B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

CHECC14001T: Basic Concepts of Chemistry - I

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Explain the concepts of covalent and ionic bonding using Valence Bond Theory, VSEPR theory, hybridization, Similarities and differences between Valence bond and Molecular orbital Theory.

CO2: Analyze molecular orbital diagrams for homonuclear and heteronuclear diatomic molecules and compare Molecular Orbital Theory with Valence Bond Theory.

CO3: Identify and interpret electronic effects, types of bond fission, reactive intermediates, and reagent types in organic chemistry reactions.

CO4: Apply principles of stereochemistry to understand conformations, isomerism, chirality, and nomenclature using various structural representations.

CO5: Describe the physical behavior of real gases using Van der Waals equation, Maxwell's distribution, and Joule-Thomson effect, and explain deviations from ideal behavior.

SYLLABUS

Unit-I: Chemical Bonding-I

Covalent Bond – Valence bond theory, shapes of some inorganic molecules and ions on the basis of VSEPR theory and hybridization (sp, sp^2 and sp^3) with suitable examples, bonding in diborane (3c-2e bonding).

Molecular Orbital theory – Postulates, Molecular orbital diagram of homonuclear (H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, O_2+, O_2^-, O_2^{2-}, O_2^{2+} and heteronuclear (CO and NO) diatomic molecules.

Unit-II: Chemical Bonding-II

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy, solvation energy and their importance in the context of stability and solubility of ionic compounds. Born-Landé equation for calculation of lattice energy (statement only), Born-Haber cycle and its applications (for NaCl).

Radius ratio: Radius ratio effect and coordination number, Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Hydrogen Bonding: Types and impact of inter and intra molecular hydrogen bonding.

Unit-III: Basic Concepts of Organic Chemistry

Electronic displacements: inductive effect, electromeric effect, resonance, necessary conditions for resonance, contribution of resonationg structures, hyperconjugation and its effects. Types of fission: homolytic and heterolytic bond fission. Types of reagents- electrophiles and nucleophiles, Reactive intermediates- carbocations, carbanions, free radicals.

Stereochemistry: Conformations of ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro; D and L; cis- trans nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C-C systems).

Unit-IV: Aliphatic Hydrocarbons

Functional group approach for the following-

Alkanes (Upto 5 Carbons)

Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution (halogenation).

Alkenes (Upto 5 Carbons)

Preparation: Elimination reactions, dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule), cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromination), Addition of HX (Markovnikov's and anti- Markovnikov's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Unit-V: Gaseous State

Deviation from ideal behavior, Vander Waals equation of state and its discussion. Critical Phenomena: PV isotherms of real gases, critical phenomenon continuity of states, relationship between critical constants and Vander Waals constants, the law of corresponding states, reduced equation of state. Molecular velocities: Root mean square, average and most probable velocities (no derivation). Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect).

SUGGESTED READINGS

1. Fundamentals of Chemistry-I (Hindi) by Dr. Vikal Gupta, Dr. Arun Arora, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
2. Fundamentals of Chemistry-II (Hindi) by Dr. Vikal Gupta, Dr. Arun Arora, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
3. Chemistry-I (Hindi) by Dr. K. R. Genwa, 2024, RBD, Jaipur
4. Bhotik Rasayan-I (Hindi) by K. R. Genwa, 2023, RBD, Jaipur.
5. Chemistry (English) by Dr. K.R. Genwa, Dr. Minakshi Jonwal, Dr. R.L. Saini, 2025, RBD, Jaipur
6. Inorganic Chemistry by Satya Prakash by G.D. Tuli, S.K. Basu & R.D. Madan**,** 19th Indian Edition, S. Chand & Company Ltd.
7. Inorganic Chemistry by R. C. Agarwal, 8th Edition, Krishna Prakashan Media, S. Chand.
8. Inorganic Chemistry by P. L. Soni, 20th Revised Edition**,** Sultan Chand & Sons.
9. Inorganic Chemistry by G. C. Shivhare & V. P. Lavania**,** 5th & 6th edition, Geeta Book Depot, Meerut.
10. Advanced Organic Chemistry by Mukherjee & Kapoor (Vol. I & II), New Central Book Agency (NCBA), Kolkata.
11. A Text Book of Organic Chemistry by R. K. Bansal, 5th Edition, New Age International Pvt. Ltd.
12. Organic Chemistry by R. T. Morrison & R. N. Boyd (Prentice Hall), 6th Edition, Prentice Hall of India.
13. The Elements of Physical Chemistry — P. W. Atkins, 6th Edition, Oxford University Press.
14. Principles of Physical Chemistry — B. R. Puri, L. R. Sharma & M. S. Pathania, Shobhan Lal Naginchand & Co.
15. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co., by S. Chand.

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

CHECC14002T: Basic Concepts of Chemistry - II

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Explain various concepts of acids and bases (Arrhenius, Brönsted-Lowry, Lewis, Usanovich), acid-base titrations, indicators, redox titrations, and the behavior of non-aqueous solvents like liquid ammonia and sulfur dioxide.

CO2: Classify and describe the structure, preparation, and chemical reactions of dienes and alkynes, including mechanisms such as 1,2- and 1,4-additions, Diels-Alder reaction, and hydroboration-oxidation.

CO3: Understand aromaticity using Huckel's rule, describe electrophilic substitution reactions, and analyze the structure, reactivity, and substituent effects in arenes and their derivatives.

CO4: Interpret the principles of chemical kinetics, derive rate laws for various reaction orders, and compare theories of reaction rates including collision theory and transition state theory with numerical problem-solving.

CO5: Analyze the behavior of liquid mixtures using Raoult's law and phase diagrams; explain distillation techniques, azeotropes, and concepts like consolute temperature in partially miscible and immiscible systems.

SYLLABUS

Unit – I Concepts of acids and bases

Arrhenius, Brönsted-Lowry, Lewis and Usanovich concept. Acid base titrations, Theory of indicators, Redox titrations Non aqueous solvents: Physical properties of solvent, types of solvents and their general characteristics. Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Unit – II Dienes and Alkynes Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions – 1, 2-and 1, 4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidic nature of 1-alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, oxidation and polymerization.

UNIT III: Aromaticity & Arenes:

Aromaticity: Aromaticity: Huckel's rule, aromatic ions. Aromatic electrophilic substitution – general pattern of the mechanism, role of σ and π- complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Arenes: Nomenclature of benzene derivatives. Aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

UNIT IV Chemical Kinetics

Chemical kinetics and its scope, rate of reaction, factors influencing rate of reaction. Mathematical characteristics of simple chemical reactions- zero, first, second and pseudo first order reactions, half-life and mean life. Determinations of the order of reaction- differential methods, methods of integration, methods of half-life period and isolation method. Radioactive decay. Theories of Reaction Rate: Simple collision theory and its limitations, transition state theory (equilibrium hypothesis) and derivation of the rate constant, Numericals.

UNIT V: Solutions

Types of liquid mixtures, Raoult's law, Ideal and Non-Ideal mixtures, Vapour pressure of liquid mixtures, vapour pressure-Composition and Boiling point-composition curves of completely miscible binary solutions, Azeotropic mixtures and Distillation of Immiscible liquid mixtures. Partially miscible liquids mixtures-phenol-water, triethylamine-water, nicotine-water-systems, consolute temperature-lower and upper, Effect of impurity on consolute temperature-Phenol-water system, immiscible liquids, Numericals

SUGGESTED READINGS

1. Fundamentals of Chemistry-I (Hindi) by Dr. Vikal Gupta, Dr. Arun Arora, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
2. Fundamentals of Chemistry-II (Hindi) by Dr. Vikal Gupta, Dr. Arun Arora, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
3. Chemistry-I (Hindi) by Dr. K. R. Genwa, 2024, RBD, Jaipur
4. Bhotik Rasayan-I (Hindi) by K. R. Genwa, 2023, RBD, Jaipur.
5. Chemistry (English) by Dr. K.R. Genwa, Dr. Minakshi Jonwal, Dr. R.L. Saini, 2025, RBD, Jaipur
6. Inorganic Chemistry by Satya Prakash by G.D. Tuli, S.K. Basu & R.D. Madan**,** 19th Indian Edition, S. Chand & Company Ltd.
7. Inorganic Chemistry by R. C. Agarwal, 8th Edition, Krishna Prakashan Media, S. Chand.
8. Inorganic Chemistry by P. L. Soni, 20th Revised Edition**,** Sultan Chand & Sons.
9. Inorganic Chemistry by G. C. Shivhare & V. P. Lavania**,** 5th & 6th edition, Geeta Book Depot, Meerut.
10. Advanced Organic Chemistry by Mukherjee & Kapoor (Vol. I & II), New Central Book Agency (NCBA), Kolkata.
11. A Text Book of Organic Chemistry by R. K. Bansal, 5th Edition, New Age International Pvt. Ltd.
12. Organic Chemistry by R. T. Morrison & R. N. Boyd (Prentice Hall), 6th Edition, Prentice Hall of India.
13. The Elements of Physical Chemistry — P. W. Atkins, 6th Edition, Oxford University Press.
14. Principles of Physical Chemistry — B. R. Puri, L. R. Sharma & M. S. Pathania, Shobhan Lal Naginchand & Co.
15. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co., by S. Chand.

B.Sc. Semester: III 2026-27

Discipline Centric Core Course (DCC)

CHECC15003T: Inorganic and Organic Chemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand periodic trends and chemical properties of s- and p-block elements, including their compounds and hydrides.

CO2: Explain the electronic configuration, oxidation states, and characteristic properties of transition elements.

CO3: Describe the structure, bonding, nomenclature, and isomerism in coordination compounds and their analytical applications.

CO4: Compare the properties of lanthanides and actinides, including their electronic structure, oxidation states, and magnetic behavior.

CO5: Classify and analyze the structure, preparation, and reactions of alcohols, phenols, and carbonyl compounds.

SYLLABUS

Unit-I: s and p-block elements

s-block Elements

Periodicity in properties of alkali and alkaline earth metals. Complexation tendency, Solvation tendency, Synthesis and applications of important hydrides: NaH, $NaBH_4$, LiH, $LiBH_4$, $LiAlH_4$ and CaH_2.

p-Block Elements: Periodicity in properties of Group 13 (Boron group), Group 14 (Carbon group), Group 15 (Nitrogen group), Group 16 (Oxygen group), Group 17 (Halogens) and Group 18 (Noble gases), Silicates.

Unit-II: Chemistry of Transition Elements

General Characteristics and Periodicity in properties with emphasis on their electronic configuration and multiple oxidation states of 3d, 4d and 5d series elements. Colored ion formation, magnetic, catalytic properties and complex formation tendency in 3d series elements.

Unit-III: Coordination compounds

Werner's coordination theory and experimental verification, Effective Atomic Number concept, chelates, nomenclature of coordination compounds, stereoisomerism in complexes of coordination number 4 and 6. Complexometric titrations and theory of metallochrome indicators.

Unit-IV: f-Block elements

Chemistry of Lanthanides: Electronic structure, oxidation state, ionic radii, colour, spectral and magnetic properties. Lanthanide contraction and its consequences.

Chemistry of actinides: General characteristics, comparative treatment of actinides and lanthanides with respect to ionic radii, oxidation states, magnetic behavior and spectral properties.

Unit-V: Hydroxyl Compounds

Monohydric alcohols: nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols: Methods of formation, chemical reactions of vicinal glycols.

Trihydric alcohols: Methods of formation, chemical reactions of glycerol. Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohol and phenol, resonance stabilization of phenoxide ion. Reactions of phenols: Electrophilic aromatic substitution, acylation and carboxylalion. Mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, LedererManasse reaction and Reimer Tiemann reaction.

SUGGESTED READINGS

1. Advanced Chemistry-I (Hindi) by Dr. Vikal Gupta, Dr. Priyanka Purohit, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
2. Advanced Chemistry-II (Hindi) by Dr. Vikal Gupta, Dr. Priyanka Purohit, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
3. Advanced Chemistry-I (Hindi) by Dr. K. M. Gangotri, Dr. Sangeeta Loonker,Dr. K.R. Genwa, RBD, Jaipur.
4. Advanced Chemistry-II (Hindi) by Dr. K. M. Gangotri, Dr. Sangeeta Loonker,Dr. K.R. Genwa, RBD, Jaipur.
5. Inorganic Chemistry by P.L. Soni & M. Katyal
6. Concise Inorganic Chemistry by J. D. Lee, 5th Edition, by Blackwell Science / Wiley-Blackwell.
7. Organic Chemistry" by Morrison & Boyd, 6th edition published by Prentice-Hall.
8. Basic Inorganic Chemistry by F. A. Cotton & G. Wilkinson, John Wiley & Sons, 2nd edition**.**
9. A Textbook of Organic Chemistry by O.P. Tandon.
10. Physical Chemistry by Puri, Sharma & Pathania, 48th edition**,** Vishal Publishing Company**.**

B.Sc. Semester: IV 2026-27

Discipline Centric Core Course (DCC)

CHECC15004T: Organic and Physical Chemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Explain the structure, nomenclature, acidity, and key reactions of carboxylic acids, hydroxy acids, and dicarboxylic acids.

CO2: Describe the preparation, properties, and interconversion of carboxylic acid derivatives, and understand their reaction mechanisms.

CO3: Apply principles of electrochemistry to analyze conductivity, ion migration, transport numbers, and perform related calculations.

CO4: Understand and apply the laws of thermodynamics and thermochemistry to evaluate energy changes, spontaneity, and equilibrium in chemical systems.

CO5: Interpret phase diagrams and apply the phase rule to single and multi-component systems, including partially miscible liquids and azeotropes.

SYLLABUS

Unit-I: Carbonyl Compounds

Nomenclature and structure of the carbonyl group. Physical properties and Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids.

Unit-I: Carboxylic Acid

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength, preparation of carboxylic acids, reactions of carboxylic acids– Hell-Volhard- Zelinisky reaction, reduction of carboxylic acids, mechanism of decarboxylation, mechanism of esterification and hydrolysis (acidic and basic).

Nitrogen Compounds

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Amine salts as phase-transfer catalysts.

Unit-III: Basics of Electrochemistry

Conductance, specific conductance and equivalent conductance, variation of equivalent and specific conductance with dilution, migration of ions and Kohlrausch's law, Arrhenius theory of electrolytes, Ostwald's dilution law- its uses and limitations, Debye- Huckel Onsager`s equation for strong electrolytes (elementary treatment only).

Transport number: definition and determination by Hittorf's method and moving boundary method. Applications of conductivity measurements; determination of degree of dissociation, Ka of acids, solubility product of a sparingly soluble salts and conductometric titrations.

Unit-IV: Thermodynamics and Thermochemistry

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy, Heat capacity- heat capacities at constant volume and constant pressure and their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature.

Second law of thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Concept of entropy, entropy as a criteria of spontaneity and equilibrium.

Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, Gibbs and Helmholtz functions- A & G as criteria for thermodynamic equilibrium and spontaneity.

Thermochemistry: Standard state, standard enthalpy of formation- Hess`s Law of heat summations and its applications, heat of reactions at constant pressure and constant volume. Kirchhoff's equation.

Unit-V: Phase Equilibrium

Phase Rule, explaination of the terms- phase, component and degree of freedom, phase equilibria of one component system- water and CO_2 systems, Phase equilibria of two component system- Pb-Ag systems, desilverisation of lead, Liquid- liquid mixtures, Ideal solution, Non-ideal system-azeotropes- minimum boiling point azeotrope- ethanol-water system, Maximum boiling point azeotrope- HCl-H_2O system, Henry's law, Nernst distribution law.

SUGGESTED READINGS

1. Advanced Chemistry-I (Hindi) by Dr. Vikal Gupta, Dr. Priyanka Purohit, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
2. Advanced Chemistry-II (Hindi) by Dr. Vikal Gupta, Dr. Priyanka Purohit, Dr. Sawai Singh Rathore, 2024, Associated Book Company, Jodhpur.
3. Advanced Chemistry-I (Hindi) by Dr. K. M. Gangotri, Dr. Sangeeta Loonker,Dr. K.R. Genwa, RBD, Jaipur.
4. Advanced Chemistry-II (Hindi) by Dr. K. M. Gangotri, Dr. Sangeeta Loonker,Dr. K.R. Genwa, RBD, Jaipur.
5. Organic Chemistry" by Morrison & Boyd, 6th edition published by Prentice-Hall.
6. A Textbook of Organic Chemistry by O.P. Tandon.
7. Physical Chemistry by Puri, Sharma & Pathania, 48th edition**,** Vishal Publishing Company**.**

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

CHESE16005T1: Analytical Chemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Distinguish between qualitative and quantitative analysis and explain the steps in the analytical process.

CO2: Identify and minimize types of errors in analysis using statistical tools for data treatment.

CO3: Perform systematic qualitative analysis of cations and anions, including handling of interfering radicals.

CO4: Apply gravimetric and volumetric methods for quantitative chemical analysis with accuracy.

CO5: Understand principles and applications of modern instrumental techniques like UV-Vis, AAS, and thermal analysis.

SYLLABUS

Unit-I: Basics of Analytical Chemistry

Introduction: Qualitative vs quantitative analysis, analytical process, Scope and importance.

Errors in chemical analysis: Types of error and their minimization, Accuracy, Precision

Statistical data treatment: Average deviation from mean, Standard Deviation, relative standard deviation, t-test, Q-test

Unit-II: Qualitative Analysis-I

Theoretical basis of qualitative analysis, theory of ionization, theory of precipitation Common-ion effect, complex ion formation, solubility product & their applications. Oxidizing and reducing agents and buffers used in analysis.

Unit-III: Qualitative Analysis-II

Systematic analysis of Acidic and Basic radicals (including interfering radicals, identification of cations and anions, interfering anions and their removal, Chemical reactions involved.

Unit-IV: Quantitative Analysis

Definition, types of quantitative analysis: Gravimetric and volumetric analysis.

Volumetric Analysis: Terms, Basic principle, standard solutions, types of standard solutions(Primary and Secondary),Cautions in Titrimetry.

Gravimetric analysis: Steps involved in gravimetric analysis Precipitation, Digestion, Filtration, Washing, Drying, Ignition, Weighing. Advantages of gravimetric analysis, Cautions in Gravimetry, Co precipitation and Post precipitation.

Unit-V: Optical and Basic Instrumental Techniques

UV-Visible Spectrophotometry: Beer-Lambert law, instrumentation, applications

Instrumentation of Flame Photometry and Atomic Absorption Spectroscopy (AAS), estimation of Na^+ and K^+ .

pH-metry and conductometry.

SUGGESTED READINGS
1. Inorganic Chemistry – I (Hindi & English) by P. Bhagchandani, Sahitaya Bhawan Publication, Agra. 2. Inorganic Chemistry – II (Hindi & English) by P. Bhagchandani, Sahitaya Bhawan Publication, Agra. 3. Vogel's Textbook of Quantitative Chemical Analysis – G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, 6th Edition, Prentice Hall. 4. Vogel's Textbook of Qualitative Chemical Analysis – G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, 6th Edition, Prentice Hall. 5. Analytical Chemistry – Gary D. Christian, 7th Edition, John Wiley & Sons / Wiley-VCH. 6. Instrumental Methods of Chemical Analysis – B. K. Sharma, Krishna Prakashan Media / Goel Publications, Meerut.

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

CHESE16005T2: Spectroscopic Techniques

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand the fundamental principles of UV and IR spectroscopy, including absorption laws, types of transitions, molecular vibrations, and spectral regions.

CO2: Analyze UV and IR spectra to identify chromophores, auxochromes, and common organic functional groups through spectral shifts and fingerprint analysis.

CO3: Apply theoretical models of rotational spectroscopy to interpret molecular spectra, determine bond lengths, and understand isotope effects.

CO4: Explain and evaluate vibrational and Raman spectra using concepts like harmonic and anharmonic oscillators, force constants, and polarizability.

CO5: Interpret ^{1}H NMR spectra of simple organic compounds, including analysis of chemical shifts, splitting patterns, coupling constants, and signal intensities.

SYLLABUS

Unit-I: Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. Numericals.

Infra-Red Spectroscopy: Infrared radiation and types of molecular vibrations, Hooke's law, functional group and finger print region. IR spectra of common organic functional groups. Numericals.

Unit-II: Rotational Spectroscopy

Rotational Spectrum Diatomic molecules, Energy levels of a rigid rotator (semi classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotator, isotope effect. Numericals.

Unit-III: Vibration Spectroscopy

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. Numericals.

Unit-IV: Raman Spectroscopy

Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. Numericals.

Unit-V: Nuclear magnetic resonance (NMR) spectroscopy

Proton magnetic resonance (1H PMR) spectroscopy , nuclear shielding and de-shielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

SUGGESTED READINGS
1. Organic Chemistry by Dr. K.M. Gangotri, RBD, Jaipur. 2. Organic Chemistry by P. Bhagchandani, Sahitaya Bhawan Publication, Agra. 3. Elementary Organic Spectroscopy by Y. R. Sharma, 4th Edition, published by S. Chand & Co Ltd. 4. Spectroscopy of Organic Compounds by P. S. Kalsi, 6th Edition (revised), published by New Age International Private Limited. 5. Molecular Structure and Spectroscopy by G. Aruldhas, 2nd Edition Prentice Hall India Learning Private Limited. 6. Organic Spectroscopy by Jagdamba Singh, Pragati Prakashan.

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

CHESE16006T1: Biochemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Explain the role of essential and trace bioinorganic elements (Na, K, Mg, Ca, Fe) in biological systems, including the process of biological nitrogen fixation.

CO2: Classify and analyze the structure, properties, and chemical behavior of amino acids, including their acid-base characteristics, stereochemistry, and analytical techniques.

CO3: Describe the structure, classification, and synthesis of peptides and proteins, and apply methods for structure determination and functional group analysis.

CO4: Illustrate the classification, reactions, and structural features of carbohydrates, including monosaccharides and disaccharides, with emphasis on stereochemistry and interconversion mechanisms.

CO5: Identify and explain the structure, biological functions, and nutritional significance of nucleic acids and vitamins, along with the consequences of their deficiencies.

SYLLABUS

Unit-I: Bioinorganic Chemistry

Essential and trace elements in biological processes, Biological role of alkali (Na, K, Li) and alkaline earth (Mg, Ca) metals. Role of metal ion (Fe) in biological process. Biological Nitrogen fixation.

Unit-II: Amino Acids

Classification, structure and stereochemistry of amino acids; Acid-base behavior, isoelectric point, electrophoresis and separation of amino acids by chromatography. Preparation and reactions of α-amino acids. Distinctive properties of α-, β-, and γ-amino acids. analysis of amino acid. Glycine- preparation, physical & chemical properties.

Unit-III: Peptides and Proteins

Introduction, composition, and nature of proteins. Isolation of proteins. Structure and nomenclature of peptides and proteins. Classification of proteins. selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Peptide structure determination, end group analysis, Structures of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation. Analytical tests and uses of proteins. Estimation of free amino and carboxyl groups

Unit-IV: Chemistry of Carbohydrates

Classification and nomenclature. Monosaccharides, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose into mannose. , mechanism of osazone formation, Formation of glycosides, ethers and esters. Cyclic structure of D(+)-glucose. Determination of ring size of monosaccharides, Mechanism of mutarotation.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Unit-V: Nucleic Acids and Vitamins

Nucleic acids: Introduction, constituents of nucleic acids - ribo and deoxy ribonucleosides, nucleotides and structure of DNA and RNA.

Vitamins: Introduction, Biological importance and diseases caused by the deficiency of Vitamin A, B complex, C, D, E and K.

SUGGESTED READINGS

1. Chemistry (Hindi) By R.L. Madan (S. Chand & Co.)
2. K. Hussain Raza – Textbook of Bioinorganic Chemistry
3. Asim K. Das – Bioinorganic Chemistry, 2nd Edition, Books & Allied (P) Ltd (India)
4. Morrison & Boyd – Organic Chemistry, 6th Edition (1992), Prentice-Hall
5. Finar – Organic Chemistry, Volume 2, Pearson Education / Longman.
6. J.L. Jain – Fundamentals of Biochemistry, S. Chand & Company.

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

CHESE16006T2: Industrial Chemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand and apply basic metallurgical principles and processes (e.g., leaching, magnetic separation, Bessemerisation) for the extraction and refining of metals.

CO2: Analyze the extraction processes and properties of specific metals like copper, platinum, zinc, and uranium, and evaluate their industrial applications.

CO3: Explain the composition, manufacturing, and setting mechanisms of cement and glass, and their industrial relevance.

CO4: Differentiate between various industrial polymers, with a focus on silicone materials, their curing methods, forms, processing, and comparative properties.

CO5: Demonstrate knowledge of oils, fats, waxes, and detergents; their properties, classification, analysis techniques, and industrial applications.

SYLLABUS

Unit-I: Concepts of Metallurgy

Basic principles and main steps of Metallurgy, Magnetic separation, Leaching, Bessemerisation, Reverberatory furnace, Blast furnace, Alumino- thermic process, Refining of metal. Types of metallurgical processes.

Unit-II: Metallurgy of Typical Metals

Metallurgy of Copper and platinum, extraction of Zinc from zinc blende, extraction of uranium from pitch blende, Uses of Uranium,

Unit-III: Cement, Lime and Glass

Classification Of Cement, Raw Materials Used, Manufacture of Portland Cement, Chemical Composition, Importance, Properties of Cement, Setting and Hardening of Cement, Specification of Cement, Analysis of Cement

Lime: Industrial preparation, Properties and Uses.

Glass: Types and properties of glasses, coloring agents, Industrial manufacturing of glass

Unit-IV: Industrial Polymers and Silicon Materials

Industrial polymers, types including natural, synthetic, and elastomeric rubbers, silicone polymers overview.

Industrial Silicone Polymers**:** Curing mechanisms, special grades, production methods, forms (e.g., sheets, foams, elastomers), and emerging processing techniques like 3D printing.

Key industrial uses of silicone rubber, comparative study with organic (natural and synthetic) rubbers, thermosetting and thermoplastic polymers.

Unit-V: Fats, Oils, Detergents

Introduction to oil, and fats. Mineral oils, essential oils. Extraction, physical and chemical properties of oil and fats. Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Analysis of oil & fats- Saponification value, iodine value, acid value, R/M value. Classification of oils. Difference between animal & vegetable oils.

Soaps & soapless detergents. Soaps- manufacture of soap, toilet soap & laundry soap, special varieties of soaps, cleansing action of soap, synthetic detergents, alkyl and aryl sulphonates.

SUGGESTED READINGS

1. Industrial Chemistry – R. Gopalan, D. Venkappayya, S. Nagarajan
2. Textbook of Polymer Science – F.W. Billmeyer, 3rd Edition, John Wiley & Sons,
3. Industrial Chemistry – B.K. Sharma, 20th Edition, Goel Publishing House, Meerut
4. A Textbook of Engineering Chemistry – Jain & Jain, 17th Edition, Dhanpat Rai Publishing Company
5. Textbook of Engineering Chemistry by C. Parameswara Murthy, C. V. Agarwal & Andra Naidu, Standard (St) Edition, BS Publications

B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

CHECC14001P: Practical Chemistry - I

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.
Qualitative analysis of inorganic mixture containing 5-radicals (anions and cations), separation and identification of (group 0, I, II, III, IV, V and VI) and anions including interfering radicals and special combination of acidic radicals (CO_3^{2-}, SO_3^{2-}, NO_3^-,NO_2^-, NO_3^-, Br^-, Cl^-, Br^-, I^-, S^{2-}, SO_3^{2-}, SO_4^{2-})

Exercise 2.
Organic Models (Using Ball and Stick Model Box): R and S configuration of optical isomers D and L configuration of optical isomers E/Z configuration of geometrical isomers Conformational isomerism of ethane and n-butane

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry - Ist Semester by K.M. Gangotri
3. Practical Chemistry – Ist Semester by Dr. Vikal Gupta, Dr. Arun Arora

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

CHECC14002P: Practical Chemistry - II

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.
Redox Titrations: (i) To determine the strength of given unknown copper sulphate solution iodometrically using starch as indicator.
(ii) To determine the strength of given unknown potassium dichromate solution iodometrically using starch as indicator.

Exercise 2.
a) Viscosity:
(I) To determine the viscosity of the given organic liquid by Ostwald Viscometer
(II) To determine the % composition of a binary solution by Viscosity measurement.

(b) Surface Tension:
(I) To determine the surface tension of a given organic liquid by Stalagmometer.
(II) To determine the % composition of a binary solution by surface tension measurement.

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry – Ind Semester by K.M. Gangotri
3. Practical Chemistry - IInd Semester by Dr. Vikal Gupta, Dr. Arun Arora

B.Sc. Semester: III 2026-27

Discipline Centric Core Course (DCC)

CHECC15003P: Practical Chemistry - III

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.
Gravimetric analysis (by using Silica / Sintered Crucible)

i. To estimate Barium as barium sulphate.
ii. To estimate copper as cupric oxide/ copper (I) thiocynate.
iii. To estimate Zinc as Zinc oxide.

Exercise 2.
Measurement of pH of different solutions like aerated drinks, fruit juices and shampoos using pH meter.

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry – IIIrd Semester by K.M. Gangotri

B.Sc. Semester: IV 2026-27

Discipline Centric Core Course (DCC)

CHECC15004P: Practical Chemistry - IV

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.

i. To study the hydrolysis of an ester catalyzed by an acid and determine the rate constant and order of reaction.
ii. To study saponification of ester and determine the rate constant and order of reaction.
iii. To study the reaction b/w acetone and iodine with respect to iodine and determine the rate and order of reaction.

Exercise 2.

i. Calibration of Thermometer and determination of M.P. & B.P.: - The following compounds may be used for the calibration purpose naphthalene (M.P. 80–82 °C), acetanilide (M.P. 113.5–114.0 °C), urea (M.P. 132.5–133.0 °C), and benzoic acid (M.P. 122.0 °C).
ii. Qualitative Analysis: - Identification of organic compounds (one liquid or one solid) through the functional group analysis (containing only one functional group).

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry – IVth Semester by K.M. Gangotri

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

CHECC16005P: Practical Chemistry - V

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.
Preparations: Micro cosmic salt
Tetraamminecopper(II) sulphate
Nickel ammonium sulphate
Sodium thiosulphate
Chrome Alum
Ferrous Sulphate
Ferrous Ammonium Sulphate

Exercise 2.
Qualitative Analysis: - Analysis of an organic mixture containing two solid components, using water, $NaHCO_3$ and NaOH for separation.

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry by K.M. Gangotri

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

CHECC16006P: Practical Chemistry - VI

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXERCISES

Exercise 1.
Synthesis of organic compounds:
(i) Acetylation of salicylic acid, aniline and p-nitroacetanilide
(ii) Preparation of iodoform from ethanol and acetone
(iii) Diazotization/Coupling of primary aromatic amines (aniline)
(iv) Preparation of methyl orange

Exercise 2.
Preparation of sols (i) As_2S_3 Sol (ii) Fe $(OH)_3$ Sol

Distribution law:
To determine the partition coefficient of benzoic acid between water and benzene at R.T.

Adsorption:
To study the adsorption of acetic acid by activated charcoal and verify the Freundlich adsorption isotherm.

SUGGESTED READINGS

1. Practical Chemistry by Dr. O.P. Pandey, Dr. S. Giri
2. Practical Chemistry by K.M. Gangotri

B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

BOTCC14001T: Microbiology, Fungi, Plant Pathology and Algae

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Classify and characterize fungi on the basis of vegetative and reproductive features .

CO2: Discuss the Economic importance of Fungi.

CO3: Differentiate some plant diseases with special reference to the causative agents, symptoms, etiology and control measures

CO4: Identify and classify the structure, pigmentation, food reserves and methods of reproduction of Algae.

CO5: Explain the Economic importance of algae and lichen.

SYLLABUS

Unit-I: Introduction of microbes:

Viruses:- General characters, structure and multiplication of viruses. Structure of Tobacco mosaic virus (TMV) and Yellow Vein Mosaic Virus (YVMV). Transmission of plant viruses. Bacteriophages. General account of Viroids and Prions. Economic importance of viruses.

Bacteria:

Discovery, general characteristics, types - archaebacteria, eubacteria, structure, nutrition, reproduction and economic importance of Bacteria .

Cyanobacteria–Important features and Life history of *Nostoc and Oscillatoria*. Nitrogen fixation–by Cyanobacteria (Blue green algae).

Unit-II: General characters and classification of algae (Fritsch's classification) and economic importance.Structure and life history of *Volvox, Chara, Vaucheria, Ectocarpus and Polysiphonia* .

Unit-III:. General characters and classification of Fungi(Alexopoulos&Mim's 1979) Economic importance of fungi, . Important features of Mastigomycotina ,Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina. Structure and life history of *Albugo, Rhizopus, Aspergillus, Agaricus, Puccinia and Alternaria.*

Unit-IV:. Brief account of *Mycoplasma*,*Spiroplasma* and *Phytoplasma*. Symptoms, causal organism and disease cycle of plant diseases with special reference to green ear disease of Bajra, loose smut of wheat, citrus canker, little leaf of brinjal and root knot nematode disease of vegetables

Unit-V:. Morphology, anatomy and reproduction of Lichens (Crustose,Foliose,Fructicose). Mycorrhiza and their significance.Economic Importance of Lichen.

SUGGESTED READINGS

1.Sharma, O.P. 1992. *Text Book of Thallophytes*.

2.McGraw Hill Pub.Co,

3. Sharma. P.D. 1991.

3 *The Fungi*. Rastogi & Co. Meerut Dube. H.C. 1990.

4. *An Introduction of Fungi*. Scientific Pub. House, Jodhpur Clifton A. 1985.

5. *Introduction of the Bacteria*. McGraw Hill & Co. New York.
6. Kumar HD (2017), *Introductory Phycology*, East West Pub.,
7. New Delhi Vashishtha BR et al. (2010) *Algae*,
8. S Chand & Comp. New Delhi
9. Lee R (2008), *Phycology*, Cambridge Univ. Press
10. 4th Edition Sharma, O.P. 1992. *Text Book of Thallophytes*.
11. Singh. Pande .Jain. *A Text Book Of Botany*
12 Trived . Sharma . Dhankhad . Devda

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

BOTCC14002T: Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Interpret the general characters and classification, stelar evolution, heterospory and origin of seed habit.

CO2: Determine the structure, life history and Economic importance of Gymnosperms.

CO3: describe and identify the morphology, anatomy, reproduction, and life cycles of bryophytes, pteridophytes, and gymnosperms.

CO4: classify bryophytes, pteridophytes, and gymnosperms, and explain their economic and ecological significance

CO5: analyze and interpret plant evolutionary history, using fossil plants

SYLLABUS

Unit-I: General characters, alternation of generations,economic importance of Bryophyta, and classification of Bryophyta. Structure and life history of *Riccia, Marchantia, Anthoceros and Sphagnum.*

Unit-II: Geological time scale, Fossils: types and Fossilization. General characters and classification of Pteridophytes. Stelar systems in Pteridophyta. Brief account on fossil *Rhynia*. Important characters of Psilophyta; Structure and life cycle of *Psilotum.*

Unit-III: Origin of seed habit - heterospory. Important characters of lycopsida, sphenopsida&pteropsida. Structure and reproduction in *Lycopodium , Selaginella, Equisetum, Adiantum, Marsilea.*

Unit-IV: General characteristics, classification and evolution of gymnosperms. Important characters of Cycadophyta, Coniferophyta,Gnetphyta. Morphology, anatomy, reproduction and life cycle of *Cycas ,Pinus* .

Unit-V: Morphology, anatomy, reproduction and life cycle of *Ephedra*. Economic importance of Gymnosperms.

SUGGESTED READINGS

1 .Bhatnagar. S. P. and Moitra, A 1996. *Gymnosperms.* New Age international limited. New Delhi.

2. Stewart, W. M. 1983. *Palaeobotany* and the evolution of plants. Cambridge University Press, Cambridge.

3. Rashid A. 1999 Introduction to *Pteridophyta*, Vikas Publishing House, New Delhi

4 .Biswas C and Johri BM 1997, *The Gymnosperm*,

5. Springer Verlag Heywood, V.H. and Moore. D.M (cds)1984 .Harper and Foul, Co., New York, 1980.

6. Gifford, E.M. and Foster, A.S. *Morphology and Evolution of Vascular Plants,* W.H. Freeman and Company, New York, 1988.

7.. Pandey, S.N., Mishra, S.P., Trivedi, P.S. *A Text Book of Botany* vol. 11, Vikas Pub. House Pvt. Ltd., New Delhi 2000.

8 .Sharma, O.P, *Pteridophytes, Today and Tomorrow* Publication, 2000.

9. Sporne, K.R. *The Morphology of Gymnosperms*, B.L Publ. Pvt., Bombay, Calcutta, Delhi, 1991.

10.Vashista, P.C. *Gymnosperm*, S. Chand & Co. Ltd., New Delhi, 2002.
11. Vashista, P.C. *Pteridophyta*, S. Chand & co. Ltd., New Delhi, 2002.
12. Wilson, N.S. and Rothewall, G.W. *Palaeobotany and evolution of Plants*, (2nd ed.), Cambridge University Press, U.K., 1993
13. Singh. Pande .Jain. *A Text Book Of Botany*

B.Sc. Semester: III 2025-26

Discipline Centric Core Course (DCC)

BOTCC15003T: Anatomy, Taxonomy and Embryology of Angiosperm and Economic Botany

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Define the types of classifications- artificial, Natural and phylogenetic.

CO2: Explain the knowledge about ICBN.

CO3: Determine the herbarium techniques.

CO4: Compare the taxonomic evidences from molecular, numerical and chemicals

CO5: concept of tissue system and understand economic importance of plants

SYLLABUS

Unit-I: Plant Anatomy: Structure and function of stem cell, Meristematic and permanent tissues, Concept of tissue system, Classification of meristems, Apical meristem (SAM and RAM), Organization of SAM and RAM, Primary anatomy of root, stem and leaf of monocot and dicot, Normal and abnormal secondary growth.

Unit-II: Plant taxonomy: Components of taxonomy; Taxonomic resources: Herbarium-functions & important herbaria, Botanical gardens, and Flora, Artificial Keys. Principles and rules of Botanical Nomenclature according to ICN. Systems of classification – Bentham and Hooker (upto series),,Engler&Prantl,

Unit-III: Diversity of flowering plants as illustrated by members of the families Ranunculaceae, Caryophyllaceae, Papaveraceae, Cucurbitaceae, Apiaceae, Asteraceae, Acanthaceae,Apocynaceae, Lamiaceae ,Poaceae.

Unit-IV: Plant Embryology: Contributions of Indian embryologists, Microsporangium, Microsporogenesis, Microgametogenesis, Pollen embryosac, Megasporangium – Structure of typical Angiosperm ovule. Types of ovules, Megagametogenesis, type of female gametophyte (embryosac, Structure of mature embryosac; Pollination and fertilization: Structural and functional aspects of pollen, stigma and style. Post pollination events; Significance of double fertilization, Post fertilization changes. Endosperm – Types.

Unit-V: Economic Botany :Plant Resources and their Utilization:

Food Plants: Rice, wheat, maize, potato, sugarcane.

Fibers: Cotton and jute

Vegetable oils: Groundnut. mustard and coconut

General account of sources of firewood, timber and bamboos, Spices, Medicinal plants, Beverages: Tea and coffee Rubber.

SUGGESTED READINGS

1.Heywood, V.H. and Moore. D.M (cds)1984 .Current concepts in *"Plant taxonomy"* Academic press, London. Jeffrey.C. 1982,

2. *An Introduction to Plant Taxonomy*, Cambridge University press Cambridge, London. Jones.S.B Jr. and Luchsinger, A.E. 1986.

3 .*Plant Systematics* (2nd edition) McGraw Hill Book Co., New York. Radford, A.E. 1986.

4 . *Fundamentals of Plant Systematics*. Harper and Row, New York. Singh. G 1999.

5. Plant systematics: Theory and practice, Oxford and IBH Pvt. Ltd. New Delhi.

6. Stale. C.A.1989, *Plant Taxonomy and Biosystematics* (2nd edition) Edward Arnold London.

7. Bhojwani S.S., Bhatnagar S.P. and Dantu P.K. 2015, *The embryology af angiosperms*, Vikas Publishing house, New Delhi
8. Pandey B.P. 2001, *Plant Anatomy*, S Chand Pub. New Delhi

B.Sc. Semester: IV 2025-26

Discipline Centric Core Course (DCC)

BOTCC15004T: Ecology, Plant Physiology, Cell Biology and Genetics

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: The students will be learning tounderstand the concept, types, development and functions of various ecosystems and their communication application of these concepts to solve environmental problems.

CO2: The various environmental factors governing these ecosystems are also clearly understood.

CO3: The students will be able to understand the various physiological life processes occurring in plants. They will also gain knowledge about the various uptake and transport mechanisms. They understand the role of various hormones, signalling compounds, thermodynamics and enzyme kinetics.

CO4: During the course, students will enrich themselves with the phenomenon of metabolism of primary and secondary metabolites and their role in plants

CO5: To understand the pattern of inheritance in various life forms. To develop strong fundaments basics for further molecular studies.

SYLLABUS

Unit-I: Ecology: Definition, Ecological Factors, Positive and negative interactions. Ecosystem– Concept, structure and function of an ecosystem. Abiotic and biotic components and their interrelationship, Biogeochemical and hydrological cycles, Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types of Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids; Primary and Secondary Production and Productivity; Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

Unit-II: Plant-water relations: diffusion and osmosis; absorption, transport of water and transpiration: phýsiology of stomata. Transport of organic substances: Mechanism of phloem transport:source-sink relationship. Mineral nutrition: Essential macro- and micro-elements and their role; mineral uptake: Basics of enzymology:Discovery and nomenclature; characteristics of enzymes: holoenzyme, apoenzyme, coenzyme and cofactors; regulation of enzyme activity, mechanism of action.

Photosynthesis: Significance,photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photophosphorylation; Calvin cycle; C4 pathway, CAM plants; photorespiration.

Unit-III: Respiration: ATP - the biological energy currency; aerobic and anaerobic respiration: Kreb's cycle; electron transport mechanism (chemiosmotic theory): redox potential; oxidative phosphorylation; pentose phosphate pathway.

Nitrogen and lipid metabolism: Biology of nitrogen fixation; the importance of nitrate reductase and its regulation; ammonium assimilation.

Unit-IV: Growth and Development: Definitions: phases of growth and development; kinetics of growth; seed dormancy, seed germination and factors of their regulation; plant movements; the concept of photoperiodism; physiology of flowering; florigen concept; Vernalization, biological clocks; physiology of senescence, fruit ripening. Plant hormones.

Unit-V: 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 structure .Cell cycle: mitosis and meiosis.

Genetics: Chromosome theory of inheritance, Mendelian and non-mendelian inheritance crossing over and linkage; Concept of sex determination and Sex chromosomes; . Variation in Chromosome number (Numerical aberrations and structural)DNA structure, types of DNA, types of genetic material. Mechanism of DNA replication (Prokaryotes), Transcription Types of structures of RNA,Translation, (Prokaryotes)

SUGGESTED READINGS

1. Hopkins, W.G. 1995, *Introduction to Plant Physiology*. John Wiley & Sons. Inc., New York. USA.
2. Lea, P.J. and Leegood. R.C. 1999 *Plant Biochemistry and Molecular Biology*, John Wiley & Sons. Chicheste. England.
3. Salisbury, F.B. and Ross, C.W. 1992. *Plant Physiology* (4th Edition).Wadsworth Publishing Co.. California, USA.
4. Taiz. L. and Zeiger, E. 1998. *Plant Physiology* (2" Edition). Sinauer Associates, Inc., Publishers. Massachusetts, USA
5. Gupta P. K. 1999 *A textbook of cell and Molecular Biology* , Rastogi Publications. Meerut India.
6. Kleinsmith. L. J. and Kish. V.M. 1995. *Principles of Cell and Molecular Biology* (2nd edition) Harper Collins College Publishers. New York USA.
7. Wolfe. S.L. 1993. *Molecular and Cellular Biology*. Wadsworth Publishing Co. California USA
8. Trivedi . Sharma . Meena . verma . *Plant biotechnology and Molecular Biology*
9. Shukla ,R.S. and Chandel , P.C. *A Text Book Of Plant Ecology*
10 . Trivedi .Sharma and Dhankhad ,*Ecology and Environmental biology*

B.Sc. Semester: V 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16005T1: PLANT BIOTECHNOLOGY

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: The students will learn about the Concepts, tools and techniques related to in vitro propagation of plants.

CO2: Different methods used for genetic transformation of plants, use of Agrobacterium as a vector for plant transformation, components of a binary vector system.

CO3: Various case studies related to basic and applied research in plant sciences using transgenic technology.

CO4: Students will be able to understand the basic concept of In vitro cellular and developmental biology and their applied aspects.

CO5: Students will be able to use various tools and techniques of plant biotechnology for human welfare. They will be able to understand the basic concept of genetic engineering and their use for the welfare of society.

SYLLABUS

Unit-I: Biotechnology: Basic concept, definitions and history. Major fields of biotechnology and applications. In vitro biology: the basis of biotechnology.

Unit-II: cell theory and concept of totipotency and pluripotency. History of plant tissue culture: Beginning of plant cell, tissue and organ culture. Applications of plant tissue culture. Contributions of botanist in the field of plant cell, tissue and organ culture.

Unit-III: Concept of aseptic culture. Basic tools and techniques in plant biotechnology: sterilization of various instruments, glassware, and culture medium. types of culture media. Surface sterilization of explants and aseptic inoculation. Maintenance of cultures in growth chamber. Hardening of in vitro regenerated plantlets and field transfer. Haploid culture and its applications. Germplasms conservation

Unit-IV Micropropagation of plants: morphogenesis, organogenesis and axillary shoot activation. Somatic embryogenesis and synthetic seeds. Somaclonal variations. Physical and chemical means of protoplast isolations. methods of protoplast culture. Somatic hybrids and cybrids.

Unit-V: In vitro production of secondary metabolites: types of bioreactors and its applications. Genetic engineering of plants: various methods of gene transfer in plants and its applications. Bt cotton and golden rice. Biology and genetic engineering of biological nitrogen fixation, applications and prospects. Nanobiotechnology and its applications.

SUGGESTED READINGS

1. K. and Thorpe. T. A. 1994. *Plant Cell and Tissue Culture*. Kluwer Academic Publishers. The Netherlands

2. Alberts, B. Bray, D., Lewis J. Raft, M., Roberts.K. and Watson I. D. 1999. *Molecular Biology of Cell.* Garland Pub.

3. Bhojwani, S.S. *Plant Tissue Culture: Application and Limitation,*

4.Elsevier Science Publishers, New York, USA, 1990. Raghavan, O. *Embryogenesis in Angiosperms: A Developmental and Experimental Study,* CambridgeUniversity, Press, New York, USA, 1986.

5. Vasil, I.K. and Thorpe, T.A. *Plant Cell and Tissue Culture*, Kluwer Academic Publishers, The Netherlands, 1994.

6 Ball, R.D. (ed.) *Plant Cell Culture Protocols*, Humana Press, Inc. New Jersey, USA, 1999.
7.Dixon, R.A. (ed.) *Plant Cell culture:* a Practical Approach, IRL, Press Oxford, 1987.
8.Roberts, J. and Tucker, G.A. (eds.) *Plant Hormone Protocols* Humana Press, New Jersey, USA 2000.
9. Gupta ,P.K . *Molecular biology and Biotechnology*
10. Trivedi. Sharma and Dhankhad

B.Sc. Semester V 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16005T2: Plant Breeding

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understanding the basic concepts of plant breeding.

CO2: Analyze the diferent selection and breeding methods applied in crop improvement.

CO3: Ability to apply the concepts, principles and tools of biotechnology and plant tissue culture techniques on research problems pertinent to crop improvement.

CO4: Link the rapid advances in cell and molecular biology to better understanding of contemporary Plant Breeding techniques.

CO5: Students would be able to develop Comprehensive, detailed understanding regarding the experimental steps and methods involved in generating new varieties using classical and contemporary breeding practices.

SYLLABUS

Unit-I: Introduction and objectives. Breeding systems; modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit-II: Methods of crop improvement Introduction:Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization.

Unit-III: Selection methods: For self-pollinated, cross-pollinated and vegetatively propagated plants; Hybridization - Procedure, advantages and limitations

Unit-IV: Quantitative inheritance Concept, mechanism, examples of inheritance of Kernel colour in wheat, complexion in human beings(pigmentation). Monogenic vs polygenic Inheritance.

Unit-V: History, genetic basis of inbreeding depression and heterosis; Applications. Crop improvement and breeding ,Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

SUGGESTED READINGS

1. Singh, B.D. (2005). Plant Breeding: *Principles and Methods*. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). *Elementary Principles of Plant Breeding*
3. Oxford - IBH. DSE-2b *Analytical Techniques in Plant Sciences* (4+2) 2ndedition.
4. Acquaah, G. (2007). *Principles of Plant Genetics & Breeding*. Blackwell Publishing.

B.Sc. Semester: VI 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16006T1: Industrial and Environmental Microbiology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcome: On successful completion of the course, the students will be able to-

CO1: Understand the main concepts and principles of modern applied microbiology

CO2: Knowledge of Various microbes and the Microbial physiology which may be harnessed for human health and hygiene industrial and environmental purposes.

CO3: Discuss the applications and use of microbial power in industry and for various environmental issues.

CO4: Gain hands-on experience of basic culture techniques, water analysis tests.

CO5: understanding and comprehending the theory and practical aspects and report writing.

SYLLABUS

Unit-I: Scope of microbes in industry and environmnent

Bioreactors/Fermenters and fermentation condition, processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratories, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit-II: Microbial production of industrial products:

Microorganisms involved, media, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands-on on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or
glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

Unit-III: Microbial enzymes of industrial interest and enzyme immobilization : Microorganisms for industrial applications and hands-on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large-scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit-IV: Microbes and quality of environment :

Distribution of microbes in air; Isolation of microorganisms from soil, air and water. Microbial flora of water Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples

Unit-V: Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples. Microbes in agriculture and remediation of contaminated soils Biological fixation; Mycorrhizae; Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

SUGGESTED READINGS
1. Pelczar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). *Microbiology: An application based approach.* Tata McGraw Hill Education Pvt. Ltd., Delhi. 2. Tortora, G.J, Funke, B.R., Case. C.L. (2007). *Microbiology*. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition 3. Singh . Pande . Jain 4.Singh,D.P,Dwivedi,S.K.*" Environmental Microbiology and Biotechnology*"

B.Sc. Semester : VI 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16006T2: Advanced Tools and Analytical Techniques in Plant Biology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: The students have first-hand knowledge of the basic and contemporary techniques in biological sciences and the equipment and instruments thereof, along with an understanding of the application and limitations.

CO2: competent in the basic principles of major techniques used in study of plants.

CO3: understand principles and uses of light, confocal, transmission and electron microscopy, centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques.

CO4: Understand the basic principles of different chromatography techniques.

CO5: Understand the principles of PCR, primer design, and the enzymes involved.

SYLLABUS

Unit-I: Imaging and related techniques: Electron microscopy: Transmission and Scanning electron microscopy, cryofixation, negative staining, shadow casting, freeze-fracture, freeze-etching; Chromosome banding, FISH, GISH, chromosome painting. Centrifugation: types of rotors, differential and density gradient centrifugation, sucrose density gradient, ultracentrifugation, caesium chloride gradient; marker enzymes for analysis of cellular fractions.

Unit-II: Radioisotopes: Types of radioisotopes; types of emissions (alpha, beta, gamma radiations); half life; use of radioisotopes in biological research; auto-radiography; pulse-chase experiment; Bio safety measures and disposal of radioactive material

Unit-III: Spectrophotometry: Principles and applications of UV, Visible and IR spectrophotometry, Mass spectrometry; X-ray diffraction; X-ray crystallography; Electrophoresis: AGE, PAGE, SDSPAGE

Unit-IV: Chromatography: Principles and applications of Paper chromatography, Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, Molecular sieve chromatography, Affinity chromatography

Unit-V: Techniques for detection and analysis of nucleic acids and proteins: PCR – design of PCR primers, enzymes used for PCR, cloning of PCR products; DNA polymorphism and its applications (RFLP, AFLP, SSR, SNPs); RNA isolation and analysis, cDNA synthesis and qRT-PCR; Extraction of proteins, PAGE (Native and denaturing); Blotting and hybridization techniques: Southern (Radioactive and Non-radioactive), Northern and Western; DNA sequencing – Sanger's dideoxy sequencing; ELISA.

SUGGESTED READINGS
1. Plummer, D.T. (1996). *An Introduction to Practical Biochemistry*. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition. 2. Ruzin, S.E. (1999). *Plant Microtechnique and Microscopy*, Oxford University Press, New York. U.S.A. 3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). *Short Protocols in Molecular Biology*. John Wiley & Sons. 3rd edition . 4. Zar, J.H. (2012). *Biostatistical Analysis*. Pearson Publication. U.S.A. 4th edition. 5 . Raghvendra Pratap Narayan, Durgesh K. Tripathi and R.K. Gaur. Technological Advancements In Plant Science.

B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

BOTCC14001P: Practical : Microbiology, Fungi, Plant Pathology and Algae

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXERCISEs

1. Study of genera included under Microbiology, Fungi and Pathology.
2. Observation of disease symptoms in hosts infected by fungi, viruses, bacteria and phytoplasma. Section cutting of diseased material and identification of the pathogens as per the theory syllabus.
3. Study of morphology, reproductive structures and anatomy of the examples cited in the theory under Algae, Lichens .
4. Gram Staining.

SUGGESTED READINGS

Bendre and kumar

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

BOTCC14002P: Practical for Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXCERCISEs

1. **Bryophyta**: .Study of morphology, reproductive structures and anatomy of the examples cited in the theory under Bryophytes.
2. **Palaeobotany.:** *Rhynia*: External Morphology (photograph)
3. **Pteridophytes:** *Lycopodium Selaginella*: External morphology. T.S. of stem and L.S. of cone (slide/photograph).: External morphology. T.S. of stem and L.S. cone/whole mounting

Equisetum: External morphology, T.S. of stem (Internode) and L.S. of cone (slide/photograph
Adiantum: External morphology. L.S. of Sporophyll through indusium *Marsilea.*

4. **Gymnosperms:** External Morphology, T.S. of Rhizome and H.L.S. of sporocarp *Cycas*: Study of external morphology of plant parts, T.S. of leaflet. Corolloid root and rachis (slide). Study of Male cone and Megasporophyll *Pinus*: Study of external morphology of plant parts: 1.S. of Needle. whole mount of pollen grains, Study of Male cone and Female cone. *Ephedra*: Study of external morphology of plant parts: T.S. of stem, Preparation of male lower (whole mount) and female flower/cone (L..S).

SUGGESTED READINGS

Bendre and kumar

B.Sc. Semester: III 2025-26

Discipline Centric Core Course (DCC)

BOTCC15003P: Practical for Anatomy, Taxonomy and Embryology of Angiosperm and Economic Botany

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXCERCISEs

Angiosperms:Txonomy

The following species are suitable for study:

1. Ranunculaceae: *Delphinium*
2. Papaveraceae;*papaver,argemone.*

3 Caryopyyllaceae:*Dianthus*

4 Cucurbitaceae: Any cucurbit

5 Apiaceae*:Coriandrum*

6 Asteraceae: *Halianthus*

7 Acanthaceae. *:Adathoda*

8. Lamiaceae: *Ocimum*

9 Apocynaceae: *Thivitia,Nerium,Catharanthus*

10. Poaceae: *Triticum*

Anatomy: T.S. of monocot and dicot root, stem and leaf, Anomalous Structure in *Nyctanthes, Boerhaavia, Bignonia, Achyranthes, Salvadora, Leptadenia, Dracaena*

Spots: Special types of inflorescences: Verticillaster, Cyathium and Hypanthodium

1.Types of fruits

2.Structure of ovule

3.Types and Structure of endosperms in dicots and monocots

4.Study of Placentation

Economic Botany:Utilization of Plants under the Economic Botany.

SUGGESTED READINGS

Bendre and Kumar

B.Sc. Semester: IV 2025-26

Discipline Centric Core Course (DCC)

BOTCC15004P: Practical for Ecology, Plant Physiology, Cell Biology And Genetics

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXERCISES

ECOLOGY

1. Determine frequency, density and abundance from quadrat sample sheet
2. Determine IVI from quadrat sample data
3. To estimate qualitatively nitrate and phosphate in soil samples

Spots

1. *Opuntia, Euphorbia* – Xerophytes-Succulents
2. *Capparis, Calligonum, Leptadenia, Parkinsonia*- Xerophytes - True
3. *Atriplex, Chloris*- Halophytes – salt secreting
4. *Suaeda*–Halophytes – salt accumulating
5. *Eichhornia, Nymphaea, Hydrilla*- Hydrophytes
6. *Cuscuta, Orobanche* – Parasites

PLANT PHYSIOLOGY

1. Determine osmotic potential by diffusion pressure deficit
2. Demonstrate opening and closing of stomata using distil water, sucrose and KCl (0.1M, 0.5M, 1.0M)
3. Demonstrate plasmolysis using 0, 0.1, 0.2, 0.3, 0.4, 0.5 & 0.6M sucrose solution and identify incipient plasmolytic concentration
4. Separate chlorophyll pigments by paper chromatography

Spots

1. Contribution of Scientist to Physiology and Biochemistry: M. Calvin, H.P. Hatch and C.R. Slack, E. Fischer, P. Mitchel, J.C. Bose
2. Ripening of fruits
3. IBA effect on rooting
4. Photomorphogenesis
5. Senescence
6. RQ
7. Membrane permeability
8. Root nodules (Types, internal structure, organogenesis, symbiotic home)

Cytogenetics

1. Numerical problems based on genetics.
2. Prepare temporary mounting of root tip to study the mitosis.
3. To study the various cellular organelles through digital resources.

SUGGESTED READINGS

Prof.(Dr.)P.C.Trivedi
Dr. Niranjan Sharma
Dr. R.S.Dhankad
Dr.Dinesh Hans

B.Sc. Semester: V 2025-26

Discipline Specific Elective Course(DSE)

BOTSE16005P1: Practical :Plant Biotechnology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXCERCISES

Practical for Plant Biotechnology

1. Prepare MS Medium using suitable PGRs for activation of axillary shoot bud. Surface sterilized suitable explant and inoculate under aseptic condition.
2. Prepare MS Medium using suitable PGRs for induction of callus from haploid cells (anther). Surface sterilized suitable explant and inoculate under aseptic condition.
3. Prepare MS Medium using suitable PGRs for induction of callus from somatic cells. Surface sterilized suitable explant (young leaf, apical shoots, nodal shoot segment) and inoculate under aseptic condition.
4. Contribution of botanist in plant biotechnology: Gottlieb Haberlandt, PR White, Ball, Miller and Skoog, Guha and Maheshwari
5. To study Tools for aseptic culture: Laminar air flow bench, Autoclave, growth chamber, Hardening unit, Micropropagation, Somatic embryogenesis
6. Synthetic seeds
7. Organogenesis
8. Bioreactor
9. In vitro production: Shikkonin, Diosgenine
10. To study the transgenic plant Bt cotton, Golden rice.

SUGGESTED READINGS

1. Prof. Santosh Nagar and Dr. Madhavi Adhav
2. Dr. Lokesh gaur, Dr. Radheshyam Sharma and Dr. R. Shiv Rama Krishnan
3. S S Purohit

B.Sc. Semester: V 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16005P2: Practical for Plant Breeding

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXERCISES

1. Introduction to field /controlled pollinations in field and laboratory (temporal details of anthesis, anther dehiscence, stigma receptivity and pollen viability, emasculation, bagging)
2. Analysis of the breeding system of chosen crop species by calculating Pollen: Ovule Ratio
3. Calculation of Index of self-incompatibility (ISI) and Confirmation of Self-Incompatibility.
4. Study of Quantitative and qualitative characters in selected crops.
5. Study of Pollinators.
6. Assessment of genetic diversity by using Molecular Markers.

SUGGESTED READINGS

1.S.K. Gupta
2.Akshay Tendulkar , Anil kumar Choudhry

B.Sc. Semester: VI 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16006P1: Practical for Industrial and Environmental Microbiology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXCERCISES

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Isolation of root nodulating bacteria
4. Isolation and culture of microorganisms from soil, air and water
5. Determination of BOD, COD,TDS and TOC of water sample
6. Types and functioning of different bioreactors (Using photographs/ Diagrams and flowcharts)

SUGGESTED READINGS

1.Dr. Sanjeeb Kumar Nath

B.Sc. Semester: VI 2025-26

Discipline Specific Elective Course (DSE)

BOTSE16006P2: Practical for Advanced Tools and Analytical Techniques in Plant Biology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

LABORATORY EXCERCISES

1. Study of microscopic techniques using digital resources (freeze-fracture, freeze-etching, negative staining, FISH, chromosome banding).
2. Isolation of chloroplasts by differential centrifugation.
3. Separation of nitrogenous bases by paper chromatography.
4. Separation of sugars by thin layer chromatography
5. Separation of chloroplast pigments by column chromatography (demonstration)
6. Amplification of DNA by PCR and visualization of PCR products.
7. Detection of DNA polymorphism (SSR based DNA fingerprinting).
8. Gel based and capillary based DNA sequence data analysis.
9. Estimation of protein concentration by Bradford method.
10. PAGE to study overexpression of proteins/ Separation of proteins by PAGE.
11. Blotting techniques: Southern, Northern and Western using digital resources

SUGGESTED READINGS

1 .DR. Suniti Kumar Kuriyal, Dr. Bharti Chouhan, Dr. Deepti Shukla,Dr.Keshav Shukla.
2. Dr. Sanjeeb Kumar Nath
3.Suresh Kumar ,Alok Kumar, Soumya Mukherjee, vandana.

B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

ZOOCC14001T: Lower Invertebrate Zoology and Animal Diversity and Evolution

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand the principles of taxonomy and classification.
CO2: Gain knowledge of the structure and function of invertebrates.
CO3: Describe evolutionary adaptations in non-chordates.
CO4: Correlate body plans with ecological roles.
CO5: Explain the significance of symmetry, coelom, segmentation in evolution.

SYLLABUS

Unit-I: Principles of Taxonomy and Classification

Introduction to Taxonomy and Systematics, Five Kingdom Concept, Levels of organization: Protozoa to Metazoa, Symmetry, Coelom, Segmentation, Embryogeny.

Unit-II: Protozoa and Porifera

General characters and classification up to classes of Protozoa and Porifera.
Paramecium: Locomotion, nutrition, conjugation.
Sycon: Canal system, reproduction, development.

Unit-III: Coelenterata, Ctenophora, Platyhelminthes and Aschelminthes

Classification and characters of Coelenterata, Ctenophora, Platyhelminthes and Aschelminthes
Obelia: Polyp and medusa forms, life cycle.
Taenia: Structure of body wall, excretory and nervous systems, reproduction and developmental stages in life cycle.
Fasciola: Digestive, excretory and reproductive systems, developmental stages andlife cycle.

Unit-IV: Evolutionary Concepts

Origin of Life, Miller's experiment, Lamarckism and Darwinism, Natural Selection, genetic basis of evolution, speciation, Evidences of organic evolution.
Variations, Isolation and Adaptations, Geological time scale and animal distribution in different era

Unit-V: Introduction to Cell Biology

Interphase nucleus and cell-cycle including regulation.
Mitosis: Phases and process of mitosis, structure and function of spindle apparatus, Theories of cytokinese.
Meiosis: Phases and process of meiosis, synaptonemal complex, formation and fate of chiasmata recombination and significance of crossing over.

SUGGESTED READINGS

1. **R. L. Kotpal** – *Modern Textbook of Zoology: Invertebrates*
2. **P. S. Verma & V.K. Agarwal**–*Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*
3. **Veer Bala Rastogi** – *Organic Evolution*
4. **Ekambaranatha Ayyar & T.N. Ananthakrishnan** – *Manual of Zoology, Volume I*
5. **E.L. Jordan & P.S. Verma** – *Invertebrate Zoology*
6. **Veer Bala Rastogi** – *Cell Biology*

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

ZOOCC14002T: Higher Invertebrate Zoology and Molecular Principles of Genetics

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand cell structure and organelles.
CO2: Explain molecular processes like DNA replication and protein synthesis.
CO3: Describe mitosis, meiosis, and their significance.
CO4: Apply Mendelian principles to inheritance problems.
CO5: Interpret chromosomal aberrations and blood group inheritance.

SYLLABUS

Unit-I: Arthropoda and Annelida

General characters and classification up to classes of Arthropoda and Annelida
Palaemon: Systems and appendages
Nereis: Parapodial locomotion, digestive, blood vascular, excretory, nervous and reproductive systems, development and metamorphosis.

Unit-II: Mollusca and Echinodermata

General characters and classification up to classes of Aschelminthes, Mollusca and Echinodermata.
Pila: Digestive, respiratory, blood vascular, nervous and reproductive systems,sense organs.
Asterias: Water – vascular system, digestive, circulating and nervous systems,sense organs, reproduction, life history and regeneration

Unit-III: Cell Structure and Organelles

Characteristics of prokaryotic and eukaryotic cells, Characteristics of cell membrane molecules, fluid-mosaic models of Singer and Nicolson, passive and active transport, Structures and functions of endoplasmic reticulum, ribosome, Golgi complex, lysosome, mitochondria, centriole, microtubules and nucleus

Unit-IV: Molecular Biology Basics

Structure of Chromatin and Chromosomes, semiconservative mechanism of replication, elementary idea about topoisomerases, replication forks, leading and lagging strands, RNA primers and Okazaki fragments, RNA structure and types, mechanism of transcription, Genetic Code and protein synthesis.

Unit-V: Mendelian and Non-Mendelian Genetics

Mendelism: Brief history of genetics and Mendel's work: Mendelian laws, their significance and current status, linked gene inheritance. Chromosomal aberration: Structural - translocation, inversion, deletion and duplication; Numerical - haploidy, diploidy, polyploidy, aneuploidy, euploidy, polysomy and genetic implications. Genetic interaction: supplementary genes, complementary genes, duplicate genes, multiple gene interaction, ABO blood groups and their genotypes, Multiple alleles.

SUGGESTED READINGS

1. **R. L. Kotpal** – *Modern Textbook of Zoology: Invertebrates*
2. **P. S. Verma & V.K. Agarwal** – *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*
3. **Veer Bala Rastogi – Organic Evolution**
4. **Ekambaranatha Ayyar & T.N. Ananthakrishnan – Manual of Zoology, Volume I**
5. **E.L. Jordan & P.S. Verma** – *Invertebrate Zoology*
6. **Veer Bala Rastogi** – *Cell Biology*

B.Sc. Semester: III 2026-27

Discipline Centric Core Course (DCC)

ZOOCC15003T: Vertebrate Zoology and Functional Anatomy

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Classify chordates and describe the morphology of protochordates.

CO2: Explain larval forms and evolutionary affinities among Hemichordata, Urochordata, and Cephalochordata.

CO3: Compare integumentary structures, jaw suspension, limbs, and girdles in vertebrates.

CO4: Describe the circulatory, respiratory, and digestive systems in representative vertebrates.

CO5: Analyze nervous and urogenital systems and interpret adaptations in snakes, birds, and aquatic mammals.

SYLLABUS

Unit-I: Protochordates

Classification and characters of phylum Chordata (excluding extinct forms) up to orders, Comparisons of habit, habitat, external features and anatomy of Balanoglossus, Herdmania and Branchiostoma (excluding development)

Unit-II: Protochordate Affinities

Ascidian tadpole larva and its Metamorphosis, Affinities of Hemichordate, Urochordate and Cephalochordates, Habit, Habitat and salient features of Petromyzon, Ammocoete larva

Unit-III: Comparative Vertebrate Anatomy I

Integument including structure and development of placoid scales, feathers and hairs, Jaw suspensorium, limbs and girdles of Rana, Uromastix, Columba and Oryctolagus.

Unit-IV: Comparative Vertebrate Anatomy II

Heart and aortic arches, respiratory system and alimentary canal of Scoliodon, Rana, Uromastix, Columba and Oryctolagus.

Unit-V: Nervous and Urogenital Systems

Brain, urinogenital system (Scoliodon, Rana, Uromastix, Columba and Oryctolagus), Identification of poisonous and non poisonous snakes. Biting mechanism in snakes, flight adaptations in birds. Adaptations in aquatic mammals.

SUGGESTED READINGS

1. **R.L. Jordan & P.S. Verma** – *Chordate Zoology*
2. **R.L. Kotpal** – *Modern Textbook of Zoology: Vertebrates*
3. **Veer Bala Rastogi** – *Chordate Zoology*
4. **Cleveland P. Hickman, Larry S. Roberts & Allan Larson** – *Integrated Principles of Zoology*
5. **Kent G.C. & Carr R.K.** – *Comparative Anatomy of the Vertebrates*

B.Sc. Semester: IV 2026-27

Discipline Centric Core Course (DCC)

ZOOCC15004T: Developmental Biology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand the processes of gametogenesis, fertilization, and early embryonic development in chordates.

CO2: Analyze cleavage patterns, gastrulation, and morphogenetic movements during embryogenesis.

CO3: Describe the development of representative vertebrates including chick and mammal embryos.

CO4: Explain the concepts and applications of stem cells, cloning techniques, and assisted reproductive technologies.

CO5: Demonstrate knowledge of organogenesis in mammals, including development of key organs and systems.

SYLLABUS

Unit-I: Gametogenesis and Fertilization

Formation of egg and sperm, vitellogenesis and fertilization. Types of eggs and sperms, parthenogenesis, regeneration

Unit-II: Cleavage and Gastrulation

Planes and patterns of cleavage in chordates, significance of cleavage and blastulation, Morphogenetic cell movement, Fate maps and significance of gastrulation

Unit-III: Embryology

Development of Branchiostoma (Amphioxus) up to gastrulation; chick egg and its development up to the formation of primitive streak, Extra embryonic membranes of chick, development of placenta in rabbit, types and functions of placenta in mammals

Unit-IV: Stem Cells and Assisted Reproduction

Various types of stem cells and their applications (with special reference to embryonic stem cells), Cloning of animals: nuclear embryonic transfer technique, nuclear transfer technique; Identical, Siemese and fraternal twins and Artificial insemination, Introduction and types of IVF techniques.

Unit-V: Organogenesis

Organogenesis of alimentary canal, eye, kidney, gonads and brain in mammal.

SUGGESTED READINGS

1. ***Dr. Asha Sharma*** – *Developmental Biology*
2. **P.S. Verma & V.K. Agarwal** – *Chhatwal and Anand: Developmental Biology*
3. ***Veer Bala Rastogi*** - *Animal Distribution & Developmental Biology*
4. **B.I. Balinsky (Adapted by K.V. Sastry)** – *An Introduction to Embryology*
5. **T.S. Saraswati & P. Sivakami** – *Animal Developmental Biology*

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16005T1: Animal Physiology and Biochemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Students will be able to understand the physiology of digestion, blood circulation, muscle contraction, and excretion in animals.

CO2: Explain the structure and function of the respiratory and nervous systems including impulse conduction and reflexes.

CO3: Describe the role and regulation of endocrine glands and the physiological effects of hormonal imbalances.

CO4: Analyze the biochemical pathways involved in glucose oxidation, ATP production, and amino acid metabolism.

CO5: Apply knowledge of physiological mechanisms to understand coordination among organ systems in animals.

SYLLABUS

Unit-I: Digestion; digestive enzymes, process of digestion, digestion of rotein,carbohydrate and lipid
Blood : Composition and functions, Blood groups, Rh factor and their significance, blood clotting mechanism, blood pressure and cardiac cycle, respiratory pigments, cardiac muscle activity.

Unit-II: Muscle : Structure of various types of muscles and mechanism of muscle contraction
Excretion : Structure of kidney, types of nephron, mechanism of urine formation and its eliminationand arginine, ornithin cycle

Unit-III: Respiration : Structure of lung, mechanism of respiration, respiratory pigment, exchange and transport of oxygen and carbon dioxide. Nervous System : Structure of neuron and its classification, Nerve impulse, impulse conduction and reflex action

Unit-IV: Endocrine glands : Structure and functions of various endocrine glands, diseases caused by hormonal deficiency ; Mechanism of hormone action

Unit-V: Structure of Protein and Carbohydrates; oxidation of glucose through glycolysis, Krebs cycle and oxidative phosphorylation, deamination, transamination and decarboxylation.

SUGGESTED READINGS

1. **P.S. Verma & V.K. Agarwal** – *Animal Physiology and Biochemistry*
2. **S.C. Rastogi** – *Essentials of Animal Physiology*
3. **A.K. Berry** – *A Textbook of Animal Physiology*
4. **Lehninger, Nelson & Cox** – *Principles of Biochemistry*

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16005T2: Immunology and Applied Zoology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand the fundamental concepts of immunity, antigen-antibody interactions, and types of immunoglobulins.

CO2: Gain knowledge of poultry breeds, housing, disease management, and commercial egg production.

CO3: Explain the biology, rearing practices, and economic importance of sericulture and vermiculture.

CO4: Demonstrate understanding of bee species, hive management, honey extraction, and their role in crop pollination.

CO5: Acquire practical knowledge of aquaculture practices, fish breeding, pond management, and fishing industry by-products.

SYLLABUS

Unit-I: Types of immunity (innate and acquired, humoral and cell mediated), Antigen: Antigenicity of molecules, haptens, Antibody: Structure and functions of each class of immunoglobulins (IgG, IgM, IgD, IgA and IgE), antigen – antibody reactions.

Unit-II: Poultry keeping – Types of poultry breeds, poultry housing, farm and farm management, system of poultry farming; Grading, handling and marketing of eggs. Poultry diseases and Vermiculture; Methodology and products.

Unit-III: Sericulture : Different kinds of silk producing insects in India and its potentialities. Host plants of silk insects. Grainage, rearing and life cycle. Breeding and various diseases of silkworm. Reeling and fibre technology. Economics of Sericulture.

Unit-IV: Apiculture : Different kinds of honey bees found in India and, their identification. Identification of Queen, worker and drone. Importance of keeping bees in artificial hives and different kinds of hives. Care and management of bee colonies. Bee enemies and their control. Extraction and processing of honey from the comb. Utility and economics of production of honey. Honey bees and pollination strategy in agricultural crops.

Unit-V: General principles of aquaculture; transportation of fish seed and brooders. Induced Breeding, Composite fish culture, Lay out of fish farm and its management, By-products of fishing industry; Prawn culture; Management of water bodies for aquaculture.

SUGGESTED READINGS

1. Kuby, J., Goldsby, R.A., Kindt, T.J. & Osborne, B.A. – Immunology
2. Shukla & Upadhyay - Applied and Economic Zoology
3. R. Malhotra & A.K. Sinha – Applied Fisheries and Aquaculture
4. A.L. Smith – Insect Biology and Diversity

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16006T1: Ecology and Ethology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand ecological principles, environmental factors, and species interactions influencing ecosystems.

CO2: Analyze population dynamics, energy flow, ecological pyramids, and nutrient cycles in ecosystems.

CO3: Evaluate the structure and function of major ecosystems, ecological succession, pollution, and conservation strategies.

CO4: Describe animal behavior, including hormonal control, biological rhythms, and methods of behavioral study.

CO5: Explain learning processes, communication in animals, and wildlife conservation with emphasis on Rajasthan fauna.

SYLLABUS

Unit-I: Introduction of ecology, definition, history, sub division and scope of ecology. Envirnmental factors; physical factors- soil, water, air and temperature. Biotic factorsinterspecific and intraspecific relations, neutralism, mutualism, commensalism, antibiosis, parasitism, predation, competition. Concept of limiting factors, Liebig's law of minimum, Shelfords law of tolerance, combined concept of limiting factors

Unit-II: Population and community ecology, measurement of population density. Factors affecting population growth, growth factors, dispersal, characteristic of community, concept of ecosystem and niches. Food chain, food web, Ecological pyramid. Energy flow in an ecosystem, biogeochemical cycles of CO2, N2, O2, S and P. Prospects and stratigies of sustainable development

Unit-III: Brief introduction to the major ecosystem of the world and ecological succession, conservation of natural resources; Brief account of environmental pollution, global warming and its impact upon Human Race, Environmental laws, EIA (Environmental Impact Assessment).

Unit-**IV:** General survey of various types of animal behaviour; Methods of studying animal behaviour, Role of hormones and pheromones in behaviour, Biological rhythms.

Unit-V: Learning and Memory – Conditioning, Habituation, Insight learning, Association learning, Reasoning and Communication; Wildlife of Rajasthan and its conservation.

SUGGESTED READINGS

1. P.D. Sharma – Ecology and Environment
2. E.P. Odum & N. Singh – Fundamentals of Ecology (Indian Adaptation)
3. A.K. Agarwal – Environmental Pollution and Ecology
4. Reena Mathur - Animal Behaviour
5. John Alcock – Animal Behavior: An Evolutionary Approach

B.Sc. Semester: VI 2027-28
Discipline Specific Elective Course (DSE)
ZOOSE16006T2: Microbiology and Biotechnology
(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to:

CO1: Understand the historical developments and key contributions that led to the foundation of microbiology.

CO2: Describe the structural components and genetic organization of bacterial cells including plasmids and chromosomes.

CO3: Explain bacterial growth, reproduction, culture conditions, and the significance of medically important bacteria.

CO4: Demonstrate knowledge of recombinant DNA technology, cloning tools, gene transfer methods, and their applications.

CO5: Identify the role of microbes in environmental and industrial biotechnology including fermentation and bioremediation.

SYLLABUS

Unit-I: Historical Foundations of Microbiology

Theory of spontaneous generation, germ theory of fermentation and diseases, contributions of Louis Pasteur, contributions of John Tyndall, contributions of Robert Koch, contributions of Edward Jenner.

Unit-II: Bacterial Structure and Genetics

Bacterial cell membrane, patterns of bacterial arrangement, structure of capsule, structure of cell envelopes, organization of cytoplasmic membrane in Gram-positive strains, organization of cytoplasmic membrane in Gram-negative strains, bacterial chromosome, plasmids.

Unit-III: Bacterial Growth and Reproduction

Asexual and sexual reproduction in Bacteria, Culture of Bacteria: Carbon and energy source, Nitrogen and minerals and Organic growth factors, Effect of environmental factors on bacterial culture: Temperature, hydrogen ion concentration; Medical importance of Gram-negative and Gram-positive bacteria

Unit-IV: Recombinant DNA Technology

Recombinant DNA technology: Introduction and principles, restriction endonucleases, cloning vehicles (plasmids, bacteriophages); methods of gene transfer and applications.

Unit-V: Applied and Environmental Biotechnology

Environmental Biotechnology (outline idea only): Metal and petroleum recovery, pest control, waste-water treatment, Food, Drink and Dairy Biotechnology (outline idea only): Fermented food production: dairy products, alcoholic beverages and vinegar: microbial spoilage and food preservation

SUGGESTED READINGS

1. **Kuby, J., Goldsby, R.A., Kindt, T.J. & Osborne, B.A. – Immunology**
2. **R.C. Dubey & D.K. Maheshwari** – *A Textbook of Microbiology*
3. **P. Chakraborty** – *A Textbook of Microbiology*
4. **S. Sivasankar** – *Bioengineering and Biotechnology*

B.Sc. Semester: I 2025-26

Discipline Centric Core Course (DCC)

ZOOCC14001P: Lower Invertebrate Diversity and Biochemical Techniques

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Study of permanent slides:
   - Paramecium (binary fission & conjugation), Euglena, Amoeba
   - Sponge spicules and gemmules, Obelia colony & medusa
   - Hydra sections,
2. Identification of museum specimens:

   Protozoa, Porifera, Coelenterata, Ctenophora, Platyhelminthes and Aschelminthes

3. Permanent preparations: Obelia colony
4. Study of permanent slides:
   - Fasciola/Taenia proglottids, Cyclops, Daphnia, trochophore larva, Glochidium larva.
5. Cell biology:
   - Structure of typical animal cells (from charts/models)
6. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Invertebrate Practical Zoology
2. S.S. LAL - Invertebrate Practical Zoology

B.Sc. Semester: II 2025-26

Discipline Centric Core Course (DCC)

ZOOCC14002P: Higher Invertebrate Diversity and Cell Biology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Dmonstration & Diagramatic Representation of Dissections:
   - Nereis: Digestive, nervous system
   - Pila: Nervous system
2. Identification & museum specimens:

   Arthropoda, Annelida, Mollusca and Echinodermata

3. Permanent preparations: sponge spicules gemmules, Nereis parapodia, Cyclops, Daphnia.
4. Genetics:
   - ABO blood group determination
   - Study of blood smear for cell types
5. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Invertebrate Practical Zoology
2. S.S. LAL - Invertebrate Practical Zoology

B.Sc. Semester: III 2026-27

Discipline Centric Core Course (DCC)

ZOOCC15003P: Vertebrate Morphology and Osteology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Dmonstration & Diagramatic Representation of Dissections:
   - Scoliodon: General anatomy, cranial nerves
2. Identification & museum specimens:
   - Cephalochordata: *Amphioxus,* Hemichordata: *Balanoglossus*
   - Urochordata: *Salpa, Doliolum* and *Herdmania*
   - Cyclostomata: Petromyzon and Myxine
   - Pisces: *Zygaena, Scoliodon, Pristis, Torpedo, Trygon, Protopterus, Labeo, Heteropneustis* (*Saccobranchus*), *Belone, Exocoetus, Anabas* and *Echeneis*
   Amphibia: *Necturus, Amphiuma, Amblystoma, Axolotal larva, Hyla, Uraeotyphlus*
   Reptilia: *Trionyx, Chelone, Varanus, Uromastix, Ophiosaurus, Naja, Bungarus, Echis, Hydrophis, Eryx, Ptyas, Crocodilus* and *Gavialis*
   - Aves: *Columba, Pavo, Choriotis, Francolinus, Streptopelia*
   - Mammalia: *Meriones, Funambulus, Rattus, Hemiechinus, Suncus, Ptecopus, Presbytis* and *Macaca*
3. Permanent preparations: Placoid scales
4. Osteology: Disarticulated skeleton of Rana & Varanus
5. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Invertebrate Practical Zoology
2. S.S. LAL - Invertebrate Practical Zoology

B.Sc. Semester: IV 2026-27

Discipline Centric Core Course (DCC)

ZOOCC15004P: Embryology, Developmental Anatomy and Osteology

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Dmonstration & Diagramatic Representation of Dissections:
   - Labeo: General anatomy, cranial nerves
2. Study of chick embryology: Whole mounts (18, 24, 33, 48, 72 hrs)
3. Study of permanent slides:
   - Hemichordata: Section through proboscis and branchiogenital region *Branchiostoma:* T.S. oral hood, pharynx, gonads, intestine and caudal region *Scoliodon*: T.S. gill and scroll valve
   - Rana*:* T.S. through various organs, T.S. and L.S. of developmental stages Reptilia: V.S. skin of lizard
   - Aves: V.S. skin, different types of feathers
4. Osteology: Disarticulated skeleton of Gallus & Oryctolagus
5. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Invertebrate Practical Zoology
2. S.S. LAL - Invertebrate Practical Zoology

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16005P1: Physiology and Clinical Biochemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Blood physiology:
   - Estimation of haemoglobin, ESR, PCV
   - Blood smear, identification of blood cells
   - Blood group determination
2. Biochemical tests:
   - Sugar (Benedict's), Protein (Biuret), Lipid (Sudan IV)
   - Enzyme activity: Amylase, catalase (demo)
3. Physiology:
   - Measurement of blood pressure, use of colorimeter, pH meter
   - Urine analysis (sugar, protein, pH)
4. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Practical Zoology
2. S.S. LAL - Practical Zoology

B.Sc. Semester: V 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16005P2: Physiology and Clinical Biochemistry

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Identification and permanent mounts:
   - Mouthparts: Butterfly, mosquito, cockroach
   - Termite soldiers and workers
   - Honey bee pollen basket
2. Vermiculture setup (demo/project)
3. Sericulture: Study of life cycle stages, host plants
4. Poultry breeds (photographic/museum specimens), egg grading (demo)
5. Aquaculture: Pond layout, fish seed transport methods
6. Project report on local economic animals or apiculture visit
7. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Practical Zoology
2. S.S. LAL - Practical Zoology

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16006P1: Ecology, Applied Zoology and Microbiology Study

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Ecology & physiology:
   - Measurement of temperature, humidity, soil moisture, water holding capacity
   - Use of spray equipment, pesticides (precautions)
2. Study of ecosystems:
   - Pond water: Identification of zooplankton
   - Aquarium ecosystem analysis
3. Project report: Local fauna report
4. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Practical Zoology
2. S.S. LAL - Practical Zoology

B.Sc. Semester: VI 2027-28

Discipline Specific Elective Course (DSE)

ZOOSE16006P2: Ecology, Applied Zoology and Microbiology Study

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
2 Credits	4 Hours	60 Hours

SUGGESTED LABORATORY EXCERCISES

1. Study of microbes in curd (Gram staining or wet mount)
2. Culture of bacteria on agar (demo or prepared slides)
3. Demonstration of Dissection:
   - Rattus: Digestive, blood vascular, and urogenital systems
4. Permanent mounts:
   - Stored grain pests, bacterial colonies
5. Project report: Fermented product or microbial analysis
6. Record submission

SUGGESTED READINGS

1. P.S. VERMA - Practical Zoology
2. S.S. LAL - Practical Zoology

B.Sc. Semester: I 2025-26

Skill Enhancement Course (SEC)

CLPSC14001T: Chemical Safety and Laboratory Practices

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcome: On successful completion of the course, the students will be able to:

CO1: Apply Standard Operating Procedures (SOPs) to ensure consistent and safe laboratory practices.

CO2: Demonstrate understanding and implementation of Good Laboratory Practices (GLP) to maintain quality, reliability, and integrity of experimental work.

CO3: Identify, report, and document laboratory incidents and accidents in compliance with safety regulations and institutional protocols.

CO4: Administer appropriate first aid measures in response to chemical exposures or laboratory-related injuries.

CO5: Evaluate and respond effectively to emergency situations in laboratory settings, ensuring personal and environmental safety

SYLLABUS

Unit-I: Introduction to Chemical Safety

Importance of chemical safety in teaching and research laboratories
Types of hazards: chemical, physical, biological, mechanical
Routes of exposure: inhalation, ingestion, skin contact, injection

Unit-II: Personal Safety Measures

Personal Protective Equipment (PPE): gloves, goggles, lab coats, face shields
Lab ventilation: fume hoods, biosafety cabinets
Emergency equipment: eyewash stations, fire extinguishers, spill kits

Unit-III: Environmental Safety Measures

Good Housekeeping and Hygiene Practices, Safety signage and labels
Green Chemistry principles in laboratory safety

Unit-IV: Safe Handling, Storage, and Disposal of Chemicals

Safe handling practices: transport, pipetting, mixing, heating
Storage of chemicals based on compatibility (flammables, oxidizers, corrosives)
Chemical inventory management
Waste segregation and disposal methods (solid, liquid, hazardous)

Unit-V: Laboratory Practices and Emergency Preparedness

Standard Operating Procedures (SOPs), Good Laboratory Practices (GLP)
Incident and accident reporting, First aid in case of chemical exposure or injury

SUGGESTED READINGS

1. Handbook on Laboratory Safety – Directorate General, CSIR
2. Environmental Chemistry and Pollution Control by S.S. Dara – S. Chand Publishing
3. Laboratory Manual in Organic Chemistry by B.S. Furniss et al., adapted by Indian publishers
4. A Textbook of Practical Chemistry by Vishnoi, Malik & Narang – New Age International

B.Sc. Semester: II 2025-26

Skill Enhancement Course (SEC)

PWMSC14002T: Principles of Waste Management

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Identify various types and sources of waste and understand their impacts on health and environment.

CO2: Demonstrate techniques for waste segregation, storage, and transportation.

CO3: Understand and apply various recycling and waste treatment methods.

CO4: Analyze sustainable waste management practices, including 3Rs and circular economy concepts.

CO5: Design small-scale, eco-friendly waste management/recycling models with community engagement.

SYLLABUS

Unit-I: Fundamentals of Waste Management

Introduction to waste and its classification: biodegradable, non-biodegradable, hazardous, e-waste, biomedical

Sources of waste: domestic, industrial, agricultural, commercial

Health and environmental impacts of improper waste disposal

Unit-II: Waste Collection, Segregation and Transportation

Methods of waste collection and segregation at source, Tools and containers for segregation

Transportation and handling of waste

Unit-III: **Waste Treatment and Disposal Methods**

Composting (aerobic, anaerobic) and vermicomposting, Incineration, landfilling, pyrolysis

Bio-methanation and energy recovery

Unit-IV: Recycling Techniques

Principles of recycling, Recycling of paper, plastic, glass, metal, and e-waste, Energy recovery from waste

Unit-V: Sustainable Waste Management and Community Participation

3Rs: Reduce, Reuse, Recycle, Concepts of circular economy and zero waste

Role of NGOs, startups, and government initiatives (e.g., Swachh Bharat Abhiyan)

Awareness campaigns and community-based projects

SUGGESTED READINGS

1. M.N. Rao & Razia Sultana – Solid and Hazardous Waste Management, CBS Publishers & Distributors Pvt. Ltd.
2. John Pichtel – Waste Management Practices: Municipal, Hazardous, and Industrial, CRC Press.
3. Peavy, Rowe, & Tchobanoglous – Environmental Engineering, McGraw-Hill Education.
4. S. K. Garg – Environmental Engineering Vol. I & II, Khanna Publishers.
5. Central Pollution Control Board (CPCB) Guidelines.

B.Sc. Semester: V 2027-28

Skill Enhancement Course (SEC)

FQASC16005T: Food Quality & Adulteration

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Identify various types of food adulterants and understand their health impacts.

CO2: Perform basic physical detection tests for common adulterants in food items like milk, oils, grains, and spices.

CO3: Interpret food quality parameters and understand the usage of basic instruments like pH meters, refractometers, and spectrophotometers.

CO4: Describe microbial contamination and apply basic methods to detect spoilage or unsafe food.

CO5: Demonstrate awareness of Indian food safety laws and the role of regulatory bodies such as FSSAI in preventing food adulteration.

SYLLABUS

Unit-I: Introduction

Introduction to food adulteration

Adulterants: types, sources and their impact on health.

Criteria of adulterated food. Awareness towards food adulteration.

Unit-II: Detection of Adulterants – I

Physical and Chemical tests of-

Milk and milk products

Oils and fats

Unit-III: **Detection of Adulterants – II**

Physical and Chemical tests of-

Sweetening agents

Food grains

Spices

Unit-IV: Food Quality and Instrumental Testing

Introduction to quality parameters: pH, moisture, shelf-life, Basics of instrumental methods: pH meter, refractometer, spectrophotometer (demo level), Microbial contamination: basic understanding and detection, Sensory evaluation: taste, odor, texture, color

Unit-V: Food Laws and Regulatory Framework

Overview of FSSAI and its role, Food Safety and Standards Act, 2006

Prevention of Food Adulteration Act

SUGGESTED READINGS

1. "Food Science" – B. Srilakshmi, : New Age International Pvt. Ltd.
2. "Food Analysis" **–** S. Suzanne Nielsen, Springer Cham.
3. "Handbook of Food Analysis" **–** Leo M.L. Nollet, CRC Press.
4. "Food Laws and Regulations in India" **–** S. R. Sharma.
5. "Food Safety and Quality Control" **–** Dr. V. K. Joshi.

B.Sc. Semester: I 2025-26

Skill Enhancement Course (SEC)

NGRSC14001T: Nursery and Gardening

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Develop conceptual of nursery and gardening.

CO2: Gain knowledge about developing commercial enterprise of nursery.

CO3: On successful completion of this course, the students will be able to perform soil and plant nutrients management activities, make compost, perform nursery planning and management activities.

CO4: perform communication and professionalism development activities,

CO5: perform entrepreneurship development activities.

SYLLABUS

Unit-I: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planningand seasonal activities - Planting - direct seeding and transplants.
Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy- Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification.

Unit-II: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatmentof cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house

Unit-III: Gardening: definition, objectives and scope - different types of gardening-landscape and homegardening - parks and its components - plant materials and design-computer applications in landscaping.

Unit-IV: Soilless media- Vermiculite, Soilrite, Cocopeat, Peat moss Composting and composts- Vermicompost, Vermiwash, Leaf-Mold, Organic and chemical fertilizers, Integrated Fern management. Grafting and its types- Agrochemicals and PGRs in horticulture.

Unit-V : Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.
Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

SUGGESTED READINGS

1. Bose TK. and Mukherjee, D. 1972 Gardening in India, Oxford & IBH Publishing Co. New Delhi.
2. Sandhu, M.K. 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajlaxmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co. New Delhi.
5. Agrawal, P.K. 1993 Handbook of seed technology. Dept. of Agriculture and Co-operation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979 Horticultural Science (3rd Ed.), W.H. Freeman and Co. San Francisco.

B.Sc. Semester: II 2025-26

Skill Enhancement Course (SEC)

FWBSC14001T: Food Waste and By-Product Utilization

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Identification of waste from agriculture and food processing.

CO2: Identification of various co-products from dairy industry.

CO3: Students will know about physico-chemical properties of wastewater.

CO4: Utilization of different waste product from dairy industry and cereal industry

CO5: Gain practical skills in converting waste to value-added products. Ability to start small- scale ventures or contribute to sustainability programs.

SYLLABUS

Unit-I: Identification of waste from agriculture and food processing (Dairy/ Meat/ Fruits Vegetables / Alcoholic beverages/ cereals). Study and layout of waste water treatment system (ETP).

Unit-II Identification of co-products from F&V industry, estimation and utilization to develop value added products (pectin, banana fibre, lycopene from tomato waste, watermelon/pumpkin rind).

Unit-III:. **:** Identification of waste from animal industry and utilisation to develop value added products (gelatin, egg shell). Identification of various co-products from dairy industry, estimation and utilization to develop value added products (utilisation of ghee residue, buttermilk beverage, whey).

Unit-IV: Identification of co-products from cereal industry, estimation and utilization to develop value added products (cereal husk, wheat fibre). Determination of physico-chemical properties of wastewater. Production of alcohol/ acetic acid from waste material

Unit-V: Management and Reduction Strategies:Food waste hierarchy (reduce, reuse, recycle).Household and institutional food waste management.Government policies and initiatives (FSSAI, FAO)

SUGGESTED READINGS

1. 1.Marriott, N. G., Gravani, R. B., & Schilling, M. W. (2006). Principles of food sanitation (Vol. 22). New York: Springer.
2. Sadasivam, A, & Manickam, A. (2021). Biochemical Methods. New Age InternationalPublishers.
3. Green, J. H., & Kramer, A. (1979). Food Processing. Waste Management. Avi PublishingCompany, 629.
4. Herzka, A. and Booth, R.G. Food Industry and Trade: Recycling Waste. Applied SciencePublishers, 1981.
5. Tegge, G., Green, J. H., and A. Kramer. Food Processing Waste Management; AVI Publishing, 1979
6. Marriott, N. G., Gravani,R. B., & Schilling, M. W. (2006). Principles of food sanitation (Vol. 22). New York: Springer.
7. Sadasivam, A, & Manickam, A. (2021). Biochemical Methods. New Age InternationalPublishers.
8. Green, J. H., & Kramer, A. (1979). Food Processing. Waste Management. Avi PublishingCompany, 629.
9. Herzka, A. and Booth, R.G. Food Industry and Trade: Recycling Waste. Applied SciencePublishers, 1981.
10. 10. Tegge, G., Green, J. H., and A. Kramer. Food Processing Waste Management; AVIPublishing, 1979

B.Sc. Semester: V 2025-26

Skill Enhancement Course (SEC)

GBDSC16005T: Green Belt Development for Smart Cities

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
4 Credits	4 Hours	60 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Improved air quality, reduced noise pollution, and moderated urban temperature through increased green cover.

CO2: Integration of ecological principles into urban development, promoting balanced growth.

CO3: Conservation and enhancement of urban flora and fauna through dedicated green spaces.

CO4: Creation of recreational spaces leading to better mental and physical health of citizens.

CO5: Reduction in urban carbon footprint by planting trees and vegetation that absorb CO_2.

SYLLABUS

Unit-I: Methods of vegetation sampling and calculation of importance value index. Measuring Tree Basal Area, Height and Canopy Cover to estimate green cover of an area.

Unit-II: Estimation of Total Carbon stock of an area. Understanding methods for selection of plants according to pollutant load of both air and water (includes field survey). Assessing air pollution tolerance of plant species using APTI (Air pollution tolerance index).

Unit-III: Use Open Source Softwares for mapping the GPS points and generating a cover map. Measurement of Dissolved Oxygen (DO) from treated wastewater

Unit-IV: Measurement of BOD and TDS from tank and treated pond. Determination of total dissolved and suspended solids in water.

Unit-V: Understanding of Instruments for measuring microclimatic variables viz., light, wind, temperature, humidity and precipitation

SUGGESTED BOOKS

1. Bell, J. R., Wheater, C. P., Cook, P. A., Bell, J. R., Wheater, C. P., Cook, P. A. (2011). Practical Field Ecology: A Project Guide. United Kingdom: Wiley.
2. Singh J.S., Singh S.P. & Gupta S.R. · 2014. Ecology, Environmental Science & Conservation. (2014). India: S. Chand Pvt. Limited.
3. Measurements for Estimation of Carbon Stocksin Afforestation and Reforestation Project Activities under the Clean Development Mechanism, Afield Manual UNFCCC.
4. Slingsby, D., Cook, C., Slingsby, D., Cook, C. (2016). Practical Ecology. United Kingdom: Macmillan Education UK.
5. 5. Mukerji, K. G. (2013). Laboratory Manual of Food Microbiology. India: I.K. International Publishing House Pvt. Limited.

B.Sc. I-Semester

Skill Enhancement Course (SEC)

VOWSC14001T: Vermiculture and Organic Waste Management

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcome: To equip students with practical knowledge of vermicomposting techniques, earthworm biology, and sustainable organic waste management to promote environmental protection and income generation.

SYLLABUS

Unit I: Unit I: Basics of Vermiculture

- Scope and importance
- Types of earthworms
- Role in soil fertility

Unit II: Earthworm Biology

- Morphology and anatomy
- Reproduction
- Common species used (e.g., Eisenia fetida)

Unit III: Vermicomposting Process

- Waste collection and segregation
- Methods (pit, bin, heap, tank)

Unit IV: Environmental Conditions

- Moisture, aeration, temperature
- Harvesting of vermicompost

Unit V: Applications and Benefits

- Nutrient content of vermicompost
- Comparison with traditional compost
- Environmental & economic significance

SUGGESTED READINGS

1. Edwards, C.A. & Bohlen, P.J. – *Biology and Ecology of Earthworms*
2. Ismail, S.A. – *The Earthworm Book*
3. Yadav, K.D. et al. – *Vermicomposting of Organic Waste*

B.Sc. II-Semester

Skill Enhancement Course (SEC)

SATSC14002T: Sericulture and Aquaculture (Fishery) Techniques

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcome: To provide practical and entrepreneurial knowledge in silkworm rearing and fish culture with understanding of biological cycles, disease management, and economic returns.

SYLLABUS

Unit I: Sericulture Overview

- Types of silk moths (Bombyx mori, Antheraea spp.)
- Life cycle, host plants

Unit II: Silkworm Rearing

- Grainage and breeding
- Disease control in silkworms

Unit III: Aquaculture Basics

- Candidate fish species
- Pond preparation, water quality

Unit IV: Breeding and Health

- Induced breeding
- Fish nutrition and disease management

Unit V: Economics and Sustainability

- Marketing, cost analysis
- By-products and entrepreneurship

SUGGESTED READINGS

1. Ganga, G. & Sulochana Chetty – An Introduction to Sericulture
2. Pillay, T.V.R. – Aquaculture: Principles and Practices
3. Shukla & Upadhyay – Applied and Economic Zoology

B.Sc. V-Semester

Skill Enhancement Course (SEC)

RMSSC16005T: Research Methodology and Scientific Writing

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcome: To train students in basic research design, data interpretation, and effective scientific writing for thesis, research articles, and presentations.

SYLLABUS

Unit I: Foundations of Research
- Objectives, types, ethics
- Plagiarism and hypothesis formation

Unit II: Research Design
- Sampling techniques
- Experimental setup

Unit III: Data Collection
- Tools (questionnaires, observations)
- Types: primary and secondary

Unit IV: Data Analysis
- Graphs, statistical tools (mean, SD, t-test)
- Basics of Excel/SPSS

Unit V: Scientific Communication
- Structure of thesis/papers (IMRAD)
- Referencing styles (APA, MLA)
- Presentations and posters

SUGGESTED READINGS

1. Kothari, C.R. – Research Methodology: Methods and Techniques
2. Kumar, R. – Research Methodology: A Step-by-Step Guide
3. Day, R.A. & Gastel, B. – How to Write and Publish a Scientific Paper
4. Duolingo / Grammarly / QuillBot – for practice and improvement

Multidisciplinary Course (MDC)

BCSMC15003T: Basic Concepts of Science

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand the Nature and Methodology of Science.
CO2: Apply Fundamental Concepts of Physics.
CO3: Demonstrate Understanding of Basic Chemistry Concepts.
CO4: Comprehend Biological Systems and Principles.
CO5: Apply Basic Mathematical Skills in Scientific Contexts.

SYLLABUS

Unit-I Nature and Scope of Science

Overview of Science, Scientific Method: Observation, Hypothesis, Experiment, Conclusion, Importance of Science in Daily Life, Science and Society.

Unit-II Fundamentals of Physics

Basic Physical Quantities (mass, length, time, temperature),
Motion and Force (concepts only), Energy: Forms and Conservation,
Electricity in Daily Life (simple ideas).

Unit-III Basics of Chemistry

States of Matter: Solid, Liquid, Gas, Atoms and Molecules (simple introduction),
Acids, Bases, and Salts (everyday examples), Common Chemical Reactions (cooking, rusting, etc.).

Unit-IV Basic Concepts of Biology

Living and non-living things, Cells: Basic Unit of Life,
Human Body Systems (digestive, respiratory, circulatory – overview),
Environment and health (clean air, water, hygiene), Nutrition and Health.

Unit-V: Science in Everyday Life

Common Scientific Tools and Devices (mobile phone, thermometer, etc.),
Health and Hygiene, Waste Management and Clean Energy,
Digital Literacy and Science.

SUGGESTED READINGS

1. New Science in Everyday Life (2020 revised edition; OUP India) – for contextual and daily-life science topics.
2. Fundamentals of Science (8th ed., 2014; Dhanpat Rai) – for physics, chemistry, biology core concepts.
3. Foundation Science for Class X (1st ed., 2015; Cengage Learning India) – for additional structured depth and exercises.
4. Use New Science in Everyday Life (Oxford, 2025 edition, Books 7 & 8) for contextual science, hygiene, tools, environment, and digital literacy (Units I & V).
5. Rely on Fundamentals of Science (S. Chand or Dhanpat Rai) to systematically present physics, chemistry, biology fundamentals (Units II–IV).

Multidisciplinary Course (MDC)

EVSMC15004T: Environmental Science

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand the scope, multidisciplinary nature, and importance of environmental studies.
CO2: Demonstrate knowledge of ecological principles and ecosystem dynamics.
CO3: Analyze natural resources and associated environmental issues.
CO4: Identify different types of environmental pollution and propose control measures.
CO5: Explain biodiversity concepts and conservation strategies.

SYLLABUS

Unit-I Introduction to Environmental Studies
Multidisciplinary nature, Scope & importance. Concepts: sustainability, sustainable development.

Unit-II Ecology & Ecosystems
Ecology vs. ecosystem, structure & function, Energy flow: food chains, webs, ecological pyramids, Succession, Case studies: forest, grassland, desert, aquatic (ponds, rivers, oceans, estuaries), mountain ecosystems.

Unit-III Natural Resources
Renewable vs. non-renewable resources, Land: land use change, degradation, soil erosion, Desertification, Forest resources: deforestation, Afforestation, Water resources: overuse, floods, droughts, inter-state/international Issues, Energy resources: conventional (coal, oil, nuclear) and alternative (solar, wind, biogas, geothermal, hydrogen).

Unit-IV Environmental Pollution
Types: air, water, soil, noise pollution; nuclear/thermal hazards, Causes, effects & control measures, Solid and industrial waste—management & disposal, Climate change topics: global warming, ozone depletion, acid rain.

Unit-V Biodiversity & Conservation
Levels of biodiversity: genetic, species, Ecosystem, Biodiversity patterns: hotspots, India as mega-diverse nation .Threats: habitat loss, poaching, human–wildlife conflict, invasive species Conservation strategies: in-situ and ex-situ, ecosystem services (ecological, ethical, economic, social, informational, aesthetic).

SUGGESTED READINGS

1. Textbook of Environmental Studies for Undergraduate Courses, 3rd Edition published by Universities Press (India) Private Limited in 2021 — Erach Bharucha.
2. Environmental Science — S. C. Santra, 3rd Edition published by New Central Book Agency on 1 January 2011.
3. Fundamentals of Ecology — Eugene P. Odum & Gary W. Barrett, The version released in India is the 5th Edition, copyright 2006.
4. **पर्यावरण अध्ययन** by Dr. Suman Gupta – 1st Edition, *2025*, Sultan Chand & Sons.
5. **पर्यावरण अध्ययन** by Dayashankar Tripathi – 2005 edition, Motilal Banarsidass.

Multidisciplinary Course (MDC)

FSQMC16005T: Food Safety and Quality Management

(20 CIA + 80 EoSE. = Max. Marks: 100)

ourse Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand the fundamentals of food safety and its significance.
CO2: Demonstrate knowledge of national and international food laws and regulations.
CO3: Explain and apply concepts of food safety management systems.
CO4: Apply sampling techniques and perform basic food safety analysis.
CO5: Identify and analyze emerging issues and trends in food safety.

SYLLABUS

Unit-I Introduction to Food Safety

Definition and importance of food safety, Types of food hazards: Biological (bacteria, viruses, parasites), Chemical (pesticides, toxins, heavy metals) &Physical (glass, metal, plastic), & Foodborne illnesses and outbreaks.

Unit-II Food Laws and Regulations

Overview of national and international food laws, Food Safety and Standards Act (FSSA), 2006 (India),FSSAI – structure, roles, and responsibilities, Codex Aliment Arius, WTO – SPS and TBT agreements, BIS, AGMARK, ISO standards.

Unit-III *Food Safety Management Systems*

Total Quality Management (TQM), Risk analysis: risk assessment, risk management, and risk communication, Traceability and recall procedures & Documentation and record-keeping.

Unit-IV *Sampling and Analysis*

Sampling techniques, Statistical quality control, Microbiological and chemical analysis for food safety & Rapid methods in food microbiology.

Unit-V *Emerging Issues and Trends in Food Safety*

Food fraud and adulteration, Food allergens and intolerance, Genetically Modified Foods (GMOs), Novel and functional foods, Climate change and food safety.

SUGGESTED READINGS

1. **Food Safety and Protection: Protecting Our Food from Farm to Table** by V Ravishankar Rai & Jamuna A. Bai.
2. **Food Safety: Theory and Practice** by Paul L. Knechtges.
3. Food Safety and Standards Act, 2006 with Rules & Regulations (FSSAI).
4. **Food Safety Management: A Practical Guide for the Food Industry** by Yasmine Motarjemi & Huub Lelieveld.
5. **Genetically Modified Organisms in Food: Production, Safety, Regulation and Public Concerns** by Ronald L. Herring.

B.Sc. Semester: III 2025-26

Value Added Course (VAC)

ESSVC15003T: Environmental and Sustainability Studies

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Understand and describe the key components of the environment, including biotic and abiotic factors.
CO2: Understand principles of sustainable resource management.
CO3: Understand the impact of environmental factors on public health.
CO4: Explain the causes and consequences of climate change.
CO5: Define sustainability and sustainable development concepts.

SYLLABUS

Unit-I: Introduction to Environment and Ecology
Components of the environment: biotic & abiotic, Ecosystems: structure and function, Biodiversity: types, importance, and threats, Relationship between humans and nature.

Unit-II: Natural Resources and Conservation
Types of natural resources: renewable & non-renewable, Sustainable resource management, Water and forest conservation, Traditional knowledge and uses of resource.

Unit-III: Environmental Pollution and Health
Types of pollution: air, water, soil, noise, Causes, effects, and control measures, Solid waste management and e-waste, Public health and environmental impact.

Unit-IV: Climate Change and Global Issues
Causes and effects of climate change, Carbon footprint and mitigation strategies, International agreements (Paris Agreement, SDGs), Environmental justice and ethics.

Unit-V: Sustainability and Green Practices
Concept of sustainability and sustainable development, Role of individuals and communities, Green technologies and practices, Campus sustainability initiatives.

SUGGESTED READINGS

1. Environmental Studies: From Crisis to Cure **– R. Rajagopalan, 4th Edition (2023)**, **Oxford University Press India.**
2. Environmental Ecology, Biodiversity & Climate Change: Towards Sustainable Development **– H. M. Saxena, 1st Edition (2015), Rawat Publications (Jaipur/New Delhi).**
3. Textbook of Environmental Studies for Undergraduate Courses **– Erach Bharucha, 2nd Edition (2013), Universities Press, Hyderabad.**
4. पर्यावरण अध्ययन (Environmental Studies) – Dr. Ratan Joshi, Edition Latest (2022), Sahitya Bhawan Publications.

B.Sc. Semester: VI 2025-26

Value Added Course (VAC)

HAWVC16006T: Health and Wellness

(20 CIA + 80 EoSE. = Max. Marks: 100)

Course Credits	No. of Teaching Hours Per Week	Total No. of Teaching Hours
3 Credits	3 Hours	45 Hours

Course Outcomes: On successful completion of the course, the students will be able to-

CO1: Practice basic yoga and mindfulness techniques for improved mental well-being.
CO2: Apply nutritional knowledge to maintain a balanced and healthy lifestyle.
CO3: Understand exercise science principles and develop personalized fitness plans.
CO4: Demonstrate essential first aid and emergency response skills.
CO5: Implement effective stress management and work-life balance strategies.

SYLLABUS

Unit-I: Yoga and Mental Well-being

Fundamentals of Yoga: Asanas, Pranayama, Meditation, Role of Yoga in mental health and emotional balance, Mindfulness and mental resilience techniques, Scientific evidence supporting Yoga for wellness.

Unit-II: Nutrition and Healthy Lifestyle

Basics of human nutrition: Macronutrients and micronutrients, Balanced diet planning and common nutritional disorders, Impact of lifestyle choices on health (sleep, hydration, habits), Nutritional myths and facts.

Unit-III: Physical Fitness and Exercise Science

Principles of physical fitness and types of exercise, Cardiovascular, strength, flexibility, and endurance training, Exercise physiology basics and benefits, Designing a personal fitness routine.

Unit-IV: First Aid and Emergency Care

Basic first aid skills: wound care, burns, fractures, CPR, Handling common emergencies: choking, bleeding, poisoning, Importance of safety and prevention strategies, When and how to seek professional medical help.

Unit-V: Stress Reduction and Work-Life Balance

Understanding stress: causes, symptoms, and effects, Techniques for stress management (relaxation, time management), Building work-life balance: setting priorities, boundaries, Role of hobbies, social support, and positive mind-set.

SUGGESTED READINGS

1. "Yoga for Wellness" – Dr. Renu Mahtani
2. "Nutrition and Dietetics" – Dr. M. Swaminathan
3. "Exercise Physiology: Theory and Application to Fitness and Performance" – Scott Powers & Edward Howley
4. "First Aid Manual" – St. John Ambulance / Red Cross
5. "The Relaxation and Stress Reduction Workbook" – Martha Davis et al.