Department of Biotechnology

M.Sc. Biotechnology

(Two-Year P.G. Programme) as per NEP

Course Contents
&
Syllabus

[For the students enrolled in the 2026-27 academic session onwards]

Hemvati Nandan Bahuguna Garhwal University

(A Central University)

Srinagar Garhwal-246174 (Uttarakhand)

Syllabus for M.Sc. Biotechnology 2-Year PG Programme

First Semester for 2-year P.G. Programme

Entry requirement	3-year Bachelor's degree (minimum 120 credits) or 4-Year Bachelor's Degree (In case of B. Tech and B.E Programmeme-Minimum-160 credits) and candidates who have met the entrance requirements, including specified levels of attainment, in the Programme admission regulations.	
Course category	**Semester-I**	**Credits (T + P)**
Discipline Specific Core (DSC)	DSC-1 Biochemistry and Metabolism	5 (3+2)
	DSC-2 Advanced Molecular Biology	5 (3+2)
	DSC-3 Microbes and Microbial Technology	5 (3+2)
SEC/Vocational	SEC-1 Plant Biotechnology	5 (3+2)
Discipline Specific Elective (DSE)	DSE-1 a. Omics Technology b. Biofuels	4 (3+1)
	Or	
Multidisciplinary Elective (MDE)	MDE-1 Biopolymer	4 (3+1)
A student may opt for either one Discipline Specific Elective (DSE) or one Multidisciplinary Elective (MDE) as an elective course.		
AEC (Non-CGPA Course)	Indian Knowledge System	1
Total Credits		24

Second Semester for 2-year P.G. Programme

Course category	**Semester-II**	**Credits (T + P)**
Discipline Specific Core (DSC)	DSC-4 Bioanalytical Techniques	5 (3+2)
	DSC-5 Immunology	5 (3+2)
	DSC-6 Genetic Engineering and Applications	5 (3+2)
SEC/Vocational	SEC-2 Herbal Biotechnology	5 (3+2)
Discipline Specific Elective (DSE)	DSE-2 a. Nanobiotechnology b. Cancer Biology	4 (3+1)
	Or	
Multidisciplinary Elective (MDE)	MDE-2 Biofertilizer and Organic Farming	4 (3+1)
A student may opt for either one Discipline Specific Elective (DSE) or one Multidisciplinary Elective (MDE) as an elective course.		
VAC (Non-CGPA Course)	Constitutional, Ethical, and Moral Values	1
Total Credits		24

Third Semester for 2-year P.G. Programme

Course category	**Semester-III**	**Credits (T + P)**
Discipline Specific Core (DSC)	DSC-7 Molecular Genetics	5 (3+2)
	DSC-8 Bioinformatics and Biostatistics	5 (3+2)
	DSC-9 Molecular Cell Biology	5 (3+2)
	DSC-10 Industrial Biotechnology	5 (3+2)
Discipline Specific Elective (DSE)	DSE-3 a. Immunotechnology b. Enzymes and Enzyme Technology	4 (3+1)

	Or	
Multidisciplinary Elective (MDE)	MDE-3 Research Methodology and Scientific Writing	4 (3+1)
A student may opt for either one Discipline Specific Elective (DSE) or one Multidisciplinary Elective (MDE) as an elective course.		
SEC (Non-CGPA Course)	Academic Library Systems and Services	1
	Or	
SEC (Non-CGPA Course)	Entrepreneurship & Start-up Awareness	1
Total Credits		24

Fourth Semester for 2-year P.G. Programme

Course category	**Semester-IV**	**Credits (T + P)**
Discipline Specific Core (DSC)	DSC-11 Intellectual Property Rights	5 (3+2)
	DSC-12 Biosafety and Bioethics	5 (3+2)
	DSC-13 Environmental Biotechnology	5 (3+2)
	DSC-14 AI in Biotechnology	5 (3+2)
Optional Component (Research / Skill Oriented) in lieu of DSC	**Option–I: Minor Dissertation / Project Work** *(in lieu of any **one** DSC)*	5
	Option–II: Major Dissertation / Project Work *(in lieu of any **two** DSCs)*	10
Discipline Specific Elective (DSE)	DSE-4 a. Bio-entrepreneurship and Bio-business Management b. Animal Biotechnology	4 (3+1)
	Or	
Multidisciplinary Elective (MDE)	MDE-4 Molecular Diagnostics	4 (3+1)
A student may opt for either one Discipline Specific Elective (DSE) or one Multidisciplinary Elective (MDE) as an elective course.		
SEC (Non-CGPA Course)	Community Outreach Activities	1
Total Credits		24
NHEQF Level- 6.5	***Student on successfully completing two-year PG Programme (i.e., securing minimum required 96 credits will be awarded "Postgraduate Degree", in related field/discipline/subject.***	
NHEQF Level 7	***In Case of Engineering Programme, Student on exit after successfully completing second year of 2-year P.G. Programme (i.e., securing minimum 96 credits will be awarded "Postgraduate Degree" (M.Tech/M.E etc) of Two years, in related field/discipline/subject***	

Programme Learning Outcomes of Biotechnology P.G. Programme

Programme Learning Outcomes of Biotechnology P.G. Programme Qualification descriptors are outcomes and attributes that learners achieve through learning acquired during a Programme of study. These descriptors are specific to each Programme and are designed to capture the knowledge, skills, attitudes, and values acquired through the Programme. These outcomes include disciplinary-area-specific skills, generic skills, and transferable global skills. Students should demonstrate these skills upon completing the P.G. Programme for the Degree qualification. They also focus on knowledge and skills that prepare students for further study, employment, and citizenship. Programme learning outcomes outline the minimum essential learning required to complete a Programme of study, ensuring comparability of learning levels and academic standards across colleges/universities. They provide a broad picture of the level of competence of graduates of a given Programme of study. Here are 10 Programme Learning Outcomes (PLOs) for a postgraduate (M.Sc.)

Students of this Programme will be able to:

PLO1. Demonstrate Conceptual and Procedural Knowledge: Demonstrate critical understanding of advanced theoretical and methodological approaches in Biotechnology, including the ability to analyze and synthesize knowledge across multidisciplinary fields.

PLO2. Exhibit Critical Thinking and Problem-Solving Abilities: Exhibit the ability to critically analyze complex biological problems, evaluate diverse perspectives, and evidence to identify and solve disciplinary and interdisciplinary problems in Biotechnology.

PLO3. Uphold Research Ethics and Social Responsibility: Develop an understanding of research ethics in Biotechnology and quality publications, along with a commitment towards integrity, equity, and social justice.

PLO4. Function Effectively in Teamwork and Leadership Roles: Effectively collaborate in diverse teams with multidisciplinary areas in Biotechnology, demonstrating interpersonal skills, conflict resolution abilities, and the capacity to lead with vision and accountability.

PLO5. Apply Research and Analytical Skills: Design, conduct, and interpret research in Biotechnology using suitable methodologies and tools, contributing to knowledge creation and evidence-based practices.

PLO6. Utilize Digital Learning and Communication Skills: Engage with advanced computational and artificial intelligence technologies in Biotechnology to access, manage, and share information effectively and communicate opinions clearly through various platforms.

PLO7. Apply Knowledge in Real-World Contexts: Develop and apply academic knowledge with practical applications in Biotechnology to address challenges in industry, community, and environmental research for contributing to new knowledge in the discipline.

PLO8. Demonstrate Entrepreneurship and Employment Skills: Exhibit innovation, business, and professional abilities in Biotechnology for fostering entrepreneurship and enhancing employability in various work environments.

PLO9. Engage in Global and Local Contexts: Demonstrate an understanding of Biotechnological knowledge's relevance to local communities and global contexts and contribute solutions to emerging global challenges.

PLO10. Promote Environmental and Sustainable Practices: Understand environmental challenges and promote sustainable practices to society, human health, and the environment

M.Sc. Biotechnology Semester-I

Core Course: Paper-I Biochemistry and Metabolism (SOLS/MBT/DSC-1)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic concepts of biomolecules (carbohydrates, fatty acids, nucleic acids, amino acids), and enzymes and their classification. • Understand the structure, synthesis pathway, and function of biomolecules and enzymes. • Apply the knowledge of biomolecules and enzymes in metabolic pathways and their regulation. • Analyse the differences in these biomolecules and their functional characteristics. • Evaluate the role of these biomolecules in complex biological functions.

Paper-I Biochemistry and Metabolism
(Course Code: SOLS/MBT/DSC-1)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Carbohydrates: Classification, structure, and functions. Carbohydrate metabolism I: Pathway and regulation of glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis.

Carbohydrate metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway, and its regulation.

UNIT- II (Cr- 0.75)

Fatty acids: Classification and structure.

Fatty acid metabolism: Fatty acid oxidation and regulation, β-oxidation, oxidation of unsaturated fatty acids and odd chain fatty acids, β-oxidation in peroxisomes, ketone bodies and their overproduction. Fatty acid biosynthesis and regulation: Reactions of fatty acid synthase, synthesis of triglycerols, cholesterol biosynthesis, and regulation.

UNIT- III (Cr- 0.5)

Nucleic acids: Structure and functions.

Nucleic acid metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis, and its regulation, formation of deoxyribonucleotides, Salvage pathway for purine and pyrimidine nucleotides, degradation of purines and pyrimidines. Conversion of nitrogen to ammonia by microorganisms.

UNIT-IV (Cr- 1.0)

Amino acids: Classification, structure, and functions, Protein: Classification, structure, and functions. Enzymes: Introduction and classification, concept of E-S complex, lock and key hypothesis, induced-fit hypothesis, Michaelis-Menten equation, enzyme inhibition.

Amino acid metabolism: overview of amino-acid biosynthesis and degradation, urea cycle (Linkage between urea cycle and citric acid cycle).

Recommended Books:

1. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
2. Berg J.M., Tymoczko J.L., Gatto G.J.Jr., Stryer L. Biochemistry. 2023. 10th ed. Macmillan Learning.
3. Kennelly P.J., Botham K.M., McGuinness O.P., Rodwell V.W., Weil P.A. Harper's Illustrated Biochemistry. 2022. 32nd ed. McGraw-Hill.
4. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry: Life at the Molecular Level. 2023. 6th ed. John Wiley & Sons.
5. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
6. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

SOLS/MBT/DSC(P)-1 Biochemistry and Metabolism (Practical) (Cr. -2)

1. Quantitative estimation of protein.

2. Quantitative estimation of carbohydrate.

3. Quantitative estimation of cholesterol.

4. Determination of the acid value of fats.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-II Advanced Molecular Biology (SOLS/MBT/DSC-2)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamentals of nucleic acids and their physical and chemical properties. • Understand the mechanism of DNA replication and gene regulation in prokaryotes and eukaryotes. • Apply the theories of genetic materials in research and biotechnological applications • Analyze the differences in DNA and RNA properties and their synthesis and regulation mechanisms. • Evaluate the molecular mechanism and gene expression for advanced biotechnological applications.

Paper-II Advanced Molecular Biology

(Course Code: SOLS/MBT/DSC-2)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Nucleic acids: Structure and types of RNA and DNA, Topological properties of DNA, DNA as genetic material; DNA replication: Mechanism of DNA replication in prokaryotes and eukaryotes; DNA damage: Types and repair mechanisms.

UNIT- II (Cr- 0.75)

Mechanism of transcription: Promoter, *cis* and *trans* elements, and consensus sequences, mechanism of transcription in prokaryotes and eukaryotes, reverse transcription.

Post-transcriptional processing of RNA: Capping, polyadenylation, splicing, and RNA editing.

UNIT-III (Cr- 0.75)

Mechanism of translation in prokaryotes and eukaryotes: Genetic code, Wobble hypothesis, Aminoacyl-t RNA synthetase and its role, steps of initiation, elongation and termination of translation process and the proteins and enzymes involved. Post-translational modifications and its relevance.

UNIT-IV (Cr- 0.75)

Regulation of gene expression in prokaryotes and eukaryotes: Positive and negative regulation, *lac* operon, and *trp* operon, regulatory proteins and DNA binding, chromatin modifications associated with gene expression, and regulatory modules for eukaryotic promoters.

Recommended Books:

1. Brown T.A. Genomes 5. 2023. 5th ed. CRC Press.
2. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's Genes XII. 2018. 12th ed. Jones & Bartlett

Learning.
4. Watson J.E. Molecular Biology of the Gene. 2014. 7th ed. Pearson Publishers.

SOLS/MBT/DSC(P)-2 Advanced Molecular Biology (Practical) (Cr. -2)

1. Isolation of genomic DNA.

2. Qualitative and quantitative estimation of DNA.

3. Determination of the melting temperature of DNA.

4. Preparation of the absorption spectra of DNA.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-III Microbes and Microbial Technology (SOLS/MBT/DSC-3)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic knowledge of microbes and their biodiversity, and the definition of metagenomics. • Understand the fundamentals of microbial growth, culture conditions, plant-microbe interactions, and bioinformatics tools for studying metagenomics sequence data and biodiversity. • Apply the concepts of microbial cell factories in biotechnological research. • Analyse the differences in microbial characteristics and unculturable microorganisms. • Evaluate the traditional microbial biosynthesis approaches and economy.

Paper-III Microbes and Microbial Technology

(Course Code: SOLS/MBT/DSC-3)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Microorganisms: General structure, characteristic features and classification of bacteria, fungi and viruses. Laboratory culture and methods to study microbes: Concept of pure culture, aseptic conditions, sterilization and staining methods. Microbial culture media and its types.

UNIT– II (Cr- 0.75)

Bacterial growth: Monoauxic, diauxic, and synchronous growth, growth phases, and growth curve. Factors affecting bacterial growth, modes of bacterial nutrition, methods to control microbial growth.

UNIT– III (Cr- 0.75)

Microbial applications in food & health: Microbial processes and their application in food and healthcare industries, food processing and food preservation, Single cell proteins (*Spirulina*, and Yeast), and microbial production of organic acids, vitamins, and amino acids.

UNIT–IV (Cr- 0.75)

Microbial cell factories: Definition and concept, advantages over traditional chemical synthesis, and applications. Plant growth promoting bacteria: Types and their applications. Microbial production of nanoparticles.

Metagenomics: Definition and concept.

Recommended Books:

1. Willey, J., Sherwood, L., Woolverton, C.J. Prescott's Microbiology. 2023. 10thed. New York, McGraw Hill Education.
2. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M., Stahl, D.A. Brock Biology of Microorganisms. 2021. 16th ed. Pearson Education Ltd.
3. Tortora, G.J., Funke, B. ll R., Case, C.L. Microbiology: An Introduction. 2019. 13th ed. Chicago, Pearson.
4. Pelczar, M.J., Chan, E.C.S., Krieg, N.R. Microbiology. 2001. 6th ed. McGraw Hill Education.

SOLS/MBT/DSC(P)-3 Microbes and Microbial Technology (Practical) (Cr. -2)

1. Enumeration of microorganisms.
2. Preparation of pure culture of microorganisms.
3. Staining of microbial cells/Gram staining.
4. Preparation of agar slant and glycerol stock for microbial culture preservation.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-IV Plant Biotechnology (SOLS/MBT/SEC-1)

Course Credits	**5 (Five)**
Course Learning Outcomes	• Learn the basic concept, techniques, and application of plants. • Understand the knowledge of tissue cultures, their characterization, and applications. • Apply the theories of plant tissue culture in human welfare and environmental research. • Analyse the differences in plant tissue culture techniques and their potential biotechnological applications. • Evaluate functional aspects of plant tissue culture in sustainable biotechnology.

Paper-IV Plant Biotechnology
(Course Code: SOLS/MBT/SEC-1)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Plant tissue culture: Laboratory and materials requirement, Aseptic techniques, media composition & preparation, Clonal propagation/micro propagation: Concept of Totipotency, types and applications of clonal propagation–Meristem culture, Callus culture, suspension culture, Embryo culture & Embryo rescue.

UNIT- II (Cr- 0.75)

Haploid culture: Androgenesis & Gynogenesis Protoplast culture & protoplast fusion – Cybrids, Symmetric & Asymmetric hybrid. Somatic embryogenesis and Somaclonal variations Cryo-preservation, production of synthetic seeds.

UNIT- III (Cr- 0.75)

Plant Transformation: *Agrobacterium* mediated gene transfer, Electroporation, Biolistics, etc. Transgenic technology: Integration of transgenes, action of transgenes, Stress tolerance: Abiotic (Heat, salt, drought) and biotic stress tolerance (Insect resistance, Bt crops, *Cry* protein and action) in plants using biotechnological tools.

UNIT-IV (Cr- 0.75)

Applications of plant transgenic: Flavr-savr tomato, Golden Rice and, Terminator gene technology. Phytohormones: Introduction of phytohormones, cross talk and signalling. Plant growth promoting bacteria, PGPR traits, uses and applications, Bio fertilisers, Phytopriming for stress responses.

Recommended Books:

1. Singh B.D. A Textbook of Biotechnology. 2021. 6th ed. Kalyani Publishers.
2. Patrick G.L. An Introduction to Medicinal Chemistry. 2023. 7th ed. Oxford University Press.
3. Buchanan B.B., Gruissem, W., Jones, R. L. Biochemistry and Molecular Biology of Plants. 2015. 2nd ed. John Wiley & Sons.
4. Dubey R.C. A Textbook of Biotechnology. 2022. 5th ed. S. Chand Publishing.

5. Stewart C.N.Jr. Plant Biotechnology and Genetics: Principles, Techniques, and Applications. 2025. 3rd ed. John Wiley & Sons.

SOLS/MBT/SEC(P)-1 Plant Biotechnology (Practical) (Cr. -2)

1. Aseptic methods in plant tissue culture.
2. Preparation of MS stock reagents and MS media.
3. Surface sterilization of seeds.
4. Callus culture using any explants.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-V Omics Technology (SOLS/MBT/DSE-1a)

Course Credits	04 (Four)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of genomics and proteomics. • Understand the genomic mapping, genome organization of prokaryotic and eukaryotic cells, and essential characteristics of transcriptomics and metabolomics. • Apply the concepts and techniques of genomics and proteomics for biotechnological applications • Analyze the differences in genomics, transcriptomics, and metabolomics and their variations. • Evaluate the structural and functional aspects of the gene in organisms and humans for sustainable biotechnology.

Paper-V Omics Technology
(Course Code: SOLS/MBT/DSE-1a)

No. of Credits: 3

Unit I (Cr- 0.75)

Introduction to omics technologies and systems biology, genome organization and comparative genomics, Historical background and evolution of epigenetics, Genome vs epigenome principles of epigenomics including DNA methylation, acetylation and chromatin remodelling and epigenetic memory.

Unit II (Cr- 0.75)

Introduction to proteomics and protein structure, protein extraction and separation techniques including SDS-PAGE and 2D electrophoresis, mass spectrometry techniques protein interactions.

Unit III (Cr- 0.75)

Concept of transcriptomics and gene expression analysis, coding and non-coding RNAs, transcriptomic techniques including RT-PCR, quantitative Real Time-PCR, and differential gene expression analysis.

Unit IV (Cr- 0.75)

Introduction to metabolomics and metabolic profiling, targeted and untargeted metabolomics approaches, analytical techniques and applications of metabolomics.

Recommended Books:

1. Brown T.A. Genomes 5. 2023. 5th ed. CRC Press.
2. Twyman R. Principles of Proteomics. 2014. 2nd ed. Taylor & Francis.
3. Primrose S.B., Twyman R. Principles of Genome Analysis and Genomics. 2009. 3rd ed. John Wiley & Sons.
4. Liebler D.C. Introduction to Proteomics: Tools for the New Biology. 2002. 1st ed. Humana Totowa, NJ.

5. Villas-Boas S.G., Nielsen J., Smedsgaard J., Hansen M.A., Roessner-Tunali U. Metabolome Analysis: An Introduction. 2007. 1st ed. John Wiley & Sons.
6. Pevsner J. Bioinformatics and Functional Genomics. 2015. 2nd ed. John Wiley & Sons.

SOLS/MBT/DSE(P)-1a Omics Technology (Practical) (Cr. -1)

1. Multiple sequence alignment using CLUSTALW.

2. Prediction of subcellular localization of given protein sequences.

3. Retrieval and analysis of gene and protein sequences from public databases.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-V Biofuels (SOLS/MBT/DSE-1b)

Course Credits	**04 (Four)**
Course Learning Outcomes	• Learn the basic concepts of biofuels, and their properties. • Understand the pathways and metabolism for microbes producing various biofuels. • Apply the knowledge of biofuels for potential applications • Analyze the differences in the generation of biofuels and biowaste composition. • Evaluate the importance of biofuels production economics, commercialization, and global sustainability.

Paper-V Biofuels
(Course Code: SOLS/MBT/DSE-1b)

No. of Credits: 3

UNIT–I (Cr- 0.75)

Introduction to biofuels and biomass feedstocks: Concept and overview of biofuels; fossil vs. renewable energy sources, global bioenergy status, types of biomasses and their composition, and physical and chemical properties of biomass.

UNIT–II (Cr- 0.75)

Biochemical and chemical conversion technologies: Anaerobic digestion of biowaste to produce biogas; microbial fermentation processes for waste-to-energy systems to produce biohydrogen; and transesterification for biodiesel production.

UNIT–III (Cr- 0.75)

Liquid biofuels and advanced technologies: Microbial processes for bioethanol, biomethanol, and biobutanol production, generations of biofuels, and emerging technologies such as microbial fuel cells.

UNIT–IV (Cr- 0.75)

Bioenergy systems integration and application: Integrating conversion processes to produce biofuels (biohydrogen, biomethane, bioethanol, and bioelectricity), sustainability, economics, and policy.

Recommended Books:

1. Sevda S. The Principles of Green Energy and Technology. 2026. 1st ed. CRC Press.
2. Stabnikova O., Shevchenko O., Stabnikov V., Paredes-López, O. Bioconversion of Wastes to Value-added Products. 2024. 1st ed. CRC Press.
3. Maddela N.R., Eller L.K.W., Prasad, R. Microbiology for Cleaner Production and Environmental Sustainability. 2023. 1st ed. CRC Press.
4. Dar M.A., Zabed H.M., Shahnawaz, M. Recent Trends in Lignocellulosic Biofuels and Bioenergy: Advancements and Sustainability Assessment. 2025. 1st ed. Springer Nature.

5. Brandli L., Dalla Rosa F., Petrorius R., Avila L.V., Leal Filho, W. The Contribution of Life Cycle Analyses and Circular Economy to the Sustainable Development Goals. 2025. 1st ed. Springer Nature.

SOLS/MBT/DSE(P)-1b Biofuels (Practical) **(Cr. -1)**

1. Determination of the composition of biowaste(s).
2. Estimation of total sugars in biomass hydrolysate.
3. Estimation of the total phenolics in biomass hydrolysate.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-I

Core Course: Paper-V Biopolymers (SOLS/MBT/MDE-1)

Course Credits	**04 (Four)**
Course Learning Outcomes	• Learn the basic concepts of biopolymers, and their properties. • Understand the pathways and metabolism for microbes producing various biopolymers. • Apply the knowledge of biopolymers for potential applications • Analyse the differences in the generation of biopolymers composition. • Evaluate the importance of biopolymers production economics, commercialization, and global sustainability.

Paper-V Biopolymers
(Course Code: SOLS/MBT/MDE-1)

No. of Credits: 3

UNIT–I (Cr- 0.75)

Introduction, classification, and source of biopolymers: Concept of biopolymers, classifications of biopolymers (Polysaccharides, proteins, polynucleotides, and lipids), and bioplastics.

UNIT–II (Cr- 0.75)

Structure, properties, and characterization: Molecular structures of biopolymers, their key properties (Biocompatibility, biodegradability, crystallinity, and barrier properties), and characterization (molecular weight distribution, FTIR, NMR, X-ray diffraction, and thermal analysis.

UNIT–III (Cr- 0.75)

Natural biopolymers: Types of natural biopolymers and their benefits over synthetic plastics. Polyhydroxyalkanoates (PHA): Microbial biodiversity of PHA-producers, their metabolism, and microbial production of PHA co-polymers.

UNIT–IV (Cr- 0.75)

PHA application: Biotechnological advancement in the application of PHA as biocontrol agents, drug carriers, medical implants, and tissue engineering. Commercialization of PHA: Updates on commercial production of microbial PHA.

Recommended Books:

1. Kalia V.C. Polyhydroxyalkanoates: Sustainable Production and Biotechnological Applications I - Microbial Biodiversity, Biowastes, and Bioprocesses. 2025. 1st ed. Springer Nature.
2. Rawat N.K., Volova T.G., Haghi A.K. Applied Biopolymer Technology and Bioplastics: Sustainable Development by Green Engineering Materials. 2021. 1st ed. CRC Press.
3. Abdul Khalil H.P.S., Nurul Fazita M.R., Mohd Nurazzi M. Biopolymers and Biopolymer Blends: Fundamentals, Processes, and Emerging Applications. 2024. 1st ed. CRC Press.
4. Jawaid M., Khiari R., Singh B., Abu-Jdayil B. Applications of Biopolymers and Biocomposites. 2026. 1st ed. Woodhead Publishing.

SOLS/MBT/MDE(P)-1 Biopolymers (Practical) (Cr. -1)

1. Determination of dry cell mass of bacterial culture.
2. Estimation of polyhydroxyalkanoate accumulation by bacteria.
3. Demonstration of compositional characteristics of polyhydroxyalkanoate.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-I Bio-Analytical Techniques (SOLS/MBT/DSC-4)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic knowledge of various bio-analytical techniques. • Understand the principles and applications of different bio-analytical techniques. • Apply the concepts and working principles of bioanalytical techniques in biological research. • Analyse the differences in various bioanalytic techniques and their potential applications. • Evaluate the importance of bioanalytic techniques for diverse areas of biotechnological applications.

Paper-I Bio-Analytical Techniques
(Course Code: SOLS/MBT/DSC-4)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Chromatography: General principles and applications of chromatography, Types of Chromatography, Concepts of modern chromatographic methods. Spectroscopic methods: Principle and applications, types of spectroscopy and modern spectrometric methods.

UNIT- II (Cr- 0.75)

Electrophoresis: General principle and applications, paper electrophoresis, moving boundary method, gel electrophoresis (Native, denaturing & reducing), isoelectric focussing (IEF), and isotachophoresis.

UNIT- III (Cr- 0.75)

Centrifugation: Basic principles and applications, types of rotors, common centrifuges used in laboratory, clinical, high speed & ultracentrifuges. Differential centrifugation, density gradient centrifugation-zonal and isopycnic.

UNIT–IV (Cr- 0.75)

Basic knowledge of the principles and applications of microscopy: Light, phase contrast, fluorescence microscopy, confocal laser scanning microscopy, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy.

Recommended Books:

1. Alberts B., Heald R., Johnson A., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell. 2022. 7th ed. WW Norton & Co.
2. Egbuna C., Patrick-Iwuanyanwu K.C., Shah M.A., Ifemeje J.C., Rasul A. Analytical Techniques in Biosciences: From Basics to Applications. 2021. 1st ed. Academic Press.
3. Ghosal S., Avasthi A.S. Fundamentals of Bioanalytical Techniques and Instrumentation. 2018. 2nd ed. PHI.

4. Hofmann A., Clokie S. Wilson & Walker's: Principles and Techniques of Biochemistry and Molecular Biology. 2018. 8th ed. Cambridge Univ. Press.
5. Jayaraman, J. Laboratory manual in biochemistry. 2011. 1st ed. New Age International Private Ltd.

SOLS/MBT/DSC(P)-4 Bio-Analytical Techniques (Practical) (Cr. -2)

1. Separation of compounds through paper chromatography.
2. Separation of cells from a suspension/biological sample by centrifugation.
3. Protein separation by SDS-PAGE.
4. Preparation of standard curve and determination of the concentration of unknown compound using UV-Visible spectroscopy.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-II Immunology (SOLS/MBT/DSC-5)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic concept of immunology and its historical development. • Understand the fundamentals of the immune system, various types of cells, hypersensitivity, and monoclonal antibodies. • Apply techniques of immunology in biotechnological research and applications • Analyse the differences in type, structure, and function of cells involved in immunological processes. • Evaluate the antigen-antibody interactions, various immunological manifestations, and biotechnological applications. • Understand the principles of various techniques involved in immunology.

Paper-II Immunology
(Course Code: SOLS/MBT/DSC-5)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Historical perspective of Immunology. Overview of the Immune system, Innate and adaptive immunity, Hematopoiesis. Cells and organs of the immune system, Antigens, antigenicity and immunogenicity, haptens& epitopes. Immunoglobulins: Structure and function.

UNIT- II (Cr- 0.75)

Precipitation and agglutination reactions, RIA, ELISA, western blotting. Immunoglobulin gene structure, Multigene organization of Ig genes, variable region gene rearrangements, generation of antibody diversity, class switching among constant region genes, expression of Ig genes. Structure and functions of BCR & TCR. Major histocompatibility complex.

UNIT- III (Cr- 0.75)

Antigen processing and presentation. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis, Ab-dependent cell mediated cytotoxicity (ADCC). Introduction and importance of Monoclonal antibodies: Difference between polyclonal and monoclonal antibodies, Hybridoma technology.

UNIT–IV (Cr- 0.75)

General properties of cytokines and chemokines. Complement system. Introduction and types of hypersensitivity and autoimmunity. Introduction to organ transplantation and graft rejection. Vaccines: Types & applications, Active and passive Immunization.

Recommended Books:

1. Stranford S., Owen J.A., Punt J., Jones P. Kuby: Immunology. 2022. 8th ed. W.H. Freeman.

2. Male D., Peebles R.S.Jr., Male, V. Immunology. 2020. 9th ed. Elsevier.

3. Hofmann A., Clokie S., Wilson & Walker's: Principles and Techniques of Biochemistry and Molecular Biology. 2018. 8th ed. Cambridge Univ. Press.

4. Elgert, K.D. Immunology: Understanding the Immune System. 2009. 2nd ed. Wiley Blackwell.

5. Hay, F.C., Westwood, O.M.R. Practical Immunology. 2002. 1st ed. Wiley-Blackwell.

SOLS/MBT/DSC(P)-5 Immunology (Practical) (Cr. -2)

1. Blood group detection.
2. Precipitation test and Oudin tube test.
3. Ouchterlony's double diffusion test.
4. Dot-ELISA test for detection of antigen.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-III Genetic Engineering and Applications (SOLS/MBT/DSC-6)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic concept of recombinant DNA technology. • Understand the fundamentals of genetic materials, gene cloning, and gene therapy technologies. • Apply the theories of recombinant DNA technological techniques in biotechnological research and applications. • Analyse the differences in cloning vectors and various techniques involved in genetic engineering. • Evaluate the nucleic acid structure, properties, and various tools and procedures in recombinant DNA technology.

Paper-III Genetic Engineering and Applications
(Course Code: SOLS/MBT/DSC-6)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Recombinant DNA technology: Introduction to Recombinant DNA technology and applications. Nucleic acid modification: Nucleic acid modifying enzymes, and restriction endonucleases. Cloning vectors: Plasmid and phage based vectors, cosmid, phagemid, yeast cloning vectors, animal and plant viruses as vectors. BAC, PAC & YAC.

UNIT- II (Cr- 0.75)

Nucleic acid isolation: Isolation of nucleic acid from plant, animal & bacteria. Basic steps of gene cloning and heterologous expression: Cloning strategies, genomic library, selection of rDNA clones and their expression products, cDNA and cDNA library, expression of cloned genes in heterologous hosts.

UNIT- III (Cr- 0.75)

DNA sequencing: Chemical and enzymatic methods, NGS.PCR: Types and applications, and real-time PCR, Nucleic acid analysis techniques: Gel retardation assay, DNA foot-printing, DNA finger-printing, southern blotting and northern blotting.

UNIT-IV (Cr- 0.75)

Probe labelling, and hybridization, Site directed mutagenesis, Transgenic technology: Types, approaches & applications (plants & animals), Gene therapy: Types and applications, Genome editing technologies: Principles and applications, and CRISPR technology.

Recommended Books:

1. Glick B.R., Pasternak C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. 2022. 6th ed. Wiley-Blackwell.
2. Grover, D.M. Gene Cloning and DNA Analysis. 2021. 8th ed. John Wiley & Sons Ltd.
3. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley-Blackwell.

4. Williamson, R. Genetic Engineering 3. 2012. 2nd ed. Springer.
5. Watson, J.D., Caudy, A.A., Myers, R., Witkowski, J.A. Recombinant DNA. 2007. 3rd ed. W H Freeman & Company.

SOLS/MBT/DSC(P)-6 Genetic Engineering and Applications (Practical) (Cr. -2)

1. Restriction digestion of DNA sample.
2. Ligation of fragmented DNA.
3. Preparation of competent cells.
4. Demonstration of PCR.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-IV Herbal Biotechnology (SOLS/MBT/SEC-2)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental principles of plant tissue culture and the biosynthetic pathways of secondary metabolites in medicinal plants. • Understand the role of genetic engineering and molecular markers in the improvement and standardization of herbal drug production. • Apply the knowledge of biotechnological techniques to enhance the yield of bioactive compounds. • Analyse the differences in the quality, safety, and efficacy of herbal products using advanced methods. • Evaluate the ethical and biosafety implications of biotechnological interventions.

Paper IV-Herbal Biotechnology
(Course Code: SOLS/MBT/SEC-2)

No. of Credits = 3

UNIT –I (Cr- 0.75)

Herbal medicines: history and scope. Local health traditions, ethnomedicines, Important Medicinal and aromatic plants (MAPs) of Garhwal Himalayas- their diversity, distribution, traditional knowledge, Phytochemistry - active principles of herbal drugs-Biological testing, phytochemical screening for secondary metabolites.

UNIT –II (Cr- 0.75)

Knowledge of few important MAPs, their uses. Phytometabolites of medicinal importance, important genes and proteins related to metabolites, signalling pathways, transgenic plants-Overexpression and downregulation approach to manipulate the metabolite levels in medicinal plants.

UNIT –III (Cr- 0.75)

Diseases associated with raw/processed medicinal plants, and diagnostics related, few initiatives for cultivation and conservation of medicinal plants, Plant Tissue culture as an alternative for conservation of MAPs- prospects and challenges, Demand and supply, Herbal Industries at national and state levels. Ministry of AYUSH, National/ State Medicinal plant board- Organization, aims, Role of herbal drugs at International levels.

UNIT – IV (Cr- 0.75)

Economic importance, biotechnological applications and challenges of herbal biotechnology. Green synthesis of nanoparticles using medicinal plants Phytopharmaceuticals: examples and applications, Nutraceuticals: examples and applications.

Recommended Books:

1. Singh B.D. Biotechnology. 2024. 6th ed. New Delhi.

2. Patrick G.L. An Introduction to Medicinal Chemistry. 2023. Oxford University Press.
3. Shah B., Seth A.K. Textbook of Pharmacognosy and Phytochemistry. 2024. 2nd ed. CBS Publishers.

SOLS/MBT/SEC(P)-2 Herbal Biotechnology (Practical) (Cr. -2)

1. Preparation of herbarium of medicinal and aromatic herbs of the locality.
2. Preparation of methanolic extract of an important medicinal herbal plant.
3. Qualitative estimation of secondary metabolites of an important medicinal herbal plant.
4. Estimate the antimicrobial activity of the above methanolic plant extract.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-V Nanobiotechnology (SOLS/MBT/DSE-2a)

Course Credits	04 (Four)
Course Learning Outcomes	• Learn the basic concept, definition, and application of nanotechnology. • Understand the knowledge of nanoparticle synthesis, their characterization, biological activity, and applications. • Apply the theories of nanotechnology in nanomedicine and environmental research. • Analyse the differences in properties of nanomaterials synthesis methods and their characteristics for suitability in biotechnological applications. • Evaluate the structural and functional aspects of chemically and biologically synthesized nanomaterials in sustainable biotechnology.

Paper-V Nanobiotechnology
(Course Code: SOLS/MBT/DSE-2a)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Introduction to Nanobiotechnology: Concepts, historical perspectives, types and various applications and uses of nanomaterials. 'Top-Down' and 'Bottom-Up' approaches.

UNIT- II (Cr- 0.75)

Synthesis of nanoparticles: Physical, chemical, and biological approach of nanoparticle synthesis, limitations of physical and chemical approaches, and advantages of using the green synthesis approach. Characterization of nanoparticles: UV spectrophotometer, XRD, SEM, TEM, HR-TEM, FTIR and DLS, etc.

UNIT- III (Cr- 0.75)

Biological activities and applications of nanoparticles: Antimicrobial activity, antioxidant activity, anticancer activity, anti-inflammatory activity, and Nano fertilizers, Nanomedicine: Nanoparticles within a biological environment, nanoparticle dynamics in biological media. Nanoparticles for therapy: Drug delivery, gene delivery, protein delivery, and uptake.

UNIT–IV (Cr- 0.75)

Application of nanoparticles in the treatment of Industrial wastewater, and pollution control. Environmental impact of nanomaterials: Exposure and risk assessment, cytotoxicity and phytotoxicity of nanoparticles.

Recommended Books:

1. Visakh P.M., Bayraktar, O. Recent Progress in Nanobiotechnology: Modern Techniques in Biomedical Applications. 2024. 1st ed. Springer, Singapore.
2. Tomar R.S., Jyoti A., Kausik, S.K. Nanobiotechnology. 2020. 1st ed. Apple Academic Press Inc.
3. Hermanson G.T. Bioconjugate Techniques. 2013. 3rd ed. Elsevier.
4. Summers, H.D. Nanomedicine. 2013. 1st ed. Elsevier.

5. Decher G., Schlenoff J.B. Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials. 2012. 2nd ed. Wiley-VCH Verlag GmbH.
6. Ramsden J.J. Nanotechnology: An Introduction. 2011. 1st ed. Elsevier.

SOLS/MBT/DSE(P)-2a Nanobiotechnology (Practical) (Cr. -1)

1. Green synthesis of nanoparticles using plant extract.
2. Characterization of nanoparticles using UV-Vis Spectroscopy
3. Evaluation of the antimicrobial activity of nanoparticles.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-V Cancer Biology (SOLS/MBT/DSE-2b)

Course Credits	04 (Four)
Course Learning Outcomes	• Learn the basics of cells regulation and cancer. • Understand fundamentals of various types of cancers and their characteristics. • Apply the concepts of cancer detection and therapeutic approaches. • Analyse the differences in the development stages in various types of cancer. • Evaluate cancer development's structural and functional aspects and their activation mechanism.

Paper V: Cancer Biology
(Course Code: SOLS/MBT/DSE-2b)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Introduction: Basic characteristics of cancer cells, morphological and ultrastructural properties of various types of cancer cells, Types of growth: Hyperplasia, dysplasia, anaplasia and neoplasia, nomenclature of neoplasms, and differential characteristics of benign and malignant tumors.

UNIT- II (Cr- 0.75)

Cancer biology and biochemistry: Aberrant metabolism in cancer development, para-neoplastic syndromes, tumor markers, cellular proto-oncogenes, and their activation mechanism. Growth factors: EGF, TNF, TGF and growth factor receptors, signal transduction in cancer, and the mechanism of transcription factors.

UNIT- III (Cr- 0.75)

Carcinogenesis: Radiation and chemical carcinogenesis and their mechanism. Stages in chemical carcinogenesis: Initiation, promotion, and progression. Role of free radicals, and antioxidants in cancer. Cell cycle regulation: Tumor suppressor genes. Cell adhesion: Invasion and metastasis, VEGF signalling, and angiogenesis.

UNIT–IV (Cr- 0.75)

Epigenetics: Role of DNA methylation in gene silencing, epigenetic silencing of tumor suppressor genes and its benefits. Apoptosis in cancer: Cell death by apoptosis, detailed mechanism, and the role of caspases. Death signalling pathways: Mitochondrial and death receptor pathways. Detection methods of cancer: Type of detection and prediction of aggressiveness of cancer.

Recommended Books:

1. Kumar D.U. An Introduction to Epigenetics of Cancer. 2025. 1st ed. B P Internation.
2. Kalka R. Cancer Epigenetics. 2024. 1st ed. Springer Cham.
3. Gray S.G. Epigenetic Cancer Therapy. 2023. 2nd ed. Academic Press.
4. Qazi A.S., Tariq K. Therapeutic Approaches in Cancer Treatment. 2023. 1st ed. Springer Cham.
5. Tollefsbol T.O. Cancer Epigenetics. 2019. 1st ed. CRC Press.
6. Sarkar F.H. Epigenetics and Cancer. 2013. 1st ed. Springer Dordrecht

SOLS/MBT/DSE(P)-2b Cancer Biology (Practical) (Cr. -1)

1. Protein sequence analysis of cancer related genes.
2. Homology search for cancer related genes.
3. In-silico determination of physicochemical properties and 3-D structure analysis of a cancer related protein.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-II

Core Course: Paper-V Biofertilizer and Organic Farming (SOLS/MBT/MDE-2)

Course Credits	**04 (Four)**
Course Learning Outcomes	• Learn the basics concepts and prospects of biofertilizer in the organic farming • Understand fundamentals of biofertilizers preparation, characteristics and their applications. • Apply the concepts of organic forming for sustainable agriculture. • Analyse the differences in the biofertilizer types and their properties. • Evaluate functional aspects of organic forming over use of synthetic fertilizers.

Paper V: Biofertilizer and Organic Farming
(Course Code: SOLS/MBT/MDE-2)

No. of Credits: 3

UNIT–I (Cr- 0.75)

Introduction to organic farming and soil health: Organic farming definition, history, concepts, and principles, distinction between organic and conventional farming systems, soil management (soil structure and fertility, and organic matter decomposition), organic farming ecosystems, and environmental benefits.

UNIT–II (Cr- 0.75)

Organic manures and compost production: Types of organic manures and their nutrient composition, composting methods and its applications, concept of vermicomposting, and nutrient management.

UNIT–III (Cr- 0.75)

Biofertilizers - Types and production, Importance of microbes (PGPR) used as biofertilizers and their advantages over chemical fertilizers; concept of bacterial biofertilizers; algal and fungal bio-fertilizers.

UNIT–IV (Cr- 0.75)

Basics of mass-production techniques of above biofertilizers, Quality control standards for biofertilizers and organic fertilizers, basics of organic certification and marketing strategies.

Recommended Books:

1. Panda H. Manufacture of biofertilizer and organic farming. 2025. 1st ed. Asia Pacific Business Press.
2. Madhav V. Biofertilizer and Organic Farming. 2022. 1st ed. New Delhi: BFC Publications.
3. Murthy V.R.K. Principles and Practices of Organic Farming and Conservation Agriculture. 2026. 1st ed. SR Edu Publications
4. Panda H., Hota D. Biofertilizer and Organic Farming. 2009. 1st ed. Gene-Tech Publications.
5. Davis E. Organic Farming: Biofertilizers and Nutrients. 2018. 1st ed. Bio-Geen Publication.

SOLS/MBT/MDE(P)-2 Biofertilizer and Organic Farming (Practical) (Cr. -1)

1. Vermicompost and compost preparation.
2. Study of bio-fertilizer quality parameters.
3. Study of soil quality parameters.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-I Molecular Genetics (SOLS/MBT/DSC-7)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic structure of chromosomes and their properties, and the concept of genetics. • Understand the genetic inheritance and functional perspectives of genetics. • Apply the knowledge of genetics principles in understanding metabolic and inherited biological functions. • Analyze the differences in the mechanisms of inheritance and mutation, and their characteristics. • Evaluate the role of genetic inheritance in biological functions and biodiversity.

Paper-I Molecular Genetics
(Course Code: SOLS/MBT/DSC-7)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Chromatin: Structure of chromatin and higher order packaging in chromosome. Principles of Genetic Inheritance: Mendelian law of Inheritance and its variations, linkage and crossing over, gene mapping, recombination, complementation, and extrachromosomal inheritance.

UNIT- II (Cr- 0.75)

Mutations: Types, mutation rate, reversion vs. suppression, mutagenic agents, molecular mechanism of mutagenesis. Chromosomal aberrations: Change in number and structure. Transposons: General idea of transposable genetic elements.

UNIT–III (Cr- 0.75)

Bacterial Conjugation: F-factor, conjugal transfer process, high frequency recombination (Hfr) strains. Bacterial transformation: Competence, DNA uptake by competent cells and mechanism of transformation.

UNIT-IV (Cr- 0.75)

Transduction: General & specialized transduction. Genetics of bacteriophages: Lytic and lysogenic, cycle, expression of phage genes in regulation of lytic and lysogenic circuit.

Recommended Books:

1. Shergojry S.A., Nisham M.U. Introduction to Molecular Genetics. 2024. 1st ed. Lambert Academic Publisher.
2. Bhat T.A., Shakoori R., Al-Khayri J.M. Molecular Genetics, Structure, Mechanism, and Functions. 2024. 1st ed. CRC Press.
3. Andres A., Parafianowicz P., Lantz K. Molecular Genetics. 2021. 1st ed. Kendall/Hunt Publishing Company.
4. Snustad D.P., Simmons M.J. Principles of Genetics. 2016. 7th ed. John Wiley & Sons.

5. Maloy S.R., Cronan J.E., Freifelder D. Microbial Genetics. 1994. 2nd ed. Jones and Bartlett Publishers, Inc.

SOLS/MBT/DSC(P)-7 Molecular Genetics (Practical) (Cr. -2)

1. Preparation of Master and Replica Plates.
2. Study of the effect of mutagens on bacterial cells.
3. Observation of different conformations of plasmid DNA through Agarose gel electrophoresis.
4. Demonstration of bacterial conjugation.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-II Bioinformatics and Biostatistics (SOLS/MBT/DSC-8)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the basic definition, objectives, and scope of bioinformatics and biostatistics. • Understand the concepts and application of bioinformatics and biostatistics in research. • Apply the knowledge of bioinformatics and biostatistics in the processing of complex biological data. • Analyse the differences in data prediction and experimental validation. • Evaluate the role of bioinformatics and biostatistics in the synthetic design for performing complex biological functions.

Paper-II Bioinformatics and Biostatistics
(Course Code: SOLS/MBT/DSC-8)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Introduction to bioinformatics: Objectives, applications and scopes of information technology in biology, bioinformatics resources, Word wide web, and web browsers. Biological databases: Primary, secondary database, GENBANK, EMBL, DDBJ, PDB, and UNIPROT. Search engines: Entrez, SRS, web server-NCBI and EBI.

UNIT- II (Cr- 0.75)

Sequence alignment: Definition and applications, Sequence similarity searching tools: FASTA, and BLAST, multiple sequence alignment (MSA) and applications, software and tools for MSA, phylogenetic analysis, tools for phylogenetic analysis and their applications.

UNIT- III (Cr- 0.75)

Protein structure: Prediction tools, molecular modelling (Homology modelling), visualization tools, protein-protein interactions and online tools for prediction.

UNIT–IV (Cr- 0.75)

Biostatistics and its importance in biological research. Types of data and analysis: Qualitative vs. quantitative, discrete vs. continuous, primary and secondary data, methods of data collection, graphical representation of data. Statistical methods: Mean, mode, median, standard error, standard deviation, Statistical data calculation using computational tools.

Recommended Books:

1. Pasha C., Swathi Rajan A. Bioinformatics & Biostatistics. 2021. 1st ed. Divya Lakshmi Publishers.
2. Arumugam N., Gopi A. Mumaresan V., Meena A., Sundaralingam R. Biostatistics, Computer Application and Bioinformatics. 2019. 4th ed. Saras Publication.
3. Lesk A.M. Introduction to Bioinformatics. 2019. 5th ed. Wiley Publications

4. Rastogi S.C., Mendiratta N., Rastogi P. Bioinformatics: Methods and Applications—Genomics, Proteomics, and Drug Discovery. 2013. 4th ed. Prentice Hall of India Private Ltd.
5. Balagurusamy E. Fundamentals of Computers. 2008. 1st ed. Tata McGraw Hill.
6. Pevsner J. Bioinformatics and Functional Genomics. 2015. 3rd ed. Wiley-Blackwell.

SOLS/MBT/DSC(P)-8 Bioinformatics and Biostatistics (Practical) (Cr. -2)

1. Study of NCBI, PubMed databases.

2. Retrieval of nucleotide or protein sequences from the NCBI database.

3. Localization prediction of a protein sequence using the CELLO server.

4. Use of statistical methods (mean, mode, median, etc.).

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-III Molecular Cell Biology (SOLS/MBT/DSC-9)

Course Credits	05 (Five)
Course Learning Outcomes	• Learn the fundamental structures and functions of cellular organelles and the molecular building blocks that compose them. • Understand the complex molecular mechanisms underlying DNA replication, transcription, translation, and the regulation of gene expression. • Apply the laboratory techniques and molecular protocols to investigate cellular processes and solve experimental biological problems. • Analyse the signaling pathways and regulatory networks that govern cell growth, division, and specialized cellular responses. • Evaluate current scientific literature and experimental data to assess the molecular basis of human diseases and cellular dysfunctions.

Paper-III Molecular Cell Biology
(Course Code: SOLS/MBT/DSC-9)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Prokaryotic and eukaryotic cell: Cell structure and organization, cell organelles, and cell wall. Cell organelle's structure and function: nucleus, mitochondria, golgi body, endoplasmic reticulum, chloroplast, lysosome, peroxisome, ribosome and plasma membrane. Cytoskeleton and its components.

UNIT- II (Cr- 0.75)

Membrane transportation: Membrane proteins, principle of membrane transport, types of cellular transport, channel proteins and their types, carrier proteins and functions, ion channels (Ion selective and voltage-gated ion channels) and membrane potential.

UNIT- III (Cr- 0.75)

Protein Sorting: Anterograde & retrograde mode of protein trafficking, vesicular transport, secretory and endocytic pathways, protein folding, unfolded protein response, cell signalling and their types, crosstalk in signalling pathways, and secondary messengers.

UNIT–IV (Cr- 0.75)

Cell growth: Cell division and differentiation, cell cycle and its regulation (Cyclins, CDK, and checkpoints), necrosis and its implications. Autophagy: Process and regulation, role in aging and neurodegenerative diseases. Programmed cell death: Definition, significance, and types (overview). Proto-oncogenes and tumour suppressor genes.

Recommended Books:

1. Alberts B., Heald R., Johnson A., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell. 2022.7th ed. WW Norton & Co.
2. Lodish H., Berk A., Kaiser C.A. Molecular Cell Biology. 2021. 9th ed. W. H. Freeman & Co.

3. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W. H. Freeman & Co.
4. Cooper G.M., Hausman R.E. The Cell: A Molecular Approach. 2019. 7th ed. Sinauer Associates Inc.
5. Watson J.D., Tania A.B., Stephen P.B. Molecular Biology of the Gene. 2017. 7th ed. Pearson Education.

SOLS/MBT/DSC(P)-9 Molecular Cell Biology (Practical) (Cr. -2)

1. Measurement of cell size.
2. Study of mitosis and meiosis.
3. Study of the osmosis process.
4. Chlorophyll estimation using a spectrophotometer.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-IV Industrial Biotechnology (SOLS/MBT/DSC-10)

Course Credits	05 (Five)
Course Learning Outcomes	• Learn the fundamental concepts of microbial growth kinetics and metabolism in industrial bioprocess. • Understand the principals of bioreactor design, scale-up strategies, and upstream and downstream processing technique. • Apply tools for the enhancement on yield and productivity. • Analyse bioprocess data, mass and energy balances, and economic feasibility factors to optimize production efficiency and trouble-shoot fermentation bottlenecks. • Evaluate the environmental impact, sustainability metrics, regulatory compliance of biotechnology products and processes.

Paper- IV Industrial Biotechnology
(Course Code: SOLS/MBT/DSC-10)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Fermentation: Introduction and its types, Improvement and preservation of industrially important microbes, and microbial growth kinetics in batch, and continuous processes. Solid state fermentation and its applications.

Media formulation for industrial fermentation: Use of raw material, precursors, inducers and antifoam agents.

UNIT- II (Cr- 0.75)

Bioreactors: Types, general configuration and applications (CSTR, bubble column, airlift, fluidized bed, packed bed), scale up and scale down, measurement and control of bioprocess parameters, volumetric mass-transfer coefficient and its measurement.

UNIT- III (Cr- 0.75)

Downstream processing: Cell disruption techniques, separation techniques (Filtration, centrifugation, sedimentation, flocculation, liquid-liquid extraction, precipitation, reverse osmosis, ultrafiltration), drying, crystallization, storage and packaging.

UNIT–IV (Cr- 0.75)

Fermentation products: Microorganisms and raw material/media used, fermentation, conditions and purification steps for production of ethanol, antibiotics (Penicillin, and tetracycline), alcoholic beverages, enzymes, xanthan gum, and Baker's yeast.

Recommended Books:

1. Verma P. Industrial Microbiology and Biotechnology: An Insight into Current Trends. 2024. 1st ed. Springer Singapore.
2. Benvenuto M.A. Industrial Biotechnology. 2024. 2nd ed. De Gruyter.

3. El-Mansi M., Bryce C.F. Fermentation Microbiology and Biotechnology. 2018. 4th ed. Boca Raton.
4. Bailey J.E., Ollis D.F. Biochemical Engineering Fundamentals. 2017. 2nd ed. McGraw Hill Education.
5. Casida J.R. Industrial Microbiology. 2016. 2nd ed. New Age International Publishers.
6. Stanbury P.F., Whitaker, A. Principles of Fermentation Technology. 2010. 3rd ed. Oxford Pergamon Press.
7. Blanch H.W., Clark D.S. Biochemical Engineering. 1997. 2nd ed. CRC Press.

SOLS/MBT/DSC(P)-10 Industrial Biotechnology (Practical) (Cr. -2)

1. Bacterial growth curve preparation.
2. Screening of soil microflora for enzyme production.
3. Demonstration of bioreactor.
4. Production of enzyme/organic acid/solvent through fermentation.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-V Immunotechnology (SOLS/MBT/DSE-3a)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental components of the immune system, including the structure and function of antibodies, antigens, and lymphoid organs. • Understand the molecular mechanisms behind innate and adaptive immune responses. • Apply immunological principles to the design and development of diagnostic tools. • Analyse the strategies used in vaccine production and the therapeutics in treating infectious diseases and cancer. • Evaluate current advancements in immunotherapy and the ethical implications of manipulating immune responses for clinical applications.

Paper-V Immunotechnology
(Course Code: SOLS/MBT/DSE-3a)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Monoclonal antibodies: Introduction, polyclonal antibody versus monoclonal antibody, advantages and limitations of monoclonal antibodies, Storage and applications of monoclonal antibodies. Monoclonal antibody production: Hybridoma technology, phage display technology, single B-cell technology.

UNIT- III (Cr- 0.75)

Recombinant monoclonal antibody production: Development of engineered monoclonal antibodies, murine, chimeric, humanized and fully human antibody. Hybrid monoclonal antibodies and catalytic monoclonal antibodies (Abzymes), Cancer Immunotherapy.

UNIT–IV (Cr- 0.75)

Antigen-antibody interactions: Precipitation reactions and application, agglutination reactions and applications, Immunological assays: Immunodiffusion, immunoelectrophoresis, RIA, ELISA, immunofluorescence, and western blotting. General physiology and application of cytokines for therapy, interferon colony stimulating factor, preparation of lymphokines by r-DNA technology.

UNIT-IV (Cr- 0.75)

Vaccines: Introduction and types (Inactivated, attenuated, toxoid, subunit and multivalent vaccines), purified macromolecules, and conjugate vaccines. New generation vaccines: Synthetic peptide vaccines, recombinant antigen vaccines, DNA vaccines, immune stimulants, adjuvants, novel vaccine delivery systems. New emerging diseases and vaccine development.

Recommended Books:

1. Mohapatra A.D., Sahu P.S. Advances in Immunology and Immunotechniques: Updates Concepts and Recent Applications. 2024. 1st ed. Springer Singapore.
2. Punt J., Stranford S., Jones P., Owen J. Kuby: Immunology. 2022. 8th ed. W.H. Freeman.
3. Ghosh S. Immunology and Immunotechnology. 2021. 1st ed. Books & Allied.

4. Delves P.J., Martin S.J., Burton D.R., Roitt I.M. Essential Immunology, 2017. 13th ed. Willey Blackwell.
5. Bloom B., Lambert P.-H. The Vaccine Book. 2016. 2nd ed. Academic Press.
6. Greenfield E.A. Antibodies: A Laboratory Manual. 2014. 2nd ed. Cold Spring Harbor Laboratory Press.
7. Hay F.C., Westwood O.M.R. Practical Immunology. 2002. 1st ed. Wiley-Blackwell.
8. Male D.K., Champion B., Cooke A. Advanced Immunology. 1998. 1st ed. Mosby.

SOLS/MBT/DSE(P)-3a Immunotechnology (Practical) (Cr. -1)

1. Identification of leukocyte subsets and total count.
2. Immunoelectrophoresis.
3. Rocket immunoelectrophoresis.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-V Enzymes & Enzyme Technology (SOLS/MBT/DSE-3b)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental structures, classifications, and nomenclature of enzymes to identify their specific biological roles. • Understand the mechanisms of enzyme kinetics and inhibition to explain various factors that affect reaction rates. • Apply techniques for enzyme purification to solve practical problems in industrial and clinical settings. • Analyse the performance of the enzymatic system and bioreactors to optimize bioprocess efficiency and yield. • Evaluate the latest advancements and ethical implications in enzyme engineering and directed evolution to determine their suitability for sustainable technology.

Paper-V Enzymes & Enzyme Technology
(Course Code: SOLS/MBT/DSE-3b)

No. of Credits: 3

UNIT – I (Cr- 0.75)

Properties of enzymes: Catalytic power, specificity, Holoenzymes, Apoenzyme, Coenzyme and Cofactor. Nomenclature and classification of enzymes, active site. Fischer and Koshland models. Collision theory, activation energy and transition state energy, the law of mass action and order reaction.

UNIT – II (Cr- 0.75)

Enzyme kinetics: Kinetics of single substrate enzyme catalyzed reaction, Michaelis-Menten equation, Lineweaver Burk plot . Determination of V_{max}, Km, Kcat and their significance. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Enzyme Inhibition: Reversible inhibition- competitive, uncompetitive and non-competitive inhibition, allosteric and irreversible inhibitions.

UNIT – III (Cr- 0.75)

Enzyme purification and criteria of purity, large scale production of enzyme and industrial applications of enzymes

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Concerted and sequential models. Isozymes- special reference to lactate dehydrogenase. Ribozymes, site directed mutagenesis.

UNIT – IV (Cr- 0.75)

Mechanism of enzyme action: General mechanistic principle, Factors contributing to the catalytic efficiency-proximity and orientation, nucleophilic and covalent co-valent catalysis, acid-base catalysis, metal ion catalysis. Mechanism of reactions catalyzed by enzymes: Specific examples

(Chymotrypsin, Lysozyme, Ribonuclease and Carboxypeptidase). Industrial applications of enzymes.

Recommended Books:

1. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
2. West E.S., Todd W.R., Manson H.S., Vanbruggen T.V. Textbook of Biochemistry. 2022. 1st ed. CBS Publishers
3. Finar I.L. Organic Chemistry Vol 2: Stereochemistry and the Chemistry of Natural Products. 2022. 5th ed. Pearson Education India.
4. Zubay G.L. Biochemistry. 2008. 4th ed. WM. C. Brown Publishers.
5. Devasena T. Enzymology. 2010. 3rd ed. Oxford University Press.

SOLS/MBT/DSE(P)-3b Enzymes & Enzyme Technology (Practical) (Cr. -1)

1. Salivary Amylase activity on starch.

2. Enzyme activity of salivary amylase.

3. Effect of temperature on salivary amylase activity.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-V Research Methodology and Scientific Writing (SOLS/MBT/MDE-3)

Course Credits	**04 (Four)**
Course Learning Outcomes	• Learn the fundamental principles of the scientific method and the ethical standards required for conducting and reporting research. • Understand different research designs, sampling techniques, and data collection methods appropriate for qualitative and quantitative studies. • Apply standard formatting styles and technical writing conventions to produce clear, concise, and well-structured scientific manuscripts. • Analyse raw data using appropriate statistical tools and logical reasoning to derive meaningful patterns and insights. • Evaluate existing scholarly literature and peer-reviewed articles to identify research gaps and justify the significance of a proposed study.

Paper-V Research Methodology and Scientific Writing
(Course Code: SOLS/MBT/MDE-3)

No. of Credits: 3

UNIT – I (Cr- 0.75)

Importance and need of scientific research, Problem identification, objectives, significance, scope and limitations, Literature survey: Use of books, journals, libraries, online survey, Importance and designing of the problem to be undertaken.

UNIT – II (Cr- 0.75)

Sampling techniques: Simple and random sampling methods, data collection, types of data, qualitative and quantitative data, Primary and secondary data, data summarization, Data representation: Tabular and diagrammatic representation of data, Measures of central tendency: Use of mean, mode, median. Data interpretation, Descriptive and inferential statistics.

UNIT – III (Cr- 0.75)

Project Report Preparation: Introduction of the problem, Materials and methods Review of literature, Results, Discussion.

UNIT – IV (Cr- 0.75)

Referencing technique, Summary of research/Abstract etc. Plagiarism and their removal. Plagiarism related tools, Publication of scientific data, writing research paper & report, AI in research writing and related tools.

Recommended Books: -

1. Holmes D., Moody P., Dine D., Trueman L. Research Methods for the Biosciences. 2017. 1st ed. Oxford University Press.
2. Gurumani N. Scientific Thesis Writing and Paper Presentation. 2019. 1st ed. MJP Publisher.
3. Schweizer M. Methods in Biotechnology. 1997. 1st ed. CRC Press.

SOLS/MBT/MDE(P)-3 Research Methodology and Scientific Writing (Practical) (Cr. -1)

1. Reading a given research article and Referencing Techniques.
2. Reviewing the given topic and research gap finding.
3. Data representation and measures of central tendency.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-I Intellectual Property Rights (SOLS/MBT/DSC-11)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental concepts, types, and legal frameworks governing intellectual property. • Understand the significance of IPR in protecting intangible assets, fostering innovation, and rewarding human intellect, as well as the societal and economic purposes of granting exclusive rights. • Apply statutory provisions and registration processes to protect specific forms of IP, including the ability to identify patentability criteria, register trademarks, and draft copyright notices. • Analyse rights and responsibilities of IPR holders to identify potential infringement cases and legal remedies in national and international contexts. • Evaluate the effectiveness of IPR strategies and case laws, specifically regarding fair dealing, compulsory licensing, and emerging trends in technology.

Paper-I Intellectual Property Rights
(Course Code: SOLS/MBT/DSC-11)

No. of Credits: 3

UNIT-I (Cr- 0.5)

Intellectual property (IP): Introduction, history and evolution of IP. Types of IP: Patents, trademarks, copyright & related rights, Idea-expression dichotomy, industrial design, traditional knowledge, geographical indications, significance of IPR.

UNIT- II (Cr- 0.75)

International conventions and treaties: History of GATT & TRIPS agreement, World trade organization, post TRIPS scenario, Madrid agreement, Hague agreement, Budapest treaty, patent cooperation treaty, Indian patent act 1970 & recent amendments, India's IPR policy, and World Intellectual Property Organization (WIPO).

UNIT- III (Cr- 0.75)

Discovery vs invention: A concept of 'prior art', invention in context of 'prior art', introduction & classifications of patents, and patentability criteria. Diamond vs Chakraborty case study, IP as a factor in R&D, legal and IPR issues in biotechnology, licensing and compulsory licensing, patent infringement and legal action.

UNIT–IV (Cr- 1)

Patent drafting basics: structure of patent (title, abstract, specification, claims). Procedure for filing a patent in India: provisional and complete specification, publication, examination, opposition and grant. Patent laws in India: overview of the Indian Patent Act 1970 and its implementation. Patent enforcement: infringement, remedies and legal protection. Commercial aspects of patents: licensing, technology transfer and role of patents in innovation and industry.

Recommended Books:

1. Gurnani S.R. Intellectual Property Rights. 2024. 1st ed. C. Jamnadas & Co.
2. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy. 2017. 1st ed. McGraw-Hill Education.
3. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Government of India (http://www.ipindia.nic.in).
4. World Trade Organisation (http://www.wto.org).
5. World Intellectual Property Organisation (http://www.wipo.int).

SOLS/MBT/DSC(P)-11 Intellectual Property Rights (Practical) (Cr. -2)

1. IP-related case studies.

2. Study of the salient features of a patent document.

3. Exploring web portals for IPR in India.

4. Distinguish between patentable and non-patentable biotechnology inventions.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-II Biosafety and Bioethics (SOLS/MBT/DSC-12)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental principles of laboratory safety, containment levels, and the regulatory frameworks governing biological research. • Understand the ethical theories and moral dilemmas associated with modern biotechnology, such as gene editing and cloning research. • Apply standardized risk assessment protocols to identify and mitigate potential hazards when handling infectious agents or recombinant DNA. • Analyse the social, legal, and environmental implications of releasing genetically modified organisms into the ecosystem. • Evaluate current bioethical policies and institutional biosafety guidelines to ensure compliance with international health and safety standards.

Paper-II Biosafety and Bioethics
(Course Code: SOLS/MBT/DSC-12)

No. of Credits: 3

UNIT-I (Cr- 0.5)

Introduction to biosafety and bioethics: concepts, history, and significance. Principles of bioethics: Definition, scope, principles, and significance, issues of ownership, monopoly, biodiversity, traditional knowledge access & benefit sharing, social ethical issues in biotechnology. Scope and importance of biosafety in biotechnology. Levels of biosafety (BSL-1 to BSL-4) and laboratory practices.

UNIT-II (Cr- 0.75)

National and international biosafety regulations and guidelines, Role of organizations such as World Health Organization and National Institutes of Health. Overview of the Cartagena Protocol on Biosafety. Biosafety regulatory framework in India: IBSC, RCGM, GEAC, Guidelines for handling genetically modified organisms (GMOs).

UNIT-III (Cr- 0.75)

Risk assessment and risk management in biotechnology. Containment strategies and biosafety measures in laboratories and industries, Environmental and health impacts of GMOs. Ethical issues in biotechnology: cloning, stem cells, gene editing, Case studies highlighting ethical dilemmas.

UNIT-IV (Cr- 1)

Biosafety compliance and documentation: standard operating procedures (SOPs), risk communication. Ethical review processes: Institutional Ethics Committees (IEC) and approvals. Regulations for research involving humans and animals. Intellectual property vs bioethics: access, benefit sharing, and equity. Emerging issues: synthetic biology, CRISPR, data privacy, and global bioethics concerns.

Recommended Books:

1. Goel D., Parashar S. IPR, Biosafety and Bioethics. 2013. 1st ed. Pearson Education India.
2. Sateesh M.K. Bioethics and Biosafety. 2013. 1st ed. IK International Pvt Ltd.
3. Uzochukwu S., Esiobu N.D., Okoli A.S., Nwoba E.G., Christpeace E.N., Adetunji C.O., Ibrahim A.B., Ubi B.E. 2022. Biosafety and Bioethics in Biotechnology: Policy, Advocacy, and Capacity Building. 1st ed. CRC Press.
4. Campbell A. Bioethics: The Basics. 2017. 1st ed. Routledge.
5. Faden R.R., Beauchamp T.L. A History and Theory of Informed Consent. 1986. 1st ed. Oxford University Press.

SOLS/MBT/DSC(P)-12 Biosafety and Bioethics (Practical) (Cr. -2)

1. Biopiracy related case studies.

2. Exploring web portals for start-ups in India.

3. CRISPR-related case studies.

4. Lab requirements for BSL status.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-III

Core Course: Paper-III Environmental Biotechnology (SOLS/MBT/DSC-13)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental principles of microbial ecology and molecular biology techniques used to monitor and manage environmental quality. • Understand the biochemical pathways and genetic mechanisms that allow microorganisms to degrade hazardous compounds. • Apply biotechnological strategies to restore contaminated soil, water, and air. • Analyze the efficiency of biological waste treatment systems and renewable production processes. • Evaluate the environmental impact and biosafety of deploying genetically modified organisms (GMOs) for large-scale ecological interventions.

Paper-III Environmental Biotechnology
(Course Code: SOLS/MBT/DSC-13)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Environment and pollution: Introduction to environment, pollution and its control, and pollution indicators. Waste management: Domestic, industrial, solid & hazardous waste, wastewater treatment, contributions of biotechnology to waste treatment and environmental management and biodiversity and its conservation.

UNIT-I (Cr- 0.75)

Bioremediation: Fundamentals, methods & strategies of bioremediation, application of bacteria and fungi in bioremediation of various pollutants (heavy metals, radionuclides, organic pollutants, and xenobiotic compounds), use of nanoparticles in bioremediation. Phytoremediation: Fundamentals and description of major methods of applications (Phytoaccumulation, phytovolatilization, rhizofiltration, and phytostabilization).

UNIT- III (Cr- 0.75)

Environmental biotechnology and biofuels: Biogas, bioethanol, biodiesel, and biohydrogen, microorganisms involved and biotechnological interventions for optimizing production, microbiologically enhanced oil recovery (MEOR), bioleaching of metals, production of bioplastics, production of biosurfactants and bioemulsifiers. Paper production: Use of xylanases and white rot fungi.

UNIT-I (Cr- 0.75)

Bioinsecticides, biopesticides & biofungicides: Introduction and applications. Role of GMOs in environment clean-up and biotechnological interventions for dye removal and oil spillage. Biosensors for environment monitoring. Algal biotechnology: Concepts, uses and applications.

Recommended Books:

1. Verma P. Biotechnology for Environmental Sustainability. 2024. 1st ed. Springer Nature.
2. McCarty P.L., Rittmann B.E. Environmental Biotechnology: Principles & Applications. 2021. 2nd ed. McGraw Hill
3. Kumar P., Kumar V. Textbook of Environmental Biotechnology. 2018. 1st ed. Woodhead Publishing.
5. Kumar R., Sharma A.K., Ahluwalia S.S. Advances in Environmental Biotechnology. 2017. 1st ed. Springer, Singapore.

SOLS/MBT/DSC(P)-13 Environmental Biotechnology (Practical) (Cr. -2)

1. Determination of various physicochemical parameters in polluted water samples.

2. Coliform test for water quality analysis.

3. Study of bioremediation by microorganisms.

4. Production of bio-fertilizers.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-IV AI in Biotechnology (SOLS/MBT/DSC-14)

Course Credits	05 (Five)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of AI tools. • Understand the biological analysis by AI applications. • Apply the concepts and techniques AI for biotechnological discovery and industrial applications • Analyse the differences in bioinformatics and AI ethics. • Evaluate the engineering aspects of AI for sustainable development.

Paper-IV AI in Biotechnology
(Course Code: SOLS/MBT/DSC-14)

No. of Credits: 3

UNIT–I (Cr- 0.75)

Foundations of AI and Biological Data: Introduction and overview of machine learning, deep learning, and AI applications in life sciences; Biological data (genomics, transcriptomics, proteomics) and structural data (PDB); Handling missing data, normalization, and data mining techniques in biotechnology.

UNIT–II (Cr- 0.75)

AI in sequence analysis, AI-based alignment, and gene annotation, protein structure prediction, genome editing, and engineering.

UNIT–III (Cr- 0.75)

AI-Driven Drug Discovery and Design: Concept of drug-target interaction, virtual screening, and molecular docking; target Identification and validation for finding novel drug targets and understanding disease pathways.

UNIT–IV (Cr- 0.75)

Industrial AI Applications and Future Trends: AI in medical imaging and diagnostics, ethical, legal, and regulatory aspects of AI in biotechnology. AI correlation with IPR.

Recommended Books:

1. Srivastav A.K., Das P., Ghodke B. Artificial Intelligence in Biotechnology and Genomics. 2025. 1st ed. BFC Publications.
2. Mohanan P.V. Artificial Intelligence and Biological Sciences. 2025. 1st ed. CRC Press.
3. Khade S.M., Mishra R.G. Future of AI in Biomedicine and Biotechnology. 2024. 1st ed. IGI Global.
4. Hannoon A., Mahmood A. The Artificial Intelligence-Driven Biotechnology Revival: Innovative Approaches to Sustainable Development. 2026. 1st ed. Springer Nature.
5. Pandey B., Pandey D., Khamparia A., Dutta V., Balas, V.E. Artificial Intelligence in Microbial Research. 2025. 1st ed. Springer, Singapore.

SOLS/MBT/DSC(P)-14 AI in Biotechnology (Practical) (Cr. -2)

1. Demonstration of biological databases.
2. Demonstration of protein structure.
3. Demonstration of sequence alignment tools.
4. Demonstration of molecular docking.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-V Bio-entrepreneurship and Bio-business Management (SOLS/MBT/DSE-4a)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental principles of biotechnology commercialization. • Understand the unique challenges of the "lab-to-market" transition, specifically regarding high capital requirements and long product development cycles. • Apply strategic management tools to develop a comprehensive business plan for a biological product or service, including market entry and scaling strategies. • Analyse the global bio-economy landscape to identify emerging trends, competitive threats, and opportunities for innovation in healthcare or agriculture. • Evaluate the financial viability and ethical implications of bio-business ventures, weighing venture capital requirements against societal impact.

Paper-V Bio-entrepreneurship and Bio-business Management
(Course Code: SOLS/MBT/DSE-4a)

No. of Credits: 3

UNIT–I (Cr- 0.5)

Introduction to bio-entrepreneurship: concept, scope, and importance. Characteristics of bio-entrepreneurs and startup ecosystem. Overview of biotechnology industries: pharma, agriculture, healthcare, environment. Role of innovation and entrepreneurship in biotechnology.

UNIT–II (Cr- 0.75)

Entrepreneurship- risk and benefits, general idea about bio-sector firms and commercialization of a biotechnological product, introduction to the entrepreneurship development Programmes (MSME, DBT, BIRAC, and Make in India), incubation centre, and start-up India.

UNIT–III (Cr- 0.75)

Bio-business management: production, quality control, and regulatory compliance. Technology Readiness Levels (TRL): concept and role in innovation and commercialization. Basics of pitching: preparing pitch decks and communicating business ideas. Marketing strategies in biotechnology products and services. Intellectual property management and commercialization.

UNIT–IV (Cr- 1)

Technology transfer and commercialization of biotech innovations. Scaling up: from lab to industry (pilot to commercial production). Advanced pitching strategies: investor pitching, funding rounds, and negotiation, Case studies of successful biotech start-ups and business models. Ethical, legal, and social issues in bio-business. Global trends and future opportunities in bio-entrepreneurship.

Recommended Books:

1. Shimasaki C.D. Biotechnology Entrepreneurship: Starting, Managing and Leading Biotech Companies. 2020. 2nd ed. Academic Press.
2. Pisano G.P. Science Business: The Promise, the Reality, and the Future of Biotech. 2006. 1st ed. Harvard Business Review Press.
3. Friedman Y. Building Biotechnology. 2022. 5th ed. Think Biotech LLC.
4. Desai V. Dynamics of Entrepreneurial Development and Management. 2021. 1st ed. Himalaya Publishing House.
5. Hisrich R.D., Peters M.P., Shepherd D.A. Entrepreneurship. 2020. 11th ed. McGraw Hill Education.
6. Rai A.K. Bioinformatics, Biotechnology and Business Management. 2018. 1st ed. CBS Publishers & Distributors.
7. Satyanarayana U. Biotechnology: Books and Industrial Applications. 2017. 1st ed. Books and Allied Pvt Ltd.
8. Baron D.P. Business and Its Environment. 2014. 7th ed. Pearson Education.

SOLS/MBT/DSE(P)-4a Bio-entrepreneurship and Bio-business Management (Practical) (Cr. -1)

1. Basics about TRL.
2. Case studies of a Biotech related product.
3. IP related data of any Biotech product.
4. To nearby industrial visit (optional).

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-V Animal Biotechnology (SOLS/MBT/DSE-4b)

Course Credits	05 (Five)
Course Learning Outcomes	• Learn the fundamental principles of molecular biology, genomics, and reproductive technologies used in animal sciences. • Understand the ethical, legal, and social implications surrounding animal cloning and genetic modification. • Apply gene transfer techniques and biotechnological tools to enhance livestock productivity and disease resistance. • Analyse data from diagnostic assays and genetic screens to identify specific traits or pathogens in various animal species. • Evaluate the effectiveness of current biotechnological interventions in improving animal health and public food safety.

Paper-V Animal Biotechnology
(Course Code: SOLS/MBT/DSE-4b)

No. of Credits: 3

UNIT-I (Cr- 0.75)

Animal cell culture: History, basic requirements, cell culture media and reagents, animal cell culture methods, primary culture, secondary culture, suspension cultures, cell lines, continuous cell lines.

UNIT- II (Cr- 0.75)

Transgenic animals: Applications of transgenic animal technology, Techniques of gene transfer: Microinjection, lipofection, electroporation, chemical-based transformation, and viral vectors.

UNIT- III (Cr- 0.75)

Animal genomics: Introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, RFLP, RAPD, genetic basis for disease resistance, gene knock out technologies, Animal cloning: Basic concept and cloning for conservation of endangered species.

UNIT–IV (Cr- 0.75)

Applications of animal cell cultures: Cell culture-based products, vaccines, hybridoma technology, *in vitro* testing of drugs, production of pharmaceutical proteins, stem cells and their use.

Recommended Books:

1. Kumar P.H.P., Soumya C., Shobha G. Animal Biotechnology. 2024. 1st ed. Scientific International Publication.
2. Glick B.R., Patten C.L. Molecular Biotechnology: Principle and Applications of Recombinant DNA. 2022. 6th ed. ASM Press.
3. Verma A.S., Singh A. Animal Biotechnology (Models in Discovery and Translation). 2020. 2nd ed. Elsevier, Academic Press.
4. Singh B., Gautam S.K., Chauhan M.S. Text book of Animal Biotechnology. 2014. 1st ed. TERI

Press.
5. Pörtner R. Animal Cell Biotechnology: Methods and Protocols. 2007. 2nd ed. Humana Press.

SOLS/MBT/DSE(P)-4b Animal Biotechnology (Practical) (Cr. -1)

1. Preparation and filter sterilization of animal tissue culture medium.
2. Quantification of cells by haemocytometer.
3. Determination of viable and non-viable cells by trypan blue dye exclusion method.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Core Course: Paper-V Molecular Diagnostics (SOLS/MBT/MDE-4)

Course Credits	**05 (Five)**
Course Learning Outcomes	• Learn the fundamental principles of nucleic acid structure, replication, and the specific molecular techniques used in clinical laboratories. • Understand the pathophysiology of genetic disorders, infectious diseases, and malignancies at the molecular level. • Apply standardized protocols for DNA/RNA extraction, amplification (PCR), and sequencing to detect specific biomarkers. • Analyze complex molecular data and diagnostic test results to identify genetic mutations or pathogen presence. • Evaluate the clinical validity, limitations, and ethical implications of molecular assays for patient diagnosis and personalized medicine.

Paper V: Molecular Diagnostics
(Course code: SOLS/BT/MDE-4)

No. of Credits: 3

UNIT–I (Cr- 0.75)

Molecular Diagnostics: Overview of Molecular Diagnostics; History of Molecular Diagnostics; Ethical, Social and Legal Issues to Molecular Diagnostics; Personal safety and laboratory safety; Applications of Molecular Diagnostics in Post Genomic Era Areas and Future Prospects.

UNIT–II (Cr- 0.75)

Polymerase Chain Reaction: Principle, Instrumentation, and Applications, Nuclear hybridization methods: Southern, Northern, Microarray, Western Blotting, Biomarkers: Single nucleotide polymorphism, RAPD, and RFLP.

UNIT–III (Cr- 0.75)

Immunodiagnostics: Overview, types and applications of ELISA, Introduction, Principle and Applications: Immunoblotting, immune histochemical techniques, Immunofluorescence.

UNIT–IV (Cr- 0.75)

Genetic testing, Diagnostic Testing for Cystic Fibrosis., Molecular Testing for HIV-1. Role of Molecular diagnostics in bone marrow transplantation and organ Transplantation. Whole genome sequencing for diagnosis of drug resistance in bacterial pathogens.

Recommended Books:

1. Hofmann A., Clokie S. Wilson & Walker's: Principles and Techniques of Biochemistry and Molecular Biology. 2018. 8th ed. Cambridge Univ. Press.
2. Brooks G.F., Butel J.S., Morse S.A. Medical Microbiology. 2007. 1st ed. McGraw-Hill Medical Publications.
3. Goering R., Dockrell H., Zuckerman M., Roitt I., Chiodini P.L. *Mims'* Medical Microbiology. 2012. 1st ed. Elsevier Health Sciences.

4. Glick B.R., Pasternak J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2003. 3rd ed. American Society for Microbiology.

SOLS/MBT/MDE(P)-4 Molecular Diagnostics (Practical) (Cr. -1)

1. Demonstration of PCR.

2. Demonstration of electrophoresis.

3. Haemoglobin Test for Diabetes.

Any other related practical based on the facility.

M.Sc. Biotechnology Semester-IV

Optional Component (Research / Skill Oriented) in lieu of any one DSC: Minor Dissertation / Project Work

Course Credits	**5 (Five)**
Course Learning Outcomes	• Learn advanced laboratory techniques and specialized scientific literature. • Understand complex biological mechanisms and current research gaps. • Apply statistical tools and experimental protocols to generate data. • Analyze raw experimental results using bioinformatics and computational software. • Evaluate data validity, project limitations, and ethical implications.

Optional Component (Research / Skill Oriented) in lieu of any two DSC: Major Dissertation / Project Work

Course Credits	**10 (Ten)**
Course Learning Outcomes	• Learn and summarize key literature, theoretical framework and existing research gaps in biotechnology. • Understand to explain the underlying philosophical paradigms and describe their relevance to the research design. • Apply the appropriate research methodologies, data collection tools and ethical guidelines to address specific research work. • Analyse quantitative or qualitative data by comparing them to established theories and assessing the research limitation. • Evaluate and formulating new theories, models, or evidence-based recommendations that address the research problem.