MOUNT CARMEL COLLEGE, AUTONOMOUS

DEPARTMENT OF BIOTECHNOLOGY

Syllabus for BSc Biotechnology Dual Major

OPEN ELECTIVE- SEMESTER I

BIOTECHNOLOGY -NEW ERA OF BIOREVOLUTIONS

COURSE OUTCOMES

S No	Modes	CLO
1.	Interdisciplinary perspective of Biotechnology	To get familiarised with the interdisciplinary nature of Biotechnology
2.	Nature's Tool Box for Biotechnology	An insight to the biotechnological boons to mankind
3.	Biomimicry and Science	Demonstration of nature s inspiration to technological intervention
4.	Industrial relevance of Biotechnology	Novel areas of Biotechnological development
5.	Biotechnology in the Business Sector	Introduction of relevance of business ideas and intellectual property rights

OPEN ELECTIVE- SEMESTER I

BIOTECHNOLOGY -NEW ERA OF BIOREVOLUTIONS

Units	Topic	Description	Hours
1.	**Interdisciplinary perspective of Biotechnology**	➢ Importance of Physical Sciences in Biotechnology ➢ Importance of other biological Sciences in Biotechnology	**3**
2.	**Nature's Tool Box for Biotechnology**	➢ Fermented Food ➢ Antibiotics ➢ Natural food colours ➢ Food preservation ➢ Chemiluminescence ➢ Bio based feed stock	**7**

3.	**Biomimicry and Science**	➢ Spiders & Protective Glass ➢ Lotus & Oil Repellents ➢ Namibian Beetles & Water Collection ➢ Sharks & Aquatic Vehicles ➢ Butterflies & Solar Power ➢ Whales & Wind Turbines	**7**
4.	**Industrial relevance of Biotechnology**	➢ Brewing industry ➢ 3D printing in food ➢ Green meat production ➢ Artificial Intelligence in medical diagnostic	**6**
5.	**Biotechnology in the Business Sector**	➢ Entrepreneurship and Biotechnology ➢ Basics of IPR – Patents, Trade Marks and Trade Secret, Copyright	**4**
6.	**Current Biotech Education Reforms**	➢ Biotechnology in Research and Education system ➢ Biotechnology in day to day life	**3**
		TOTAL HOURS	**30**

Practical Sessions:

1. Vermicomposting and soil analysis
2. Biomimicry - animation videos
3. Case Studies based on IPR (6 cases)
4. Basic Sensory methods for food evaluation
5. Developing a business plan related to food biotechnology (bakery or any fermented product)

OPEN ELECTIVE- SEMESTER II

FUNDAMENTALS OF BIOTECHNOLOGY

COURSE OUTCOMES

S NO.	MODULE	CLO
1.	Principle and concepts of Biotechnology	Gives an ideal of overall response to Biotechnology
2.	Recombinant DNA Technology	Significance of rDNA tools and its applications
3.	Microbial Biotechnology	Role of microbial systems in Biotechnology
4.	Biotechnology in food science	Biotechnological contributions to Food industry
5.	Biotechnology in Healthcare	Applications of Biotechnology in health sector

OPEN ELECTIVE- SEMESTER II

FUNDAMENTALS OF BIOTECHNOLOGY

Units	Module	Description	Hours
1.	**Principle and concepts of Biotechnology**	➢ Definition and History of Biotechnology (old and new) ➢ Public Perception ➢ Scope of Biotechnology	3
2.	**Recombinant DNA Technology**	➢ Basic techniques in genetic engineering and LMO's ➢ Human genome project ➢ Ethical issues in rDNA research	5
3.	**Microbial Biotechnology**	➢ Basic techniques of microbial biotechnology ➢ Applications of microbial biotechnology ➢ Fermentation Technology ➢ Biotransformation	6
4.	**Biotechnology in food science**	➢ Genetically modified Foods ➢ Single Cell Protein	4

		➢ Single cell oil ➢ Nutrigenomics	
5.	**Biotechnology in Healthcare**	➢ Disease Diagnosis ➢ Medical Forensics ➢ Pharmaceutical products of DNA technology	7
6.	**Eco biotechnology**	➢ Biodiversity conservation ➢ Biofuels ➢ Bioplastics ➢ Biopesticides and Biofertilizers	5
		Total	**30**

Practical Sessions:

1. Introduction to lab instruments and Good Laboratory Practices
2. Observation of chromosomes in plant cells
3. Isolation and morphological characterisation of bacteria and fungi
4. Analysis of quality of milk (Lactic acid and Casein Estimation)
5. Determination of BOD in water sample
6. Serum separation and blood glucose estimation

OPEN ELECTIVE- SEMESTER III
BIOTECHNOLOGY FOR HUMAN WELFARE
COURSE OUTCOMES

COURSE OUTCOMES	MODULE	CLO
1.	Application of biotechnology in industry	Contribution of Industrial Biotechnology
2.	Environment	Biodegradation through living systems
3.	Forensic science	Investigatory rDNA tools and techniques
4.	Health	Significance of genetic engineering in diagnostics and treatment
5.	Application of biotechnology in industry	Contribution of Industrial Biotechnology

OPEN ELECTIVE- SEMESTER III

BIOTECHNOLOGY FOR HUMAN WELFARE

Units	Topic	Description	Hours
1.	**Application of biotechnology in industry**	Industrial production of ➢ Alcoholic beverage (wine) ➢ Antibiotic (Penicillin) ➢ Enzyme (lipase)	**7**
2.	**Environment**	➢ Application of Biotechnology in environmental aspects ➢ Bioremediation of organic pollutants - chlorinated and non-chlorinated compounds ➢ Bioremediation of hydrocarbons and agricultural wastes.	**7**
3.	**Forensic science**	➢ DNA finger printing technique(criminal cases, paternity)	6
4.	**Health**	➢ Application of biotechnology in health: ➢ Genetically engineered insulin ➢ Recombinant vaccines ➢ Gene therapy ➢ Molecular diagnostics using ELISA, PCR ➢ Monoclonal antibodies and their use in cancer.	10
		TOTAL HOURS	**30**

Practical Sessions:

1. Biochemical calculations
2. Preparation of Buffers
3. Wine production and alcohol analysis
4. Bioethanol production from Domestic waste
5. PCR Basic method
6. Agarose gel electrophoresis

DISCIPLINE SPECIFIC COURSE, SEMESTER I
CELL BIOLOGY AND GENETICS
PROGRAM OUTCOME AND COURSE OUTCOMES

Program Outcome	• This program explores and employs the molecular basis in living cells with the technical tools to study the ways they interact and communicate within and between cells and organs. • Students can acquire skills to use modern analytical tools and advanced mechanisms to analyze and solve problems in various courses of biotechnology. • Program helps to understand the fundamental concepts in core (plant, animal, industrial biotechnology, molecular biology, genetic engineering and genetics) and allied (microbiology, immunology and physiology) branches of life sciences. • Get exposure to various research fields and thrust area of the core and interdisciplinary subjects**.**	
S No	**Modules**	**CLO**
1	Cell as a Basic unit of Living Systems and Cellular Organelles	By this module the student will understand the concept of structure and function of cell, role of cellular organelles and their activities
2.	Chromosomes	A deep understanding of eukaryotic chromosome structure and organization and their involvement in cell division
3.	Cell Division	Clear knowledge of cell cycle and identification of checkpoints involved
4.	Genetics	Knowledge about how genetic information are transferred by a range of mechanisms for generating genetic diversity
5.	Linkage and Crossing Over	Will be able to explain the relation between chromosomal inheritance and disorders and the causes for such abnormalities

DISCIPLINE SPECIFIC COURSE, SEMESTER – I
CELL BIOLOGY AND GENETICS

S No.	Module	Description	Hours
1.	**Cell as a Basic unit of Living Systems and Cellular Organelles**	Historical perspectives, Discovery of cell, The cell Theory, Ultra structure of a eukaryotic cells (plant and animal)	12
		Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes	
		Cell Organelles: Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosome, Peroxisomes, Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments)	
2.	**Chromosomes**	General introduction, Discovery, Morphology and structural organization- Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Single-stranded and multi- stranded hypothesis, folded- fiber and nucleosome models. Special type of chromosomes: Salivary gland and Lamp brush chromosomes	12
3.	**Cell Cycle**	Phases, Mitosis, Meiosis, Regulation of cell cycle, Cell cycle checkpoints, Enzymes involved in regulation, Significance of cell cycle, achromatic apparatus, synaptonemal complex Cell Senescence and programmed cell death.	10
4.	**Genetics**	History of genetics: Introduction and brief history of genetics, Mendel's laws of inheritance – law of dominance, incomplete dominance, co-dominance, law of segregation, law of independent assortment, back cross and test cross and multiple alleles Deviations from Mendelian genetics: Dihybrid ratio (Comb pattern in fowl), Recessive epistasis (9:3:4 Bombay phenotype), Dominant epistasis (12:3:1 fruit color in summer squash), duplicate recessive epistasis (9: 7 flower colour in sweet peas), duplicate dominant genes (15:1), dominant and recessive interaction (13: 3), Multiple factors: Skin colour in human beings, Multiple allelism: Blood groups in Human beings. Maternal Inheritance: Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in paramecium, Sex-linked inheritance, Chromosome theory of inheritance.	12
5.	**Linkage and Crossing Over**	Introduction, Coupling and repulsion hypothesis, Linkage in maize and Drosophila, Mechanism of	

		crossing over and its importance, chromosome mapping-linkage map in maize. Mutations: Types of mutations, Spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level, Mutations in plants, animals and microbes for economic benefit of man. Chromosomal variations: A general account of structural and numerical aberrations, chromosomal evolution of wheat and cotton. Sex Determination in Plants and animals: Concept of allosomes and autosomes, XX- XY, XX-XO, ZW-ZZ, ZO-ZZ types. Human Genetics: Karyotype in man, inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome and Cri-Du-Chat Syndrome)	14
		TOTAL	**60**

Practical Sessions:

1) Study and maintenance of simple and compound microscope, centrifuge, pH meter
2) Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
3) Study of stages in mitosis from onion root tips
4) Study of stages in meiosis in grasshopper testes/onion or Rhoeo flower buds
5) Mounting of polytene chromosomes from Drosophila Larvae
6) Buccal smear - Barr bodies
7) Karyotype analysis – Human (Normal, Down and Turner's syndromes) and Onion
8) Isolation and staining of Mitochondria
9) Isolation and staining of Chloroplast
10) RBC/ yeast cell count by Haemocytometer
11) Simple genetic problems based on theory

DISCIPLINE SPECIFIC COURSE, SEMESTER – II
MICROBIOLOGICAL METHODS AND TECHNIQUES
COURSE OUTCOMES

S No	Modules	Outcomes
1.	Instruments used in Biotechnology	Students will be able to understand the theory behind various techniques and apply their knowledge better in the laboratory.
2.	Sterilization techniques	They will understand the importance of sterilization and the application of sterilants/disinfectants in medical and industrial domains.
3.	Microbiological techniques	Students will learn the different types of media that are used to grow different types of bacteria and also learn to preserve cultures for long-term use. Staining techniques will help them understand the importance of characterizing bacteria based on their cell wall components.
4.	Microbial taxonomy and growth	Students will appreciate the different shapes of bacteria and their arrangement and also understand the pattern in which bacteria grows.
5.	Antimicrobial agents	They will understand the mode of action of various drugs and how exactly diagnostic laboratories process samples.
6.	Bacterial genetics	They will comprehend how genes get passed on from one organism to the other horizontally.
7.	Basic Virology	They will understand the basis on which viruses are classified and the life cycle they follow.

DISCIPLINE SPECIFIC COURSE, SEMESTER – II
MICROBIOLOGICAL METHODS AND TECHNIQUES

Units	Module	Description	Hours
1.	**Instruments used in Biotechnology**	Microscopy: Resolving power and numerical aperture Working principle and applications of Compound microscope, Dark field microscope, Phase contrast microscope, Fluorescence Microscope, confocal microscope, Electron Microscopes- TEM and SEM Working principles and applications of Centrifuge, Ultracentrifuge, Spectrophotometer and Chromatography: Paper and TLC	9
2.	**Sterilization techniques**	Definition of sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic and antimicrobial agents Physical methods: Principle, construction and applications of moist heat sterilization, Pasteurization, Fractional sterilization-Tyndallization and autoclave. Dry heat sterilization-Incineration and hot air oven. Filtration – Diatomaceous earth filter, seitz filter, membrane filter and HEPA Radiation : Ionizing radiation-γ rays and non-ionizing radiation- UVrays Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents	8
3.	**Microbiological techniques**	Culture Media: Components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Pure culture methods: Serial dilution and plating methods (pour, spread, streak); cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria Stains and staining techniques: Principles of staining, Types of stains-simple stains, structural stains and differential stains.	9

4.	**Microbial taxonomy and growth**	Classification based on form and cell surface and nutritional types, Growth curve	7
5.	**Antimicrobial agents**	Five modes of action with one example each: Inhibitor of nucleic acid synthesis (Rifampin); Inhibitor of cell wall synthesis (Cephalosporins); Inhibitor of cell membrane function (Polymyxin B); Inhibitor of protein synthesis (Tetracyclines); Inhibitor of metabolism (Trimethoprim) Antifungal agents: Mechanism of action of Amphotericin B Antiviral agents: Mechanism of action of Amantadine Antibiotic resistance, MDR Antibiotic sensitivity testing methods: MIC, Disc and Agar well diffusion techniques and Etest	14
6.	**Bacterial genetics**	Transformation, conjugation and transduction	5
7.	**Basic Virology**	Baltimore classification, life cycle of lambda phage (lytic and lysogenic), Morphology and Structure Viral disease	7
		Total	60

Practical Sessions:

1. To study the principle and applications of biological safety cabinet, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter
2. Sterilization using Autoclave, Hot Air Oven and membrane filtration
3. Preparation of culture media for bacteria, fungi and their cultivation.
4. Plating techniques: Spread plate, pour plate and streak plate.
5. Isolation of bacteria and fungi from soil, water and air
6. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts
7. Colony characteristics study of bacteria from air exposure plate
8. Staining techniques: Bacteria– Gram, Negative, Endospore staining
9. Fungi – Lactophenol cotton blue staining
10. Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, Gelatin hydrolysis
11. Bacterial cell motility - hanging drop technique

DISCIPLINE SPECIFIC COURSE, SEMESTER III
BIOMOLECULES
COURSE OUTCOMES

Course Outcomes:	Modules	The students will be getting the following outcomes
1.	Introduction and Bioenergetics	Understand the fundamental energetics of biochemical processes
2.	Carbohydrates	Understand in detail the structure and physico chemical properties of carbohydrates from monosaccharide to polysaccharides.
3.	Amino Acids, Peptides and proteins	To introduce the building blocks of proteins and to understand how they interact to form proteins
4.	Lipids	To know the types of lipids and their role in biological systems
5.	Enzymes	Have a deeper insight in to the fundamentals of enzyme structure and function and kinetics
6.	Vitamins, Nucleic acids and Hormones	To recognize and understand each of the molecules and their significance
7.	Bioanalytical tools	Exhibit a knowledge base of the different instruments that are commonly used in the field of biochemistry and to understand their practical applications

DISCIPLINE SPECIFIC COURSE, SEMESTER III
BIOMOLECULES

	MODULE	DESCRIPTION	HOURS
1.	**Introduction and Bioenergetics**	pH, Buffers, Molarity & Normality. Biochemical calculations Laws of Thermodynamics, Entropy, Enthalpy, Free Energy Change Structure and properties of ATP	4
2.	**Carbohydrates:**	Introduction, sources, classification of carbohydrates. Structure, function and properties of carbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives – amino sugars and ascorbic acid Oligosaccharides – Sucrose and Fructose Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides - storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure, properties), Heteropolysaccharides - glycoproteins and proteoglycans (Brief study). Metabolism: Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation.	7
3.	**Amino Acids, Peptides and Proteins**	Introduction, classification and structure of amino acids. Concept of – Zwitterion, isoelectric point, pK values. Essential and nonessential amino acids. Peptide bond and peptide, classification of proteins based on structure and function, Structural organization of proteins [primary, secondary (α, β), tertiary and quaternary]. Fibrous and globular proteins, denaturation and renaturation of proteins, General aspects of amino acid metabolism: Transamination, deamination, decarboxylation and urea cycle.	7

4.	**Lipids**	Classification and function of lipids, properties (saponification value, acid value, iodine number, rancidity), Hydrogenation of fats and oils, Saturated and unsaturated fatty acids. General structure and biological functions of - phospholipids, sphingolipids, glycolipids, lipoproteins, prostaglandins, cholesterol, ergosterol. Metabolism: Beta-oxidation of fatty acids. Biosynthesis of cholesterol.	7
5.	**Enzymes**	Introduction, nomenclature and classification, enzyme activity, specific activity, activation energy and transition state, factors influencing enzyme activity, enzyme kinetics. Coenzymes and their functions (one reaction involving FMN, FAD, NAD), metalloenzymes. Enzyme inhibition- Irreversible and reversible (competitive, non-competitive and uncompetitive inhibition with an example each) Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH, Creatine kinase, Alkaline phosphatase and their clinical significance).	7
6.	**Vitamins** **Nucleic acids** **Hormones**	Water and fat soluble vitamins, dietary source and biological role of vitamins. Deficiency manifestation of vitamin A, B, C, D, E and K Structures of purines and pyrimidines, nucleosides, nucleotides in DNA, Denovo and salvage pathway of purine and pyrimidine synthesis. Classification of hormones based on chemical nature and mechanism of action. Chemical structure and functions of the following hormones: Glucagon, Cortisone, Epinephrine, Testosterone and Estradiol.	14

7.	**Bioanalytical tools**	a) Chromatography: Principle, procedure and applications of - paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography, Gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performance liquid chromatography (HPLC). b) Electrophoresis: Principle, procedure and applications of electrophoresis (paper electrophoresis, gel electrophoresis -PAGE, SDS- PAGE & agarose gel electrophoresis) and isoelectric focusing. c) Spectroscopy: UV-Vis spectrophotometry; mass spectroscopy, atomic absorption spectroscopy.	14
		Sub – Total Hours	**60**

DISCIPLINE SPECIFIC COURSE, SEMESTER III
BIOMOLECULES
Practical Sessions

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Definitions and calculations: Molarity, Molality, Normality, Mass percent % (w/w), Percent by volume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions.
3. Preparation of standard buffers by Hendersen-Hasselbach equation – Acetate, phosphate, Tris and determination of pH of solution using pH meter.
4. Estimation of glucose by DNS method
5. Determination of α-amylase activity by DNS method
6. Estimation of proteins by Bradford method
7. Estimation of amino acid by Ninhydrin method
8. Extraction of protein from soaked/sprouted green gram by salting out method
9. Separation of plant pigments by circular paper chromatography
10. Separation of amino acids by thin layer chromatography
11. Native PAGE
12. Determination of iodine number of lipids

DISCIPLINE SPECIFIC COURSE, SEMESTER IV
MOLECULAR BIOLOGY

Course Outcomes:	Modules	The students will be getting the following outcomes
1	Molecular basis of life and Nucleic Acids	Students are exposed to the history of molecular biology through several experiments that made a breakthrough in science.
2.	DNA Replication and Repair	They will understand how DNA replicates and the differences between prokaryotic and eukaryotic DNA replication.
3.	Transcription and RNA processing	They will understand the fundamental concept of transcription and how genes are coded both in prokaryotes and eukaryotes.
4.	Regulation of gene expression and translation	They will understand the link between replication, transcription and translation and will also be able to comprehend the various modifications brought out in the protein once produced.

DISCIPLINE SPECIFIC COURSE , SEMESTER IV
MOLECULAR BIOLOGY

	MODULE	DESCRIPTION	HR
1.	**Molecular basis of life and Nucleic Acids**	An introduction to RNA and experimental proof of DNA as genetic material – Griffith's experiment, Hershey and Chase, Avery, Mcleod Types and structure of DNA and RNA, Watson and Crick model of DNA. Functions of DNA and RNA including ribozymes Structure of prokaryotic and eukaryotic genes, features of genetic code, wobble hypothesis	10
2.	**DNA Replication and Repair**	Replication of DNA – Conservative, dispersive and semi-conservative Replication of DNA in prokaryotes and eukaryotes– Meselson and Stahl experiment, Enzymes and proteins involved in replication including polymerases, Theta model, linear and rolling circle model, The replication complex: Pre-primming proteins, primosome, replisome, unique aspects of eukaryotic chromosome replication, Fidelity of replication DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair. Homologous recombination and Holliday model	16
3.	**Transcription and RNA processing**	Transcription in prokaryotes: RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. Operons – Lac operon and Trp operon	18
4.	**Regulation of gene expression and translation**	Translation in prokaryotes and eukaryotes- ribosome, enzymes and factors involved in translation. Mechanism of translation- activation of amino acid, aminoacyl tRNA synthesis, Mechanism- initiation, elongation and termination of polypeptide chain. Fidelity of translation, Inhibitors of translation. Protein folding and modifications, Post translational modifications of proteins.	16
		Total Hours	**60**

DISCIPLINE SPECIFIC COURSE, SEMESTER IV
MOLECULAR BIOLOGY
Practical sessions

1. Isolation of DNA from liver
2. Estimation of DNA by DPA method
3. Estimation of RNA by Orcinol method
4. Column chromatography – gel filtration (Demo)
5. Extraction and partial purification of protein from plant source by Ammonium sulphate precipitation.
6. Extraction and partial purification of protein from animal source by organic solvents.
7. Protein separation by SDS-Polyacrylamide Gel Electrophoresis (PAGE)
8. DNA purity by UV Spectrophotometry

DISCIPLINE SPECIFIC COURSE, SEMESTER V

GENETIC ENGINEERING

Course Outcomes:	Modules	The students will be getting the following outcomes
1	**Introduction**	Students will be introduced to the concepts of genetic engineering.
2.	**Tools of R-DNA Technology**	The different tools that are used in genetic engineering experiments will be taught in detail to the students.
3.	**Vectors used in Gene Cloning**	The various vectors used in genetic engineering techniques, the advantages and disadvantages of each vector their construct will be understood by the students.
4.	**Methods of gene cloning**	Students will be introduced to the various methods used for gene cloning.
5.	**Techniques in Genetic Engineering**	The various techniques involved in genetic engineering and their importance and relevance to the present times will be understood by the students.
6.	**Applications**	Students will learn to apply their knowledge by studying various domain specific examples.

DISCIPLINE SPECIFIC COURSE, SEMESTER V
GENETIC ENGINEERING

S No	MODULE	DESCRIPTION	HOURS
1.	**Introduction**	Gene Cloning and Genetic Engineering	**2**
2.	**Tools of r-DNA Technology**	Enzymes involved in r-DNA techniques –Nucleases (Exo and Restriction Endo nucleases), DNA Ligase, DNA Polymerases, Taq Polymerase, Reverse Transcriptase).	**6**
3.	**Vectors used in Gene Cloning**	Different types of vectors- Description of Cloning Vectors, Plasmid (pBR322, pUC8), phage (Lambda and M13), cosmids, Phagemids, Yeast vectors-YAC, Plant vectors (Ti plasmid), Animal vectors (Animal Viruses) eg: retroviruses, SV40, Basic features of expression vectors (promoters, RBS, Terminators)	**16**
4.	**Methods of gene cloning**	Extraction of Bacterial genomic and Plasmid DNA. Isolation of DNA from Plant and Animal Tissue. Introduction of DNA into Bacterial Cells (transformation) Selection process for transformed cells. Expression of Cloned Gene in *E.coli* (Eg. Insulin, Growth hormone)	**16**
5.	**Techniques in Genetic Engineering**	*In vitro* methods of DNA *i*ntroduction - microinjection, gene gun, electroporation, liposome fusion-$CaPO_4$, DMSO. Blotting Techniques-Brief description of Western and Northern Blotting, Southern Blotting, DNA sequencing(Maxam-Gilbert, Sanger, introduction to NGS), PCR	**12**
6.	**Applications**	Applications of gene cloning in medicine, agriculture and forensic science.	**8**
		TOTAL HOURS	**60**

Practical sessions:

1. Isolation of Genomic DNA from plant and Bacteria (2 units)
2. Isolation of plasmid DNA from *E. coli*
3. Restriction digestion of DNA
4. Ligation of DNA
5. Bacterial transformation
6. Western blotting
7. Southern blotting

8. PCR

DISCIPLINE SPECIFIC COURSE, SEMESTER V
PLANT BIOTECHNOLOGY

Course Outcomes:	Modules	The students will be getting the following outcomes
1	Plant tissue culture	Students are introduced to the various terminologies and concepts of Plant Tissue Culture.
2.	Laboratory Organization	The framework and design of a plant tissue vulture lab is explained in detail that will help them apply their knowledge in the future if they become entrepreneurs.
3.	Sterilization techniques	The importance of sterilization is dealt with in great detail to prevent any contamination in the laboratory.
4.	Nutrition media	Students will get introduced to the different types of media and the ways to prepare them.
5.	Types of culture	They will appreciate the various types of cultures obtained in a PTC laboratory.
6.	Micropropagation	Students will be able to comprehend how an explant is grown in the lab and acclimatized to the outside environment.
7.	Protoplast Isolation and Fusion	The importance of protoplast cultures will be appreciated by the students and the various techniques used for the same will be studied.
8.	Somaclonal variation	The numerous variations obtained while growing cultures in the lab will be studied in detail.
9.	Cell suspension and secondary metabolites	Students will learn the applications of cell suspension cultures
10.	Applications of Plant Biotechnology	Applications of plant biotechnology with respect to the different crops will be learnt in much detail.

DISCIPLINE SPECIFIC COURSE, SEMESTER V

PLANT BIOTECHNOLOGY

S No	MODULE	DESCRIPTION	HOURS
1.	**Introduction & Laboratory Organization**	An Overview: Introduction, Terms and Definitions Instrumentation and Media, Culturing Facilities, Specifications of laboratory Equipment. Laboratory and Personal Safety.	**4**
2.	**Sterilization techniques & Nutrition media**	Preparation of Sterile Media, Sterilization techniques (Chemical , Physical and mechanical methods) Explant Preparation: Age of the plant tissue, size of the Explant. Media Composition: Inorganic nutrients, Carbon and Energy Sources, and Vitamins. Use of Growth Regulators (Auxins, Cytokinins and Gibberellins), Organic Supplements, Gelling Agents, pH indicators, Antibiotics, Protocol: General methodology for medium preparation – MS Medium.	**15**
3.	**Types of culture & Micropropagation**	Seed culture, Embryo culture, Callus culture, Organ culture, Endosperm culture, Ovary and ovule culture Stages of Micropropagation, Types of Micropropagation- Shoot bud/tip culture, Meristem Culture. Organogenesis- Via Callus culture, Direct Organogenesis. Embryogenesis. Somatic embryogenesis. Advantages and Disadvantages of Micropropagation, Greenhouse.	**13**
4.	**Protoplast Isolation and Fusion**	Protoplast Isolation: Mechanical method, Enzymatic Method-Direct method, Sequential method. Protoplast viability testing, Culture techniques. Somatic Hybridization: Protoplast fusion-methods of fusion, Mechanism of fusion. Identification and selection of hybrid cells. Cybrids. Advantages and Disadvantages of Somatic Hybridization.	**8**
5.	**Somaclonal variation**	Basis of somaclonal variation, steps for obtaining somaclonal variation, application, Gametoclonal variations.	**7**
6.	**Cell suspension and secondary metabolites**	Types of suspension cultures- batch culture, continuous culture, and synchronization of suspension culture cells Techniques for single cell culture- Bergmanin cell plating technique and applications. Secondary metabolites: Caffeine Production. Applications in different fields (BT crops)	**13**
		TOTAL HOURS	**60**

Practical sessions:

1. Laboratory setup and design

2. Preparation of plant tissue culture media – MS media

3. Sterilization of explants, inoculation, and production of callus

4. Embryo culture

5. Nodal culture

6. Protoplast isolation and fusion

7. Preparation of synthetic seeds

DISCIPLINE SPECIFIC COURSE, SEMESTER V
IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY
COURSE OUTCOMES

Course Outcomes	Modules	The students will be getting the following outcomes
1.	Introduction	Helps to demonstrate the basic knowledge of immunological processes
2.	Immune System	Provide students with the basic knowledge about the functioning of the immune system, inflammation, immune response against infectious agents
3.	Antigen and Antibody Interactions	Elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses
4.	MHC	Understand and explain the basis of immunological mechanisms involved in recognition and rejection of cells and tissues
5.	Auto-Immunity and Immune Deficiency diseases	Understand and explain the basis of immunological tolerance, autoimmunity and immunodeficiencies
6.	Stem cell	Become aware of the potentials of stem cells and the associated ethical issues
7.	Regenerative Medicine, Medical Products and Gene Therapy	Lets the students know about the benefits of the therapeutic products
8.	Disease diagnosis	Know the tools available for disease diagnosis
9.	Nano Biotechnology	Get introduced to the use of nanotechnology in therapy

DISCIPLINE SPECIFIC COURSE, SEMESTER VI
IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY

S No	MODULE	DESCRIPTION	HOURS
1.	**Immune System**	Innate and adaptive immunity Hematopoiesis Primary and secondary lymphoid organs Humoral and Cell-mediated Immunity Structure, composition and functions of cells and organs involved in immune system (T-cells, B-cells, Macrophages, Ag-Processing cells, granulocytes, Mast cells, killer T cells and dendritic cells)	12
2.	**Antigen and Antibody Interactions**	**Antigens**: Structure, properties and types, adjuvants, antigen specificity, epitopes, haptens and antigenicity **Antibodies**: Basic structure, classes, biological properties, and antigenic determinants **Ag-Ab interactions:** Antibody affinity,avidity cross reactivity, precipitation and agglutination reactions Definition, Types and mechanisms of hypersensitive reactions	10
3.	**MHC**	General organization, Structure and Functions of MHC Types of grafts, graft rejections and antigen processing and presentation. Tissue-engineered skin, scaffolds, cells, and materials for scaffolds	10
4.	**Auto-Immunity and Immune Deficiency diseases**	Autoimmunity: Definition, organ-specific autoimmune diseases, Example: Insulin-dependent Diabetes Mellitus and its diagnosis Immunodeficiency: Definition, primary and secondary disorders, Example: AIDS and its diagnosis, probes for diagnosis of AIDS	6
5.	**Stem cell, Regenerative Medicine, Medical Products and Gene Therapy**	Stem cell technology (adult and embryonic stem cells), Ethical issues in stem cell research Medical products-Human protein replacements (Insulin, Factor VIII), Therapeutic agents - TPA, Interferons, Gene therapy - *Ex vivo* gene therapy (ADA, familial hypercholesterolemia); *In vivo* gene therapy (cancer); Antigene and anti-sense therapy (cancer)	9
6.	**Disease diagnosis and Nano biotechnology**	Methods for disease diagnosis- RIA, ELISA, RIEP, ODD, Western Blotting, immunofluorescence. Introduction, types of nanoparticles, Drug designing and delivery using Microspheres and nanoparticles.	11
		TOTAL	60

Practical sessions:

1. Blood group identification
2. Radial ImmunoDiffusion
3. Ouchterlony double diffusion
4. Rocket Immunoelectrophoresis
5. Dot ELISA
6. Serum separation and quantification of serum proteins
7. Western Blotting (DEMO)
8. Differential Count of WBC

DISCIPLINE SPECIFIC COURSE, SEMESTER VI

BIOPROCESS TECHNOLOGY

S No	Modules	The students will be getting the following outcomes
1.	**Fermentation**	Understand the basics of fermentation process and also able to describe the fermentor through analyzing the materials and methods for the working of a fermentor
2.	**Downstream processing of fermentation**	Students gain knowledge in deep about process and product optimization, also be able to produce, analyse and interpret data from fermentation
3.	**Production of Primary metabolites**	Students are able to learn the steps and operations involved in microbial primary metabolites production
4.	**Production of Enzymes and other bioproducts**	Students are familiarize with industrially relevant microbial strains and processes for production of enzyme, biopolymer and food products
5.	**Production of Secondary metabolites and modern Biotechnology products**	Students are able to connect with secondary metabolites production, also the use of recombinant technology in pharmaceutically important microbial bioproducts production

DISCIPLINE SPECIFIC COURSE, SEMESTER VI
BIOPROCESSING TECHNOLOGY

S No	Module	Description	Hours
1.	**Fermentation**	Historical overview of industrial fermentation processes -traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation (Batch, continuous and fed-batch) and fermentation media. Basic design of a fermenter, Types of fermenters- tower fermenter, air-lift fermenter.	12
2.	**Downstream processing of fermentation**	Cell separation: Filtration and Centrifugation; Cell disruption; Chromatography; Membrane processes; Drying and Crystallization	12
3.	**Production of Primary metabolites**	Production of organic acids (citric acid); amino acids (glutamic acid), and alcoholic beverages (wine).	12
4.	**Production of Enzymes and other bioproducts**	Immobilization of enzymes. Applications of enzymes in food, pharmaceutical, and detergent industries. Production of industrial enzymes (amylases). Biofertilizers, biopreservatives (Nisin), and biopolymers (PHB). Microbial foods – Single-cell protein (SCP) eg: spirulina, Single-cell Oils (SCO) eg: polyunsaturated fatty acids (PUFAs). Cheese.	12
5.	**Production of Secondary metabolites and modern Biotechnology products**	Production processes for various classes of secondary metabolites: antibiotics: (penicillin), and vitamins (Vit B12). Production of recombinant proteins with therapeutic and diagnostic applications (insulin), Production of recombinant vaccines (Hepatitis B vaccine).	12
		TOTAL	60

Practical sessions

1. Estimation of citric acid in fruit juices
2. Wine production
3. Estimation of alcohol using Ceric Ammonium Nitrate/specific gravity method
4. Submerged fermentation using yeast
5. Extraction of amylase enzyme and estimation of enzyme activity
6. Immobilisation of amylase enzymes
7. Mushroom Cultivation