to Red data book, botanical gardens, National park, Sanctuaries and Bioserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of BSI.
V	Phytogeography: Introductory concepts of -Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Vegetational types in Uttar Pradesh.
VI	Environmental audit & Sustainability Introductory concepts of environmental audit; Guidelines of environmental audit; Concept of energy and green audit, Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.
VII	Pollution, Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, digesters, fixed film reactors, bioscrubbers, biotrickling filters; case study: Ganga Action Plan; implementation of CNG; Waste- Types, collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation, Incineration, Pyrolysis and gasification, Sanitary landfilling ; composting, Biogas production.
VIII	Environmental ethics, Carbon Credits & Role of GIS Introduction to Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.

Course Code: BOT 307 (B040603P)	
Course Title: Cytogenetics, Conservation & Environment management	
Credits: 0+2	
Unit	Topic
I	Cell biology 1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.
II	Genetics 1. Monohybrid cross (Dominance and incomplete dominance)

	<ol style="list-style-type: none"> 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) <ol style="list-style-type: none"> a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: 1 c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.
III	<p>Biostatistics:</p> <ol style="list-style-type: none"> 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 3. Computer application in biostatistics - MS Excel and SPSS
IV	<p>Plant tissue culture</p> <ol style="list-style-type: none"> 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration
V	<p>Ecology & Environment</p> <ol style="list-style-type: none"> 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanchae) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites
VI	<p>Soil Formation, Properties & Conservation</p> <ol style="list-style-type: none"> 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map
VII	<p>Biodiversity and Phytogeography:</p> <ol style="list-style-type: none"> 1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps 3. Phytogeographical areas of India
VIII	<p>Pollution & Waste management</p> <ol style="list-style-type: none"> 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter

	<p>2. Estimation of chloride and dissolved oxygen content in water sample</p> <p>3. Comparative anatomical studies of leaves from polluted and less polluted areas.</p> <p>4. Measurement of dissolved O₂ by azide modification of Winkler's method.</p> <p>5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.</p> <p>6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water</p> <p>7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung.</p> <p>Climate Change, Carbon Credits & Role of GIS</p> <p>1. Conducting Waste Audit of your Institution -Demo</p> <p>2. Green auditing of the College/University -Demo</p>
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Course Code: BOT 308 (B040604R)	
Course Title: Project in Botany for Graduation	
Credits: 0+4	
	SUGGESTIVE LIST OF PROJECTS
	<p>Prepare beds for growing nursery for herbs, shrubs and trees.</p> <p>Develop Green house facility in college and grow plants</p> <p>Develop hydroponics facility in college and grow plants.</p> <p>Develop botanical garden in the college with labelling</p> <p>Vertical gardens, roof gardens.</p> <p>Culture & art of making bonsai.</p> <p>Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing)</p> <p>Phytochemical Analysis of Medicinal plants</p> <p>Bio composting and Vermicomposting.</p> <p>Performing Aromatherapy by essential Oils</p>

B.Sc. Zoology

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Zoology
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: ZOO 101 (B050101T)	
Course Title: Basics of Zoology	
Credits: 2+0	
Unit	Topics
I	Basic Concepts of Zoology and Scope of Zoology <ol style="list-style-type: none"> 1. Role of Zoology in Amelioration of Human problems (Vector, Parasite and Pest Control) 2. Application of Zoology in Everyday life: Domestication of Livestock, Poultry, Fisheries, Prawn Culture, Pearl culture Apiculture, Sericulture, Vermiculture
II	Origin of Life on Earth, Products of evolutionary process <ol style="list-style-type: none"> 1. Origin of life on Earth: Arrival of simple form from primordial chemicals, Multicellularity: from simple collections of poorly differentiated cells to complex body plans. 2. Biological diversity, Systematics and taxonomy, Species concept. 3. Nomenclature and utility of scientific names. 4. Classification: morphological and evolutionary (molecular) 5. Phylogenetic Relationship of taxa
III	Structural and Functional Unit of Life <ol style="list-style-type: none"> 1. Cell Theory 2. Macromolecules in Cell 3. Flow of energy and Information in Cell 4. Concept of continuity of life 5. Concept of Inheritance: Phenotype, Genotype, Genes, Alleles and Linkage
IV	Interaction between Environment and Human population <ol style="list-style-type: none"> 1. Flow of energy- Trapping Solar energy, Energy pathway, Food Chain, Food Web 2. Biogeochemical Cycles 3. Natural Resources and their Conservation 4. Anthropogenic Effects- Acid rain, Global Warming, Ozone Depletion, Pollution.

Course Code:: ZOO 102 (B050101T)	
Course Title: Cytology	
Credits: 4+0	
Unit	Topic
I	Structure and Function of Cell Organelles I <ul style="list-style-type: none"> • Plasma membrane: chemical structure—lipids and proteins • Endomembrane system: protein targeting and sorting, endocytosis, exocytosis Introduction to all national Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)
II	Structure and Function of Cell Organelles II <ul style="list-style-type: none"> • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation • Peroxisome and ribosome: structure and function
III	Nucleus and Chromatin Structure <ul style="list-style-type: none"> • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA supercoiling, chromatin organization, structure of chromosomes • Types of DNA and RNA
IV	Cell cycle, Cell Division and Cell Signaling <ul style="list-style-type: none"> • Cell division: mitosis and meiosis • Cell cycle and its regulation, apoptosis, Signal transduction: intracellular signaling and cell surface receptors via G-protein linked receptors, JAK-STAT pathway
V	Mendelism and Sex Determination <ul style="list-style-type: none"> • Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses • Complete and Incomplete Dominance, • Penetrance and expressivity, • Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in <i>Drosophila</i>, Sex Determination in Humans, • Sex-linked characteristics and Dosage compensation
VI	Extensions of Mendelism, Genes and Environment <ul style="list-style-type: none"> • Extensions of Mendelism: Multiple Alleles, Gene Interaction, • Cytoplasmic Inheritance, Genetic Maternal Effects, • Genomic Imprinting, Anticipation, • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics
VII	Human Chromosomes and Patterns of Inheritance <ul style="list-style-type: none"> • Human karyotype, Chromosomal anomalies: Structural and numerical aberrations with examples, • Pedigree analysis
VIII	Immune System and its Components <ul style="list-style-type: none"> • Historical perspective of Immunology, Innate and Adaptive Immunity, Structure and functions of different classes of immunoglobulins, Hypersensitivity, • Immune system: innate and adaptive immunity, clonal selection, complement system, • Humoral immunity and cell mediated immunity, • Immunoglobulin and T-cell receptor genes: organization of Ig gene loci, molecular mechanism of generation of antibody diversity HLA complex: organization, class I and II HLA molecules, expression of HLA genes

Course Code: ZOO 103 (B050102P)	
Course Title: Cell Biology & Cytogenetics Lab	
Credits: 0+2	
Unit	Topic
I	<ol style="list-style-type: none"> 1. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue. 2. To study the different stages of Mitosis in root tip of onion. 3. To study the different stages of Meiosis in grasshopper testis. 4. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. 5. To check the permeability of cells using salt solution of different concentrations.
II	<ol style="list-style-type: none"> 1. To study different mammalian blood cell types using Leishman stain. 2. Determination of ABO Blood group 3. Cell counting and viability test from splenocytes of farm bred animals/cell lines. 4. Enumeration of red blood cells and white blood cells using haemocytometer
III	<ol style="list-style-type: none"> 1. Study of mutant phenotypes of <i>Drosophila</i>. 2. Preparation of polytene chromosomes. 3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human). 4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. 5. To prepare family pedigrees.
IV	Virtual Labs <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com, 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu

Course Code: ZOO 104 (B050201T)	
Course Title: Biochemistry and Physiology	
Credits: 4+0	
Unit	Topic
I	Structure and Function of Biomolecules <ul style="list-style-type: none"> • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, • Levels of organization in proteins; Simple and conjugate proteins
II	Enzyme Action and Regulation <ul style="list-style-type: none"> • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action; • Isozymes; Mechanism of enzyme action; • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver-Burk plot; Enzyme inhibition; • Allosteric enzymes and their kinetics; Regulation of enzyme action
III	Metabolism of Carbohydrates and Lipids <ul style="list-style-type: none"> • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway Glycogenolysis and Glycogenesis Lipids --- Biosynthesis of palmitic acid; Ketogenesis, β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms
IV	Metabolism of Proteins and Nucleotides <ul style="list-style-type: none"> • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotides and vitamins • Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation
V	Digestion and Respiration <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; • Histology of trachea and lung, • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood, Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration
VI	Circulation and Excretion <ul style="list-style-type: none"> • Components of blood and their functions • Haemostasis: Blood clotting system, • Blood groups: Rh factor, ABO and MN • Structure of mammalian heart, Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation Structure of kidney and its functional unit; Mechanism of urine formation
VII	Nervous System and Endocrinology <ul style="list-style-type: none"> • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them

	<ul style="list-style-type: none"> • Classification of hormones; Mechanism of Hormone action
VIII	Muscular System <ul style="list-style-type: none"> • Histology of different types of muscle, • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor unit, summation and tetanus

Course Code: ZOO 105 (B050201T)	
Course Title: Physiological, Biochemical & Hematology Lab	
Credits: 2+0	
Unit	Topic
I	<ol style="list-style-type: none"> 1. Estimation of haemoglobin using Sahli's haemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Recording of blood pressure using a sphygmomanometer 4. Recording of blood glucose level by using glucometer 5. Preparation of molecular models of amino acids, dipeptides etc.
II	<ol style="list-style-type: none"> 1. Study of permanent slides of Mammalian skin, Cartilage, Bone, 2. Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 3. Recording of simple muscle twitch with electrical stimulation (or Virtual) 4. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
III	<ol style="list-style-type: none"> 1. Ninhydrin test for -amino acids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Paper chromatography of amino acids. 6. Action of salivary amylase under optimum conditions
IV	Virtual Labs <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu

Course Code: ZOO 201 (B050301T)	
Course Title: Molecular Biology and Bioinstrumentation& Biotechniques	
Credits: 4+0	
Unit	Topic
I	Process of Transcription <ul style="list-style-type: none"> • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes
II	Process of Translation <ul style="list-style-type: none"> • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyl Trna synthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes
III	Regulation of Gene Expression I <ul style="list-style-type: none"> • Regulation of gene expression in prokaryotes: <i>lac</i> and <i>trp</i> operons in <i>E. coli</i> • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation, RNA editing.
IV	Regulation of Gene Expression II <ul style="list-style-type: none"> • Regulation of gene expression in eukaryotes: • Regulation at translational level, Post- translational modifications: protein folding etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi)
V	Principle and Types of Microscopes <ul style="list-style-type: none"> • Principle of Microscopy and Applications • Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, • Fluorescence microscopy, confocal microscopy, electron microscopy
VI	Centrifugation and Chromatography <ul style="list-style-type: none"> • Principle of Centrifugation: • Types of Centrifuges: high speed and ultracentrifuge • Types of rotors: Vertical, Swing-out, Fixed-angle etc. • Principle and Types of Chromatography: paper, thin layer, column---ion-exchange, gel filtration, HPLC, affinity
VII	Spectrophotometry and Biochemical Techniques <ul style="list-style-type: none"> • Colorimetry and spectrophotometry: Beer-lambert law, absorption spectrum • Biochemical techniques: Measurement of pH, • Preparation of buffers and solutions • Measurement, applications and safety measures of radio-tracer techniques
VIII	Molecular Techniques <ul style="list-style-type: none"> • Nucleic acid fractionation, detection by electrophoresis, DNA sequencing, Polymerase Chain Reaction (PCR), primer designing, DNA fingerprinting, site directed mutagenesis, RFLP • Molecular cloning, genomic libraries, Gene transfer techniques: electroporation, microinjection • Detection of proteins, PAGE, ELISA, Western blotting, • Hybridoma technology

Course Code: ZOO 202 (B050302P)	
Course Title: Bioinstrumentation & Molecular Biology Lab	
Credits: 0+2	
Unit	Topic
I	<ol style="list-style-type: none"> To study the working principle and Simple, Compound and Binocular microscopes. To study the working principle of various lab equipments such as pH Meter, Electronic balance, vortex mixer, use of glass and micropipettes, Laminar flow, Incubator shaker, Waterbath, Centrifuge, Chromatography apparatus, etc.
II	<ol style="list-style-type: none"> To prepare solutions and buffers. To learn the working of Colorimeter and Spectrophotometer. Demonstration of differential centrifugation to fractionate different components in a mixture
III	<ol style="list-style-type: none"> To prepare dilutions of Riboflavin and verify the principle of spectrophotometer. To identify different amino acids in a mixture using paper chromatography. Demonstration of DNA extraction from blood or tissue samples. To estimate amount of DNA using spectrophotometer.
IV	Virtual Labs <ol style="list-style-type: none"> www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu info@premiereducationaltechnologyies.com https://li.wsu.edu

Course Code: ZOO 203 (B050401T)	
Course Title: Gene Technology and Human Welfare	
Credits: 4+0	
Unit	Topic
I	Principles of Gene Manipulation <ul style="list-style-type: none"> • Recombinant DNA Technology • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy • Selection and identification of recombinant cells
II	Applications of Genetic Engineering <ul style="list-style-type: none"> • Single cell proteins, • Biosensors, Biochips, • Crop and live stock, Improvement, Development of transgenic organisms, • Development of DNA drugs and, vaccines.
III	Enzyme Technology <ul style="list-style-type: none"> • Microbial culture, • Methods of enzyme production, • Immobilization of enzymes, • Applications
IV	DNA Diagnostics <ul style="list-style-type: none"> • Genetic analysis of human diseases, detection of known and unknown mutations • DNA fingerprinting • Concept of pharmacogenomics and pharmacogenetics • Personalized medicine—optimizing drug therapy
V	Biostatistics I <ul style="list-style-type: none"> • Calculations of mean, median, mode, variance, standard • Deviation, • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application
VI	Biostatistics II <ul style="list-style-type: none"> • Data summarizing: frequency distribution, graphical,presentation—bar, pie diagram, histogram, • Tests of significance: one and two sample tests, t-test and Chi-square test
VII	Basics of Computers <ul style="list-style-type: none"> • Basics (CPU, I/O units) and operating systems, • Concept of homepages and websites, World Wide Web, URLs, using search engines
VIII	Bioinformatics <ul style="list-style-type: none"> • Databases: nucleic acids, genomes, protein sequences, and structures, Bibliography, • Sequence analysis (homology): pairwise and multiple, sequence alignments- BLAST, CLUSTALW, • Phylogenetic analysis

Course Code: ZOO 204 (B050402P/R)	
Course Title: Genetic Engineering Lab, Genetic Counseling & Telemedicine	
Credits: 0+2	
Unit	Topic
I	<ol style="list-style-type: none"> 1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.
II	<ol style="list-style-type: none"> 1. To perform bacterial culture and calculate generation time of bacteria. 2. To study Restriction enzyme digestion using teaching kits. 3. To study Polymerase Chain Reaction (PCR) using teaching kits. 4. Demonstration of agarose gel electrophoresis for detection of DNA. 5. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 6. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.
III	<ol style="list-style-type: none"> 1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. 5. To learn how to perform Primer designing for PCR using available softwares etc.
IV	<ol style="list-style-type: none"> 1. Gel Documentation System https://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSI4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7UI0JnY9A 6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer- https://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_BOZCHNsSg

Course Code:: ZOO 301 (B050501T)	
Course Title: Diversity of Non-Chordates, Parasitology and Economic Zoology	
Credits: 4+0	
Unit	Topic
I	Protozoa to Coelenterate <ul style="list-style-type: none"> • Protozoa - <i>Euglena</i>, <i>Monocystis</i> and <i>Paramecium</i> • Porifera – <i>Sycon</i> • Coelenterata - <i>Obelia</i> and <i>Aurelia</i>
II	Ctenophora to Nematelminthes <ul style="list-style-type: none"> • Ctenophora - Salient features • Platyhelminthes - <i>Fasciola</i> (Liver fluke) and <i>Taenia</i> (Tape worm) Nematelminthes - <i>Ancylostoma</i> (Hook worm)
III	Annelida to Arthropoda <ul style="list-style-type: none"> • Annelida - <i>Nereis</i> and <i>Hirudinaria</i> (Leech) • Arthropoda - <i>Palaemon</i> (Prawn) and <i>Schistocerca</i>(Locust)
IV	Mollusca to Hemichordata <ul style="list-style-type: none"> • Mollusca - <i>Lamellidens</i> (Fresh water mussel) and <i>Pila</i> • Echinodermata -<i>Pentaceros</i> (excluding development)
V	Parasitology <ul style="list-style-type: none"> • Structure, life cycle, pathogenicity, including diseases, causes symptoms and control of the following parasites of domestic animals and humans: <i>Trypanosoma</i>, <i>Giardia</i> and <i>Wuchereria</i>
VI	Vectors and pests <ul style="list-style-type: none"> • Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control.
VII	Economic Zoology-1 <ul style="list-style-type: none"> • Animal breeding and culture: Aquaculture, Pisciculture, Poultry
VIII	Economic Zoology- 2 <ul style="list-style-type: none"> • Sericulture, Apiculture, Lac-culture, Vermiculture

Course Code:: ZOO 302 (B050502T)	
Course Title: Diversity of Chordates and Comparative Anatomy	
Credits: 4+0	
Unit	Topic
I	Origin of Chordates & Hemichordata <ul style="list-style-type: none"> • Origin of Chordates. • Classification of Phylum Chordata upto the Order. • Hemichordata: General characteristics, classification and detailed study of <i>Balanoglossus</i> (Habit and Habitat, Morphology, Anatomy, Physiology and Development).
II	Cephalochordata and Urochordata <ul style="list-style-type: none"> • Cephalochordata : General characteristics, classification and detailed study of <i>Branchiostoma (Amphioxus)</i> (Habit and Habitat, Morphology, Anatomy, Physiology). • Urochordata : General characteristics, classification and detailed study of <i>Herdmania</i> (Habit and Habitat, Morphology Anatomy, Physiology and Post Embryonic Development).
III	Classification and General Characteristics of Vertebrates <ul style="list-style-type: none"> • General characters and Classification of different classes of Pisces and Amphibia up to the order with examples. • Neoteny and Paedogenesis
IV	Classification and General Characteristics of Vertebrates <ul style="list-style-type: none"> • General characters and Classification of different classes of Reptilia, Aves and Mammalia up to the order with examples. • Poisonous and Non Poisonous Snakes, Biting mechanism of snakes. • Flight Adaptations in Birds • Adaptive Radiations in Eutheria
V	Integumentary System <ul style="list-style-type: none"> • Structure, functions and derivatives of integument Skeletal System <ul style="list-style-type: none"> • Overview of axial and appendicular skeleton, Jaw suspensorium Visceral arches
VI	Digestive System <ul style="list-style-type: none"> • Alimentary canal and associated glands Respiratory System <ul style="list-style-type: none"> • Skin, gills, lungs and air sacs; Accessory respiratory organs
VII	Circulatory System <ul style="list-style-type: none"> • General plan of circulation, evolution of heart and aortic arches Urinogenital System <ul style="list-style-type: none"> • Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri
VIII	Nervous System <ul style="list-style-type: none"> • Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals Sense Organs <ul style="list-style-type: none"> • Classification of receptors Brief account of visual and auditory receptors in man

Course Code:: ZOO 303 (B050503P)	
Course Title: Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	
Credits: 0+2	
Unit	Topic
I	<ol style="list-style-type: none"> 1. Study of animal specimens of various animal phyla. 2. To prepare permanent stained slide of septal nephridia of earthworm. 3. To take out the nerve ring of earthworm To take out hastate plate from <i>Palaemon</i>
II	<ol style="list-style-type: none"> 1. Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms(Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales 4. Comparative study of bones of different vertebrates 5. Comparative study of histological slides of different tissues of vertebrates.
III	<ol style="list-style-type: none"> 1. Permanent Preparation of: <i>Euglena, Paramecium</i> 2. Study of prepared slides/ specimens of <i>Entamoeba Giardia, Leishmania, Trypanosoma, Plasmodium Fasciola, Cotugnia, Taenia, Rallietina, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma</i>; 3. Permanent Preparation of <i>Cimex</i> (bed bug)/ <i>Pediculus</i>(Louse), <i>Haematopinus</i> (cattle louse), fresh water annelids, arthropods; and soil arthropods, Larval stages of helminths and arthropods 4. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly 5. Permanent preparation of ticks/ mites, abdominal gills of aquatid insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly Identification of pests. 6. Life history of silkworm, honeybee and lac insect 7. Different types of important edible fishes of India 8. Slides of plant nematodes 9. Study of an aquatic ecosystem, its biotic components and food chain 10. Project Report/ model chart making 11. Dissections : through multimedia / models 12. Cockroach : Central nervous system 13. Wallago : Afferent and efferent branchial vessels Cranial nerves, Weberian ossicles
IV	Virtual Labs <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. https://www.vlab.co.in 5. https://zoologysan.blogspot.com 6. www.vlab.iitb.ac.in/vlabwww.onlinelabs.in 7. www.powershow.comhttps://vlab.amrita.edu 8. https://sites.dartmouth.edu

Course Code:: ZOO 304 (B050601T)	
Course Title: Evolutionary and Developmental Biology	
Credits: 4+0	
Unit	Topic
I	Theories of Evolution <ul style="list-style-type: none"> • Origin of Life • Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection) • Modern synthetic theory of evolution • Patterns of evolution (Divergence, Convergence Parallel, Coevolution)
II	Population Genetics <ul style="list-style-type: none"> • Microevolution and Macroevolution: allele frequencies, genotype frequencies, • Hardy Weinberg equilibrium and conditions for its maintenance • Forces of evolution: mutation, selection, genetic drift
III	Direct Evidences of Evolution <ul style="list-style-type: none"> • Types of fossils, Incompleteness of fossil record, • Dating of fossils, Phylogeny of horse
IV	Species Concept and Extinction <ul style="list-style-type: none"> • Biological species concept (Advantages and Limitations); • Modes of speciation(Allopatric, Sympatric) • Mass extinction (Causes, Names of five major extinctions)
V	Gamete Fertilization and Early Development <ul style="list-style-type: none"> • Gametogenesis, Fertilization • Cleavage pattern • Gastrulation, fate maps • Developmental mechanics of cell specification • Morphogenesis and cell adhesion
VI	Developmental Genes <ul style="list-style-type: none"> • Genes and development • Molecular basis of development • Differential gene expression
VII	Early Vertebrate Development <ul style="list-style-type: none"> • Early development of vertebrates (fish, birds & mammals) • Metamorphosis, regeneration and stem cells • Environmental regulation of development
VIII	Late Developmental Processes <ul style="list-style-type: none"> • The dynamics of organ development • Development of eye, kidney, limb • Metamorphosis: the hormonal reactivation of development in amphibians, insects • Regeneration: salamander limbs, mammalian liver, Hydras • Aging: the biology of senescence

Course Code:: ZOO 305 (B050602T)	
Course Title: Ecology, Ethology, Environmental Biology and Wildlife	
Credits: 4+0	
Unit	Topic
I	Introduction to Ecology <ul style="list-style-type: none"> History of ecology, Autecology and synecology Levels of organization, Laws of limiting factors Study of physical factors
II	Organization of Ecosystem <ul style="list-style-type: none"> Levels of organization, Laws of limiting factors Study of physical factors, Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle
III	Community Ecology <ul style="list-style-type: none"> Community characteristics: species richness, dominance diversity, abundance, Ecological succession with one example
IV	Environmental Hazards <ul style="list-style-type: none"> Sources of Environmental hazards Climate changes Greenhouse gases and global warming Acid rain, Ozone layer destruction
V	Effects of Climate Change <ul style="list-style-type: none"> Effect of climate change on public health Sources of waste, types and characteristics Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.
VI	Behavioural Ecology and Chronobiology <ul style="list-style-type: none"> Origin and history of Ethology Instinct vs. Learnt Behaviour Associative learning, classical and operant conditioning, Habituation, Imprinting Circadian rhythms; Tidal rhythms and Lunar rhythms Chronomedicine
VII	Introduction to Wild Life <ul style="list-style-type: none"> Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.
VIII	Protected areas <ul style="list-style-type: none"> National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve

Course Code:: ZOO 306 (B050603P)	
Course Title: Lab on Ecology, Environmental Science, Behavioral Ecology & wildlife	
Credits: 0+2	
Unit	Topic
I	<ol style="list-style-type: none"> 1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. 2. Study of population dynamics through numerical problems. 3. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
II	<ol style="list-style-type: none"> 1. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary
III	<ol style="list-style-type: none"> 1. Demonstration of basic equipment needed in wildlife studies use, care and maintenance(Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 2. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest antlers etc. 3. Demonstration of different field techniques for flora and fauna
IV	Virtual Labs <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab