2.6.1. Programme Outcomes (POs) and Course Outcomes (COs) for all Programmes offered by the institution are stated and displayed on website.

S.No	Programs	Courses	Links on the HNBGU/SDSUV sites
1	B.Sc.	Biotechnology	https://www.hnbgu.ac.in/sites/default/files/2024-05/PO_PSO_CO_Biotechnology.pdf
		Botany	https://www.hnbgu.ac.in/school/lifescience/botanymicro/srinagar/course-details/883
		Zoology	https://www.hnbgu.ac.in/school/lifescience/zoology-biotech/srinagar/course-details/903
		Chemistry	https://www.hnbgu.ac.in/sites/default/files/2023-03/CO%20and%20PSO-BSc%20Chemistry.pdf
2	M.Sc. Biotechnology		https://www.hnbgu.ac.in/sites/default/files/2024-05/PO_PSO_CO_Biotechnology.pdf
3	M.Sc. Microbiology		https://www.hnbgu.ac.in/school/lifescience/botanymicro/srinagar/course-details/883
4	M.Sc. Chemistry		https://www.hnbgu.ac.in/sites/default/files/2023-03/CO%20and%20PSO-MSc.pdf

Programme Outcomes (POs) and Course Outcomes (COs) for all Programmes offered by the institution are stated in following pages.

PROGRMA OUTCOME (PO), PROGRAM SPECIFIC OUTCOME (PSO) AND COURSE OUTCOME (CO)
B.Sc. Biotechnology (under CBCS)

NAME OF PROGRAM	PROGRAM OUTCOME	PROGRAM SPECIFIC OUTCOME	COURSE DETAILS	COURSE OUTCOME
B.Sc. (Biotechnology)	The students will have the basic knowledge of Biotechnology and its applications	After graduation, the students shall be able to pursue postgraduate degree, get industry jobs and prepare for various competitive exams for Govt. jobs	**I Semester** S0LS/BBT/C 0001 Cell Biology & Genetics	Basic knowledge of cell organelles, Knowledge of how basic life unit functions and laws of inheritance and basic genetics
			I Semester S0LS/BBT/C 0002 Lab course based on C0001	Knowledge about the laboratory practicals related to Cell Biology & Genetics
			II Semester S0LS/BBT/C 0003 Biochemistry & Metabolism	Knowledge of Bio molecules and their functions.
			II Semester S0LS/BBT/C 0004 Lab course based on C0003	Knowledge about the laboratory practicals related to Biochemistry & Metabolism
			III Semester S0LS/BBT/C0005 Microbiology & Immunology	Knowledge on various basic aspects of Microbiology and Immunology
			III Semester S0LS/BBT/SE001a Cell culture and applications	Skill enhancement in the area of animal cell culture and plant tissue culture techniques
			III Semester S0LS/BBT/SE001b Biological Tools & Techniques	Skill enhancement regarding various tools and techniques used in biological sciences.
			III Semester S0LS/BBT/C 0006 Lab course based on C0005	Knowledge about the laboratory practicals related to Microbiology and Immunology
			IV Semester S0LS/BBT/C 0007	Fundamental knowledge of Molecular Biology and

			Molecular Biology & Recombinant DNA Technology	Recombinant DNA Technology
			IV Semester S0LS/BBT/SE002a Bioethics, Bio-safety & Human Welfare	Skill enhancement by developing the understanding of Bioethics and Biosafety and their importance in human welfare.
			IV Semester S0LS/BBT/SE002b Molecular Diagnostics	Skill enhancement by developing the understanding of various molecular techniques and diagnostic methods
			IV Semester S0LS/BBT/C0008 Lab course based on C0007	Knowledge about laboratory practicals related to Molecular Biology and Recombinant DNA Technology
			V Semester S0LS/BBT/DSE01a Virology & Vaccine Development	Fundamental as well as advanced knowledge of viruses, vital infections and basic understanding about vaccine development
			V Semester S0LS/BBT/DSE01b Animal Biotechnology	Basic knowledge of Animal Biotechnology and its applications
			V Semester S0LS/BBT/DSE01c Biostatistics and Basic Bioinformatics	Basic understanding of various methods and techniques of Bioinformatics and Biostatistics.
			V Semester S0LS/BBT/SE003a Intellectual Property Rights & Patenting	Skill enhancement by developing understanding of the issues related to IPR and Patenting methods and their growing importance in Biotechnology
			V Semester S0LS/BBT/SE003b Environmental Biotechnology	Skill enhancement by understanding the various components of environment, pollution and biotechnological solution.
			V Semester S0LS/BBT/DSE02 Lab Course based on DSE01	Knowledge about laboratory practicals related to DSE 01 course

			VI Semester S0LS/BBT/DSE03a Medical Microbiology	Fundamental knowledge of Medical Microbiology and its relevance.
			VI Semester S0LS/BBT/DSE03b Plant Biotechnology	Conceptual knowledge of theoretical and practical aspects of Plant Biotechnology
			VI Semester S0LS/BBT/DSE03c Basics of Forensic Science	Knowledge about basics of forensic science and applications
			VI Semester S0LS/BBT/SE004a Bioprocess Technology	Basic understanding of Bioprocess, product formation and recovery
			VI Semester S0LS/BBT/SE004b Enzymology	Fundamental knowledge of enzymes, their action and applications
			VI Semester S0LS/BBT/DSE04 Lab Course based on DSE03	Knowledge about laboratory practical related to DSE03 course

PROGRMA OUTCOME (PO), PROGRAM SPECIFIC OUTCOME (PSO) AND COURSE OUTCOME (CO)

B.Sc. Biotechnology (under NEP)

NAME OF PROGRAM	PROGRAM OUTCOME	PROGRAM SPECIFIC OUTCOME	COURSE DETAILS	COURSE OUTCOME
B.Sc. (Biotechnology)	The students will have the basic knowledge of Biotechnology and its applications	After completing the course the students shall be able to get jobs in the area of Biotechnology or related fields. They can also go for higher studies or prepare for various competitive exams.	**I Semester** CBT-1 Introductory Biotechnology	Theoretical and practical knowledge of basics of biotechnology
			I Semester AID-BT-1 Introductory Biotechnology	Fundamental knowledge of biotechnology
			I Semester SEC-BT-1 Cell and Tissue culture	Basic knowledge about tissue culture techniques and development of

				practical understanding of the subject
			II Semester CBT-2 Biomolecules	Basic knowledge about various biological macromolecules, their functions and practical analysis
			II Semester AID-BT-2 Biomolecules	Basic knowledge about various biological macromolecules.
			II Semester Sec-BT-2 Enzymology	Theoretical and practical understanding of enzymes, their types. functions and applications
			III Semester CBT-3 Elementary Microbiology	Basic knowledge about various types of microorganisms and techniques related to their cultivation and analysis
			III Semester AID-BT-3 Elementary Microbiology	Basic knowledge about various types of microorganisms
			III Semester SEC-BT-3 Food Biotechnology	Theoretical and practical knowledge of fermented food production, food related disease, hygiene and biotechnological interventions
			IV Semester CBT-4 Basics of Molecular Biology	Fundamental knowledge of gene expression and practical skills for isolation and analysis of genetic material.
			IV Semester AID-BT-4 Basics of Molecular Biology	Basic knowledge of DNA, RNA and Proteins and their generation
			IV Semester Sec-BT-4 Molecular Diagnostics	Theoretical and practical understanding of Molecular Diagnostic methods.

PROGRMA OUTCOME (PO), PROGRAM SPECIFIC OUTCOME (PSO) AND COURSE OUTCOME (CO)
M.Sc. Biotechnology (under CBCS)

NAME OF PROGRAM	PROGRAM OUTCOME	PROGRAM SPECIFIC OUTCOME	COURSE DEATILS	COURSE OUTCOME
M.Sc. **(Biotechnology)**	The students will have the advanced knowledge of the core principles and topics of Modern day Biotechnological methods and applications.	M.Sc. Biotechnology students are specifically trained for basic as well as applied research and industrial requirement. It is also the basic requirement for Higher Studies like Ph.D.	**1st Semester** 1. Biochemistry (S0LS/MBT/C 0001) 2. Cell Biology & Membrane Biophysics (S0LS/MBT/C 0002) 3. Molecular Biology & Genetics (S0LS/MBT/C 0003) 4. Bio-Analytical Techniques (S0LS/MBT/C 0004) 5. Lab Course based on course C0001 & C0002 (SOLS/MBT/C0005) 6. Lab Course based on course C0003 & C0004 (SOLS/MBT/C0006)	1. Knowledge about the structure, function and metabolism of various biomolecules 2. Information about the structure and functions of cell, its organelles and membrane components 3. Understanding of genes, steps of gene expression and principles of heredity. 4. Knowledge about various tools and techniques used in the field of Biotechnology 5. Hands on laboratory experiments based on courses (S0LS/MBT/C 0001) & (S0LS/MBT/C 0002) 6. Hands on laboratory experiments based on courses (S0LS/MBT/C 0003) & (S0LS/MBT/C 0004)
			2nd Semester 7. Immunology (SOLS/MBT/C 0007) 8. Microbiology & Microbial Genetics (S0LS/MBT/C0008) 9. Genetic Engineering & Applications (S0LS/MBT/C 0009)	7. Knowledge about immune system and immune responses. 8. Conceptual knowledge of microorganisms and understanding about their genetics. 9. Understanding the principals, process and applications of genetic engineering

			10. Biostatistics & Bioinformatics (S0LS/MBT/C0010) 11. Lab Course based on course C0007 & C0008 (SOLS/MBT/C0011 12. Lab Course based on course C0009 & C0010 (SOLS/MBT/C0012) 13. Epigenetics & Cancer Biology (SOLS/MBT/SS001) 14. Biomedical Technology (SOLS/MBT/SS002)	10. Knowledge about the concepts of Biostatistics and Bioinformatics 11. Knowledge about the laboratory practicals related to Immunology and Microbiology & Microbial Genetics 12. Knowledge about the laboratory practicals related to Genetic Engineering and Biostatistics & Bioinformatics. 13. Self-learning of the concepts of Epigenetics & Cancer Biology 14. Self-learning of the concepts of Biomedical Technology
			3rd Semester 15. Plant Biotechnology (S0LS/MBT/C 0013) 16. Intellectual Property rights, Bioethics, Bio-Entrepreneurship (S0LS/MBT/C 0014) 17. Lab course based on course C0013 & C0014 (SOLS/MBT/C0015) 18. (i) SOLS/MBT/E0001a Protein Engineering	15. Fundamental as well as advanced knowledge of Biotechnology using plants and genetic engineering 16. Understating of the issues like IPR, Patenting & Bioethics and their importance in Biotechnology. Also the basic knowledge of Bio-Entrepreneurship. 17. Knowledge about the laboratory practicals based on course C0013 & C0014 18. (i) Fundamental as well as advanced knowledge of the protein building molecules and their

				engineering for various applications.
			(ii) SOLS/MBT/E0001b Immunotechnology	(ii) Fundamental as well as advanced knowledge in the area of Immunotechnology.
			(iii) SOLS/MBT/E0001c Nanobiotechnology	(iii)Knowledge about nanotechnology and applications in biological sciences.
			19. (i) SOLS/MBT/E0002a Food & Beverages Biotechnology (ii) SOLS/MBT/E0002b Animal Biotechnology (iii) SOLS/MBT/E0002c Enzymology & Enzyme Technology	19. (i) Knowledge about the biotechnological products and applications in Food & Beverages industry (ii) Fundamental as well as advanced knowledge of the principles and applications of Animal Biotechnology. (iii) Knowledge about properties, kinetics, inhibition and mechanism of enzyme action
			20. SOLS/MBT/E0003 Lab Course based on course E0001 & E0002	20. Knowledge about the laboratory practicals based on courses E0001 & E0002
			21. Research Methodology: Tools & Techniques (SOLS/MBT/SS003)	21. The students will learn about the importance of Research methodology and its use in biological research
			22. Science Communication & Scientific Writing (SOLS/MBT/SS004)	22. Development of scientific temper and skills of scientific writing and presentation

			4th semester 23. Environmental Biotechnology (S0LS/MBT/C 0016) 24. Fermentation & Bioprocess Technology (S0LS/MBT/C 0017) 25. Lab Course based on course C0016 & C0017 26. (i) Advanced Bioinformatics (SOLS/MBT/E0004 a) (ii) Herbal Biotechnology (SOLS/MBT/E000 4b) (iii) Genomics & Proteomics (SOLS/MBT/E0004c) 27. Dissertation (SOLS/MBT/E0005) 28. Vaccines & Drug Development (SOLS/MBT/SS005) 29. Molecular Virology (SOLS/MBT/SS006)	23. Knowledge of biotechnological innovations towards solution of environmental issues. 24. Knowledge of fermentation and bioprocesses and product recovery. 25. Training on laboratory experiments in the area of Environmental Biotechnology and Fermentation & Bioprocess Technology. 26. (i) Knowledge of advance tools of bioinformatics and its applications (ii)Learning of the use of medicinal plants ant their biotechnological applications (iii) Knowledge of the concepts and applications of genomics and proteomics 27. Hand on experience on doing a research project 28. Self-learning of the concepts of Vaccines and Drug development 29. Self-learning of the concepts of Molecular Virology

B.Sc - Semester I
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

1. Course Outcome (CO) : (Core: Atomic structure, bonding, General organic chemistry and aliphatic hydrocarbons)

From Inorganic Chemistry,

CO1: Student will learn, atomic structure, various theories of quantum mechanics,
CO2: Schrodinger wave equation, quantum numbers, filling of electron rule,
CO3: chemical bonding and molecular structure, ionic and covalent bonding,
CO4: VSEPR and hybridization theory,
CO5: MO and LCAO theory by giving suitable examples.

From Organic Chemistry:

CO6: Student will learn the fundametal of organic chemistry and structure, shape of molecule
CO7: Types of intermediates structure involved in a chemical reaction
CO8: Aromaticity and reactivity of organic molecules,
CO9: Stereochemistry and isomers of organic molecules
CO10: Synthesis and reaction of alkane, alkene and alkynes.

2. Course Outcome (CO) : (Core-Lab: Atomic structure, bonding, general organic chemistry and aliphatic hydrocarbons)

From Inorganic Chemistry laboratory course:

CO1: In this part student will estimation of carbonate, Fe(II), Cu(II), oxalic acid from solution using volumetric methods

From Organic Chemistry laboratory course:

CO2: In this part student will perform experiment to detect the extra elements present in organic compounds such as N, S, Cl, Br, I
CO3: Separate two organic compounds from mixture using paper chromatography.
CO4: Separate two amino acids from mixture using paper chromatography.

Programme Specific Outcome (PSO) : (Core/Lab: Atomic structure, bonding, general organic chemistry and aliphatic hydrocarbons)

PSO1: From **atomic structure, bonding** student will learn various theories related to atomic structure, bonding, electronic configuration and energy levels in atoms and molecules. This helps student to understand why certain material exhibits electronic, magnetic or electrical properties.

PSO2: From **general organic chemistry and aliphatic hydrocarbons** student will learn structure and bonding and reactivity of organic molecules, synthesis of some of the aliphatic hydrocarbons. This helps students to understand the chemical, biological reactions and research ability towards developing efficient organic material.

PSO3: In Inorganic laboratory course, student will estimate metal ions using volumetric techniques
PSO4: In Organic laboratory course, student will identify organic compounds from various sources.

B.Sc - Semester II
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

1. Course Outcome (CO) : (DSC 2B: Chemical Energetics, Chemical Equilibrium & Functional organic chemistry)

From physical chemistry,
PO1: Student will learn various thermodynamics laws and thermodynamics parameter, electrolytes, degree of ionization, factors affecting and its applications.

From organic chemistry:
PO2: Student will learn various synthetic reactions of organic compounds with varying functional group.

2. Course Outcome (CO) : (Core-Lab: DSC 2B LAB: Chemical Energetics, Chemical Equilibrium & Functional organic chemistry)

From Physical Chemistry laboratory course:
PO1: In this part student will learn and calculate experimentally various thermodynamic parameters, (heat capacity of calorimeter, enthalpy of neutralization of acid-base reaction, enthalpy of ionization of acid, integral enthalpy of solution, etc.
PO2: Students gain knowledge about of buffer solution and measure the pH of buffer and different solutions used in our day to day life.

From Organic Chemistry laboratory course:
PO3: In organic laboratory course, student will purify organic compound using crystallization method.
PO4: Ability to synthesize organic compounds using reaction like bromination, benzoylation, etc.

Programme Specific Outcome (PSO) : (Core/Lab: Chemical Energetics, Chemical Equilibrium & Functional organic chemistry)

PSO1: Student will gain knowledge about thermodynamics and experimentally determine thermodynamic parameter of a chemical reaction
PSO2: Student will learn how to determine the pH of solutions used in our day to day life.
PSO3: Ability to synthesize, purify and crystallization of organic compounds.
PSO4: This course provide students a platform for thinking theoretical as well as observed experimentally what is taught in the classes.

B.Sc -Semester III
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

1. Course Outcome (CO) : (Core: Solutions, Phase equilibrium, conductance, electrochemistry & functional group chemistry-II)

Section A: Physical Chemistry

CO1. Student will learn the thermodynamics of ideal solutions, partial miscibility of liquids.

CO2. Phase rule and phase diagrams of few one component and two component systems.

CO3 conductivity, transference number, applications of conductance measurements, conductance titrations, reversible ,irreversible cells and potentiometric titrations.

Section B: Organic Chemistry

CO1. Student will learn the functional groups like carboxylic acid, amines and diazonium salts.

CO2. Student will learn the functional groups like amines and diazonium salts.

CO3. Student will learn the functional groups like amino acids, Peptides and Proteins.

CO4. Student will learn chemistry of carbohydrates.

2. Course Outcome (CO) : (Core-Lab: Solutions, Phase equilibrium, conductance, electrochemistry & functional group chemistry-II)

From Physical Chemistry:

CO1: The students will learn determination of critical solution temperature and composition of phenol system

CO2: Determination of cell constant, performing conductometric and potentiometric titrations

CO3: Systematic qualitative organic analysis of organic compounds possessing monofunctional groups

CO4: Separation of amino acids by paper chromatography

CO5: Differentiation between a reducing /nonreducing sugar.

Programme Specific Outcome (PSO) : (Core/Lab: Solutions, Phase equilibrium, conductance, electrochemistry & functional group chemistry-II)

PSO1: From **Solutions, Phase equilibrium, conductance, electrochemistry** student will learn various theories of ideal and real solution, which help them to generate industrial of great importance.

PSO2: Phase equilibrium principle helps them in separating various components from mixture samples such as ore.

PSO3: From conductance and electrochemistry, student will learn importance of electrodes and

their use in metal detection and purification.

PSO4: From **organic chemistry** student will learn various synthetic methods of organic and biologically important molecules like amino acids.

PSO5: In Physical laboratory course, student will learn various physical methods to determine component in mixtures of sample solution, strong and weak electrolytes using conductometric and potentiometric methods

PSO6: In Organic laboratory course, student will learn how to separate and detect organic compounds and amino acids, sugars using chromatography techniques.

B.Sc -Semester IV
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

COs of the course " DSC- 2 D: Coordination Chemistry, States of Matter & Chemical Kinetics "

CO 1 To develop a general understanding of different states of matter and the characteristic properties of each state of matter that defines their physical and chemical attributes.

CO 2 To view chemical reactions in terms of equations and rate laws.

CO 3 To train students in arithmetic methods in chemistry through integral and differential forms of zero order, first order and second order reactions in chemical kinetics and their graphical representations.

CO 4 Classification of transition elements in terms of group trends and their ability to exist in more than one oxidation states and to form complexes.

CO 5 To understand the chemistry of lanthanoids and actinoids.

CO 6 To bring out the difference in d-block and f-block elements due to their electronic configuration.

CO 7 To enhance the knowledge of students regarding coordination chemistry and Crystal Field Theory through Valence Bond Theory (VBT) and Crystal Field Effect, respectively.

CO 8 To introduce Octahedral and Tetrahedral geometries of complexes through Crystal Field Stabilization Energy (CFSE).

Cos of the Course " Chemistry Lab-Dsc 2 D: Coordination Chemistry, States Of Matter & Chemical Kinetics "

CO 1 To familiarize students with chemicals and methods used for semi-micro qualitative analysis of cations and anions.

CO 2 To develop precision skills amongst students when doing experiments in surface tension and viscosity and practically verify the properties of liquids that they have learnt in theory classes.

CO 3 To get an opportunity to prepare complexes in quantitative estimation of Mg^{2+} or Zn^{2+} with EDTA.

CO 4 To provide initiation in quality control methods like determining total hardness of a given sample of water.

CO 5 To train students in writing reports for the labwork in their practical note book.

Programme Specific Outcome (PSO) : (Core/Lab: Coordination chemistry, states of matter & chemical kinetics)

PSO1: Students will learn about the structure and properties of transition metals, lanthanoids, coordination complexes of Cr, Fe, Co, Ni and Cu.
PSO2: Understand the mechanism of complex formation using VBT and CFT theory.
PSO3: Students learn the kinetics of ideal and non-ideal gases.
PSO4: Structure of solids lattice, liquids and kinetics of chemical reactions.

PSO5: From laboratory experiment, student will learn various qualitative analysis of ionic species
PSO6: Student learn various physical techniques that help to calculate physical parameters of liquids and chemical reactions.

B.Sc -Semester V
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

1. Course Outcome (CO) : (DSE: ANALYTICAL METHODS IN CHEMISTRY)

CO1: describes qualitative and quantitative aspects of analysis of research data such as accuracy, error, precision.
CO2: describes optical methods of data analysis using UV-Vis, IR, Flame atomic absorption and emission spectrometry. Basic principle and instrumentation are also discussed.
CO3: describes thermal methods of data analysis using thermogravimetry (TG) techniques, for example estimation of calcium and magnesium are discussed using TG.
CO4: describes electroanalytical methods of data analysis using pH metric, condutometric and potentiometric titration of weak and strong electrolyte.
CO5: describes different types of Separation techniques such as solvent extraction, metal ion extraction through chelation, chromatography techniques,

2. Course Outcome (CO) : (DSE Lab: Analytical methods in chemistry)

CO1: From this unit, student will learn and separate inorganic mixture using chromatography technique such as TLC and paper chromatography.
CO2: Separate organic mixture using chromatography technique such as TLC and paper chromatography
CO3: Separate metal ion using chelation technique.
CO4: Separate metal ion and amino acid using ion exchange chromatography.

Programme Specific Outcome (PSO) : (DSE theory/ Lab: Analytical methods in chemistry)

PSO1: From DSE course Analytical methods in chemistry, student will learn various qualitative and quantitative aspects of data analysis through optical, thermal, electroanalytical and chromatogrphy techniques.
PSO2: This course, prepared a student for, how to approach a research problem using various instrumentation and data analysis techniques.

PSO3: From DSE Lab: Analytical methods in chemistry, student will learn, how to separate metal ion as well as organic compounds using chromatography and chelation techniques.

PSO4: Ability to develop analytical mind, which helps student to absorb in industry in analytical research work.

B.Sc -Semester VI
Each theory course of Credit 04 (4 hour per week over a semester)
Each practical course of Credit 02 (6 hour per week over a semester)

1. Course Outcome (CO) : (DSE: Organometallics, biorganic chemistry, polynuclear hydrocarbons and UV, IR spectroscopy)

CO1: From Organometallic, student will learn the preparation and properties of 3d metals complexes such as peroxo compounds, organometallic compounds
CO2: From Bioorganic chemistry, student will understand the role of metal ions in biological systems such as stabilization of protein structures.
CO3: From Organic Chemistry section, student will learn the synthesis of polynuclear and heteronuclear aromatic compounds.
CO4: Student will learn various chemical reactions (electrophilic and nucleophilic substitution reactions) of polynuclear and heteronuclear aromatic compounds.
CO5: Students will learn about the applications of spectroscopy (UV-Vis, IR) in characterizing the organic molecules.

2. Course Outcome (CO) : (DSE Lab: Organometallics, biorganic chemistry, polynuclear hydrocarbons and UV, IR spectroscopy)

CO1: From Inorganic Chemistry - Students will learn and carry out preparation of 3d metal complexes
CO2: Carry out separation of 3d metal complexes using chromatography methods such as paper chromatography.
CO3: From Organic Chemistry - Students will learn how to synthesize organic compounds
CO4: Ability for qualitative analysis of organic compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines)

Programme Specific Outcome (PSO) : (DSE theory/ Lab: Organometallics, biorganic chemistry, polynuclear hydrocarbons and UV, IR spectroscopy)

PSO1: DSE laboratory course, student will learn and develop ability to synthesize 3d metal complexes
PSO2: Develop ability to characterize organic compounds using qualitative methods.
PSO3: Ability to develop synthetic and analytical research work, which helps student to absorb in pharmaceutical as well as electronics device industry..

Skill Enhancement Course (Credit: 02 each)- SEC1 to SEC2

Each theory course of Credit 02 (2 hour per week over a semester)

BSc-III sem

1. Course Outcome (CO) : (Skill-SEC-1: Basic Analytical Chemistry)

CO1: Describes concept of sampling, analytical measurement, presentation of experimental data.

CO2: Describes analysis of soil using pH concept and complexometric titration.

CO3: Describes analysis of water of data analysis using thermogravimety, pH concept and BOD and COD techniques.

CO4: Describes analysis of food products like preservatives, adulterants in common food items such as coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

CO5: Describes separation of metal ions using chromatography techniques such as paper and TLC .

CO6: Describes analysis of major and minor components of cosmetics, deodorants, talcum powder and antiperspirants, Al, Zn, boric acid, chloride, sulphate, magnesium oxide, calcium oxide, zinc oxide and calcium carbonate etc.

Programme Specific Outcome (PSO) : (Skill-SEC-1: Basic Analytical Chemistry)

PSO1: **From Basic Analytical Chemistry**, student will learn various analytical measurement and detection of impurities, toxic material in our day to day used common items such as water, cosmetics, foods, soil using pH, chromatography and other analytical techniques.

BSc-VI sem

1. Course Outcome (CO) : (Skill-SEC-2: Green Methods in Chemistry)

CO1: Describes 12 principles of green chemistry with suitable example.

CO2: Describes the real world cases in green chemistry with suitable examples for each principle mention above.

CO3: Students learn to synthesize environmentally safe marine antifoulant, synthetic azo pigments used in dye industry instead of toxic organic and inorganic pigments,

CO4: Green synthesis of a compostable and widely applicable plastic (poly lactic acid) from corn, etc.

Programme Specific Outcome (PSO) : (Skill-SEC-2: Green Methods in Chemistry)

PSO1: From **Skill-SEC-2: Green Methods in Chemistry**, student will learn 12 principle of green chemistry.

PSO2: Identified various factor responsible for environment pollution.

PSO3: Student will learn, how to do green chemistry in our day today life and keep the environment green and pollution free.

Course Outcome (CO) : (Skill-SEC-Polymer Chemistry)

CO1 Introduce the history and classifications of polymers to students.
CO2 To explain the kinetics and mechanisms of polymerization to students.
CO3 The students will learn the morphology of polymers ;crystallinity, and glasstransition temperature.
CO4 The course introduces to the students some aspects of thermodynamics of polymer solutions.
CO5 The students will learn about the physical, thermal, flow and mechanical properties of polymers.

Program Specific Outcome (PSO) : (Skill-SEC-Polymer Chemistry)

PSO1: The program forms a basic foundation in polymer chemistry. It is designed to prepare the student for vocational skill development.

M.Sc. (Semester-I)

Each theory course of Credit 3 (3 hour per week over a semester)

Each practical course of Credit 3 (9 hour per week over a semester)

1. Course Outcome (CO): (SOS/C001-**Inorganic Chemistry - I)**

CO1: Stereochemistry, bonding of inorganic molecules using VSEPR and hybridization theory is explained.

CO2: Metal-ligand complex formation and various factors that affect the rate and stability of complex formation is explained.

CO3: The formation of various types of inorganic complex and the mechanism using valence bond and crystal field theories including electron transfer and conjugate mechanism are explained.

CO4: In this section, using crystal field theory, Jahn-Teller distortion, Molecular Orbital Theory, the metal-ligand complex formation and application to octahedral, tetrahedral and square planar complexes is explained.

2. Course Outcome (CO) : (SOS/C002-**Organic Chemistry - I)**

CO1: Aromaticity in organic molecules using Huckel's theory is explained.

CO2: Stereochemistry and stereoisomers (conformational and configurational isomer), in organic molecules such as cyclohexane, carbohydrate and its derivatives containing heteroatoms and synthesis and reactivity of stereoisomer is explained.

CO3: Organic reactions and their mechanism using Hammond's postulate and Curtain-Hammett principle is explained. This includes the structure and reactivity of a substrate molecule with respect to transition states and intermediates.

CO4: Aliphatic nucleophilic substitution reactions and their mechanism, the effect of substrate, solvent, nucleophile and leaving group on the rate and yield of an aliphatic nucleophilic substitution reaction is explained.

CO5: Aliphatic electrophilic substitution reactions and their mechanism, the effect of substrate, solvent, electrophile and leaving group on the rate and yield of an aliphatic electrophilic substitution reaction is explained.

3. Course Outcome (CO) : (SOS/C003-**Physical Chemistry - I)**

CO1: **"Quantum Chemistry:Introduction to Exact Quantum Mechanical Results",** describes quantum mechanics, theory and principle using Eigen function, Schrodinger wave equation and by taking examples of hydrogen and helium atom. To develop a basic foundation of quantum chemistry which at advanced level is required for developing computational methods to explain or predict results from an experimental route.

CO2: **Quantum Chemistry: Approximate Methods** To stepwise approach the solutions for wave functions for hydrogen and hydrogen like atoms through advanced arithmatics.To develop a basic foundation of quantum chemistry which at advanced level is required for developing computational methods to explain or predict results from an experimental route.

CO3: **"Quantum Chemistry: Angular momentum"** To introduce the concept of spin and angular momentum amongst students.

CO4: **" Quantum Chemistry: Electronic Structure of Atoms"** To learn the electronic structure of atoms.

CO5: **Surface Chemistry: Adsorption"** describes surface chemistry of micelle and macromolecules. The course intends to equip the students to pursue research oriented studies in the field of nanotechnology and in designing catalytic and kinetic experiments with Surface Chemistry :Adsorption.

CO6: **"Thermodynamics: Classical Thermodynamics"** contains introduction to classical thermodynamics, laws of thermodynamics, non-ideal solution It is designed to build a better understanding of the world around us with topics in Thermodynamic like spontaneous processes, non spontaneous processes, chemical potential and free energy change.

4. Course Outcome (CO) : (SOS/C004-**Group Theory & Spectroscopy)**

CO1: Symmetry in organic and inorganic molecules, point group, various symmetry elements and character tables is explained.

CO2: Electromagetic radiation (EMR), and their different types of interaction with matter such as absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering properties of EMR is explained.

CO3: Application of EMR, atomic electronic spectroscopy is explained with suitable examples such as hydrogen and alkali metal atoms.

CO4: Microwave spectroscopy, principle and application, effect of substituent on the transition frequency, intensity of a molecule is explained.

CO5: Infrared spectroscopy, principle and selection rule for a vibrational transition, type of

vibrational stretching, effect of bond strength and functional group on the vibrational frequency and intensity of a molecule is explained.

5. Course Outcome (CO) : (SOS/C005-**Laboratory Course-IA)**

CO1: In Inorganic Chemistry laboratory course, student will perform qualitative analysis of mixture of six cation and six anions.

CO2: In Organic Chemistry laboratory course, student will separate, purify binary mixture of organic compounds using chromatography techniques and identify through chemical and spectroscopy methods

6. Course Outcome (CO) : (SOS/C006-**Laboratory Course-IB)**

CO1: In Inorganic Chemistry laboratory course, student will learn and perform various separation techniques such as paper, thin layer and ion exchange chromatography that are used to separate cations and anions from the inorganic mixture.

CO2: In Organic Chemistry laboratory course, student will learn and perform the synthesis of few organic compounds using acetylation, oxidation, Grignard reaction and Sandmeyer reaction.

COs of the course Lab "SOS/ C005 (Laboratory Course-IA and SOS/ C006 (Laboratory Course-IB): Physical Chemistry Paper-I"

CO 1 To train the students in handling laboratory equipments like conductivity meter through experiments in conductance measurements.

CO 2 To learn quantitative methods of analysis like determining the strength of strong and weak acids in a given mixture conductometrically.

CO 3 To obtain the rate constant of acid hydrolysis of an ester through volumetric titrations.

CO 4 To understand the concept of solubility product by finding the solubility product of sparingly soluble salts like barium sulphate and lead sulphate conductometrically.

CO 5 To introduce them to scientific writing and collecting data from handbooks.

Programme Specific Outcome (PSO) :

PSO1: From Inorganic Chemistry-I, student will learn, the importance of stereochemistry of

inorganic compounds, structure, reactivity and mechanism, various theories of Metal-ligand complex formation and its various limitations.

PSO2: From Organic Chemistry-I, student will learn, the importance of stereoisomer, structure, reactivity and mechanism in aliphatic compound (cyclic and acyclic).

PSO3: From Physical Chemistry - I, student will learn, quantum mechanics, classical thermodynamics, their importance and applications, surface phenomena of micelle and macromolecules.

PSO4: From Group Theory & Spectroscopy, student will learn, the nature of EMR and its interaction with matter. Further, how this interaction is used to characterized various vibrational, rotational and electronic transition of an atom and a molecule using Atomic electronic spectroscopy, Microwave spectroscopy and Infrared Spectroscopy. Student also learn, how EMR-matter interaction is highly dependent upon the symmetry of a molecule.

PSO5: From Lab IA, student will learn, how to identify inorganic and organic compounds by qualitative analysis and acquainted with various physical methods of determining kinetic parameters of a chemical reaction. The students are introduced to scientific writing and collecting data from handbooks.

PSO6: From Lab IB, student will learn and used, various separation techniques to separate mixture of inorganic cations and anions, Also acquainted with synthesis of organic compounds, and gain knowledge of determining kinetic parameters of a chemical reactions using conductance methods.

M.Sc. Semester-II

Each theory course of Credit 3 (3 hour per week over a semester)

Each practical course of Credit 3 (9 hour per week over a semester)

1. Course Outcome (CO) : (SOS/C007-Inorganic Chemistry - II)

CO1: Student will learn electronic spectra and amp, magnetic properties of transition metal Complexes,

CO2: Bonding, preparation and properties of metal-π-complexes and organometallic Compounds,

CO3: Reactivity, bonding and topology of boranes,

CO4: Wade's rules for the classification of Carboranes, metalloboranes and metallocarboranes and their properties,

CO5: Principles of silicates their structure, classification and use in the development of technology.

2. Course Outcome (CO) : (SOS/C008-**Organic Chemistry - II)**

In this course, students will learn

CO1: Different types of aromatic electrophilic substitution reaction and the factors that affect the reaction

CO2: Different types of aromatic nucleophilic substitution reaction with examples and the factors that affect the reaction

CO3: Free radical substitution reaction with examples.

CO4: C=C and C=X addition reactions with examples.

CO5: Different types of pericyclic reactions, their mechanism and reactivity.

3. Course Outcome (CO) : (SOS/C009-Physical Chemistry - II)

CO1: "Chemical Dynamics", This course will introduce advance theories in Chemical Kinetics to students including Unimolecular Theory.- Hinshelwood, Lindmann, RRK and RRKM theories. teaches students about steps involved in various chain mechanisms and deriving their rate constants.

CO2: "Statistical Thermodynamics", is designed to undersand a system of many molecules and deriving their microstates and thermodynamic properties through statistical treatment. To learn

Fermi dirac statistics, Bose Einstein Statistics and Maxwell Boltzmann statistics with their applications

CO3: "Non-Equilibrium Thermodynamics" aims to introduce the principles of nonequilibrium thermodynamics with examples.

CO4: "Electrochemistry" aims to learn the various spheres of application of electrochemistry like double layers in colloids, electrocatalysis, corrosion, polarography etc.

4. Course Outcome (CO) : (SOS/C010- **Spectroscopy and Separation methods)**

In this course students will learn

CO1: Principle and application of Molecular electronic spectroscopy and their application.

CO2: Principle and application of Raman spectroscopy their application.

CO3: Principle and application of Nuclear magnetic resonance spectroscopy and their application in characterizing organic molecules

CO4: Principle and application of chromatography methods such as gas liquid chromatography.

5. Course Outcome (CO) : (SOS/C011-**Laboratory Course-IIA)**

CO1: In Inorganic Chemistry Laboratory course, student will learn and perform qualitative analysis of two metal ions using volumetric and gravimetric analysis.

CO2: In Organic Chemistry Laboratory course, student will learn to synthesize organic compounds based on aromatic electrophilic substitution reactions such as nitration, bromination, etc.

CO3: In Physical Chemistry Laboratory course, student will learn how to determine molecular weight of non-volatile electrolyte and degree of ionization of electrolyte.

6. Course Outcome (CO) : (SOS/C012-**Laboratory Course-IIB)**

CO1: In inorganic chemistry laboratory course, students will synthesize selected inorganic complexes

CO2: In organic chemistry laboratory course, student will perform quantitative analysis to determine number of hydroxyl groups in a organic compounds, presence of phenol, amine, saponification values etc.

CO3: In physical chemistry laboratory course, student will determine strength of acids, dissociation constant, thermodynamic parameters using potentiometry methods.

Programme Specific Outcome (PSO) :

PSO1: Inorganic Chemistry-II: This course will help the students to understand the important properties of transition metal complexes, properties of metal-carbon bond and applications of silicates in technology. Student will get opportunity to absorb in industry.

PSO2: Inorganic Chemistry-II: This course will be also useful for students to extend their basic concepts of inorganic chemistry to a more advance level.

PSO3: Organic Chemistry-II: Students will learn organic reaction, their mechanisms, reactivity and help them to absorb in pharmaceutical industry.

PSO4: Spectroscopy and Separation methods :This course help to learn various spectroscopic and chromatography techniques for characterizing and separating organic and inorganic molecules. This help student to get absorb in analytical chemical industry.

PSO5:From laboratory course, students will able to analyze metal ions using volumetric and gravimetric analysis, synthesize simple organic compounds, synthesize inorganic complexes and able to determine the functional group in organic compounds using quantitative

M.Sc. (Semester-III)

Each theory course of Credit 3 (3 hour per week over a semester)

Each practical course of Credit 3 (9 hour per week over a semester)

1. Course Outcome (CO) : (SOS/E002-**Bioinorganic, Bioorganic, Biophysical Chemistry-I)**

CO1: Bioinorganic Chemistry-I, describes the role metal ion in biology, particularly Na/K pump, chlorophylls, photo system I and photo system II and Heme proteins.

CO2: Bioorganic Chemistry-I, describes various enzymes with mechanism of action such as chymotrypsin, ribonuclease, Enzyme catalyzed carboxylation and decarboxylation, nucleophilic displacement reaction, isomerization, etc.

CO3: Biophysical Chemistry-I, introduces, structure, function of cell membrane and ion transport mechanism. Understanding the biological reaction such as ATP hydrolysis through various biophysical parameters.

2. Course Outcome (CO) : (SOS/E005-**Spectroscopy and Solid State)**

CO1: Students will learn various electronic transition of organic compounds such as carbonyls and olefin compounds and the effect of solvent and substituent on the electronic transition of organic molecules.

CO2: Students will learn about the vibrational frequencies of aliphatic and aromatic compounds such as hydrocarbons, amine, carbonyls compound and the effect of solvent and hydrogen bonding on their vibrational frequency is studied.

CO3: This course introduces two new spectroscopy, Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD) to students, which help them to characterize organic molecules.

CO4: Students will learn theory of various solid state reaction and kinetics parameters. This includes organic solids, fullerene and molecular devices such as organic superconductors, molecular rectifiers, transistors, artificial photosynthetic devices, molecular memory, switches and sensors using organic charge transfer, magnetism, doped methods, etc.

3. Course Outcome (CO) : (SOS/E006-Organometallic Reagents and Organic Synthesis)

CO1: Students will learn various reagents based on organometallic compounds that are used in organic synthesis. The metals used are Li, Hg, Pd, Ni, Cr, Si and B.

CO2: Students get information about the application of organometallic reagents as an oxidizing agents in organic synthesis. This includes oxidation of carbonyls, carboxylic acids using

organometallic compounds with Th, Ru metal ions.

CO3: In this course, various reducing reagents will be explained to students that are used in the synthesis organic compounds such as carbonyls, alkene, alkynes, nitro, azo compounds.

CO4: This describes synthesis of organic compounds through rearrangement reactions.

CO5: Synthesis and reactions of some polycyclic organic compounds such as non-benzenoid and polycyclic aromatic compounds are explained.

4. Course Outcome (CO) : (SOS/C018-**Organic Synthesis and Photochemistry)**

CO1: Retro-synthesis of organic compounds will be explained to the students. This includes C-X disconnection approach, order of events, selectivity and specificity in synthesis.

CO2: Various protecting groups for alcohol, carboxylic acid, carbonyl compounds and their importance in organic synthesis is explained.

CO3: Retro-synthesis of organic compounds with C-C disconnection approach is explained. This includes synthesis of target molecule using acetylene and nitro compounds.

CO4: Various photo-processes and their mechanism is explained. It also contain various photochemical reaction and determination of parameters such as rate of reaction, rate constant, etc.

CO5: Various photochemical reaction of olefin and carbonyl compounds such as 1,4-and 1,5-dienes, saturated cyclic and acyclic, β,γ-unsaturated and α,β-unsaturated compounds is explained to the students.

5. Course Outcome (CO) : (SOS/C016-**Laboratory Course-Org IIIA)**

CO1: From **Laboratory Course-Org IIIA,** students will learn various separation techniques such as chromatography methods and purify and identify organic components.

6. Course Outcome (CO) : (SOS/C017-**Laboratory Course-Org IIIB)**

CO1: **Laboratory Course-Org IIIB**, students will learn multi-step synthesis of organic compounds based on their syllabus.

CO2: This includes Benzopinacolone and Benzanilide from Benzophenone,

CO3: Benzilic acid from Benzoin, Quinoline from aniline and indole from phenylhydrazine,

CO4: Alkylation of diethylmalonate using microwave in presence of alkyl and benzyl halide.

Programme Specific Outcome (PSO) :

PSO1: From **Bioinorganic, Bioorganic, Biophysical Chemistry-I**, student will gain knowledge of role of metal ion in the structure, function of metalloprotein, mechanism of action of various enzymes through their kinetic studies and understand the biological processes through various biophysical parameters.

PSO2: From **Spectroscopy and Solid State**, student will learn, principle and theory of electronic and vibrational transitions in organic molecules, solid state reaction and application of organic material in molecular devices such as memory, switches, sensors, conductors, etc.

PSO3: From **Organometallic Reagents and Organic Synthesis**, student will learn, the application of organometallic reagents in various oxidative and reductive reaction in organic synthesis. Student also learn various synthetic method to obtained benzenoid and non-benzenoid aromatic compounds.

PSO4: From **Organic Synthesis and Photochemistry**, student will learn, how to synthesized a organic molecules using retro-synthetic techniques and use of protection and deprotection of functional group. In 2nd part, student will learn various photochemical reaction and their mechanism. This will help them to synthesize organic molecule through photochemical reaction.

PSO5: From **Laboratory Course-Org IIIA**, student will learn, how to separate and identify organic compound from three mixtures of compounds by chromatography and spectral analysis.

PSO6: From **Laboratory Course-Org IIIB**, student will learn, how to work with multi-step organic synthesis and acquainted with various reagents and reaction conditions. This will help then to get absorn in pharmaceutical/ chemical industry.

M.Sc. Semester-IV

Each theory course of Credit 3 (3 hour per week over a semester)

Each practical course of Credit 3 (9 hour per week over a semester)

Organic Chemistry

1. Course Outcome (CO) : (SOS/E009- Spectroscopy)

Students will learn

CO1: The principle, theory, function and application of electron spin resonance spectroscopy

CO2: The principle, theory, function and application of nuclear magnetic resonance spectroscopy,

CO3: The principle, theory, function and application of mass spectrometry

CO4: The principle, theory, function and application of photoelectron spectroscopy.

CO5: In this course, student develop ability to characterize organic and inorganic molecules using above spectroscopy techniques.

2. Course Outcome (CO) : (SOS/E010- Bioinorganic, Bioorganic, Biophysical Chemistry-II)

CO1: In Bioinorganic Chemistry-II, the role of electron transfer, nitrogen fixation in biology is explained by giving suitable example of metallo proteins.

CO2: In Bioorganic Chemistry-II, student will learn about the function and action of various enzymes and co-enzymes and enzyme models.

CO3: In Biophysical Chemistry-II, student will learn the structure, function of biopolymer and forces involve in their interactions.

CO4: This course provides students, an understanding about the biological sciences, and its biotechnological application. Students will get opportunity to absorb in pharmaceutical and biochemical industries.

3. Course Outcome (CO) : (SOS/C027-Natural Products)

In this course, students will learn the

CO1: Isolation, properties, and structure determination of natural products in the series of terpenoids and carotenoids (abietic acid and β-carotene)

CO2: Isolation, properties, and structure determination of natural products in the series of alkaloids (ephedrine, quinine),

CO3: Isolation, properties, and structure determination of natural products in the series of steroids (cholesterol and bile acids).

CO4: Synthesis of few natural products such as Prostaglandins (PGE_2 and PGF_{2a}), haemin

pigments.

CO5: By completion of this course, student develop ability to understand the isolation and characterization of natural product. This also help to develop research ability in natural product for higher study.

4. Course Outcome (CO) : (SOS/E013- Heterocyclic Chemistry**)**

In this course, students will learn

CO1: The nomenclature of aromatic and non-aromatic heterocyclic compounds (small ring, five, six, seven and large member heterocycles).

CO2: The synthesis, reaction and properties of heterocyclic compounds (small ring, five, six, seven and large member heterocycles).

5. Course Outcome (CO) : (SOS/C025-**Laboratory Course-Org IVA)**

CO1: In Laboratory Course-Org IVA, student will extract organic compounds from natural sources such as isolation of caffeine from tea leaves, casein and lactose from milk, piperine from black pepper, lycopene from tomatoes, b-carotene from carrots, etc.

CO2: Develop ability to isolate and characterize the natural product.

CO3. Student gain knowledge of separating organic compounds using paper chromatography.

6. Course Outcome (CO) : (SOS/C026-**Laboratory Course-Org IVB)**

CO1: In Laboratory Course-Org IVB, through spectral data, (1H NMR, FTIR, Mass, etc), student will identify the unknown organic compounds

CO2: Student will estimate the concentration of natural products such as amino acids, proteins, carbohydrate, etc using spectrophotometric methods (UV/Vis).

Programme Specific Outcome (PSO) :

PSO1: Students will learn the principle, theory, function and application various spectroscopic techniques and their used in characterizing organic and inorganic molecules.

PSO2: Students gain knowledge in biological sciences. This help them in working with the biotechnological application.

PSO3: The ability to understand the structure, function and isolation of natural products.

PSO4: Students gain knowledge of synthesis and properties of aromatic and non-aromatic heterocycles compounds.

PSO4. Ability to identify and develop future drugs molecule in pharmaceutical industry

Inorganic Chemistry

1. Course Outcome (CO): SOS/C022-Laboratory Course-Inorganic. IVA

CO1: This course includes: Spectrophotometric determinations of

(a) Manganese/chromium/vanadium in steel sample.

(b) Nickle/molybdenum/tungsten/vanadium/uranium by extractive Spectrophotometric method.

(c) Fluoride/nitrite/phosphate.

(d) Iron-phenanthroline complex: Job's Method of continuous variation.

(e) Zirconium-alizarin Red-S complex: Mole-ratio method.

(f) Copper-ethylene diamine complex: Slope –ratio method.

CO2: Flame photometric determinations of

(a). Sodium and Potassium when present together.

(b). Lithium/Calcium/barium/strontium.

(c). Cadmium and magnesium in tap water.

2. Course Outcome (CO): SOS/C023-Laboratory Course-Inorganic. IVB

CO1: This course describes the following practicals: Nephelometric determinations of

(a). Sulphate

(b). Phosphate

(c). Silver

CO2: Chromatographic separations: Paper or TLC and determination of Rf values of

(a). Cadmium and Zinc.

(b). Silver, Lead and Mercury.

(c). Nickel, Magnesium, Cobalt and Zinc.

3. Course Outcome (CO) : (SOS/C024-Inorganic polymers)

CO1: This course is designed to describe Inorganic polymer synthesis and their characterization by various methods,

CO2: Synthesis of main group polymer by various condensation methods and polymerisation.

CO3: It also includes applications of inorganic polymers in various fields.

Programme Specific Outcome (PSO):

PSO1: Inorganic polymers: This course demonstrates various aspects of inorganic polymers used in different areas. Being an exciting research field, It will be able to attract the mind of young students to explore the usefulness of inorganic polymers.

PSO2: Inorganic laboratory course- IVA, This course will enhance the practical ability of students with an understanding of spectrophotometric and flame photometric techniques

PSO3: Inorganic laboratory course-IVB, This course will give an understanding of Nephelometric technique and Chromatographic separations methods.

Physical Chemistry

Course Outcome (CO) : (ADVANCED QUANTUM CHEMISTRY)

CO1 To develop a knowleddge of quantum chemistry which at advanced level is required for developing computational methods to explain or predict results from an experimental route.

CO2 To stepwise approach the solutions for wave functions for hydrogen and hydrogen like atoms through advanced arithmatics.

CO3 To learn the electronic structure theories like Hartree-Fock and self consistent field theory

CO4 Introduction to correlated methods: Configuration Interaction (CI), Many-body perturbation theory (MBPT) and Coupled-cluster theory

Programme Specific Outcome (PSO) : (Advanced Quantum Chemistry)

PSO1: To introduce advanced aspects of quantum mechanics, theory and principle which can help the students in pursuing higher research.

DEPARTMENT OF ZOOLOGY

PROGRAM OUTCOMES, PROGRAM SPECIFIC OUTCOMES AND COURSE OUTCOMES

B.Sc. (Zoology)

PROGRAM OUTCOME	PROGRAM SPECIFIC OUTCOME	Name of course	COURSE OUTCOME
The students will have the basic knowledge of structure and function of animal body.	After graduation, the student may opt for various competitive exams to get higher jobs (IAS, IFS, PCS).	**Core papers** 1. Animal Diversity **(1st semester)** 2. Comparative Anatomy and Developmental Biology **(2nd semester)** 3. Physiology and Biochemistry **(3rd semester)** 4. Genetics and Evolutionary Biology **(4th semester)**	1. Basic knowledge of Biodiversity 2. Basic idea of structure, function & development of internal parts of body 3. Knowledge of function mechanism of body systems and Chemical processes taking part there in. 4. Knowledge of origin and evolution of life forms, mechanism of genesis and variations.
		Discipline specific courses 1. Molecular Biology 2. Applied Zoology	1. Basic knowledge of body building molecules, their complexity, and working mechanism 2. Applied and economic aspect of animals, diseases caused and remedies, etc.
		Skill enhancement courses 1. Pisci-culture 2. Apiculture	Skill enhancement courses related to fish and honeybee culture. Will help one to get self employment.

NAME OF PROGRAM	PROGRAM OUTCOME	PROGRAM SPECIFIC OUTCOME	Name of course	COURSE OUTCOME
M.Sc (Zoology)	To get an expertise in Animal Science	Basic requirement for entering into HES	**Semester I** Animal Diversity I – (Lower Non-chordata)	Basic knowledge of Biodiversity related to lower non chordates
			Cell Biology & Molecular Biology	Knowledge of how basic life unit functions and Basic knowledge of complexity, and working mechanism body building molecules.
			Genetics, Evolution & Taxonomy	Idea of nomenclature and classification of animals. Knowledge of origin and evolution of life forms, mechanism of genesis and variations.
			Developmental Biology & Parasitology	It provides knowledge of reproduction and embryo development. Parasitology enriches our knowledge of parasites, diseases caused by them and preventive measures.
			Lab Course I (Paper 1,2)	It provides practical training related to animal diversity and cell and molecular biology
			Lab Course II (Paper 3,4)	It provides practical training related to Genetics, Evolution & Taxonomy, embryology and parasitology
		2nd semester	Animal Diversity-II (Higher Non-Chordata)	Basic knowledge of Biodiversity related to higher non chordates
			Animal Physiology and Toxicology	Knowledge of function mechanism of body systems and Chemical processes taking part there in. Toxicology enhances our knowledge of toxic substances and their action mechanism
			Instrumentation, Computer Application and Biostatistics	Students learn about SOP of various instruments, analytical tools and computer knowledge
			Elementary Biotechnology & Microbiology	Learning of use of techniques for the welfare of society. Importance of DNA and study of microbes.

			Lab Course I (Paper7,8)	It provides practical training related to Non chordates, animal physiology and toxicology
			Lab Course II (Paper (9-10)	It provides practical training related to Instrumentation, Computer Application Biostatistics, Biotechnology and Microbiology
M.Sc (Zoology)		3rd semester	Animal Diversity (Chordata)	Provides basic knowledge of structure and physiology of Chordtes.
			Ecology & Wildlife	Learning of ecosystem and knowledge of wildlife of India and its importance to human kind.
			Lab Course (Core Papers)	It provides practical knowledge on Chordates, ecology and wildlife.
			Fish Biology I	Knowledge of structure , classification and functioning of various systems in a fish.
			Fish Biology II	Knowledge of structure , classification and functioning of various systems in a fish.
			Lab Course II (Specialisation)	It provides practical knowledge on fish biology
		Self study	Biological & Radiotracer Techniques	Student knows about how the radiotracer techniques are used in biology.
			Aquatic Biodiversity	Provides knowledge of aquatic organisms and their structural and functional diversity.
		4th semester	Endocrinology & Animal Behaviour	Provides knowledge of working mechanism of endocrine glands and different behaviors performed by the animals.
			Biochemistry & Immunology	Knowledge of various chemical processes of the body and mechanism of body defense system
			Fisheries Science	Gives knowledge about Applied and commercial aspect of fishery. Culture and Capture fishery

			Methodology in Fisheries Science	Student learns about different methods used for biological study of fish
			Lab Course I (Core Papes)	It provides practical knowledge on fisheries science
			Lab Course II (Specialization)	It provides practical knowledge on methodology in fishery science.
			Dissertation (in place of Paper 4^{th} and Lab Course II)	It provides an opportunity to students to know how research project is undertaken and evaluated. Enhances critical assessment ability nof the student.

B.Sc. (Botany) Programme

COURSE OUTCOME

Core Courses
After studying the core courses, the students will be able to:

C-1 Biodiversity (Microbes, Algae, Fungi and Archegoniate)

CO 1	Update their understanding about the structure, types, reproduction and economic importance of Viruses and Bacteria.
CO 2	Know about the definition, types, general characteristics and economic importance of algae.
CO 3	Answer about the general characteristics, range of thalli, cellular composition, and mode of nutrition, reproduction and economic importance of fungi.
CO 4	Address the questions related to the origin of primitive land plants as also about the evolution of vascular cryptogams.
CO 5	Describe the thallus structure, anatomy and classification of *Riccia* and *Marchantia*. The economic importance and ecology of bryophytes in special reference of *Sphagnum*.
CO 6	• Discuss the general features, classification, morphology, reproduction, and the concept of alternation of generation in pteridophytes. • Describe about the heterospory, stellar evolution, ecology and economic importance of pteridophytes.
CO 7	Enhance their knowledge about the general characteristics, classification, morphology, anatomy, ecological and economic importance of Gymnosperms.

C-2 Plant Ecology and Taxonomy

CO 1	Understand the basic concepts of the plant ecology and plant taxonomy.
CO 2	Understand the effects of various ecological factors on plant growth, the concept of law of minimum and law tolerance, and ecological adaptations of hydrophytes and xerophytes.
CO 3	Learn about the characters and types of plant communities as also about the concept of ecotone and succession.
CO 4	Discuss about the various important points related to the ecosystem functioning such as food chain, food webs, and biogeochemical cycling.
CO 5	Learn the basic concept of 'Phytogeography' and to define 'Endemism' and concept and principles of biogeographical zones.
CO 6	Discuss the tenets and the advanced aspects of the plant taxonomy, the role of Palynology, Cytology, Phytochemistry and Molecular Biology in plant taxonomy, Identification, Classification and Nomenclature of plant species, and new approaches of plant taxonomy such as, numerical taxonomy and cladistics.

C-3 Plant Anatomy and Embryology

CO 1	Discuss about the general features, origin and functions of simple and permanent tissues.
CO 2	Discuss about the anatomical features of monocot and dicot roots, stems and leaves, importance of cambium in secondary growth and wood development and to distinguish

	between the heartwood and sapwood.
CO 3	Learn the functions of Epidermis, Cuticle and Stomata and to describe the various key features of adaptations of xerophytes and hydrophytes to their respective habitats.
CO 4	Discuss about the structure and functions of male and female reproductive parts of the flowers as also the importance of Double fertilization and seed development.
CO 5	Develop understanding about the general types, structure and functions of Embryo and Endosperm, phenomenon of apomixes and polyembryony and to distinguish between dicot and monocot embryos and endosperms.

C-4 Plant Physiology and Metabolism

CO 1	Discuss about the water potential, transpiration, root pressure and guttation.
CO 2	Discuss about the macro and micronutrients, role of cell membrane in transport of ions and to distinguish between active and passive transport.
CO 3	Understand the mechanisms related to the function of phloem.
CO 4	• Discuss the role of photosynthetic pigments in photosynthesis, • Distinguish between Light reaction and Carbon fixation reaction • Discuss the structure and functions and Photosystem I and II, • Describe the importance of electron transport system in conservation of energy in the form of reducing power and ATP synthesis, • Discuss the mechanism of ATP synthesis, • Discuss about the three different pathways of carbon fixation reaction in reference to overcome the harmful effects of photorespiration.
CO 5	• Discuss the steps and importance of Glycolysis, • Discuss the steps and importance of TCA, • Distinguish between aerobic and anaerobic respiration, • Discuss the mechanism of oxidative phosphorylation and • Discuss the importance of Oxidative Pentose Phosphate Pathway
CO 6	Discuss the structure, properties and action mechanisms of the enzymes.
CO 7	Discuss about the biological nitrogen fixation and assimilation of the fixed nitrogen in cell physiology.
CO 8	Learn about the importance of Auxins, Gibberellins, Cytokinins, ABA and ethylene in regulating the morphogenetic processes in the plants.
CO 9	Learn the red and far-red light responses of plant morphogenesis and describe photoperiodism, vernalization and the roles of various photoreceptor molecules, particularly, phytochromes.

Discipline Centric Elective Courses

After studying the discipline specific elective courses, the students will be able to:

DSE-1 Cell and Molecular Biology

CO 1	Learn the principles and details of using light and electron microscopes and the role of X-ray diffraction in studying the structures of cellular organelles and biomolecules.
CO 2	• Discuss the cell theory, • Distinguish between prokaryotic and eukaryotic cells, • Structure and functions of various cell organelles.

CO 3	Update the understanding of students about the structure and functioning of various cell organelles like mitochondria, chloroplast, ER, lysosomes, peroxisomes, glyoxisomes and nucleus.
CO 4	Describe the selective permeability of cell membrane and the utility of cell wall in physiology and plant protection.
CO 5	Address the various questions related with mitosis, meiosis and molecular control of the cell cycle.
CO 6	Learn the structure and replication of DNA as also the roles various enzymes that take part in replication.
CO 7	Learn the various types of RNA as also their functions in transcription process.
CO 8	Acquire the knowledge about the gene expression process and its tight regulations during cell functioning.

DSE-2 Economic Botany and Biotechnology

CO 1	Discuss about the concept of center of origin of cultivated plants in the light of the work of Vavilov.
CO 2	The CO covers the economic importance of cereals with special mention to Wheat. The students are expected learn about the origin, morphology and uses of Wheat.
CO 3	Study about the general account of legumes with special reference to Gram and Soybean.
CO 4	The CO covers economic importance of Spices. Providing a general account of various types of spices, it is expected from this CO that students will be able to discuss the specialized points related to the uses, origin and cultivation of Clove and Black Pepper.
CO 5	Discuss the origin, morphology, cultivation and processing of tea.
CO 6	Provide a general description of oils and fats yielding crops.
CO 7	Discuss about the family, uses, center of origin and cultivation of various fibre yielding plants with special focus to Cotton.
CO 8	Learn the basics of Biotechnology and to discuss about the concept of old and new Biotechnology.
CO 9	Learn the key concepts and applications of following: • Micropropagation • Angrogenesis • Gynogenesis • Embryo Culture and • Endosperm Culture
CO 10	Discuss about the Blotting techniques, DNA fingerprinting, Polymerase Chain Reaction, Molecular markers, Hybridoma technology, ELISA, Molecular diagnosis of human diseases and Human gene therapy.

DSE-3 Genetics and Plant Breeding

CO 1	• Describe brief history of discovery of Mendel's work • Describe the various terminologies of classical genetics • Discuss the modified Mendelian Ratios such as Co-dominance and incomplete dominance • Perform pedigree analysis • Discuss about cytoplasmic inheritance

	• Discuss the phenomena of multiple allelism and pleotropism • Discuss about the chromosomal theory of inheritance
CO 2	Understand about the underlying concepts of Sex-determination, and Sex-linked inheritance of the traits.
CO 3	Answer questions related to the complete and incomplete linkages, linkage maps, and concept, significance and cytological proofs of crossing over.
CO 4	Discuss about the types of mutations, mutagens as also about the various types of numerical and structural changes of chromosomes.
CO 5	Discuss about the important objectives of the plant breeding.
CO 6	Understand the concept of domestication and to describe the procedure, advantages and limitations of various crop improvement methods used for self-pollinated, cross pollinated and vegetatively propagated crops.
CO 7	Discuss the concept and mechanism of quantitative inheritance and to understand the differences between monogenic and polygenic control of traits.
CO 8	Understand the key difference between heterosis and inbreeding depression and will also be able to discuss about the genetic basis and applications of these two phenomena in crop improvement.
CO 9	Describe the importance of mutation, distant hybridization and genetic engineering in plant breeding.

DSE-4 Analytical Techniques in Plant Sciences

CO 1	Discuss the uses of various types of microscopy, staining, shadow casting and other related techniques in biological research.
CO 2	Understand the principles of different types of centrifugation and ultracentrifugation techniques, which are very common for cell fractionation.
CO 3	Describe the principles and the uses of radioisotopes in biological research.
CO 4	Know the uses of spectrophotometry in studying the biological samples.
CO 5	Describe the applications of paper chromatography, column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, molecular sieve chromatography and affinity chromatography.
CO 6	Discuss about the principles and technicality of Mass spectroscopy, X-ray diffraction, X-ray crystallography and various types of electrophoresis techniques.
CO 7	Discuss about the arrangement, graphical and tabular representation, and various types of statistical analysis of data.

DSE-5 Bioinfromatics

CO 1	Know the aim, scope and research area of bioinformatics.
CO 2	Discuss about the classification format of biological databases.
CO 3	Learn the tools and applications of NCBI and other databases.
CO 4	Learn about Multiple Sequence Alignment, Scoring Matrices, Percent Accepted Mutation etc.
CO 5	Prepare and predict the molecular phylogenetic relationships of the taxa.
CO 6	Discuss the uses of bioinformatics in drug discovery, drug design, microbial genome study and in crop improvement.

DSE-6 Research Methodology

CO 1	Distinguish between

	• research methods and methodology, • descriptive and analytical research, • applied and fundamental research, • quantitative and qualitative research and • conceptual vs empirical research.
CO 2	Know the general laboratory practices and acquire the knowledge about the common toxic chemicals and safety measures during their handling.
CO 3	Inculcate the art of data collection and documentation of observations among the students.
CO 4	Give an overview of biological problems in identifying thrust research areas and important model organisms of Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology and genome and proteome research.
CO 5	Learn the technical aspects and essential requirements of tissue culture technology.
CO 6	Explain about the staining procedures, classification of stains and uses of dyes and flurochromes in molecular biology and cytology research.
CO 7	• Learn preparing ppts and writing abstract, abbreviations, nomenclature and references and • Discuss about the copyright violation, plagiarism and ethics of the research.

Skill Enhancement Courses

After completing the Skill Enhancement Courses, the students will be able to:

SEC-1 Biofertilizers

CO 1	Learn isolation, identification and mass multiplication of Rhizobium.
CO 2	• Discuss isolation and mass multiplication of *Azospirillum* and *Azotobacter* • Describe the classification, characteristics and culture maintenance of above-mentioned organisms.
CO 3	• Discuss the importance of cyanobacteria in free and symbiotic nitrogen fixation and • Describe the uses of cyanobactria in paddy cultivation
CO 4	• Discuss the role of mycorrhizal associations in influencing the growth and yield of crop plants. • Describe the types, taxonomy, occurrence and distribution of mycorrhiza
CO 5	Learn about the green manuring, organic fertilizers, recycling of biodegradable waste materials, and methods of making biocompost and vermicomposts.

SEC-2 Herbal Technology

CO 1	• Describe history, scope, importance, and approaches of herbal medicine, • Discuss about the roles of medicinal plants in Siddha Systems of medicine, • Discuss about the cultivation, harvesting, processing, storage, marketing and utilization of medicinal plants.
CO 2	Discuss the systematic position and medicinal uses of some important plants like Tulsi, Ginger, Fenugreek, Indian Goose Berry and Ashoka.
CO 3	Discuss the active principles, methods of testing, identification and utilization of following herbs: • *Catharanthus roseus*

	• *Withania somenifera* • *Clerodendron phlomoides* • *Centella asiatica*
CO 4	Describe the following aspects: • Drug adulteration- types and methods of drug evaluation • Biological testing of herbal drugs for secondary metabolites
CO 5	Discuss the micropropagation techniques of important species and future of pharmacognosy.

SEC-3 Nursery and Gardening

CO 1	• Describe the definition, objectives and scope of Nursery and Gardening • Discuss the building up of infrastructure, planning and seasonal activities necessary for Nursery and Gardening.
CO 2	• Discuss about the structure and types of side, • Describe the seed dormancy, causes and methods of breaking dormancy, • Discuss the concept of seed bank, factors affecting seed viability and genetic erosion and • Discuss about the seed production technology, seed testing and certification
CO 3	Discuss about the methods of vegetative propagation.
CO 4	Discuss about the definition, objectives and scope of different types of gardening Describe the key steps of gardening operations including application of computer technology in landscaping.
CO 5	Discuss the sowing and raising of seeds and seedlings, transplanting and cultivation of seedlings and marketing procedures of the following vegetables: • Cabbage • Brinjal • Lady's finger • Onion • Garlic • Tomato • Carrot

SEC-4 Floriculture

CO 1	Discuss the history, importance and scope of floriculture and landscape gardening.
CO 2	Discuss the nursery management and routine activities of gardening operations.
CO 3	Describe the cultivation of various types of ornamental plants including indoor gardening and bonsai
CO 4	• Discuss about the principles of garden designs in relation to English, Italian, French, Persian, Mughal and Japanese Gardens. • Describe the features of some important gardens
CO 5	• Discuss about the landscaping of places of public importance • Discuss about the landscaping of highways and educational institutions
CO 6	Describe the commercial aspects of floriculture and cultivation of important cut flowers, such as Carnation, Aster, Chrysanthemum, Dahalia, Gerbera, Gladiolus, Marigold, Rose, Lilium and Orchids.
CO 7	Discuss about the diseases and pests of ornamental plants.

SEC-6 Medicinal Botany

CO 1	• Discuss the history, scope and importance of medicinal plants, • Discuss the definition, scope and history of Ayurveda, • Discuss about the plants used in ayurvedic and Siddha treatments • Discuss the history and concept of Unani system of treatments
CO 2	• Discuss the conservation of endangered and endemic medicinal plants • Discuss the in-situ and ex-situ conservation of medicinal plants • Describe about the propagation of medicinal plants
CO 3	• Discuss about the concept of ethno-botany and folk medicines • Discuss about the applications of ethnobotany • Discuss about the application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetes, blood pressure and skin diseases.

SEC-7 Plant Diversity and Human Welfare

CO 1	• Discus the basics and scope of plant diversity in relation to genetic, species and ecosystem level of plant diversity • Discuss the values and uses of plant diversity
CO 2	• Discuss about the loss of biodiversity, • Discuss about the management of biodiversity
CO 3	Describe the various approaches of conservation of biodiversity
CO 4	Discuss about the role of plants in human welfare

SEC-8 Ethnobotany

CO 1	• Discuss about the concept, scope and objectives of ethnobotany • Discuss about the interdisciplinary approach of ethnobotanical studies
CO 2	Learn the methodology of ethnobotanical studies related to the aspects- Field work, herbarium preparation, study of ancient literature, archaeological findings, temples and sacred places.
CO 3	• Describe the role of ethnobotany in modern medicine • Discuss the importance of commonly used medicinal plants
CO 4	Learn the legal aspects of ethnobotanical studies

SEC-9 Mushroom Culture Technology

CO 1	• Discuss the history and scope of mushroom cultivation • Distinguish between edible and poisonous mushrooms • Discuss the nutritional and medicinal values of edible mushrooms • Discuss the types of edible mushrooms available in India
CO 2	Describe the steps and requirements of mushroom culture technology
CO 3	• Discuss about the various methods which can be used for the storage of mushrooms • Describe the nutritional composition of mushrooms- proteins, amino acids, carbohydrates, crude fibre content, vitamins and mineral elements.
CO 4	• Discuss about the types of foods prepared from mushrooms • Learn about the national and international research centers, which are dedicated to mushroom research. • Discuss about the cost benefit ratio, marketing in India and abroad and export value

	of mushrooms

SEC-10 Intellectual Property Rights

CO 1	• Learn the introductory aspects of Intellectual property rights. • Discuss about the importance of WTO.
CO 2	• Discuss about the objectives and rights of patents. • Discuss about the procedure of obtaining patents.
CO 3	Discuss about the copyright law and transfer of copyright.
CO 4	Discuss about the trademarks.
CO 5	Discuss about the geographical indications.
CO 6	Discuss about the protection of traditional knowledge.
CO 7	Describe about the law of industrial designs.
CO 8	Describe about the protection of plant varieties.
CO 9	Discuss about the information technology and related intellectual property rights.
CO 10	Describe the intellectual property rights related with biotechnology.

Programme specific outcomes of B.Sc. (Botany) Programme

The students will be able to:

PSO 1: Understand the biodiversity of Microbes, Algae, Fungi and Archegoniate.
PSO 2: Understand the basics of Plant Ecology and Taxonomy.
PSO 3: Know the concepts and applications of plant anatomy and Embryology.
PSO 4: Learn the key concepts of plant physiology and Metabolism.
PSO 5: Learn the basics and advanced concepts of Cell and Molecular Biology, and Economic Botany and Biotechnology.
PSO 6: Update the knowledge of students about the genetics, plant breeding and use of various analytical techniques in plant sciences.
PSO 7: Learn the concepts of Bioinformatics and Research Methodology,
PSO 8: Learn the key concepts and applications of Biofertilizers, Herbal Technology, Nursery and Gardening, Floriculture, Medicinal Botany, Plant Diversity and Human Welfare, Ethnobotany, Mushroom and Culture Technology and Intellectual Property Rights.

COURSE OUTCOMES OF M.SC. (MICROBIOLOGY)

Students will be able to understand the following:

Course Outcomes:

Course: SLS/MIC/C001: General Microbiology

CO1	Understanding the important milestones in development of microbiology discipline and classification of micro-organisms.
CO2	To understand different types of nutrition in microbes and microbial cultivation techniques.
CO3	Knowledge about classification and ultrastructure of bacteria.
CO4	Knowledge about classification, structure and diagnosis of viruses.
CO5	To know the structural, physiological features and classification of fungi, algae, and protozoa

Course: SLS/MIC/C002: Fundamentals of Biochemistry

CO1	Knowledge about Acid- base chemistry and concepts of bioenergetics.
CO2	To understand the structure, and function of Carbohydrates
CO3	Knowledge about structure, function and classification of lipids
CO4	To understand the structure and function of proteins and nucleotides, as well regulation of nucleotide biosynthesis
CO5	Knowledge about general characters, inhibitors and kinetics of enzymes

Course: SLS/MIC/C003: Cell biology

CO1	Knowledge about structure and function of cell organelles, cytoskeleton and cell integration
CO2	Understanding various components of cell membrane and transport of metabolites across the membrane
CO3	Knowledge of different cell- cell communication mechanism
CO4	To understand the molecular mechanism of cell cycle control and cell division
CO5	Knowledge about different pathways of cell death

Course: SLS/MIC/C004: Molecular biology and Microbial genetics

CO1	Understanding the structure and function of chromosome
CO2	Knowledge about mechanism of replication and transcription of DNA.
CO3	Understanding the translation of genes and regulation of gene expression.
CO4	Knowledge about different mechanism of changes in nucleotide sequences in DNA and its repair
CO5	Understanding the different mechanisms of sexual reproduction in bacterial like Conjugation, Transformation and Transduction

Course: SLS/MIC/C005: Lab Course 1

CO1	Hands on training of fundamental microbiological techniques like media preparation, sterilization, cultivation, preservation etc.
CO2	Hands on training for qualitative and quantitative estimation of biomoloecules

Course: SLS/MIC/C006: Lab Course 2

CO1	Demonstration of various stages of cell division and effect of stress on cells
CO2	Hands on training for isolation of genomic DNA

Course: SLS/MIC/C007:Microbial Physiology and Metabolism

CO1	Understanding the phototrophic and chemotrophic nutrition in microorganisms
CO2	Knowledge about nitrogen and sulphur metabolism in microbes
CO3	Understanding the mechanism of respiration and fermentations in bacteria
CO4	Knowledge about metabolite transport across the membrane and communication mechanism in bacteria
CO5	Understanding the microbial responses in different stress conditions.

Course: SLS/MIC/C008: Immunology

CO1	Understanding the overview of Immune system and immunity
CO2	Knowledge about antigens, antibodies and the different type of interactions between them
CO3	Knowledge about complement system, cytokines and MHC
CO4	Understanding the mechanism of humoral and cell- mediated immune response
CO5	Knowledge about basics of Immunopathology and Transplantations

Course: SLS/MIC/C009: Biological Techniques

CO1	Understanding the principle and applications of Microscopy and Biosensors
CO2	Knowledge about principal and application of different types of Centrifugation
CO3	Understanding the principal and application of different types of Chromatography
CO4	Knowledge about principle and application of variousElectrophoretic techniques
CO5	Knowledge about principle of spectroscopic and radiotracer techniques

Course: SLS/MIC/C010: Recombinant DNA Technology

CO1	Understanding the basic principles and tools of Gene cloning
CO2	Understanding different Strategies of gene cloning
CO3	Knowledge about basics of cloned gene expression in heterologus system
CO4	Understanding the techniques used for nucleic acid sequence detection, amplification and modification
CO5	Knowledge about the techniques of genome analysis and applications of Gene cloning

Course: SLS/MIC/C011: Lab Course 1

CO1	Hands on training for study of various physic-chemicals factors on growth of bacteria
CO2	Hands on training for identification of bacteria on biochemical basis
CO3	Hands on training for determination of blood group
CO4	Demonstration of various antigen-antibody interactions

Course: SLS/MIC/C012: Lab Course 2

CO1	Hands on training for various chromatographic and electrophoretic techniques
CO2	Hands on training for various molecular biology techniques

Course: SLS/MIC/C013: Medical Microbiology

CO1	Understanding the basics of Medical Microbiology
CO2	Knowledge about basics of microbial pathogenesis and antimicrobial chemotherapy
CO3	Knowledge about clinical features, transmission, causal organism, diagnostics, prevention and control of bacterial diseases
CO4	Knowledge about clinical features, transmission, causal organism, diagnostics, prevention and control of viral diseases
CO5	Knowledge about clinical features, transmission, causal organism, diagnostics, prevention and control of protozoal and fungal diseases

Course: SLS/MIC/C014: Industrial Microbiology

CO1	Understanding the basics of Industrial Microbiology
CO2	Knowledge about basic aspects of Fermentation
CO3	Knowledge about the various strategies used for microbial strain development
CO4	Understanding the production aspects of antibiotics, amino acids and biopolymers
CO5	Understanding the production aspects of enzymes, vitamins and beverages

Course: SLS/MIC/C015: Lab Course 1

CO1	Hands on training for determination of antimicrobial susceptibility of pathogens using various methods
CO2	Hands on training for microbial production of various materials
CO3	Hands on training for microbial strain development for enhanced enzyme production

Course: SLS/MIC/E01A: Foodand Dairy Microbiology

CO1	Understanding the principles of Food Preservation
CO2	Knowledge about various types of contamination and microbial spoilage of food
CO3	Knowledge about various foodborne infections and intoxications.
CO4	Knowledge about various food safety measures and Quality Assurance of food stuffs
CO5	Understanding the production process of fermented foods

Course: SLS/MIC/E01B: Drug Designingand Nanobiotechnology

CO1	Understanding the basics of interaction between drug and cell surface recptor
CO2	Knowledge about strategies for Drug Targeting and Drug Delivery
CO3	Understanding the relationship between structure and activity of chemicals
CO4	Knowledge about molecular modeling technique
CO5	Understanding the basics of Nanobiotechnology

Course: SLS/MIC/E01C: Genomicsand Proteomics

CO1	Understanding the genome anatomy

CO2	Knowledge about strategies used for genome mapping
CO3	Understanding the techniques of genome sequence analysis.
CO4	Understanding the basics of proteomics and transcriptomics

Course: SLS/MIC/E01D: Epidemiology

CO1	Understanding the basics of Epidemiology
CO2	Knowledge about the various modes of diseases transmission
CO3	Understanding the basics of mathematical modeling of epidemiological studies
CO4	Understanding the various strategies for control of epidemics

Course: SLS/MIC/E01E: BioprocessTechnology

CO1	Understanding the various designs of bioreactor
CO2	Understanding of various types of Fermentation process and its kinetics
CO3	Knowledge about transfer and balance of Mass and Energy
CO4	Knowledge about different steps of downstream processing
CO5	Understanding the instrumentation and control mechanism of Fermentation process

Course: SLS/MIC/E01F: Environmental Microbiology

CO1	Understanding the fundamentals of Microbial ecology
CO2	Understanding the basics of Air and Aquatic Microbiology
CO3	Knowledge about different microbial interactions
CO4	Knowledge about different types of pollution and its control stratigies
CO5	Understanding the impact of various microbes on Environment

Course: SLS/MIC/E01G: UGC MOOC 01 (Academic Writing)

CO1	Understanding the need and principles of Academic writing
CO2	Knowledge about different types of Academic writing
CO3	Understanding the writing style of research paer, review, report, research poprosal etc.

Course: SLS/MIC/E02A: Agricultural Microbiology

CO1	Knowledge about the abiotic and biotic components of Soil
CO2	Knowledge about the rhizosphericand rhizoplane Microorganisms.
CO3	Knowledge about the symptoms, casuative organisms, disease cycle and control measures of plant diseases.
CO4	Knowledge about the isolation, purification, mass multiplication and applications ofbiofertilizers

Course: SLS/MIC/E02B: Microbial Diversity

CO1	Understandind the basics of microbial evolution and diversity
CO2	Knowledge about the classification of microbes
CO3	Knowledge about the general features, ecology and physiology of various bacterial and archeal phyla
CO4	Understanding the physiology and molecular adaptations in extremophiles

Course: SLS/MIC/E02C: PharmaceuticalMicrobiology

CO1	Understanding the basics of drug discovery process
CO2	Understanding the various strategies for development of antimicrobial agents
CO3	Knowledge about microbial production and spoilage of pharmaceutical agents
CO4	Understanding the strategies for quality assurance of pharmaceutical products
CO5	Knowledge about the regulatory practices in pharma industries

Course: SLS/MIC/E02D: Infectionand Immunity

CO1	Knowledge about various types of Infectious agents
CO2	Understanding the mechanism of Immune regulation of infections
CO3	Understanding the various immune responses to infections
CO4	Understanding the specific immune responses against bacterial, fungal viral and protozoal infections

Course: SLS/MIC/E02E: Intellectual Property Rights

CO1	Understanding the basic aspects of Intellectual property rights (IPR)
CO2	Knowledge about the International Treaties for protection of IPR
CO3	Understanding the process of patent filing granting and its significance.
CO4	Knowledge about Patent Acts, and cases of Patent Infringement
CO5	Understanding the strategies for protection of plant varieties and traditional Knowledge

Course: SLS/MIC/E02F: Research Methodology

CO1	Understanding the formulation of research problem and experimental planning
CO2	Knowledge about techniques of data collection and analysis
CO3	Understanding the statistical basis of biological assays
CO4	Knowledge about operation and significance of ANOVA
CO5	Understanding basics of Bioinformatics and Technical writing

Course: SLS/MIC/E02G: UGC MOOC 02 (Biostatistics and Mathematical Biology)

CO1	Understanding the basics of Biostatistics and data
CO2	Knowledge about various techniques of data presentation and its significance
CO3	Understanding the applications of various statistical tools

Course: SLS/MIC/E003: Lab Course 2

CO1	Hands on Training of various experiments related to any two elective papers

Course: SLS/MIC/E004: DISSERTATION

CO1	Awareness and interest towards research
CO2	Develop scientific temperament
CO3	Understanding the practical aspects of research methodology
CO 4	Develop writing skills

Programme Specific Outcomes of M.Sc. (Microbiology) Programme

PSO1.	Understanding the various types of microorganisms
PSO2.	Understanding the chemistry of biomolecules
PSO3.	Understanding the basics of cell biology
PSO4.	Understanding the basics of molecular biology and genetics of microbial cells
PSO5.	Understanding of various biological techniques
PSO6.	Understanding the Immune response mechanisms against various antigens
PSO7.	Understanding the various practices of Food and Pharma industries
PSO8.	Understanding the various diagnostic tests for infectious diseases
PSO9.	Understanding the various analytical tests in Environmental laboratory
PSO10.	Understanding diagnosis of plant pathogens, and production and applications of biofertilizers