Comparison of Course Outcomes

Semester	Name of the Course and course code	Old Course Outcomes	New Course Outcomes
Sem I	Biochemistry-I and BBTM-1083	**Theory** After passing this course the student will be able to: CO1: Gain basic knowledge about the role of pH and the physiological properties of water in biological systems. CO2: Acquire the knowledge of carbohydrates, classification, and their biological functions CO3: Understand the definition, structure and biological functions of lipids and their subclasses. CO4: Understand the definition, structure, biological functions, and classification of proteins. **Practical:** After passing this course the	**Theory** Upon successful completion of this course, the students will be able to: CO1: Explain the structure, physicochemical properties, and biological significance of water, pH, buffers, and their role in maintaining biological systems. CO2: Classify and interpret the structure, properties, and biological functions of carbohydrates and lipids, and relate them to cellular metabolism and physiological processes. CO3: Analyze the structural organization, classification, and functional significance of proteins, amino acids, and the forces governing protein stability. CO4: Evaluate the relationship between the structure and function of major biomolecules and their importance in maintaining normal biological functions and metabolic activities. **Practical:** Upon successful completion

		student will be able to: CO1: Perform Beer Lamberts Law CO2: Determine pKa value while performing practical CO3: Estimate carbohydrates in the given sample CO4: Estimate proteins and fats in the sample by different methods	of this course, the students will be able to: CO1: Explain the principles of spectrophotometric analysis and biochemical assays used for the qualitative and quantitative estimation of biomolecules. CO2: Perform biochemical experiments to estimate carbohydrates, proteins, and lipid parameters using standard laboratory techniques. CO3: Analyze experimental data to determine pKa values, verify Beer-Lambert's law, and differentiate reducing and non-reducing sugars. CO4: Evaluate the accuracy and reliability of biochemical experimental results using appropriate calculations and laboratory practices.
Sem I	Genetics and BBTM-1064	**Theory:** After passing this course the student will be able to: CO1: Understand Mendelian and Neo-mendelian genetics along with the study of phenomenon of dominance, laws of segregation, independent assortment of genes. CO2: Develop an understanding of the principles and mechanisms of	**Theory** After successful completion of this course, the students will be able to: CO1: Explain the principles of Mendelian inheritance, gene interactions, linkage, crossing over, mutation, and chromosome organization. CO2: Apply the principles of classical, microbial, and cytoplasmic genetics to solve problems related to

		linkage and crossing over. CO3: To learn various types of mutations their significance and practical applications along with basic microbial genetics. CO4: Understand the organization of chromosomes and concept of human genetics. **Practical** After passing this course the student will be able to: CO1: Understand Mendelian laws. CO2: Solve paternity disputes. CO3: Demonstrate segregation in preserved material. CO4: Study polytene chromosomes and dermatoglyphics.	inheritance, recombination, and chromosomal abnormalities. CO3: Analyze the genetic basis of mutations, chromosomal aberrations, population genetics, and human genetic disorders using appropriate genetic principles. CO4: Evaluate genetic data using pedigree analysis, karyotyping, and Hardy–Weinberg equilibrium to interpret patterns of inheritance and assess genetic disorders. **Practical:** After successful completion of this practical course, the students will be able to: CO1: Apply the principles of Mendelian genetics and probability to solve numerical problems and demonstrate patterns of inheritance. CO2: Analyze genetic traits and inheritance patterns using blood group data, dermatoglyphics, and preserved genetic materials. CO3: Examine chromosomal structures and stages of cell division through microscopic observation of polytene chromosomes and mitotic

			chromosomes. CO4: Evaluate genetic observations and experimental data to interpret inheritance patterns and chromosomal behavior using appropriate laboratory techniques.
Sem I	General Microbiology I and BBTM-1345	**Theory** After passing this course the student will be able to: CO1: Know the contribution of microbiologists and general features of various microbes. CO2: Study the structure of bacteria cell and bacterial classification CO3: Study the microbial culture collection centers, microbial preservation and sterilization methods and understand the basic concepts of bacterial nutrition. CO4: To learn different types of microscopy techniques.	**Theory** Upon successful completion of this course, the students will be able to: CO1: Explain the evolution, scope, diversity, structure, and significance of microorganisms, including their role in biotechnology and various industrial, agricultural, healthcare, and environmental applications. CO2: Apply the principles of bacterial classification, staining techniques, microbial cultivation, preservation, nutrition, and sterilization in microbiological studies. CO3: Analyze the structural, physiological, and nutritional characteristics of microorganisms and the mechanisms involved in microbial growth and nutrient transport. CO4: Evaluate the principles, applications, and limitations of different microscopic techniques used for the observation and

		Practical After passing this course the student will be able to: CO1: Understand sterilization techniques of different types of materials. CO2: Learn methods of isolation and identification of bacteria CO3: Learn methods of detection of microbes. CO4: Understand preservation methods of microbes.	characterization of microorganisms. **Practical** Upon successful completion of this course, the students will be able to: CO1: Explain microbiology laboratory safety practices, aseptic techniques, sterilization methods, and the functions of common microbiological equipment. CO2: Perform the preparation, sterilization, isolation, cultivation, purification, and preservation of microorganisms using standard microbiological techniques. CO3: Analyze the morphological characteristics of bacteria, fungi, yeast, and algae using staining methods and microscopic examination. CO4: Evaluate microbial cultures based on colony characteristics, staining reactions, and motility tests for their identification and characterization.
Sem II	Biochemistry II and BBTM 2084	**Theory** After passing this course the student will be able to: CO1: Understand basic metabolic pathways and	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the

		energy flow in biological systems. CO2: Explain the role of ATP and biological oxidation in metabolism. CO3: Describe enzyme structure, function, and catalytic mechanisms. CO4: Interpret enzyme kinetics and types of enzyme inhibition. in maintaining normal physiological functions. **Practical** After passing this course the student will be able to: CO1: Estimate the activity of enzymes like alpha-amylase and acid phosphatase from biological samples.	fundamental principles of metabolism, bioenergetics, thermodynamics, ATP-mediated energy transfer, and electron transport mechanisms underlying cellular metabolic processes. CO2: Analyze the structural organization and biochemical properties of nucleic acids and biologically important nucleotides, and examine their functional significance in cellular metabolism. CO3: Evaluate the structure, classification, catalytic mechanisms, and regulation of enzymes, and assess the biochemical significance of vitamins as enzyme cofactors roles in metabolic regulation and human health. CO4: Assess the principles of enzyme kinetics, enzyme inhibition, and hormonal regulation, and appraise their roles in metabolic regulation and human health. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Explain the principles underlying enzyme assays, enzyme kinetics, and biochemical estimation

		CO2: Study the effect of temperature and pH on enzyme activity. CO3: Perform quantitative estimation of catalase activity in plant tissues. CO4: Develop practical skills in enzyme assay techniques and data interpretation.	techniques employed in experimental biochemistry. CO2: Perform biochemical assays for the estimation of enzyme activities, creatinine, DNA, and RNA using standard laboratory protocols and Good Laboratory Practices (GLP). CO3: Analyze the effects of pH, temperature, substrate concentration, and inhibitors on enzyme activity by interpreting experimental observations and enzyme kinetic parameters. CO4: Evaluate experimental data to determine enzyme kinetic parameters and biochemical estimations, and draw scientifically valid conclusions based on the experimental findings.
Sem II	General Microbiology-II	**Theory** After passing this course the student will be able to: CO1: Know the concept of microbial growth in batch and continuous system. CO2: Know the basics of viruses and its types. CO3: Have the basic mechanism of action, diagnosis, and treatment for different viral, bacterial, and fungal diseases. CO4: Acquire the knowledge of industrial microbiology	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the principles of microbial growth, growth kinetics, factors influencing microbial growth, and bacterial sporulation in batch and continuous culture systems. CO2: Analyze the structure, classification, cultivation, and life cycles of plant, animal, and bacterial viruses, including their

		and to understand the role of microbes in environment. **Practical** After passing this course the student will be able to: CO1: Count microorganisms by different methods using microbiological practices CO2: Know the importance of personal hygiene. CO3: Identify different fungus by staining CO4: Study the growth curve of different microorganisms.	replication strategies and biological significance. CO3: Evaluate the interactions between microorganisms and the human host by examining normal microbiota, mechanisms of microbial pathogenicity, host defense systems, and the diagnosis and management of major viral, bacterial, and fungal diseases. CO4: Assess the role of microorganisms in environmental sustainability through their applications in biomining, bioconversion, bioremediation, and municipal solid waste management. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Perform microbial enumeration, isolation, and cultivation techniques using standard microbiological methods while adhering to Good Laboratory Practices (GLP) and aseptic techniques. CO2: Determine microbial growth characteristics by constructing growth curves, calculating generation time, and demonstrating bacterial sporulation using appropriate staining

			techniques. CO3: Identify clinically and agriculturally important microorganisms and viral infections through standard diagnostic procedures, including the Germ Tube Test for Candida albicans and symptom-based identification of Tobacco Mosaic Virus (TMV). CO4: Analyze the microbiological quality of environmental samples by performing Standard Plate Count (SPC) and interpreting experimental results for microbial assessment.
Sem III	Fundamentals of Biotechnology Course Code: BBTM-3063	**Theory** After passing this course the student will be able to: CO1: Know the basic concept of biotechnology and recombinant technology. CO2: Understand applications of biotechnology in health care and agriculture. CO3: Know the bio business and intellectual property rights in biotechnology. CO4: Know different ethical issues pertaining to biotechnology.	**Theory** After successful completion of this course, the students will be able to: CO1: Describe the historical evolution, scope, fundamental concepts, model organisms, and the role of biotechnology research, institutions, and career opportunities in India. CO2: Analyze the principles and applications of biotechnology in healthcare, agriculture, food production, environmental sustainability, molecular diagnostics, forensic sciences, and evolutionary biology.

			CO3: Evaluate the concepts of bio-business, intellectual property rights, patents, bioethics, biosafety, and regulatory frameworks governing biotechnology for responsible research, innovation, and commercialization. CO4: Assess the scope and potential of emerging areas of biotechnology, including marine biotechnology, nanobiotechnology, pharmacogenomics, regenerative medicine, nutraceutical biotechnology, therapeutic proteins, biosensors, bio-robotics, and bioinformatics, in addressing contemporary societal and industrial challenges.
		Practical After passing this course the student will be able to: CO1: Learn good lab practices in biotechnology laboratory. CO2: Learn principle, working and applications of instruments. CO3: Know the handling and disposal procedure regarding hazardous reagents. CO4: Know different steps in patent writing.	**Practical** Upon successful completion of this course, the learners will be able to: CO1: Demonstrate Good Laboratory Practices (GLP), laboratory safety measures, and standard operating procedures in a biotechnology laboratory. CO2: Operate and maintain basic biotechnology laboratory instruments by following standard operating procedures and laboratory protocols.

			CO3: Apply appropriate procedures for the safe handling, decontamination, and disposal of hazardous chemicals and laboratory waste in accordance with biosafety guidelines. CO4: Illustrate the process of patent drafting and filing through a biotechnology-related case study, highlighting the essential steps involved in securing intellectual property rights.
Sem III	Gene Structure and Function BBTM-3061	**Theory** After passing this course the student will be able to: CO1: Understand the structure of DNA, RNA, gene organization, genome complexity, and repetitive DNA elements. CO2: Understand the types, characteristics, and applications of transposable elements. CO3: Understand the regulation of gene expression in prokaryotes through operon models. CO4: Understand the genetic basis of cancer and the key outcomes of the Human Genome Project.	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Describe the molecular organization of DNA and RNA, gene architecture, regulatory elements, mechanisms of DNA replication, and the concepts of genome size and genome complexity in prokaryotic and eukaryotic organisms. CO2: Analyze the molecular mechanisms of transcription and the structure–function relationship of different RNA molecules, and examine the classification, characteristics, and applications of transposable elements in prokaryotic and eukaryotic genomes CO3: Evaluate the

			regulatory mechanisms governing gene expression in prokaryotic and eukaryotic systems, with special emphasis on operon models and molecular control of transcription. CO4: Assess the molecular basis of oncogenesis, tumour suppressor genes, DNA repair mechanisms, and the scientific significance of the Human Genome Project in advancing genomics, precision medicine, and biotechnology research.
		Practical After passing this course the student will be able to: CO1: Perform isolation of DNA and proteins. CO2: Analyze DNA through different methods. CO3: Study proteins through PAGE. CO4: Determine ORF and intron exon boundaries using bioinformatics.	**Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Perform the isolation of plant genomic DNA and evaluate its quality and purity using UV–Visible spectrophotometric analysis. CO2: Operate UV–Visible spectrophotometric techniques to determine the concentration, absorption characteristics, and purity of nucleic acid samples. CO3: Demonstrate the principles and applications of Native PAGE and SDS-PAGE for the separation and analysis of proteins. CO4: Analyze genomic sequences using

			bioinformatics tools to identify open reading frames (ORFs) and exon–intron organization for gene structure annotation and interpretation.
Sem III	Immunology -I BBTM-3063	**Theory** After passing this course the student will be able to: CO1: Familiarize with the types and features of immune system CO2: Understand the roles of various immune cells and organs involved in immune responses CO3: Inculcate knowledge of antigen-antibody interactions, immunogenicity, immunoglobulin structure and classes, and the complement system. CO4: Understand the structure and function of MHC class I and II molecules, and their role in T and B cell-mediated immune response.	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the fundamental concepts of innate and adaptive immunity, including immunological memory, specificity, self–non-self recognition, and the terminology associated with the immune system. CO2: Interpret the organization and functions of lymphoid cells, lymphoid organs, and the lymphatic system, and explain their coordinated roles in the generation and regulation of immune responses. CO3: Analyze the structural and functional characteristics of antigens, immunoglobulins, and the complement system, and examine their roles in humoral immune responses. CO4: Evaluate the role of Major Histocompatibility Complex (MHC) molecules and antigen receptors of T and B lymphocytes in antigen recognition, antigen

		Practical After passing this course the student will be able to: CO1: Perform total and differential leucocyte counts to assess immune status. CO2: Accurately estimate total red blood cell (RBC) count using standard laboratory techniques. CO3: Demonstrate the ability to collect blood samples through different methods and separate plasma effectively. CO4: Conduct haemagglutination and haemagglutination inhibition assays to study antigen-antibody interactions. .	presentation, and adaptive immune responses. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Perform safe blood collection, plasma separation, and hematological investigations using standard laboratory procedures and aseptic techniques. CO2: Determine total and differential blood cell counts and interpret hematological parameters for the assessment of immune and physiological status. CO3: Isolate peripheral blood mononuclear cells (PBMCs) and evaluate cell viability using standard dye exclusion techniques. CO4: Demonstrate antigen–antibody interactions by performing different immunological techniques and analyze the experimental outcomes
Sem III	Internship	After passing this course the student will be able to: CO1: Apply theoretical knowledge in real-life professional and community settings through experiential learning.	Upon successful completion of this course, the learners will be able to: CO1: Apply disciplinary knowledge, technical competencies, and standard professional practices to

		CO2: Develop practical skills, communication abilities, and professional ethics while working with industries and organizations. CO3: Understand workplace culture, teamwork, and problem-solving approaches in different professional environments. CO4: Prepare and present internship/community outreach reports effectively based on their field experiences.	perform assigned tasks effectively in industrial, research, healthcare, or other professional settings. CO2: Analyze workplace processes and real-world challenges to identify problems and recommend appropriate scientific or technical solutions. CO3: Demonstrate professional ethics, effective communication, teamwork, leadership, and responsible workplace behavior while functioning in multidisciplinary professional environments. CO4: Evaluate professional experiences and learning outcomes by preparing, presenting, and defending a comprehensive internship report that demonstrates reflective learning and professional competence.
Sem III	Skill Development in Biotechnology BBTM-3060	**Theory** After passing this course the student will be able to: CO1: Understand the types, role, and production techniques of biofertilizers and biological nitrogen fixation. CO2: Gain knowledge of medicinal plants, phytochemicals, essential oils, and their applications. CO3: Learn the basics of	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the principles, production processes, quality standards, and agricultural applications of biofertilizers, including the molecular basis of biological nitrogen fixation. CO2: Analyze the therapeutic significance of medicinal plants,

		nutraceuticals, functional foods, and their health benefits and regulations. CO4: Develop entrepreneurial insight into bioindustries, including business planning, funding, and market strategies. **Practical** After passing this course the student will be able to: CO1: Isolate and culture Rhizobium for biofertilizer production. CO2: Extract and analyze essential oils using distillation and chemical assays. CO3: Evaluate antioxidant potential and phytochemical content of essential oils. CO4: Assess the antimicrobial activity of essential oils against microbial strains.	phytochemicals, and essential oils, together with their extraction methods and industrial applications. CO3: Evaluate the scientific basis and health-promoting potential of nutraceuticals and functional foods, including nutritional genomics, quality control, and quality assurance practices. CO4: Assess the applications of biofuels, bioenergy, bioremediation, and bioentrepreneurship in promoting sustainable development and biotechnology-driven innovation. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Perform the isolation, cultivation, and production of Rhizobium-based biofertilizers using standard microbiological techniques. CO2: Demonstrate the extraction of essential oils from plant materials using appropriate distillation techniques. CO3: Analyze the phytochemical composition of essential oils by determining their total polyphenolic and flavonoid contents using standard

			analytical methods. CO4: Evaluate the antioxidant and antimicrobial potential of essential oils using DPPH and antimicrobial assays, and interpret the experimental findings for their potential biotechnological applications.
Sem IV	Molecular Biology and BBTM-4061	**Theory** After passing this course the student will be able to: CO1: Understand the structure of DNA, experimental evidence supporting DNA as genetic material, and the mechanism of DNA replication in prokaryotes and eukaryotes. CO2: Explain the structure and functions of various RNAs, the transcription process in prokaryotes and eukaryotes, and post-transcriptional modifications. CO3: Describe the genetic code, the process of protein synthesis and post-translational modifications, and the action of translation inhibitors. CO4: Understand DNA recombination mechanisms, types and causes of mutations, and their significance and applications in genetics.	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the molecular organization of DNA, experimental evidence establishing DNA as the genetic material, and the structural organization of genomes and chromosomes in prokaryotes, eukaryotes, organelles, and viruses. CO2: Analyze the mechanisms of DNA damage and the major DNA repair pathways involved in maintaining genome integrity and cellular stability. CO3: Evaluate the molecular mechanisms of genetic information flow by interpreting the processes of genetic coding, protein synthesis, post-translational modifications, and translational regulation. CO4: Assess the principles

			of genetic linkage, DNA recombination, and mutation, and appraise their significance in genome evolution, genetic diversity, and biotechnological applications.
		Practical After passing this course the student will be able to: CO1: Acquire skills in preparing stock solutions for molecular biology experiments. CO2: Demonstrate the ability to isolate genomic DNA from plant tissues using standard protocols. CO3: Set up agarose gel electrophoresis apparatus and prepare gels for DNA separation. CO4: Analyze DNA concentration and purity using spectrophotometric and fluorometric methods. .	**Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Prepare laboratory reagents and stock solutions by following Good Laboratory Practices (GLP) and standard laboratory protocols. CO2: Isolate genomic DNA from human samples and RNA from plant tissues using standard molecular biology techniques. CO3: Estimate the concentration and purity of nucleic acids using fluorometric analysis and analyze the experimental data. CO4: Perform agarose gel preparation and electrophoresis for the separation and visualization of nucleic acids
Sem IV	Biochemical and Biophysical Techniques and BBTM-4062	**Theory** After passing this course the student will be able to: CO1: Understand the principles, types, and applications of centrifugation	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the principles, instrumentation,

		techniques. CO2: Explain the theory and principles of basic chromatographic methods. CO3: Illustrate the principles and applications of advanced chromatographic techniques. CO4: Understand the principles of spectroscopy. .	and applications of centrifugation techniques, including sedimentation theory, centrifuge types, rotor selection, and factors influencing sedimentation. CO2: Analyze the principles and applications of chromatographic techniques for the separation, purification, and characterization of biomolecules. CO3: Evaluate the principles, instrumentation, and analytical applications of advanced chromatographic techniques CO4: Assess the principles, instrumentation, and applications of spectroscopic techniques for qualitative and quantitative biomolecular analysis.
		Practical After passing this course the student will be able to: CO1: Understand the concept of centrifugation. CO2: Perform separation of biomolecules using paper and thin layer chromatography techniques. CO3: Apply ion-exchange chromatography for effective separation and purification of proteins.	**Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Demonstrate the operation of different centrifugation techniques, including swing-out rotor, angle rotor, and differential centrifugation, for the separation of biological samples. CO2: Perform the separation of biomolecules using paper chromatography and thin-

		CO4: Utilize affinity chromatography for specific protein separation based on molecular interactions.	layer chromatography by following standard laboratory procedures. CO3: Analyze the separation and purification of proteins using ion-exchange and affinity chromatography based on their physicochemical properties. CO4: Interpret the experimental results obtained from centrifugation and chromatographic techniques for the qualitative analysis and purification of biomolecules.
Sem IV	Ecology and Evolution and BBTM-4065	**Theory** After passing this course the student will be able to: CO1: To explain ecological principles including ecosystem structure, species interactions, habitat, niche, and ecological succession. CO2: To analyze biodiversity, conservation strategies, and ecosystem functioning in terrestrial and aquatic environments. CO3: To understand theories of evolution, origin of life, natural selection, and mechanisms of speciation. CO4: To apply concepts of population genetics, molecular evolution, and phylogenetic relationships to	**Theory** After successful completion of this course, the learners will be able to: CO1: Explain the fundamental concepts of ecology, environmental components, habitat, niche, trophic interactions, nutrient cycling, and species interactions. CO2: Analyze ecological succession, ecosystem structure and function, energy flow, biogeochemical cycles, and biodiversity conservation strategies for sustainable ecosystem management. CO3: Interpret the principles of organic evolution, origin of life,

		study genetic variation and evolutionary processes. **Practical** After passing this course the student will be able to: CO1: Apply ecological techniques such as quadrat and species area-curve methods to study biodiversity and ecosystem parameters. CO2: Analyze water quality by estimating dissolved oxygen and total dissolved solids (TDS) in water samples. CO3: Differentiate between homologous and analogous structures and explain various types of mimicry in animals from an evolutionary perspective. CO4: Study fossils to understand the origin, evolution, and diversity of life forms through geological time. .	natural selection, and speciation using classical and modern evolutionary theories. CO4: Apply the principles of population genetics, molecular evolution, phylogenetic reconstruction, and biogeography to explain genetic variation, evolutionary relationships, and species diversification. **Practical** After completion of this practical course, the learners will be to: CO1: Identify ecological sampling methods, homologous and analogous structures, mimicry, and fossils related to ecology and evolution. CO2: Explain the principles of quadrat analysis and water quality assessment using dissolved oxygen (DO) and total dissolved solids (TDS). CO3: Perform ecological sampling and water quality analysis using standard laboratory techniques. CO4: Analyze experimental observations and evolutionary evidence to interpret ecological patterns, adaptations, and evolutionary relationships

Sem V	rDNA Technology-I BBTM-5061	**Theory** After passing this course the student will be able to: CO1: Describe the role of DNA modifying enzymes in genetic engineering. CO2: Explain various cloning vectors and selection methods in E. coli. CO3: Apply blotting and transformation techniques in molecular biology. CO4: Compare labeling methods and detection systems for DNA/RNA probes. techniques, and gene transfer methods used in molecular biology and genetic engineering. **Practical** After passing this course the student will be able to: CO1: Culture E. coli and isolate high-quality genomic DNA.	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the properties, mechanisms of action, and applications of DNA-modifying enzymes employed in recombinant DNA technology and molecular cloning. CO2: Analyze the characteristics, selection strategies, and applications of cloning vectors used for gene cloning and recombinant DNA technology in Escherichia coli. CO3: Evaluate the principles and applications of nucleic acid hybridization, blotting CO4: Assess the principles, methodologies, and detection strategies of radioactive and non-radioactive nucleic acid labelling for molecular diagnostics and biotechnology research. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Explain the principles underlying bacterial culture, genomic DNA isolation, restriction digestion,

		CO2: Quantify and assess the purity of DNA using spectrophotometry CO3: Perform agarose gel electrophoresis and restriction enzyme digestion. CO4: Demonstrate the Southern blotting technique for DNA analysis.	agarose gel electrophoresis, and Southern blotting. CO2: Perform bacterial culture, genomic DNA isolation, spectrophotometric quantification, and agarose gel electrophoresis using standard molecular biology protocols. CO3: Analyze DNA quality, restriction enzyme digestion patterns, and electrophoretic profiles to assess the integrity and characteristics of nucleic acid samples. CO4: Evaluate the results of restriction digestion and Southern blotting for the detection and characterization of specific DNA sequences in molecular biology investigations.
Sem V	Animal Biotechnology-I BBTM-5062	**Theory** After passing this course the student will be able to: CO1: Learn about the different aseptic techniques used in Animal Tissue Culture (ATC). CO2: Know about the different sources, types and eradication of contamination. CO3: Study the different culture media and reagents used in ATC. CO4: Study primary culture and establishment of cell line	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the principles, laboratory design, aseptic techniques, cryopreservation methods, and characteristics of normal and transformed cells in animal tissue culture. CO2: Analyze the sources, types, prevention, and control of contamination, laboratory biosafety

		culture **Practical** After passing this course the student will be able to: CO1: Identify sources of contamination and apply decontamination measures effectively. CO2: Prepare Hanks Balanced Salt Solution and Minimal Essential Growth Medium. CO3: Separate serum from blood samples. CO4: Isolate and culture macrophages from blood	practices, and cleanroom facilities required for safe and effective animal tissue culture. CO3: Evaluate the composition, physicochemical properties, and applications of culture media and reagents, including serum-supplemented, serum-free, and conditioned media, for the cultivation of animal cells. CO4: Assess the methodologies for primary and established cell culture, cell isolation, cultivation, growth kinetics, and cell proliferation analysis for applications in animal tissue culture research. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Explain the sources of contamination and the decontamination measures essential for maintaining aseptic conditions in an animal tissue culture laboratory. CO2: Prepare balanced salt solutions, culture media, and serum by following standard protocols. CO3: Perform the isolation and culture of lymphocytes from peripheral blood using

		samples.	aseptic techniques and appropriate cell culture procedures. CO4: Analyze the quality of prepared media, serum, and cultured cells by interpreting laboratory observations and assessing their suitability for animal tissue culture applications.
Sem V	Bioprocess Engineering-I and BBTM-5063	**Theory** After passing this course the student will be able to: CO1: Understand the fundamental principles of chemical engineering and biochemical engineering. CO2: Understand microbial growth kinetics CO3: Understand the feedback system and know the effect of physico-chemical parameters on the product synthesis. CO4: To study about sterilization of fermenter. .	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the fundamental principles of biochemical engineering, including heat and mass transfer, diffusion phenomena, oxygen transfer mechanisms, and microbial culture systems used in bioprocesses. CO2: Analyze microbial growth kinetics and evaluate the influence of kinetic parameters, substrate utilization, product formation, and biomass productivity on bioprocess performance. CO3: Evaluate the regulatory mechanisms governing microbial metabolism and product formation, including feedback regulation and the effects of environmental factors on bioprocess

			efficiency. CO4: Assess the principles, methods, and process design of sterilization systems employed in bioprocessing for ensuring aseptic operation and product quality.
		Practical After passing this course the student will be able to: CO1: Study growth curve of microorganisms while growing them in different media under optimal conditions. CO2: Determine the specific growth rate and generation time of a bacterium. CO3: Study the effect of physico-chemical parameters on microbial growth CO4: Perform assay of enzyme produced using fermentation.	**Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Explain the principles of microbial growth, fermentation processes, and sterilization techniques employed in bioprocess engineering. CO2: Perform microbial cultivation, determine growth kinetics, and evaluate specific growth rate and generation time using standard fermentation techniques. CO3: Analyze the influence of process parameters, including temperature, pH, and aeration, on microbial growth and bioprocess performance. CO4: Evaluate enzyme production and activity in bioreactor or shaking flask systems and interpret the experimental outcomes for

			process optimization.
Sem V	Environmental Biotechnology and BBTM-5064	**Theory** After passing this course the student will be able to: CO1: Understand environmental pollution, wastewater treatment, and pollution control technologies. CO2: Acquire knowledge of biomass, biofuels, and their applications. CO3: Understand biological nitrogen fixation and biofertilizers. CO4: Gain knowledge of bioremediation and biodegradation of environmental pollutants. .	**Theory** Upon successful completion of this course, the learners will be able to: CO1: Explain the causes and impacts of environmental pollution and the principles of biotechnological approaches employed for pollution monitoring, wastewater treatment, solid waste management, and environmental protection. CO2: Analyze the sources, production technologies, and applications of biomass and biofuels, and examine their potential for sustainable energy generation and environmental sustainability. CO3: Evaluate the molecular mechanisms of biological nitrogen fixation and the role of biofertilizers in enhancing agricultural productivity and promoting sustainable farming practices. CO4: Assess the applications of sustainable environmental management strategies bioremediation technologies and microbial processes for the remediation of environmental pollutants and sustainable

		Practical After passing this course the student will be able to: CO1: Perform analysis of water quality and wastewater pollution parameters. CO2: Isolate and cultivate environmentally important microorganisms. CO3: Understand vermicomposting and biofertilizer production techniques. CO4: Demonstrate bioremediation of environmental pollutants using microorganisms. .	environmental management strategies. **Practical** Upon successful completion of this practical course, the learners will be able to: CO1: Explain the principles and significance of environmental quality assessment, biofertilizer production, vermicomposting, and bioremediation in sustainable environmental management. CO2: Perform physicochemical and microbiological analyses of environmental samples, including drinking water quality assessment, determination of BOD and COD, and isolation and cultivation of environmentally significant microorganisms. CO3: Analyze the efficiency of cellulolytic microorganisms, Rhizobium, vermicomposting, and fungal strains in waste degradation, biofertilizer production, and dye bioremediation. CO4: Evaluate experimental findings to assess the effectiveness of biotechnological approaches for pollution

			control, waste management, and environmental sustainability.
Sem V	Internship BBTI-5066	After passing this course the student will be able to: CO1: Apply theoretical knowledge in real-life professional and community settings through experiential learning. CO2: Develop practical skills, communication abilities, and professional ethics while working with industries and organizations. CO3: Understand workplace culture, teamwork, and problem-solving approaches in different professional environments. CO4: Prepare and present internship/community outreach reports effectively based on their field experiences.	After passing this course the student will be able to: CO1: Apply theoretical knowledge in real-life professional and community settings through experiential learning. CO2: Develop practical skills, communication abilities, and professional ethics while working with industries and organizations. CO3: Understand workplace culture, teamwork, and problem-solving approaches in different professional environments. CO4: Prepare and present internship/community outreach reports effectively based on their field experiences.
Sem VI	Fundamentals of Bioinformatics and BBTM-6061	**Theory** After passing this course the student will be able to: CO1: understand the basic principles and concepts of computer and data storage devices. CO2: understand the basic principles of bioinformatics and sequence alignment.	**Theory** After successful completion of this course, the learners will be able to: CO1: Explain the fundamental concepts of computers, computer organization, hardware, software, storage devices, and input/output devices and their relevance in bioinformatics.

		CO3: know about scoring matrices and database searching CO4: know about primary and secondary databases. **Practical** After passing this course the student will be able to: CO1: Use of basic computer features. CO2: Extraction of data from bioinformatics software and tools. CO3: Sequence alignment using bioinformatics tools. CO4: Predication of protein functions.	CO2: Apply the principles of bioinformatics, including pairwise sequence alignment algorithms, scoring matrices (PAM and BLOSUM), and multiple sequence alignment methods for biological sequence analysis. CO3: Analyze biological sequence data using BLAST and interpret sequence alignment results for comparative analysis of nucleotide and protein sequences. CO4: Utilize major biological databases and bioinformatics resources, for retrieval, annotation, and interpretation of biological information. **Practical** After successful completion of this course, the learners will be able to: CO1: Explain the applications of MS Office tools, biological databases, and standard biological sequence formats used in bioinformatics. CO2: Retrieve biological information from online databases, including NCBI, EMBL, UniProt, and PubMed, using appropriate search strategies. CO3: Perform biological sequence analysis using

			BLAST, Clustal Omega, and standard sequence formats (FASTA and GenBank). CO4: Analyze protein sequences to identify conserved domains and functional motifs using PFAM and PROSITE.
Sem VI	Plant biotechnology-I and BBTM-6062	**Theory** After passing this course the student will be able to: CO1: Explain totipotency, differentiation, and tissue culture lab organization and sterilization techniques. CO2: Describe culture media components and functions of major plant growth regulators. CO3: Demonstrate organogenesis, somatic embryogenesis, and micropropagation techniques. CO4: Understand haploid/triploid production, embryo rescue, and somaclonal variation.	**Theory** After successful completion of this course, the learners will be able to: CO1: Describe the fundamental concepts of plant tissue culture, cellular totipotency, tissue competency, laboratory organization, and sterilization techniques. CO2: Explain the composition of culture media and the roles of plant growth regulators in the growth and development of plant tissues under in vitro conditions. CO3: Apply the principles of organogenesis, somatic embryogenesis, micropropagation, and acclimatization for in vitro plant regeneration and multiplication. CO4: Analyze the applications of haploid and triploid production, embryo, ovule and ovary culture, and somaclonal variation in plant improvement and crop

		Practical After passing this course the student will be able to: CO1: Get acquainted with functions and operations of PTC lab and various instruments used in plant tissue culture. CO2: Learn sterilization process required in plant tissue culture. CO3: Prepare media to be used in plant tissue culture. CO4: Select, prepare, sterilize and inoculate explant for culture initiation.	biotechnology. **Practical** After successful completion of this practical course, the learners will be able to: CO1: Identify the laboratory infrastructure, essential instruments, culture vessels, and sterilization methods used in plant tissue culture. CO2: Explain the principles of laboratory organization, aseptic techniques, culture media preparation, and sterilization procedures employed in plant tissue culture. CO3: Perform the preparation of stock solutions, Murashige and Skoog (MS) medium, sterilization of culture materials, and aseptic inoculation of explants for in vitro culture establishment. CO4: Analyze the suitability of explants, culture media, and sterilization procedures for the successful establishment of contamination-free plant tissue cultures.
Sem VI	rDNA Technology-II and BBTM-6063	**Theory** After passing this course the student will be able to: CO1: Explain different cloning and expression	**Theory** After successful completion of this course, the learners will be able to: CO1: Describe the

		vectors used in molecular biology. CO2: Describe genomic and cDNA cloning techniques along with linker and adapter strategies. CO3: Understand the principles and applications of PCR and microarray technologies. CO4: Analyze DNA sequencing methods and apply site-directed mutagenesis techniques. **Practical** After passing this course the student will be able to: CO1: Isolate and analyze plasmid DNA. CO2: Perform restriction digestion using different enzymes. CO3: Prepare competent cells and carry out transformation using the $CaCl_2$ method. CO4: Perform Polymerase Chain Reaction (PCR).	structure, characteristics, and applications of cloning and expression vectors used in recombinant DNA technology. CO2: Explain the principles and methodologies of genomic cloning, cDNA cloning, PCR, microarray technology, and DNA sequencing. CO3: Apply the concepts of recombinant DNA technology to the selection of appropriate cloning strategies, vectors, and molecular techniques for gene manipulation and analysis. CO4: Analyze gene modification approaches for their applications in biotechnology and genetic engineering. **Practical** After successful completion of this practical course, the learners will be able to: CO1: Identify the principles and laboratory requirements for plasmid isolation, ligation, transformation, and PCR techniques. CO2: Explain the principles underlying plasmid isolation, preparation of competent cells, transformation, and polymerase chain reaction

			(PCR). CO3: Perform plasmid DNA isolation, ligation, competent cell preparation, bacterial transformation, and PCR using standard molecular biology protocols. CO4: Analyze the outcomes of transformation and PCR experiments to verify successful gene transfer and amplification...
Sem VI	Ecology and Evolution and BBTM-6064	**Theory** After passing this course the student will be able to: CO1: To explain ecological principles including ecosystem structure, species interactions, habitat, niche, and ecological succession. CO2: To analyze biodiversity, conservation strategies, and ecosystem functioning in terrestrial and aquatic environments. CO3: To understand theories of evolution, origin of life, natural selection, and mechanisms of speciation. CO4: To apply concepts of population genetics, molecular evolution, and phylogenetic relationships to study genetic variation and evolutionary processes.	**Theory** After successful completion of this course, the learners will be able to: CO1: Explain the fundamental concepts of ecology, environmental components, habitat, niche, trophic interactions, nutrient cycling, and species interactions. CO2: Analyze ecological succession, ecosystem structure and function, energy flow, biogeochemical cycles, and biodiversity conservation strategies for sustainable ecosystem management. CO3: Interpret the principles of organic evolution, origin of life, natural selection, and speciation using classical and modern evolutionary theories.

		Practical After passing this course the student will be able to: CO1: Apply ecological techniques such as quadrat and species area-curve methods to study biodiversity and ecosystem parameters. CO2: Analyze water quality by estimating dissolved oxygen and total dissolved solids (TDS) in water samples. CO3: Differentiate between homologous and analogous structures and explain various types of mimicry in animals from an evolutionary perspective. CO4: Study fossils to understand the origin, evolution, and diversity of life forms through geological time.	CO4: Apply the principles of population genetics, molecular evolution, phylogenetic reconstruction, and biogeography to explain genetic variation, evolutionary relationships, and species diversification. **Practical** After completion of this practical course, the learners will be to: CO1: Identify ecological sampling methods, homologous and analogous structures, mimicry, and fossils related to ecology and evolution. CO2: Explain the principles of quadrat analysis and water quality assessment using dissolved oxygen (DO) and total dissolved solids (TDS). CO3: Perform ecological sampling and water quality analysis using standard laboratory techniques. CO4: Analyze experimental observations and evolutionary evidence to interpret ecological patterns, adaptations, and evolutionary relationships.
Sem VI	Skill Development in Biotechnology-II BBTM-6060	**Theory** After successful completion of the course, students will be able to:	**Theory** After successful completion of this course, learners will be able to:

		CO1: Demonstrate knowledge of phlebotomy techniques, blood sample collection, anticoagulants, and hematological investigations. CO2: Understand the principles and clinical applications of major diagnostic techniques. CO3: Explain the concepts of cancer biology, tumor markers, vector-borne diseases, and molecular diagnostic methods. CO4: Apply the principles of biomedical waste management, infection control, and safe disposal methods for infectious and non-infectious biomedical waste. **Practical** After successful completion of the practical course, students will be able to: CO1: Evaluate the antioxidant potential and antimicrobial activity of essential oils using standard biochemical techniques.	CO1: Explain the principles of phlebotomy, hematological investigations, and diagnostic techniques used in clinical laboratory practice. CO2: Apply appropriate laboratory and diagnostic procedures for the analysis of hematological parameters and the diagnosis of human diseases. CO3: Analyze the role of tumor markers, molecular diagnostic techniques, and PCR-based methods in the detection and diagnosis of infectious diseases and cancer. CO4: Evaluate biomedical waste management practices and biorisk management strategies for infection prevention, laboratory safety, and regulatory compliance. **Practical** After successful completion of this practical course, learners will be able to: CO1: Explain the principles of blood collection, peripheral blood smear preparation, and hematological investigations used in

		CO2: Perform and interpret metabolic assessments. CO3: Analyze biochemical parameters for assessment of health status. CO4: Estimate blood glucose levels and understand their clinical significance in disease diagnosis and monitoring. .	clinical diagnostics CO2: Perform hematological procedures using standard laboratory techniques. CO3: Analyze clinical diagnostic reports for disease interpretation. CO4: Evaluate biomedical waste segregation and disposal practices in accordance with Biomedical Waste Management Guidelines to ensure laboratory safety and infection control.