Vision, Mission, PEO, PO, PSO & CO
Department of Biotechnology (Kumaun University)

VISION

- To produce the best human resource in the area of Biotechnology by imparting quality education and training to the students. Department visualizes the scholastic achievements of its students in order to fulfill the demand of food, fuel, fiber and medicines for ever-increasing global population in a sustainable manner.

MISSION

- To develop trained human resource in the field of biotechnology.
- To develop the Department as an internationally reputed center for research in biotechnology.
- To develop the Department as a resource centre for providing instrumentation and training facility to the researchers and students in the region.

Programme Educational Objectives (PEOs)

M.Sc. Biotechnology Program:

*The Program Educational Objectives (PEOs) for the **M.Sc. Biotechnology** program describe accomplishments that graduates are expected to attain within two years after graduation*

PEO-1: To enable graduates to pursue research career in industry and academia by providing fundamental and practical knowledge in the field of Biotechnology.

PEO-2: To empower the students with analytical and research skills, enable them to critically analyze existing literature in an area of specialization and to nurture entrepreneurial endeavors.

PEO-3: To develop biotechnologists with professional ethics in order to address global and societal issues for sustainable development.

M.Sc. Microbiology Program:

*The Program Educational Objectives (PEOs) for the **M.Sc. Microbiology** program describe accomplishments that graduates are expected to attain within two years after graduation:*

PEO-1: To train graduates in basic and advanced areas of microbiology, Industrial Microbiology, Agriculture & Environmental Microbiology and other related subjects along with sensitizing them to the scope for research.

PEO-2: To empower the students with analytical and research skills, to nurture entrepreneurial endeavors and to prepare a competent generation of microbiologists, capable of excelling in careers of their choosing.

PEO-3: To develop microbiologists with skills to pursue careers both in academia as well as industry such as pharmaceutical, food and bioprocess industries.

Programme Outcomes (POs)

The Graduates of Masters programs (**M.Sc. Biotechnology** and **M.Sc. Microbiology**) will be able to:

PO-1: Master of Science knowledge: Apply the knowledge of biotechnology, microbiology, biochemistry fundamentals, and bioinformatics to the solution of complex biological problems.

PO-2: Problem analysis: Identify, formulate, review research literature, and analyze complex biological problems reaching substantiated conclusions using various principles of biotechnology, bioinformatics, microbiology, biochemistry, cell and molecular biology sciences.

PO-3: Design/development of solutions: Design solutions for complex biological problems and design protocols or processes that meet the

specified needs with appropriate consideration for the public health and safety, conservation of biodiversity, better understanding of the microorganisms, and using bioinformatics tools for finding solutions of various crippling human/plant diseases with ethical, societal, and environmental considerations.

PO-4: Conduct investigations of complex problems: Use the various protocols developed through extensive research-based knowledge and methods including design of experiments, analysis and interpretation of data, and provide valid and reproducible conclusions.

PO-5: Modern Molecular Biology and Bioinformatics tools usage: Develop new technologies, protocols, resources, using modern molecular biology, biotechnology and bioinformatics tools and apply it to solve complex human health problems, plant stress tolerance and conserve floral biodiversity of Himalayan region focusing on medicinally important plants with an understanding of the limitations of this region.

PO-6: Post Graduate Student and society: Apply the classic and modern biological theoretical and practical knowledge gained to address societal, health, microbial and plant biodiversity studies, safety, ethical and cultural issues and the consequent responsibilities relevant to the professional up-gradation of the student and society as a whole.

PO-7: Environment and sustainability: Understand the impact of Himalayan hot spot of biodiversity. The professional PG students will have a better understanding of societal and environmental concerns, and demonstrate their knowledge, and need for sustainable development.

PO-8: Ethics: Apply ethical principles established by different government agencies and commit to research ethics, responsibilities and norms to undertake their current and future research and development.

PO-9: Individual and team work: Be an independent thinker and researcher effectively as an individual, and as a member or leader of different teams, and in multidisciplinary research Institutions and Universities.

PO-10: Communication: Communicate effectively on complex research activities with the scientific community and with society at large, as a scientist or a teacher, be well versed with scientific writing and write

effective reports and design research projects, make effective presentations, and be able to defend it efficiently.

PO-11: Project management and finance: Write good research and development projects relevant to the needs of society and environment and attract extra mural funds for himself and his team in the Institute or University from various funding agencies and manage R&D projects effectively.

PO-12: Life-long learning: Apply the discipline, ethics and knowledge obtained to engage in independent and life-long learning in their respective fields of interest wherever they go for further higher studies or jobs.

Programme Specific Outcome (PSOs)

For M.Sc. Biotechnology program:

After the successful completion of M.Sc. Biotechnology program, the students will able to:

PSO-1: Have basic and advanced understanding of Biotechnology in its various domains including, health, nutrition, agriculture, biodiversity conservation, Biosafety etc.

PSO-2: Address research questions related to all the above mentioned domains through carrying out specific experiments.

PSO-3: Appear and successfully qualify the higher level examinations of various agencies like DBT(Department of Biotechnology), CSIR (Council of Scientific and Industrial Research), ARS (Agriculture Research Services), ICAR(Indian Council of Agriculture Research),and many more, so as to get chance to do research from reputed institutes within country and abroad with sound fellowships

PSO-4: Have enough subject knowledge to move ahead in entrepreneurship endeavors in biotechnology.

For M.Sc. Microbiology program:

Upon successful completion of M.Sc. (Microbiology), the students will be able to:

PSO-1: Get equipped with a theoretical and practical understanding of microbiology and appreciate how microbiology is applied in manufacture of industrial products

PSO-2: Know how to source for microorganisms of industrial importance from the environment

PSO-3: Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms.

PSO-4: Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.

PSO-5: Understand in depth the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also get expertise on different methods for their detection , characterization and industrial applications

PSO-6: To move ahead in entrepreneurship endeavors in microbiology

PSO-7: Appear and successfully qualify the higher level examinations of various agencies , so as to get chance to do research from reputed institutes within country and abroad with sound fellowships

Course Outcomes (COs)

- *Two courses **M.Sc. in Biotechnology** and **M.Sc. in Microbiology** are currently being run by the department besides the **Ph.D. program** on diverse aspects of Biotechnology and Life-sciences*

1. *Course name:* M.Sc. (Biotechnology)		
Semester	**Paper Code and Title**	**Course Outcome**
I	Biochemistry (1S1)	• Theoretical knowledge of various topics as per the syllabus • Exhaustive study of enzyme kinetics and bio-molecules, different metabolic pathways. • Familiarization with Bioenergetics concepts, generation of ATP • Experimentation related to enzyme kinetics, protein/sugar/lipid estimation using different methods, titrations etc.
I	Cell & Developmental Biology (IS2)	1. Study of cell theory, Cell organelles, Ultrastructure, Roles of cell organelles. 2. Exhaustive study of Cell Signaling pathways, secondary messengers etc 3. Understanding of Developmental biology: Stem cell and cancer, Differentiation in plant tissue 4. Familiarization with methods of cell-study, various forms of Microscopy, staining for microscopy etc.
I	Molecular Biology (IS3)	1. Understanding of Genome organization, Development of basic concepts in DNA/RNA structure , Replication, Repair & Recombination. 2. Knowledge of transcription and translation in prokaryotic and eukaryotic system. 3. Development of concepts of Oncogenesis, oncogenes and tumor suppressor genes. 4. Hands on training on DNA & RNA isolation by different techniques; plasmid isolation, transformation, Electrophoresis, quality check of Nucleic acids, restriction digestion, PCR, RFLP etc
I	Microbiology and Industrial	1. Theoretical knowledge of microbial diversity & systematics, Microbial growth and physiology;

	Applications (IS4)	Study of size, shape and growth pattern, nutrition type of microbes. 2. Experimental knowledge of Sterilization, disinfection, safety in microbiological laboratory. Preparation of media, Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods, Storage of microorganisms, Gram Staining and enumeration of microorganisms. 3. Familiarization of assays related to antibiotics production and demonstration of antibiotic resistance
I	Biostatistics and Computer Applications (IS5)	1. Comprehensive study of various topics including Data representation methods, measures of central tendency, variance 2. Practical knowledge of application of correlation and regression analysis, test of significance: F and t tests, Chi square test etc. 3. Study on sigma plotter, null hypothesis, Bioinformatic methods, Basic idea of computer languages 4. Familiarization with biological databases, sequence, structure and strain database, Secondary and sequence analysis of DNA, RNA and proteins
II	Plant Biotechnology (2S1)	1. Knowledge of various topics including Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis, somaclonal variation etc 2. Development of concepts in Agrobiology, Genetic transformation: its various methods and applications 3. Hands on training on Plant Tissue Culture, artificial seed production, cell suspension cultures, fermentation, secondary metabolite production and plant transgenics 4. To understand the importance of Plant Tissue Culture is an essential requirement for genetic improvement, conservation, mass propagation and maintenance of uniformity of traits through generations.

II	Analytical Techniques (2S2)	1. Concept building in various topics including: Spectroscopy, chromatography, electrophoresis, centrifugation and their different variants 2. Practical knowledge of Chromatographic techniques, Spectroscopy techniques, protein isolation/purificationusing different techniques ,quantitative and qualitative estimations of biomolecules 3. Development of understanding on Radioactivity, Radioisotopes and their uses in biology, measurement of radioactivity etc. 4. Theoretical basic concept building in Protein crystallization; Enzyme and cell immobilization techniques
II	Genetic Engineering (2S3	1. Elaborated structure and properties of genetic material; Restriction enzymes and other enzymes related to genetic manipulation. 2. Theoretical knowledge of advance techniques like, FISH, EMSA, CHIP etc. 3. Introduction to Cloning vectors, cloning methodologies, PCR and its applications; DNA sequencing 4. Hands-on experience in genomic DNA isolation, Restriction digestion, gel-purification, ligation, transformation, induction of recombinant protein synthesis, protein purification etc etc.
II	Molecular Genetics (2S4)	1. Theoretical knowledge of various topics of classical and modern genetics including: useful bacterial phenotypes, mutations, mutagenesis, transformation, conjugation and transduction. 2. Familiarization with concepts of Mendelian and non-Mendelian genetics, including: genetic diseases, human pedigrees, x-linked inheritance, Mitochondrial inheritance, genomic imprinting, behavioral traits etc 3. Study of molecular genetics of Lambda phage, lytic/lysogenic cycles. Population genetics, migration etc.
II	Genomics & Proteomics (2S5)	1. Knowledge of Structural organization of prokaryotic, eukaryotic and organelle genomes. DNA

		sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RAPD,RFLP, DNA fingerprinting etc 2. Familiarization with developments in Genome sequencing projects related to plants, animals, and different groups of microbes. 3. Concept building in pharmacogenomics, functional genomics and proteomics, PISA, DNA-array , protein-array etc
III	Bioprocess Engineering & Technology (3S1)	1. Basic concept building in Basic principle of Biochemical engineering, including, Isolation, screening and maintenance of industrially important microbes various topics as per the syllabus and isolation, screening and maintenance of microbes important for industries. 2. Application of microbes in waste management and food industry. 3. Study of downstream processing techniques: filtration, centrifugation, sedimentation, flocculation; Cell disruption; Storage and packaging
III	Environmental Biochemistry & Biotechnology (3S2)	1. Theoretical knowledge of Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Pollution, Renewable resources; Sustainability; Microbiology of degradation and decay. 2. Study of role of biotechnological techniques in environment protection. Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques 3. Concept building in alternate energy sources: Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuel etc.
III	Animal Biotechnology (3S3)	1. Theoretical knowledge of various topics as per the syllabus including basic cell culture techniques; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection,

		pleuripotency, stem cells etc 2. Study of various approaches related to vaccine production, disease diagnostic assays and many other assays involved in animal health management. 3. Concept building in animal reproductive biology, Animal genomics and DNA forensics: Embryo transfer; Micromanipulation of animal embryos; Transgenic animal technology; RFLP, RAPD, proteomics, metobolomics; DNA Barcoding; Detection of adulteration in meat using DNA based methods; microbial forensics etc.
III	Immunology &Immunotechnology (3S5)	1. Theoretical knowledge of various topics including, antigens, antibodies, adaptive and innate immunity, organs and cells of immune system etc 2. Hands on training on advanced immunological techniques viz., ELISA and its variants, western blotting, immunodiffusion methods, immunoelectrophoresis, determination of blood groups etc. 3. Idea of Immune responses generated by Lymphocytes, Antigen-Antibody interactions. 4. Vaccine technology and Clinical immunology: Immunity against Bacteria, viral, fungal and parasitic infections; Tumor immunology; DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Hybridoma etc.
III	Molecular Virology (3S6)	1. Knowledge of genome organization of different viruses e.g. Rabies, HIV, Hepatitis etc. and pathologies associated with their infection in various hosts. 2. Development of anti-virals, anti-viral host immunity, vaccinations against viruses etc. 3. Study of plant viruses: CaMV, TMV, CTV, RDV etc; their structure, genome organization and associated diseases. 4. Familiarization with Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using Agrobacterium); serological methods etc.

IV	Project/Thesis work	1. Research on various topics as per the expertise and facilities available in the department (and with collaborators), including hands on training on various advanced molecular and analytical techniques 2. An overall study on the concerned plant/animal/microbial system addressing any of relevant and pursuable scientific problems. 3. Familiarization with good laboratory practices, data presentation, thesis writing etc.

2. Course name: **M.Sc. (Microbiology)**		
Semester	**Paper Code and Title**	**Course Outcome**
I	Biochemistry (1S1)	1. Theoretical knowledge of various topics as per the syllabus 2. Exhaustive study of enzyme kinetics and bio-molecules, different metabolic pathways. 3. Familiarization with Bioenergetics concepts, generation of ATP 4. Experimentation related to enzyme kinetics, protein/sugar/lipid estimation using different methods, titrations etc.
I	Cell & Developmental Biology (IS2)	1. Study of cell theory, Cell organelles, Ultrastructure, Roles of cell organelles. 2. Exhaustive study of Cell Signaling pathways, secondary messengers etc 3. Understanding of Developmental biology: Stem cell and cancer, Differentiation in plant tissue 4. Familiarization with methods of cell-study, various forms of Microscopy, staining for microscopy etc.
I	Molecular Biology (IS3)	1. Understanding of Genome organization, Development of basic concepts in DNA/RNA structure , Replication, Repair & Recombination. 2. Knowledge of transcription and translation in prokaryotic and eukaryotic system. 3. Development of concepts of Oncogenesis, oncogenes and tumor suppressor genes. 4. Hands on training on DNA & RNA isolation by

		different techniques; plasmid isolation, transformation, Electrophoresis, quality check of Nucleic acids, restriction digestion, PCR, RFLP etc
I	Microbiology and Industrial Applications (IS4)	1. Theoretical knowledge of microbial diversity & systematics, Microbial growth and physiology; Study of size, shape and growth pattern, nutrition type of microbes. 2. Experimental knowledge of Sterilization, disinfection, safety in microbiological laboratory. Preparation of media, Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods, Storage of microorganisms, Gram Staining and enumeration of microorganisms. 3. Familiarization of assays related to antibiotics production and demonstration of antibiotic resistance
I	Biostatistics and Computer Applications (IS5)	1. Comprehensive study of various topics including Data representation methods, measures of central tendency, variance 2. Practical knowledge of application of correlation and regression analysis, test of significance: F and t tests, Chi square test etc. 3. Study on sigma plotter, null hypothesis, Bioinformatic methods, Basic idea of computer languages 4. Familiarization with biological databases, sequence, structure and strain database, Secondary and sequence analysis of DNA, RNA and proteins
II	Bacterial Metabolism (2SM1)	1. Theoretical knowledge of various topics as per the syllabus including detailed study of metabolic pathways, metabolic pathways involved in the release and dissimilation of substrates by heterotrophs and autotrophs etc 2. Concept building related to thermodynamic considerations of biological reactions, fermentation specific to various microbes, biochemistry of xenobiotics degradation etc. 3. Study of Fixation of molecular nitrogen and regulation, Biochemistry of methanogenesis and

		Regulation: enzyme synthesis and enzyme activity
II	Microbiological Techniques (2SM2)	1. Knowledge of various topics including Microbiological laboratory safety precautions, Microscopy; Preparation of culture media; Isolation of pure microbial flora from natural and extreme environments and Biochemical characterization of bacteria etc. 2. Practical knowledge of basic microbiological techniques including familiarization with equipments used in Microbiological laboratory, lab safety aspects, staining techniques and their applications, culture techniques, isolation of pure microbial flora from natural and extreme environments and biochemical characterization of bacteria etc. 3. Additional experimental knowledge of Biochemical characterization of bacteria-BIOLOG plate method, carbohydrate fermentation, catalase, peroxidase, indole, methyl red, vogus-prausker, citrate utilization test (IMViC), Nitrate Reduction Test etc.
II	Analytical Techniques (2S2)	1. Concept building in various topics including: Spectroscopy, chromatography, electrophoresis, centrifugation and their different variants 2. Practical knowledge of Chromatographic techniques, Spectroscopy techniques, protein isolation, quantitative and qualitative estimations of biomolecules 3. Development of understanding on Radioactivity, Radioisotopes and their uses in biology, measurement of radioactivity etc. 4. Theoretical basic concept building in Protein crystallization; Enzyme and cell immobilization techniques
II	Genetic Engineering (2S3	1. Elaborated structure and properties of genetic material; Restriction enzymes and other enzymes related to genetic manipulation. 2. Theoretical knowledge of advance techniques like, FISH, EMSA, CHIP etc. 3. Introduction to Cloning vectors, cloning methodologies, PCR and its applications; DNA

		sequencing 4. Hands-on experience in genomic DNA isolation, Restriction digestion, gel-purification, ligation, transformation, induction of recombinant protein synthesis, protein purification etc etc.
II	Molecular Genetics (2S4)	1. Theoretical knowledge of various topics of classical and modern genetics including: useful bacterial phenotypes, mutations, mutagenesis, transformation, conjugation and transduction. 2. Familiarization with concepts of Mendelian and non-Mendelian genetics, including: genetic diseases, human pedigrees, x-linked inheritance, Mitochondrial inheritance, genomic imprinting, behavioral traits etc 3. Study of molecular genetics of Lambda phage, lytic/lysogenic cycles. Population genetics, migration etc.
III	Applied Microbiology (3SM1)	1. Basic concept building related to Scope and importance of microbiology as applied to environment and industry, Petroleum and mining microbiology, Biopesticides and Microbiology of paints, films, pharmaceuticals etc 2. Familiarization with the concept of Environmental quality; Biodegradation of waste and pollutants; (i) solid waste disposal, sanitary, landfills and composting (ii) Treatment of liquid waste, sewage treatment, (iii) treatment and safety of water supply etc. 3. Knowledge of Microbial deterioration of cotton, jute, coir, wool, leather and wood and methods of preservation, Microbiology of biogas generation; Soil fertility and management of agricultural soil: soil microflora and organic matter decomposition, rhizosphere, Soil-plant-microbe interactions etc.
III	Environmental Biochemistry & Biotechnology (3S2)	1. Theoretical knowledge of Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Pollution, Renewable resources; Sustainability; Microbiology of degradation and decay. 2. Study of role of biotechnological techniques in

		environment protection. Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques 3. Concept building in alternate energy sources: Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuel etc.
III	Animal Biotechnology (3S3)	1. Theoretical knowledge of various topics as per the syllabus including basic cell culture techniques; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection, pleuripotency, stem cells etc 2. Study of various approaches related to vaccine production, disease diagnostic assays and many other assays involved in animal health management. 3. Concept building in animal reproductive biology, Animal genomics and DNA forensics: Embryo transfer; Micromanipulation of animal embryos; Transgenic animal technology; RFLP, RAPD, proteomics, metobolomics; DNA Barcoding; Detection of adulteration in meat using DNA based methods; microbial forensics etc.
III	Immunology & Immunotechnology (3S5)	1. Theoretical knowledge of various topics including, antigens, antibodies, adaptive and innate immunity, organs and cells of immune system etc 2. Hands on training on advanced immunological techniques viz., ELISA and its variants, western blotting, immunodiffusion methods, immunoelectrophoresis, determination of blood groups etc. 3. Idea of Immune responses generated by Lymphocytes, Antigen-Antibody interactions. 4. Vaccine technology and Clinical immunology: Immunity against Bacteria, viral, fungal and parasitic infections; Tumor immunology; DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Hybridoma etc.

III	Molecular Virology (3S6)	1. Knowledge of genome organization of different viruses e.g. Rabies, HIV, Hepatitis etc. and pathologies associated with their infection in various hosts. 2. Development of anti-virals, anti-viral host immunity, vaccinations against viruses etc. 3. Study of plant viruses: CaMV, TMV, CTV, RDV etc; their structure, genome organization and associated diseases. 4. Familiarization with Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using Agrobacterium); serological methods etc.
IV	Project/Thesis work	1. Students as per their choice and collaboration options available with the department carry out their dissertation work in different research institutes all across the nation having MOUs with the department, or within the department. 2. An overall study on the concerned plant/animal/microbial system addressing any of relevant and pursuable scientific problems. 3. Familiarization with good laboratory practices, data presentation, thesis writing etc.