BHARATHIAR UNIVERSITY: COIMBATORE 641 046

UD- Department of Biotechnology: M.Sc. Biotechnology Curriculum

(*For the students admitted during the academic year 2026-27 onwards*)

Scheme of Examination

Sub. code	Course Code	Title of the Course		Credits	Hours		Maximum Marks		
					Theory	Practical	CIA	ESE	Total
FIRST SEMESTER									
13A	**26BIOBC01**	Core-1	Biochemistry	4	4	-	25	75	100
13B	**26BIOBC02**	Core-2	Cell and Molecular Biology	4	4	-	25	75	100
13C	**26BIOBC03**	Core-3	Microbiology	4	4	-	25	75	100
13D	**26BIOBC04**	Core-4	Genetics	4	4	-	25	75	100
1EA	**26BIOGE01A**	E1ective-1	Biodiversity and Bioprospecting	4	4	-	25	75	100
1EB	**26BIOGE01B**		Bioinstrumentation						
13P	**26BIOBCP1**	Practical-1	Basic Biotechnology	4	-	6	25	75	100
1GS	**26BIOGS01**	Supportive	Tools in Biotechnology	2	2	-	12	38	50
1VA*	**26BIOBCV1**	VAC-1	Soft Skills and Business Communication Skills for Employability Training	2	2	-	50	-	50
			Total	**26**	**22**	**6**	**162**	**488**	**650**
SECOND SEMESTER									
23A	**26BIOBC05**	Core-5	Developmental Biology and Physiology	4	4	-	25	75	100
23B	**26BIOBC06**	Core-6	Immunology	4	4	-	25	75	100
23C	**26BIOBC07**	Core-7	Recombinant DNA Technology	4	4	-	25	75	100
23D	**26BIOBC08**	Core-8	Plant Physiology and Metabolic Engineering	4	4	-	25	75	100
2EA	**26BIOGE02A**	E1ective-2	Molecular Diagnostics and Clinical Testing	4	4	-	25	75	100
2EB	**26BIOGE02B**		Environmental Biotechnology						
23P	**26BIOBCP2**	Practical-2	Advanced Biotechnology	4	-	6	25	75	100
2GS	**26BIOGS02**	Supportive	Medical Biotechnology	2	2	-	12	38	50
2JA*	**26BIOBCJ1**	JOCC-1	SAS Programming for Clinical Trials Management	2	2	-	50	-	50
			Total	**26**	**22**	**6**	**162**	**488**	**650**
THIRD SEMESTER									
33A	**26BIOBC09**	Core-9	Animal Biotechnology and Stem Cell Biology	4	4	-	25	75	100
33B	**26BIOBC10**	Core-10	Plant Biotechnology	4	4	-	25	75	100
33C	**26BIOBC11**	Core-11	Bioprocess Technology	4	4	-	25	75	100
33D	**26BIOBC12**	Core-12	Bioinformatics and Systems Biology	4	4	-	25	75	100
3EA	**26BIOGE03A**	E1ective-3	Nanobiotechnology	4	4	-	25	75	100
3EB	**26BIOGE03B**		Pharmaceutical Biotechnology						
33P	**26BIOBCP3**	Practical-3	Applied Biotechnology	4	-	6	25	75	100
3GS	**26BIOGS03**	Supportive	Food Biotechnology	2	2	-	12	38	50
37V*	**26BIOBCS1**	Internship	One Month Summer Internship	2	-	-	50	-	50
3JA*	**26BIOBCJ2**	JOCC-2	Assisted Reproductive Techniques	2	2	-	50	-	50
			Total	**26**	**22**	**6**	**162**	**488**	**650**
FOURTH SEMESTER									
43A	**26BIOBC13**	Core-13	Bioethics, Biosafety, IPR and Entrepreneurship	4	4	-	25	75	100
47V	**26BIOBCPW**	Project	Project Work	8	-	-	50	150	200
4NS*	**26BIOBCNS**	Swayam	MOOC/Swayam - Online Learning Course	2	-	-	-	-	-
4VA*	**26BIOBCV2**	VAC-2	Advanced Instrumentation Training	2	2	-	50	-	50
4SP*	**26BIODM01**	SP1	Disaster Management	2	2	-	50	-	50
			Total	**12**	**-**	**-**	**75**	**225**	**300**
			Grand Total	**90**	**-**	**-**	**-**	**-**	**2250**

**Co-Scholastic Courses*

The final grading and ranking will only be based on scholastic courses. However, the award of the degree requires the mandatory completion of Co-Scholastic courses.

Co-Scholastic Courses				
S. No	**Course**	**Number**	**Credits**	**Total**
1	MOOC/Swayam - Online Learning Course	1	2	2
2	Value Added Courses	2	2	4
3	Job Oriented Certificate Courses	2	2	4
4	Summer Internship	1	2	2
5	Special Programme	1	2	2
	Total	**7**	**10**	**14**

FIRST SEMESTER

Course code	26BIOBC01	BIOCHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core Paper -1	4	✓	-	4
Pre-requisite		Basic Knowledge in Biomolecules	Syllabus Version			2026-27

Course Objectives:

The main objectives of this course are to:

1. Get an overall understanding of the structure and functions of biomolecules, enzyme kinetics, biopolymers and metabolic reactions in a living system.
2. Understand the principles of biochemical pathways which regulate the cellular mechanisms.
3. Acquire the knowledge on the role of biomolecules on general dogma of all living cell.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Recognize the structures and functions of biomolecules such as carbohydrate that form the basis of what we understand to be living organisms.	K1, K2
CO2	Provide with a firm foundation in the biochemical aspects of cellular functions with different proteins and proteomics.	K1, K2
CO3	Get information pertaining to role of enzymes, co-enzyme and cofactor in catalytic reaction as a property of biochemical pathways regulation.	K1, K2
CO4	Acquire base knowledge of metabolic pathways occurring inside living cells in respect to lipids and fat.	K1, K2
CO5	Understand the limitations of biomolecules in regulation of molecular functions in mammals especially in humans.	K1, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Glycobiology and Bioenergetics	10 hours

Carbohydrate classification; Occurrence, isolation, purification, properties and biological reactions of polysaccharides; Sugars-mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose. Glycoproteins and proteoglycans: Structural features of homoglycans, heteroglycans and complex carbohydrates; Carbohydrate metabolism: Glycolysis and TCA cycle; Glycogenesis; Glycogenolysis; Gluconeogenesis; interconversion of hexoses and pentoses; Coordinated control of metabolism; Oxidative phosphorylation; Introduction to GPCR, Inositol/DAG//PKC and Ca++ signalling pathways.

Unit:2	Chemistry of Amino Acid and Proteins	10 hours

Proteins: Classification and physico-chemical properties of amino acids and peptides; Peptide and covalent bond; Primary, secondary, tertiary and quaternary structures of proteins; Ramchandran plot; Silk fibroin, coiled coils, collagen triple helix and hemoglobin; Denaturation and renaturation of proteins; Basic principles of protein purification; tools to characterize expressed proteins; Protein folding; Protein metabolism-degradation and pathway controlling protein degradation; Protein turnover and amino acid catabolism. Peptide hormones.

Unit:3	Enzyme and Enzyme Kinetics	10 hours
IUB classification and nomenclature of Enzymes; Enzyme kinetics (negative and positive cooperativity); Ordered and ping pong mechanism; Regulation of enzymatic activity and covalent modification; Active sites; Enzymes and coenzymes: Coenzymes interactions, activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes; Lysozyme: mechanism of action. Brief account on ribozymes and abzymes. Enzyme catalysis - catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase. Bioluminescence.		
Unit:4	**Structure, Function and Metabolism of Lipids**	**10 hours**
Lipids-Classification, structure and functions: Triglycerides; Phospholipids; Steroids and Terpenes; Lipoproteins: Structure and functions of lipoproteins; Role of lipids in biomembranes; Biosynthesis: Fatty acids; Triglycerides; Phospholipids; membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway. β-oxidation of fatty acids.		
Unit:5	**Structure, Functions of DNA, RNA and Nucleic Acids**	**10 hours**
Physical properties and structure of double stranded DNA (A, B and Z DNA). The biological significance of double strandedness; Sequence-dependent variation in the shape of DNA. Biological importance of nucleotides. Types of RNAs and their biological significance. Topology of DNA, Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis. Purines and pyrimidines biosynthesis.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**

Text Book(s)	
1	Laurence AM, Robert AH, Gray S and Marc P (2022). Principles of Biochemistry, Pearson Education, 14th edition.
2	Berg JM, Tymoczko JL and Stryer L (2019). Biochemistry, WH Freeman and Company, 9th edition.
3	Ritu S, Rajeev G and Denice RF (2024). Lippincott's Illustrated Reviews – Biochemistry, Wolters Kluwer India, 2nd South Asian edition.
Reference Books	
1	Lehninger WH, David LN and Michael C (2017). Principles of Biochemistry, Freeman and Company 7th edition.
2	Peter JK, Kathleen MB, Owen MG and Victor WR (2022). Harper's illustrated Biochemistry. McGraw-Hill Professional, 32nd edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://epgp.inflibnet.ac.in/
2	http://www.partone.litfl.com/basal_metabolic_rate.html#id
3	https://www.edx.org/course/principles-of-biochemistry
Course Designed By: **Dr. S. Velayuthaprabhu, Assistant Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	L	L	L	L
CO2	S	L	M	L	L
CO3	L	M	L	L	M
CO4	M	L	L	M	L
CO5	S	M	M	S	L

*S-Strong; M-Medium; L-Low

Course code	26BIOBC02	CELL AND MOLECULAR BIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 2	4	✓	-	4
Pre-requisite		Basic Knowledge in Cell Biology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation.
2. To develop comprehensive understanding on the complete cellular and molecular function of cell organelles in terms of cell-to-cell interaction, gene regulation, cellular signalling.
3. To impart the molecular biology knowledge in applications of various human health care Industry for developing drugs.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.	K1
CO2	Exhibit a knowledge base in cell and molecular biology in biomedical sciences.	K2
CO3	Cell and molecular biology will render them chose their techniques in molecular biology research and further will help them to get job opportunities in health care industry.	K3
CO4	This paper will help the students to conduct independent work pertaining to molecular biology research.	K4
CO5	The theoretical knowledge gained from this paper will help the student to apply these concepts in their future research and innovation.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Structure and Function of Biological Membranes	10 hours

Structure and function of biological membranes: Membrane models, Composition and dynamics of membranes; Glyco conjugates and types of proteins in membrane systems. Membrane transport: Transport of ions and macromolecules; Transporters; Active and passive transport. Pumps; Classes of pumps - Sodium- Potassium pump, Neurotransmission. Calcium pump, Proton pump. Endo and Exocytosis. Channels gated and non-gated channels; Cellular junctions and adhesion; Cell Adhesion molecules; Cadherin, Selectin, Integrin molecules-based cell adhesions. Extra cellular matrix.

Unit:2	Molecular Structure and Functions of Organelle; Cytoskeleton and Cellular Motility	10 hours

Mitochondria: structure, origin and evolution, organization of respiratory chain complexes, Mitochondrial Genome. Structure-functional relationship; Structure and function of peroxisome; Structure and function of microbodies, Golgi apparatus, lysosomes and Endoplasmic reticulum; Overview of cellular cytoskeleton: Organization and role of microtubules and microfilaments; Intermediate filaments; Cellular motility; Molecular motors. Nucleus: structure and function of nuclear envelope, lamina and nucleolus; Chromatin organization and packaging.

Unit:3	**Organization and Functions of DNA; Cell cycle Regulation and Cell Signalling**	**10 hours**

Central dogma, DNA as genetic material; Organization of bacterial genome; Structure of eukaryotic chromosomes: DNA compaction, nucleosome, 10nm "beads-on-a-string" fibre, 30nm chromatin fibre and metaphase chromosome; Nuclear matrix in chromosome organization and function; Heterochromatin and Euchromatin; DNA melting and buoyant density; Tm; DNA reassociation kinetics (Cot curve analysis); Genetic code in mitochondria; Degeneracy of codons; Termination codons; Wobble hypothesis. DNA Replication: initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins and mechanisms; Fidelity; Replication of single-stranded circular DNA. Cell cycle and Cell cycle control mechanisms. Cell signalling – types of cell signalling - G protein mediated, Tyrosine kinase mediated signalling. MAP Kinases mediated cell signalling.

Unit:4	**Transcription, RNA processing and Regulation in Prokaryote**	**10 hours**

Structure and function of prokaryotic mRNA, tRNA (including initiator tRNA) and rRNA (and ribosomes); Prokaryotic Transcription -RNA polymerase and sigma factors, Transcription unit, Promoters, Promoter recognition, Initiation, Elongation and Termination (intrinsic, Rho and Mfd dependent); Processing of mRNA, rRNA and tRNA transcripts; Translation in prokaryotes. Gene regulation: Repressors, activators, positive and negative regulation, Constitutive and Inducible, small molecule regulators, operon concept: *lac*, *trp*, *his* operons.

Unit:5	**Transcription, RNA processing and Regulation in Eukaryotes**	**10 hours**

Structure and function of eukaryotic mRNA, tRNA (including initiator tRNA) and rRNA (and ribosomes). Eukaryotic transcription - RNA polymerase I, II and III mediated transcription: RNA polymerase enzymes, eukaryotic promoters and enhancers, General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAFs); assembly of pre-initiation complex for nuclear enzymes, interaction of transcription factors with the basal transcription machinery and with other regulatory proteins, mediator; Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing of RNAs and polyadenylation, Splicing of tRNA and hnRNA; snRNPs and snoRNPs in RNA processing; Regulation of RNA processing: capping, splicing, polyadenylation; RNA editing, mRNA stability and degradation: degradation and surveillance pathways.

Families of DNA-binding transcription factors: Helix-turn-helix, helix-loop-helix, homeodomain; 2C 2H zinc finger, multi cysteine zinc finger, basic DNA binding domains: Leucine zipper. Translational machinery; Mechanism of Translation: Protein synthesis in eukaryotes; Co- and Post-translational modifications of proteins.

Self-study: Types of Cancer: Benign Tumors vs Malignant Tumors. Hall marks of cancers. Common Symptoms, tumor suppressor and oncogenes. Cancer markers. Causes of Cancer: Chemical Carcinogenesis; Irradiation Carcinogenesis. Aging and Cancer.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**

Text Book(s)

1	Darnell J (1990). Molecular Cell Biology. Scientific American Books Inc, 2nd edition.
2	Lodish H et al. (2021). Molecular Cell Biology. Macmillan Publishers, 9th edition.
3	Karp G, Iwasa J and Marshall W (2021). Karp's Cell and Molecular Biology. Wiley, 9th edition.
4	Sadava DE (2009). Cell Biology: Organelle Structure and Function. CBS Publishers & Distributors.

Reference Books

1	Beck G and Wolfe SL (1995). Molecular and Cellular Biology. The Quarterly Review of Biology.
2	Brown TA (1991). Molecular Biology Labfax. Oxford, UK: BIOS Scientific Publishers.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Swayam- Molecular biology course by Dr. Nayan K. Jain, Gujarat University
2	Swayam- Cell Biology by Dr. K. Sanatombi
3	NPTEL - Molecular Cell Biology by Prof. D. Karunagaran

Course Designed By: **Dr. S. Girija, Associate Professor, Dept. of Biotechnology**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	S	S	S
CO2	M	S	S	S	S
CO3	S	S	S	S	S
CO4	M	S	S	S	S
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBC03	MICROBIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 3	4	✓	-	4
Pre-requisite		Basic Knowledge of Microorganisms	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on Microbial diversity and Molecular taxonomy of bacteria, fungi and viruses.
2. Introduce the concept polyphasic taxonomy which eventually lead to report a novel organism.
3. Enlighten on culture-independent techniques and anaerobic cultivation.
4. Obtain overall holistic knowledge on Agricultural, Food, Medical Microbiology with introduction to Molecular Diagnostics.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Learn the importance of microbiology at basic level with laboratory level understanding.	K1, K2
CO2	Get introduced to terms related to Polyphasic taxonomy and apply them while describing a new species.	K3, K6
CO3	Obtain knowledge on NGS and culture-independent techniques; Understand on cultivation of Anaerobic organisms.	K3, K4
CO4	Critically think on the role of Soil, Agriculture and Food Microbiology.	K1, K2, K3
CO5	Medical Microbiology: Apply the knowledge towards Molecular Diagnostics.	K1, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Microbial Diversity	10 hours

Concepts of species and hierarchical taxa – Bacterial nomenclature – Bergey's system of classification – Classification of Fungi and Viruses; Cultivation of bacteria, fungi, virus - Pure culture – Polyphasic taxonomy – Preservation and maintenance of microbes: Microbial Culture Collection centres – India and International organizations.

Unit:2	Molecular Taxonomy	10 hours

Microbial Identification through physiological and biochemical methods (BIOLOG, Vitex), MALDI TOF. Polyphasic approach – 16S rRNA gene sequencing, Phylogenetic grouping. Techniques used in taxonomy: Mol % G+C analysis, DNA-DNA hybridization, Fatty Acid Methyl Ester (FAME) analysis, peptidoglycan, isoprenoid, quinines.

Unit:3	Metagenomics and Anaerobic Microbiology	10 hours
Metagenomics: definition, principles, methods; Cloning for functional metagenomics: Construction of small insert and large insert metagenomic libraries. NGS technologies: 16S metagenomics. Culturing Techniques for Anaerobes: Roll tube method, Culture conditions in Anaerobic jar, Glove box.		
Unit:4	**Food and Agricultural Microbiology**	**10 hours**
Spoilage of food – Principles and types: Fresh fruits, vegetables and processed foods – Food preservation: physical and chemical- Food sanitation – Indication of food safety- Food poisoning – Food borne pathogens – Quality control and Food laws. Microorganisms in soil processes – role of microorganisms in soil fertility – carbon cycle – nitrogen cycle: Biological nitrogen fixation, microbial transformation of Phosphorus – Plant microbe interaction: Biopesticides (*B. thuringiensis* and NPV) - Biofertilizers - PGPR - mycorrhiza.		
Unit:5	**Medical Microbiology**	**10 hours**
Host-parasite relationship, epidemiology, pathogenesis, prevention and treatment. **Bacterial Diseases:** *Staphylococcus, Streptococcus, Mycobacterium, Salmonella* and *Yersinia*. **Viral Diseases:** Epidemiology, pathogenesis, prevention and Treatment - H1N1, Polio, Rabies, AIDS. **Fungal Diseases:** Infections caused by yeast (Candida), Filamentous Fungi: *Aspergillus sp*. **Protozoan and Helminth Diseases:** Malaria and Leishmaniasis; Ascariasis and Filariasis.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, Assignments, Student Seminar and Webinars		
	Total Lecture hours	**52 hours**

Text Book

1	Prescott LM (2008). Microbiology. McGraw-Hill Higher Education,7th edition.
2	Ogunseitan OA (2005). Microbial Diversity - Form and Function in Prokaryotes, Blackwell Publishing.
3	Streit WR and Daniel R (2010). Metagenomics: Methods and Protocols, Humana Press.
4	Osborn AM and Smith CJ (2005). Molecular Microbial Ecology, BIOS scientific Publishers.
5	Tate RL (1995). Soil Microbiology. John Wiley & Sons, New York
6	Subbarao NS (2006). Soil Microbiology. Oxford & IBH, New Delhi, 4th edition.
7	Paul EA (2007). Soil Microbiology, Ecology and Biochemistry, Academic Press, Oxford, UK, 3rd edition.
8	Gillespie SH and Bamford KB (2012). Medical Microbiology and Infection at a Glance, Wiley-Blackwell, 4th edition.

9	Levett PN (1992). Anaerobic Microbiology: A Practical Approach, IRL Press at Oxford University Press.
Reference Books	
1	Bergey's Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins.
2	Stackebrandt E (2006). Molecular identification, systematics, and population structure of prokaryotes, Springer-Verlag Berlin Heidelberg.
3	Madigan MT, Martinko JM, Stahl DA and Clark DP (2012). Brock's Biology of Microorganisms, Benjamin Cummings, San Francisco, CA, 13th edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1 2	https://nptel.ac.in/courses/102/103/102103015/(Microbiology) https://nptel.ac.in/courses/105/107/105107173/ (Applied and Environmental Microbiology)
Course Designed By: **Dr. S. R. Prabagaran, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	L	S	L	S
CO2	S	L	M	L	S
CO3	S	S	M	L	M
CO4	S	M	L	L	S
CO5	S	M	L	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBC04	GENETICS	L	T	P	C
Core/Elective/Supportive		Core Paper - 4	4	✓	-	4
Pre-requisite		Basic Knowledge and Principles in Genetics	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. The course offers basic knowledge of genetics encompassing prokaryotic/phage genetics, and higher eukaryotic domains and over all concepts of Mendelian genetics.
2. It makes the students understand the relationship between phenotype and genotype in human genetic traits.
3. It also imparts knowledge of basics of human genetics and disease gene mapping.
4. Students gain knowledge of the various techniques on cytogenetics, Epigenetics.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Students will gain knowledge about the genetics of prokaryotic and phage genetics.	K1, K2
CO2	Gain knowledge on Mendelian and Non-Mendelian genetics.	K1, K2
CO3	The students will understand the inheritance of genes and the diseases in the Human.	K2, K3, K5
CO4	The students learn various techniques related to cytogenetics and molecular and immunogenetics for disease diagnosis.	K2, K3
CO5	Students understand the concept of genetic variation, epigenetics and Transgenerational epigenetics.	K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Genetics of Bacteria and Bacteriophage	10 hours

Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of a gene; Restriction modification systems – history, types of systems and their characteristics, applications of RM systems, methylation-dependent restriction enzymes, transposable elements – types, properties and applications.

Unit:2	Principles of Mendelian and Non-Mendelian Genetics	10 hours

Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid, trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Approaches to analysis of complex traits- 'Nature nurture' concept, role of Family and shared environment, monozygotic and dizygotic twins and adoption studies, Multiple alleles; Sex determination; Polygenic inheritance. Extra nuclear inheritance; Linkage and crossing over. Chromosomal anomalies: variation

in chromosome number: Euploidy & aneuploidy. Variation in chromosome structure: deletion, duplication, translocation, inversion and B-chromosome.		
Unit:3	**Human Genetics**	**10 hours**
History of human genetics, Monogenic traits, Autosomal inheritance-dominant, recessive Sex-linked inheritance, Sex-limited and sex-influenced traits, Mitochondrial inheritance, OMIM number, Complications to the basic pedigree patterns- non-penetrance, variable, expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X- inactivation; Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.		
Unit:4	**Cytogenetics and Molecular genetics**	**10 hours**
Pedigree analysis: pedigree symbols, construction of pedigrees, Cytogenetics: Techniques in human chromosome analysis, Human karyotype: banding, nomenclature of banding, Pathology of human chromosomes, Nomenclature of aberrant karyotypes, Common syndromes due to numerical chromosome changes, Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletion, fragile sites) Common chromosome abnormalities in cancer, Genetics of fetal wastage Disorders of sex chromosomes and autosomes; Molecular cytogenetics– Fluorescence In situ Hybridization (FISH); Comparative Genomic Hybridization (CGH).		
Unit:5	**Mutagenesis and Epigenetics**	**10 hours**
Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism; The epigenome, epigenetic modifications: DNA methylation, histone modification, chromatin remodelling and non-coding RNAs; cellular maintenance of the epigenome; epigenetic control of gene expression, and epigenetics and development. Transgenerational epigenetic inheritance.		
Unit:6	**Contemporary Issues**	**2 hours**
Guest lectures by academic/industry experts, online seminars - webinars		
	Total Lecture hours	**52 hours**
Text Book(s)		
1	Pierce BA (2012). Genetics: a conceptual approach. Macmillan, 5th Edition.	
2	Hartwell L, Goldberg ML, Fischer JA, Hood LE and Aquadro CF (2018). Genetics: from genes to genomes (p. 960). New York, NY, USA: McGraw-Hill Education, 6th edition.	
Reference Book(s)		
1	Klug WS, Cummings MR., Spencer CA and Palladino MA (2015). Essentials of Genetics. Pearson, 12th edition.	
2	Snustad DP and Simmons MJ (2015). Principles of Genetics. John Wiley & Sons, 7th edition.	

3	Hartl DL, and Jones EW (2009). Genetics: analysis of genes and genomes. Jones & Bartlett Learning, 4th edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.classcentral.com/course/swayam-genetics-and-genomics-17623
2	https://nptel.ac.in/courses/102/104/102104052/
3	https://www.coursera.org/learn/genetics-evolution
Course Designed By: **Dr. V. Thirunavukkarasu, Associate Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	M	M
CO2	S	S	L	M	M
CO3	S	S	M	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGE01A	BIODIVERSITY AND BIOPROSPECTING	L	T	P	C
Core/Elective/Supportive		Elective - 1	4	✓	-	4
Pre-requisite		Basic Knowledge in Bioresources	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide students with comprehensive knowledge of biodiversity, conservation strategies, and the principles and applications of bioprospecting.
2. Develop scientific understanding of bioactive natural products from plants and microorganisms, including their extraction, screening, and characterization using modern analytical techniques.
3. Enable students to understand the role of bioprospecting in drug discovery, product development, commercialization, biosafety, regulatory policies, and intellectual property rights.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the concepts of biodiversity, conservation strategies, bioprospecting, and access and benefit-sharing associated with biological resources.	K1, K2
CO2	Demonstrate knowledge of extraction methods for plant and microbial bioresources and select appropriate techniques for isolation of natural products.	K2, K3, K6
CO3	Analyze modern analytical techniques used for screening, identification, and characterization of bioactive compounds from biological resources.	K2, K3, K4
CO4	Evaluate the applications of plant- and microbial-derived bioactive compounds in drug discovery, agriculture, healthcare, and industrial biotechnology.	K3, K4, K5
CO5	Assess biosafety, toxicity, regulatory frameworks, intellectual property rights, and commercialization strategies related to bioprospected products.	K2, K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Biodiversity	10 hours

Biodiversity: Introduction - Terms and Definitions; Threats to Biodiversity - Endangered species; Conservation strategy - In situ and Ex situ, Biosphere reserves of India and the world (terrestrial and marine), Indian case studies on conservation/management strategy (eg. Project Tiger), Bioresources mapping, inventorisation, and monitoring of biological diversity, The convention on biological diversity, access and benefit sharing. Bioprospecting: Introduction, Major area of Bioprospecting - Chemical prospecting, Bionic prospecting, and Gene prospecting, the INBio experiences and contracts for bioprospecting.

Unit:2	Extraction from Bioresources	10 hours

Methods for preparation of plant extracts: Types of herbal extracts, principles of extraction and selection of suitable extraction method. Different methods of extraction - infusion, decoction, digestion, maceration, percolation, successive solvent extraction, Soxhlet extraction, steam distillation, microwave assisted extraction, headspace techniques, sepbox, hot continuous extraction, pilot scale extraction with example. Methods for preparation of microbial extracts.

Unit:3	Screening of Bioactive Compounds	10 hours
Bioactive compounds discovery: Discovery from traditional bioresources. Modern tools for Bioactive compounds screening. Ultraviolet-visible spectrometry, Fourier-Transform Infrared Spectroscopy (FTIR), High-Performance Liquid Chromatography (HPLC), High-Performance Thin-Layer Chromatography (HPTLC), Gas Chromatography Mass Spectrometry (GC-MS), Liquid Chromatography Mass Spectrometry (LC-MS), Super critical fluid chromatography, X-ray diffraction (XRD), Near-Infrared Spectroscopy (NIR), Nuclear Magnetic Resonance spectroscopy (NMR). Case studies explaining about screening of bioactive compounds using advanced instruments.		

Unit:4	Bioprospecting of Microbial and Plant bioactive compounds	10 hours
Bioactive compounds of Microbial origin: Antimicrobials, pharmacologically active agents of microbial origin, bioprospecting for industrial enzymes, plant growth-promoting agents, bioprospecting novel antifoulants and anti-biofilm agents from microbes, bioprospecting of marine organisms. Bioactive compounds of Plant origin: Antitumor agent - Colchicine, Vinblastine; Cardiotonic - Acetyldigoxin, Adoniside; Anti-inflammatory - Aescin, Bromelain; Choleretic - Curcumin; Antimalarial - Quinine from Cinchona; Plant analgesic Morphine, Opium; Laxatives, Volatiles, Pigments, Terpenes, Phenols, and Flavonoids.		

Unit:5	Safety-Regulations and Bioprospecting-derived products	10 hours
Safety, Toxicity, and regulations: Factors affecting the safety of bioprospecting-derived products, Adverse reactions of novel bioactive compounds, toxicity testing and detoxifying methods; Policies and regulations, TKDL. Extracts used in commercial natural products: syrup (Stevia, Maple), cosmetics (Hibiscus, Saffron), creams (Aloe Vera, Turmeric), lotions (Vanilla, Coconut), dentifrice (Clove, Neem), immunity boosters (Papaya, Amla), oil (Olive, Canola), colours (Carrot, Mulberry), perfumes (Sandal wood, Javadhu) and preservatives (Rosemary, Garlic).		

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		

	Total Lecture hours	52 hours

Text Book(s)

1	Paterson R and Lima N (2017). Bioprospecting: success, potential and constraints. Cham, Switzerland: Springer, Springer e Books.
2	Krishnamurthy KV (2018). An advanced text book on biodiversity: principles and practices, Oxford & IBH Publishing Co Pvt. Ltd, ISBN-10: 9788120416062.
3	Akhtar MS and Swamy MK (2018). Anti-cancer plants: natural products and biotechnological implements, Volume 2, ISBN978-981-10-8064-7.
4	Mandal S, Mandal V and Konishi T (2018). Natural products and drug discovery integrated approach, Elsevier publisher.pp.1632, ISBN:9780081021040.
5	Nudupa and Bhat K (2015). A concise textbook of drug regulatory affairs, Manipal university press.

6	Chawla HS (2021). Introduction to intellectual property rights, Oxford IBH publishing, 312. ISBN-13: 978-8120417977
Reference Books	
1	Seidel V (2020). Plant-derived chemicals a source of inspiration for new drugs, MDPI Plants.9(11).
2	Koparde AA, Doijad RC and Magdum CS (2019). Natural products in drug discovery. open access peer review chapter.
3	Maghebe R, Damian D, Makaranga A, Nyandoro SS, Lyantagaye S and Hatti-Kaul R (2021). Omics for bioprospecting and drug discovery from bacteria and microalgae, MDPI Antibiotics.9(5),229.
4	Atnasov AG, Zotchev SB and Dirsch VM (2020). Natural products in drug discovery advances and opportunities, nature review drug discovery, 20, 200-216.
5	Balkwill R and Monica (2007). Managing Intellectual Property in the Book Publishing Industry A business-oriented information booklet Creative industries – Booklet No. 1. ISBN-13: 978-9280516449.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.wipo.int/edocs/pubdocs/en/copyright/868/wipo_pub_868.pdf
2	https://www.slideshare.net/bharathirathinam/bioprospecting
3	https://www.slideserve.com/hue/drugs-from-plants
4	https://www.slideshare.net/Thavasimuthucitarasu/bioprospecting-72326014
5	https://www.slideshare.net/mrudangpharma/new-drug-discovry-from-natural-products
6	https://www.slideshare.net/pscad123/quality-regulation-for-biological-products-current-and-future-6760194
Course Designed By: **Dr. M. Arun, Assistant Professor, Department of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	S	M
CO2	S	S	M	L	M
CO3	S	S	S	L	M
CO4	S	S	M	M	M
CO5	M	M	M	S	M

*S-Strong; M-Medium; L-Low

Course code	26BIOGE01B	BIOINSTRUMENTATION	L	T	P	C
Core/Elective/Supportive		Elective -1	4	✓	-	4
Pre-requisite		Basic Knowledge on Bioinstrumentation	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Develop a strong foundation in the physical and chemical principles underlying biochemical processes.
2. Acquire knowledge of electromagnetic radiation and spectroscopic techniques for biomolecular analysis.
3. Gain expertise in hydrodynamic methods, radioisotopic techniques, and their applications in biochemical research.
4. Understand and apply advanced separation, identification, and molecular biology techniques.
5. Operate and evaluate modern microscopic, spectroscopic, and analytical instruments for biotechnology research.
6. Cultivate the ability to innovate and design advanced instruments for cutting-edge applications in chemical and molecular biology.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Integrate principles of physical chemistry and biochemistry to understand biochemical processes at the molecular level.	K1, K2, K4
CO2	Analyze electromagnetic radiation and apply spectroscopic techniques (UV-Vis, IR, NMR, ESR, fluorescence) to study biomolecules.	K2, K4, K6
CO3	Demonstrate proficiency in hydrodynamic methods (centrifugation, sedimentation) and radioisotopic techniques for biochemical fractionation and reaction studies.	K2, K4, K6
CO4	Apply and evaluate separation and identification techniques (electrophoresis, chromatography, crystallography, PCR, blotting, biosensors) in molecular biology and chemical biology.	K2, K3, K4, K6
CO5	Operate advanced microscopic and spectroscopic devices (optical tweezers, confocal microscopy, mass spectrometry) and design innovative instruments for biotechnology research.	K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Fundamentals of Solution Chemistry	10 hours

Units of measurement of solutes in solution: normality, molality, molarity, percentage solutions and parts-per units; water - structure and properties; complications of pH measurement - dependence of pH on ionic strength, relationship between pH and pOH, Henderson–Hasselbalch equation; buffer preparation; types of pH electrodes; principles of glass and reference electrodes; basic thermodynamics; theories of chemical reactions.

Unit:2	Basic Principles of Electromagnetic Radiation and Related Spectroscopic Techniques	10 hours

Electromagnetic Radiation: Energy, wavelength, wavenumber and frequency; absorption and emission spectra, Beer-Lambert's law; Biochemical applications of fluorescence, emission, Fluorescence life-times, Anisotropy, time-resolved fluorescence methods and their applications.

Spectrophotometry: Basic principles, instrumentation of UV and visible spectrophotometry, their application on enzyme and kinetic assays. Protein structural studies: Basic principles, instrumentation, and applications of IR spectroscopy and fluorimetry, ESR, NMR; IR-Raman Spectroscopic applications in biology.

Unit:3	Hydrodynamic Methods, Radioactivity and Radioisotopic Techniques	10 hours

Hydrodynamic Methods: Basic principles and types of centrifugation-rotors, boundary, differential, density gradient, zonal isopycnic centrifugation, equilibrium; Sedimentation - sedimentation velocity, preparative and analytical ultracentrifugation techniques: principles and applications in biochemical fractionation methods.

Radio isotopic Techniques: Radioactivity, stable and radioactive isotopes, concepts of half-life and decay, principles of scintillation counting, GM counters, applications of isotopes, Application of radioactive isotopes in biochemical reaction mechanisms.

Unit:4	Electrophoresis, Chromatography, X-Ray Crystallography, Molecular and Chemical Biology	10 hours

Electrophoresis: Principles of electrophoretic separation, zonal and continuous electrophoresis, paper, cellulose acetate/nitrate, gel and capillary electrophoresis, use of native and denaturating gels, Protein subunit molecular weight determination using SDS-PAGE, Anomalous protein migration of some proteins in SDS-PAGE, Acid-urea PAGE and their physical basis, Isoelectric focusing and two dimensional gel electrophoresis, electroporation, pulse field gel electrophoresis, gradient gels.

Chromatography: principles of adsorption, partition and ion-exchange chromatography, gel permeation chromatography, GC, GC-MS and HPLC; X-ray Crystallography-protein crystals, Bragg's law, Principles & applications; Basic protein structure prediction methods.

Nucleic acid amplification and analysis: PCR types; DNA sequencers; Molecular hybridization: Southern blot; Northern blot. **Protein analyses:** Western blot and Immunoprecipitation; **Cytophotometry**: Flow Cytometry, FACS, MACS and Single-cell microarray.

Circular dichroism and optical rotatory dispersion, Rewriting DNA: mutations; random mutagenesis; point mutation; Site-specific mutations;
Click-chemistry, Principles & applications; Biosensors. Chemical sensors for in-cell biochemistry**.**

Unit:5	Single-molecule measurements, Optical Microscopy Methods, and Mass Spectroscopy	10 hours

Single-molecule measurements: Atomic Force microscopy, surface-enhanced Raman scattering, Near-field Microscopy- Principles and applications. Force measurements at single molecule to cell level using optical tweezers- Principles and applications.

Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy; Confocal microscope: confocal principle, resolution and point spread function; nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three dimensional reconstruction; Total Internal reflection microscopy, STED microscopy.

Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	52 hours

Text Book(s)

1	Skoog DA, Holler FJ and Crouch SR (2017). Principles of instrumental analysis, Cengage Learning, 7th edition.
2	Wilson K and Walker J (2018). Principles and techniques of biochemistry and molecular biology, Cambridge University Press, 7th edition.
3	Skoog DA, West DM, Holler FJ and Crouch SR (2014). Fundamentals of analytical chemistry, Cengage Learning, 10th edition.
4	Campbell I (2012). Biophysical techniques. Oxford University Press.
5	Lakowicz JR (2006). Principles of fluorescence spectroscopy, Springer, 3rd edition.
6	Green MR and Sambrook J (2012). Molecular cloning: A laboratory manual, Cold Spring Harbor Laboratory Press, 4th edition.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://onlinecourses.swayam2.ac.in/ugc19_bt16/preview
2	https://nptel.ac.in/courses/102103044

Course Designed By: **Dr. M. A. Shibu, Assistant Professor (DBT-RRF), Dept. of Biotechnology**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	S	S	L	M
CO3	S	S	M	M	M
CO4	S	S	S	L	M
CO5	S	S	M	L	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBCP1	BASIC BIOTECHNOLOGY	L	T	P	C
Practical	Practical - 1		6	-	✓	4
Pre-requisite	Basic Skills in Biotechnology		Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide hands-on training in fundamental laboratory techniques and experimental procedures used in biotechnology.
2. Develop practical skills in microbiology, plant biotechnology, molecular biology, biochemistry, cell biology, immunology, and protein analysis using standard laboratory protocols.
3. Enable students to perform, analyze, interpret, and troubleshoot experimental data while following laboratory safety and good laboratory practices.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Isolate, cultivate, identify, and characterize microorganisms from environmental samples using standard microbiological techniques and determine microbial diversity.	K2, K3, K4, K5
CO2	Perform cell culture, cytological, and immunological techniques including PBMC isolation, lymphocyte culture, chromosome visualization, and haematological analysis.	K1, K2, K3, K4
CO3	Extract, quantify, separate, and characterize nucleic acids and proteins using molecular and biochemical techniques such as CTAB DNA isolation, SDS-PAGE, Western blotting, and spectrophotometric assays.	K2, K3, K4, K5
CO4	Perform plant biotechnology experiments including gene transfer, micropropagation, physiological assays, antioxidant estimation, and biochemical analysis to interpret plant responses.	K2, K3, K4, K5
CO5	Design, perform, interpret, and document biotechnology experiments by integrating appropriate laboratory techniques, safety practices, and analytical skills.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Molecular Toxicology (Dr. P. Ekambaram)	**9 hours**

1. Measurement of cell size by oculometer and stage micrometer.
2. Haematology: RBC and WBC total counts, and leucocyte differential count.
3. Methylation specific PCR (MSP) analysis of cytokine gene promoters in zebrafish.

Plant Genetic Engineering (Dr. R. Sathishkumar)	**9 hours**

1. Particle gene gun mediated gene delivery of GFP in tobacco (Demo).
2. Transient expression of Green Fluorescence Protein (GFP) in tobacco by agroinfiltration and visualization using fluorescent microscope.
3. Plant genomic DNA extraction by CTAB method and quantification.

Molecular Microbiology (Dr. S. R. Prabagaran)	**9 hours**

1. Cultivation of Bacteria, Actinomycetes, and Fungi from soil samples.
2. Bacterial staining (Gram Staining) and biochemical characterization (Citrate utilization).
3. Isolation of anaerobic microorganisms from different environmental sources.

Plant Biotechnology (Dr. S. Girija)	**9 hours**

1. Determination of free radical scavenging activity by DPPH assay.
2. Micropropagation and callus induction in radish (*Raphanus sativus* L.).
3. Measurement of stomatal index using the bright field microscope.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**

1. Extraction and estimation of total protein content from chicken liver sample using Lowry's method.
2. Determination of molecular weight of a given protein using SDS-PAGE.
3. Estimation of cellular expression of a specific protein by Western blotting with enhanced chemiluminescence (ECL) detection method.

Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)	**9 hours**

1. Estimation of Blood glucose by GOD-POD method.
2. Determination of SGOT and SGPT levels in serum.
3. Titration of amino acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.

Plant Molecular Biology (Dr. M. Arun)	**9 hours**

1. Seed priming in plants and assessment on morphological attributes.
2. Extraction and quantification of total chlorophyll.
3. Quantification of proline content in plants.

Regenerative Engineering and Molecular Medicine (Dr. M. A. Shibu)	**9 hours**

1. Isolation of peripheral blood mononuclear cells and lymphocyte culture.
2. Giemsa staining technique for visualization of metaphase chromosomes.
3. Detection of protease activity by gelatin zymography.

Total Practical hours	**72 hours**

Text Book(s)

1	Benson HJ (2002) Microbiological Applications. McGrawHill Publications.
2	Kan wang (2015). *Agrobacterium* protocols. Methods in Molecular biology, springer protocols, 2(3): 372.
3	Esposito DLA and Fonseca BAL (2017) Sensitivity and detection of chikungunya viral genetic material using several PCR-based approaches, Rev. Soc. Bras. Med. Trop. vol.50.
4	Verma SK, Singh H and Sharma PC (2017) An improved method suitable for isolation of high-quality metagenomics DNA from diversesoils.3 biotech,7(3):17.

Reference Books

1	http://rapidmicromethods.com/files/tutorial.php
2	https://www.goldbio.com/documents/1018/AgrobacteriumTumefaciensmediated%20Transformation%20(AtMtT)%20of%20Colletotrichum%20graminicola%20Protocol.pdf
3	https://doi.org/10.1016/j.mex.2017.03.002
4	https://www.springer.com/gp/book/9783642491443
5	https://currentprotocols.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)2379-8068.Metabolites
Course Designed by: **All Faculty**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	M	M	M
CO2	S	S	M	S	M
CO3	S	S	M	M	M
CO4	S	S	M	M	M
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGS01	TOOLS IN BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Supportive - 1	2	✓	-	2
Pre-requisite		Basic Knowledge in Biology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Introduce the fundamental concepts of genes, genomes, recombinant DNA technology, and gene cloning tools.
2. Develop an understanding of the principles, techniques, and strategies used in gene manipulation, transformation, and screening of recombinant organisms.
3. Provide knowledge of the applications of recombinant DNA technology and emerging biotechnology tools in medicine, agriculture, and industry, along with their biosafety considerations.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the fundamental concepts of genes, genomes, and the molecular basis of genetic information in living organisms.	K1, K2
CO2	Describe the principles and functions of cloning vectors, restriction enzymes, DNA-modifying enzymes, and recombinant DNA technology used in gene manipulation.	K2, K3
CO3	Apply appropriate gene manipulation tools and analyze transformation techniques, PCR, and electrophoretic methods used in recombinant DNA experiments.	K2, K3, K4
CO4	Evaluate and design suitable strategies for the selection and screening of recombinant transformants using molecular techniques.	K3, K5, K6
CO5	Assess the applications of recombinant DNA technology in healthcare, agriculture, and industry, considering biosafety and societal implications.	K2, K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Gene and Genomes	5 hours

Gene and genomes: Prokaryotic and eukaryotic genomes - structure and form. DNA as the genetic material. Extra chromosomal DNA - plasmid, mitochondrial DNA. Central dogma – DNA-RNA-Protein.

Unit:2	Cloning Vectors and rDNA Technology	5 hours

Tools for gene manipulation: Restriction enzymes, DNA ligases, DNA modifying enzymes - alkaline phosphatase, polynucleotide kinase, and terminal transferase. Cloning vectors: Plasmid, phagemid, cosmid, artificial chromosomes - BAC.

Unit:3	**Tools for Gene Manipulation**	**5 hours**
rDNA technology-overview. Transformation techniques - $CaCl_2$ transformation technique and electroporation. PCR. Gel Electrophoresis - AGE and PAGE.		
Unit:4	**Selection Strategy and Screening of Transformants**	**5 hours**
Selection strategy and screening of transformants: Selection of rDNA clones - Blue-White selection, Markers for selection - selectable and scorable - examples. Colony hybridization, western blotting, Southern blotting, and northern blotting.		
Unit:5	**Application of rDNA Tools**	**4 hours**
Application of rDNA Tools: Cloning of insulin gene in bacteria, gene therapy, GMO -application and biosafety issues.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**26 hours**

Text Book(s)	
1	Primrose SB and Twyman RM (2014). Principles of Gene Manipulation and Genomics, Blackwell Science Limited, 7th edition.
2	Primrose SB (1994). Molecular Biotechnology, Blackwell Scientific Publishers, Oxford.
3	Alberts B, Johnson AD, Lewis J and Morgan D (2014). Molecular Biology of the Cell, Garland Science, 7th edition.
4	Brown TA (2006). Genomes, New York: Garland Science Pub. 3rd edition.
5	Old RW, Primrose SB and Twyman RM (2001). Principles of Gene Manipulation: An Introduction to Genetic Engineering, Oxford: Blackwell Scientific Publications.
Reference Books	
1	Micklossnd DA, Freyar GA (1990). DNA Science – A first course in rDNA technology, Cold Spring Harbor laboratory Press, New York.
2	Glick BJ, Pasternak JJ and Patten CL (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA.
3	Das HK (2004). Textbook of Biotechnology, Wiley India, 4th edition.
4	Brown TA (2016). Gene Cloning and DNA Analysis. An Introduction, Blackwell Scientific Publications, 7th edition.
5	Theiman WJ and Palladino MA (2014). Introduction to Biotechnology, 3rd edition.
6	Cooper GM and Hausman RE (2013). The Cell: A Molecular Approach. Washington: ASM; Sunderland. 6th edition.

7	Green MR and Sambrook J (2012). Molecular Cloning: A Laboratory Manual, Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	epgp.inflibnet.ac.in
2	https://nptel.ac.in/courses/102/103/102103013/
3	https://www.ncbi.nlm.nih.gov/books/NBK21498/
4	https://www.genome.gov/genetics-glossary/Electrophoresis
5	https://genome.crg.cat/courses/laCaixa05/Genomes/index.html
6	https://onlinecourses.swayam2.ac.in/cec20_bt07
Course Designed By: **Dr. M. Arun, Assistant Professor, Department of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	M	L	L	M
CO3	S	S	M	L	M
CO4	S	S	M	M	M
CO5	M	S	M	S	M

*S-Strong; M-Medium; L-Low

Course code	26BIOBCV1	Soft Skills and Business Communication Skills for Employability Training	L	T	P	C
Core/Elective/Supportive		Value Added Course - 1	2	✓	✓	2
Pre-requisite		Basic Knowledge about Communication and Personality Development	Syllabus Version		2026-27	

SOFT SKILLS AND BUSINESS COMMUNICATION SKILLS FOR EMPLOYABILITY	
Name of the Department	**Biotechnology**
Name and Address of the Faculty Member	Dr. S. Girija Associate Professor Department of Biotechnology Bharathiar University
Inter / Intra Department Course	Intra Department
Duration of the Course	26 Hours
Eligibility	PG students of Biotechnology
Number of Candidates to be Admitted	35 (maximum number)
Mode of the Course	In person
Collaboration if any with Companies (if Yes, Full Address of the Company Address, Name of the Contact Person, Phone, e-mail etc.)	**Er. C. K. Arivazhagan** C. K. Eduventures Pvt Limited Kalveerampalayam Coimbatore - 641046 Ph:9842685547 arivazhagank1@yahoo.co.in
Registration Procedure	NA

Job Opportunities: Research Laboratories, Pharmaceutical Companies, Knowledge Process Outsourcing Companies, Analytical Lab Equipment Service Companies

The objectives of the Course are:

The main objectives of this course are to:

1	Develop students' interpersonal, communication and professional skills required for enhanced employability.
2	Strengthen leadership, teamwork, decision-making, and business etiquette through experiential and activity-based learning.
3	Build self-confidence, presentation, interview, and time management skills for successful professional and career development.

Course Content	Lecture / Practical / Project / Internship

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the significance of self-awareness, positive attitude, teamwork, and professional behaviour for personal and career development.	K2, K3
CO2	Apply leadership, decision-making, business etiquette, and effective communication skills in academic and professional environments.	K3, K4
CO3	Demonstrate confidence, public speaking, group discussion, and interpersonal communication skills for effective professional interaction.	K3, K4
CO4	Analyze interview situations and employ appropriate communication, presentation, and time management strategies to improve employability.	K4, K5
CO5	Demonstrate professional competence through presentations, mock interviews, teamwork, and collaborative activities to achieve career readiness.	K3, K4, K5
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create		
Course content:		
Unit 1	**Self-Analysis and Attitude-** Exploring the importance of Self and Hidden qualities, Effects of attitude in work environment. Team Work and Conflict Management, Qualities of a Team player, handling workplace conflicts**.**	**5 hours**
Unit 2	**Leadership and Decision Making and Business Etiquettes:** Qualities of a Leaders and the need for Leadership in Organisations. Decision making to enhance professional excellence. Business etiquettes mentors' participants on Workplace Behaviour and Healthy relations for Professional success.	**5 hours**
Unit 3	**Self Confidence and Self Esteem, Effective Business Communication:** Importance of Self Love and respecting self-leading to increased Self-confidence and making one a better communicator. Business Communication takes the participants through the need for Reading and Writing Skills to excel in Business and achieve organisational goals**.**	**6 hours**
Unit 4	**Public Speaking Skills, Group Discussion and Criteria to Stand out in GD's:** Overcoming fear of Public Speaking to become a good communicator/presenter. Group Discussions and their importance in Job selections.	**5 hours**
Unit 5	**Interview Skills and Time Management, Mock Interviews and Practice:** Getting ready for facing Interviews to Qualify for Job prospects. Importance of Time Management in Interviews.	**5 hours**
	Total	**26 Hours**
Book(s) for Study		
1	Student Work Book shall be provided	
Book(s) for reference		
1	Carnegie D (1936). How to Win Friends and Influence People, Simon and Schuster.	
Related Online Contents		
1	ALISON Courses	
2	Supportive topic-based videos shall be screened during the Training Session	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	L	S	M	M
CO2	M	S	S	M	M
CO3	L	M	S	M	S
CO4	M	S	S	M	M
CO5	M	S	S	M	S

*S-Strong; M-Medium; L-Low

SECOND SEMESTER

Course code	26BIOBC05	DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 5	4	✓	-	4
Pre-requisite		A Basic Knowledge in Developmental Biology and Physiology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. To learn the basic overview of developmental biology and its key concepts.
2. To enable the students to learn the actual pathway of physiological metabolism of major invertebrates and vertebrates including humans.
3. To understand the mechanism behind functioning and maintenance of various living system.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Learn the importance and key concepts of developmental biology.	K1, K2
CO2	Learn the process and the mechanisms of early embryonic development (fertilization, early cleavage, blastula, gastrula, neurula) in Vertebrates including frog, chicken and mouse and Invertebrates, *Drosophila melanogaster* and Sea Urchin.	K2, K3 K4
CO3	Identify the molecular pathways controlling axis formation (anterior-posterior, dorsal-ventral and left-right axes) in amphibians (frog), mammals (mouse, humans) and fly (Drosophila) including the signalling molecules and key gene regulators.	K3, K4
CO4	Understand how individual cellular and tissue components interact to maintain the body's internal balance (homeostasis) during stressors like environmental changes or disease and apply physiological principles to understand the pathogenesis of diseases.	K1, K2, K3, K4
CO5	Comprehend the mechanical, physical and biochemical functions of major organ systems, including the cardiovascular, respiratory, nervous, endocrine, renal and reproductive systems.	K2, K3, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Developmental Biology	10 hours

Defining developmental biology. Structure and function of reproductive system: Male reproductive system, Female reproductive system. Production of gametes: Spermatogenesis, Oogenesis. Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals. Early developmental events in vertebrates.

Unit:2	Basic Concepts of Development	10 hours

Overview of homeotic genes, axis formation in sea urchin, *C. elegans*, *D. melanogaster*, amphibians and mammals; formation of vulva in *C. elegans*; Embryonic fields, potency, commitment, specification,

induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Role of epigenetics in development. Postembryonic development: metamorphosis, regeneration and aging; Developmental constraints on evolution. Developmental defects and disorders. Introduction to AI/ML in developmental biology.		
Unit:3	**System Physiology: Digestion and Haematology**	**10 hours**
Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscles, hemopoiesis, plasma function, blood volume, hemostasis. Comparative anatomy of heart structure, myogenic heart, ECG- its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.		
Unit:4	**Respiration and Excretion**	**10 hours**
Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.		
Unit:5	**Nervous System**	**10 hours**
Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of muscle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; Thermoregulation. Role of AI in physiology.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**52 hours**
Text Books		
1	Barresi MJF and Gilbert SF (2023). Developmental Biology, Oxford University Press, 13th edition.	
2	Hall JE and Hall ME (2025). Guyton and Hall Text book of Medical Physiology, Elsevier, 15th edition.	
Reference Books		
1	Carlson BM (2023). Human Embryology and Developmental Biology, Elsevier, 7th edition.	
2	Tickle C, Arias AM, Placzek M and Wolpert L (2025). Wolpert's Principles of Development, Oxford University Press. 7th edition.	
3	Rastogi SC (2019). Essentials of Animal Physiology, New Age International Publications, 4th edition.	
4	Barrett KE, Barman SM, Brooks HL, Yuan J and Boitano S (2025). Ganong's Review of Medical Physiology, McGraw Hill Professional, 27th edition.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://nptel.ac.in/courses/102/106/102106084/	

2	https://onlinecourses.nptel.ac.in/noc20_bt35/preview
3	https://nptel.ac.in/courses/102/104/102104058/
4	Luo M, Yang W, Bai L, et al. (2024). Artificial intelligence for life sciences: A comprehensive guide and future trends. The Innovation Life 2(4): 100105.
5	Villoutreix P (2021). What machine learning can do for developmental biology. Development, 148(1). https://doi.org/10.1242/dev.188474.
6	Chou YS and Cheng TL (2026). Artificial Intelligence in Physiology and Pathophysiology: A Tool for Mechanistic Insights and Translational Opportunities. Journal of Physiological Investigation, 69(2), 83–87. https://doi.org/10.4103/ejpi.EJPI-D-25-00057
7	Jacob, Ninan, Kumar BAA and Padodara R (2022). A Glimpse into Artificial Intelligence in Animal Physiology and Allied Sciences. Animal Reproduction Update. 2. 72-81. 10.48165/aru.2022.2104.
8	Geaney A, O'Reilly P, Maxwell P et al. (2023). Translation of tissue-based artificial intelligence into clinical practice: from discovery to adoption. Oncogene 42, 3545–3555 https://doi.org/10.1038/s41388-023-02857-6.
Course Designed By: **Dr. P. Ekambaram, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	S	L	S
CO2	S	S	S	L	S
CO3	S	M	S	L	S
CO4	S	M	S	L	S
CO5	S	M	S	L	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBC06	IMMUNOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 6	4	✓	-	4
Pre-requisite		A Basic Knowledge of Immune System	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course:

1. Learn about structural features of components of immune system as well as their function.
2. Emphasis on development of immune system and mechanisms by which our body elicit the immune response.
3. Understand the imperative to think like an immunologist and predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Evaluate the usefulness of immunology in different pharmaceutical companies.	K1, K2
CO2	Acquire knowledge on antibodies and their commercial importance in diagnosis and treatment of human diseases.	K1, K2
CO3	Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.	K1, K2
CO4	Understand the importance of vaccine development and identify the proper research lab working in the area of vaccine production.	K1, K4
CO5	Distinguish and characterize the CD4+ and other T helper cell lineages in the regulatory T cell.	K1, K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Immunology: Fundamental Concepts and Anatomy of The Immune System	10 hours

Components of innate and acquired immunity; Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Bone marrow, Spleen, lymph nodes, MALT. Haemopoiesis and differentiation, lymphocyte trafficking. Complement.

Unit:2	Immune Responses Generated by B and T Cells	10 hours

Lymphocyte development and activation: The maturation of B and T lymphocytes. Differentiation of B and T cells into functionally and phenotypically distinct subpopulations. B cells development and maturation; Structure of TCR and its interaction with MHC-I and MHC-II peptide Complex - T cell selection. Organization of TCR gene segments and their rearrangement. B cell activation: T cell independent and T cell dependant mechanisms. Class switching. T cell development and maturation; Humoral immune responses.

Major Histocompatibility Complex: MHC molecules and organization of their genes; Structure and function of MHC gene products. Antigen Presentation: Antigen processing; Role of MHC and non-MHC molecules in antigen presentation. T cell activation; Regulation of TH1 and TH2 subset differentiation. Activation T_H and T_C cells; Generation of T memory cells. Cell-mediated immune responses, ADCC; cytokines-properties, receptors and therapeutic uses.

Unit:3	Antigen- Antibody Interactions	10 hours

Antigens - immunogens, haptens; characteristics of antigen, adjuvants. Superantigens. The epitopes seen by B Cells and T Cells. Immunoglobulins-basic structure, classes & subclasses of immunoglobulins; multigene organization of immunoglobulin genes; Function of various classes of Immunoglobulins; Antibody-Antigen interactions; Immunization protocol; The various immunotechniques for detection and quantification of antigens/antibodies: Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques - RID, ODD, immunoelectrophoresis, rocket immunoelectrophoresis, RIA, ELISA, western blot, ELISPOT assay, flowcytometry, immunofluorescence and confocal microscopy. CMI techniques-lymphoproliferation assay, mixed lymphocyte reaction, HLA typing. Generation of antibody diversity. Antibody engineering: Hybridoma technique and monoclonal antibodies- Applications of monoclonal antibodies.

Unit:4	Clinical Immunology	10 hours

Immunity to infection: bacteria, viral, fungal and parasitic infections (Tuberculosis, HIV/ AIDS, Schistosomiasis, Kala Azar, Chikungunya, Dengue); hypersensitivity reactions – Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; transplantation – immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology – tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency-primary immune deficiencies, acquired or secondary immune deficiencies, anaphylactic shock.

Unit:5	Vaccinology	10 hours

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering- chimeric, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine; Success stories in vaccinology *e.g.* Hepatitis, Polio, Small pox, DPT.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	**52 hours**
Text Book(s)		
1	Parham P (2014). The Immune System. W. W. Norton & Company, 4th edition.	
2	Aravind K (2013). Textbook of Immunology. The Energy and Resources Institute, TERI.	
3	Abul KA, Andrew HL and Shiv P (2024). Basic Immunology Functions and Disorders of The Immune System. Elsevier, 7th Edition.	
Reference Books		
1	Jenni P, Sharon S, Patricia J and Judith AO (2018). Kuby Immunology. WH Freeman, 8th Edition.	
2	Doan T (2024). Lippincott Illustrated Reviews Immunology. Lippincott Williams & Wilkins, 3rd Edition.	
3	Peter JD, Seamus JM, Dennis RB and Ivan MR (2026). Roitt's Essential Immunology, Wiley Blackwell Science, 13th Edition.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://nptel.ac.in/courses/102/105/102105083/	
2	https://www.coursera.org/specializations/immunology	
Course Designed By: **Dr. S. Velayuthaprabhu, Assistant Professor, Dept. of Biotechnology**		

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	L
CO2	S	S	M	L	L
CO3	S	S	M	L	L
CO4	L	S	S	M	M
CO5	M	M	L	L	M

*S-Strong; M-Medium; L-Low

Course code	26BIOBC07	RECOMBINANT DNA TECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 7	4	✓	-	4
Pre-requisite		Basic Knowledge of Molecular Biology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide comprehensive knowledge of the principles, tools, enzymes, vectors, and techniques used in recombinant DNA technology.
2. Develop competency in gene cloning, library construction, heterologous gene expression, PCR, sequencing, and molecular analysis.
3. Enable students to understand, evaluate, and apply advanced recombinant DNA technologies, including gene silencing and genome editing, in biotechnology research and industrial applications.
4. Familiarize students with contemporary developments and emerging applications of recombinant DNA technology in medicine, agriculture, and environmental biotechnology.
5. Promote critical thinking in designing recombinant DNA strategies for solving biological and biotechnological problems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the principles, tools, enzymes, hybridization techniques, and blotting methods used in recombinant DNA technology.	K1, K2, K3
CO2	Apply appropriate vectors, cloning methods, library construction strategies, and foreign DNA delivery techniques for recombinant DNA experiments.	K2, K3, K4, K6
CO3	Analyze expression systems and evaluate strategies for heterologous gene expression, recombinant protein production, PCR, and sequencing technologies.	K2, K3, K4, K5
CO4	Evaluate the principles and applications of gene silencing, genome editing technologies, and recombinant DNA techniques in biotechnology research and product development.	K2, K3, K4, K5
CO5	Design recombinant DNA-based approaches using advanced molecular tools to address problems in medicine, agriculture, industry, and environmental biotechnology.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Tools and Techniques - Enzymes in Molecular Biology	10 hours

Tools and techniques: Isolation and purification of nucleic acids and protein, AGE and PAGE. Hybridization techniques: Labelling of DNA - nick translation, random priming, end labelling, radioactive and non-radioactive probes, Principles and techniques of nucleic acid hybridization -colony hybridization, fluorescence in situ hybridization (FISH). Blotting techniques: Southern, northern, western, South-western, north-western, far-western blotting techniques. Enzymes in molecular biology: Nucleases, restriction endonucleases, DNA ligases, topoisomerases, gyrases, methylases, alkaline

phosphatase, polynucleotide kinase, terminal transferase, Klenow enzyme, T4 DNA polymerase, Reverse transcriptase.		
Unit:2	**Vectors and Cloning Methods**	**10 hours**
Vectors: plasmids, pUC19, phagemids, cosmids, Lambda vectors, M13mp vectors, pBluescript vectors, Insertion and Replacement vectors, Artificial chromosomes - P1-derived artificial chromosome (PAC), Bacterial artificial chromosome (BAC), Yeast artificial chromosome (YAC). pMal, GST, pET-based vectors. Intein-based vectors. Shuttle vectors, yeast vectors, plant-based vectors - Ti and Ri as vectors, Bacmid and *pichia* vectors, Mammalian expression and replicating vectors. Cloning methods: Restriction enzyme cloning, recombination cloning (Gateway), TA/TOPO cloning, Gibson assembly, Golden gate, Ligation independent cloning, Infusion cloning.		
Unit:3	**Expression Strategies for Heterologous Genes – Genomic and cDNA Library**	**10 hours**
Expression strategies for heterologous genes: Principles for maximizing gene expression in vectors - Vector engineering, codon optimization and Host engineering. Protein purification - His-tag, GST-tag, MBP-tag. Inclusion bodies, methodologies to reduce formation of inclusion bodies. Expression systems - bacteria, yeast, insect cells, mammalian cells, and plant. Library construction: Genomic DNA library. cDNA Library construction: mRNA enrichment, linkers and adaptors, homopolymer tailing, cDNA synthesis and library construction. Strategies for library screening. Yeast two and three hybrid systems, phage display.		
Unit:4	**PCR and Sequencing - Introduction of foreign DNA into Host Cell**	**10 hours**
Polymerase Chain Reaction: Principles of PCR and applications, primer design, fidelity of thermostable enzymes, DNA polymerases, proof reading enzymes. Types of PCR - multiplex, nested, real time PCR, touchdown PCR, hot start PCR, colony PCR, Quik Change PCR. Cloning of PCR products - T-vectors. Sequencing: Human genome project, Sanger, Maxam-Gilbert, NGS, whole genome sequencing, methylation sequencing, RNA sequencing. Microarrays: DNA and protein microarray. Introduction of foreign DNA into Host Cell: transformation, electroporation, and transfection.		
Unit:5	**Gene Silencing and Genome Editing Technologies – Applications of rDNA Technology**	**10 hours**
Introduction to gene silencing technology: siRNA, miRNA, and antisense RNA. Principle and application of gene silencing. Gene silencing by homologous recombination. Epigenetic gene silencing. Genome editing: Introduction to genome editing - TALEN and Zinc-Finger-Nucleases. Genome editing by CRISPR-CAS - *in vitro* synthesis of single guide RNA (sgRNA), Cloning genomic targets into CRISPR/Cas9 plasmids, evaluation of Cas9 gene editing, applications of CRISPR/cas9 technology. Applications of rDNA technology - microbes, plants and animals.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**

Text Book(s)	
1	Primrose SB, Twyman RM and Old RW (2006). Principles of gene manipulation and genomics, Blackwell Science, Oxford, Vol. 6, 7th edition.
2	Cseke LJ, Kirakosyan A, Kaufman PB and Westfall MV (2012). Handbook of molecular and cellular methods in biology and medicine, CRC press, 3rd edition.
3	Glick BR and Patten CL (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34), John Wiley & Sons, 5th edition.
4	Bernard RG and Jack JP (2003). Molecular biotechnology, Asm Press.
5	Glick BR and Patten CL (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34), John Wiley & Sons.
6	Das HK (2007). Textbook of biotechnology, John Wiley & Sons.
Reference Books	
1	Gellissen G (2006). Production of recombinant proteins: Novel microbial and eukaryotic expression systems, John Wiley & Sons.
2	Primrose SB and Twyman R (2013). Principles of gene manipulation and genomics, John Wiley & Sons.
3	Snyder L (2001). Introduction to Genetic Engineering, Blackwell Scientific, 5th edition.
4	Primrose SB and Twyman R (2009). Principles of genome analysis and genomics, John Wiley & Sons.
5	Nicholl DS (2008). An introduction to genetic engineering, Cambridge University Press.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3
2	http://www.bch.cuhk.edu.hk/pdp2009/Home.files/PDP%20booklet%20%20(Teacher)%20v9.pdf
3	https://akmedia.press/med-96095/B01602IRQU
4	http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/75
5	https://www.swayamprabha.gov.in/index.php/program/current/9
6	https://www.youtube.com/watch?v=JCy_33hFDI&list=PLNsppmbLKJ8ItPmDcCQzWzXcKHo11AFmj
7	https://ndl.iitkgp.ac.in/result?q={%22t%22:%22search%22,%22k%22:%22rdna%20technology%22,%22s%22:[],%22b%22:{%22filters%22:[]}}
8	https://www.rpi.edu/dept/chem-eng/Biotech-Environ/Projects00/rdna/rdna.html
9	https://www.nature.com/scitable/topicpage/recombinant-dna-technology-and-transgenic-animals-34513/
10	https://byjus.com/biology/recombinant-dna-technology/
11	https://microbenotes.com/recombinant-dna-technology-steps-applications-and-limitations/
Course Designed By: **Dr. M. Arun, Assistant Professor, Department of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	S	L	L	M
CO3	S	S	M	L	M
CO4	S	S	M	M	M
CO5	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course Code	26BIOBC08	PLANT PHYSIOLOGY AND METABOLIC ENGINEERING	L	T	P	C
Core/Elective/Supportive	Core Paper - 8		4	✓	-	4
Pre-requisite	A Basic Knowledge in Plant Biology		Syllabus Version	2026-27		

Course Objectives:

The main objectives of this course are to:

1. Students will be able to explain how Plants function, drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations and development.
2. They can apply these studies in crop improvement.
3. Acquaintance of Metabolic engineering studies will help the students to apply these methods in Industries.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Know importance and scope of plant physiology. Understand the process of translocation of solutes in plants	K1
CO2	Learn about the movement of sap and absorption of water in plant body	K2
CO3	Understand about the role of stress physiology in crop improvement	K3
CO4	Acquaintance in secondary metabolism of plants	K4, K5
CO5	Applications of Metabolic engineering in phytochemical production	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Solute transport and Photoassimilate translocation	10 hours

Solute Transport: Xylem cells, uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; Gap junction, plasmodesmata, transpiration.

Photosynthesis: Chloroplast – structure, photosynthesis, light harvesting complexes: mechanism of electron transport (cyclic and non- cyclic phosphorylation), photoprotective mechanism CO_2 fixation, C3, C4 and CAM pathways and C2 cycle (photorespiration).

Photo assimilate Translocation: Translocation in the Phloem**:** Pathways of Translocation, Patterns of Translocation: Source to Sink, Materials Translocated in the Phloem, Rates of Movement, The Pressure-Flow Model, a Passive Mechanism for Phloem Transport, Phloem Loading, Phloem Unloading and Sink-to-Source Transition.

Unit:2	Growth Hormones and Photophysiology and Morphogenesis	10 hours

Plant hormones– Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action (Auxins, Cytokinin, Gibberellic acid, Ethylene). Blue-Light Responses: Morphogenesis and Stomatal Movements**.**

Photoperiodism: Photoreceptors, Phytochromes, cryptochromes. Light perception, structure and function of phytochrome. Red and Far-Red response on Photomorphogenesis. The Photo physiology of Blue-Light Responses, The Regulation of Blue Light–Stimulated Responses, Blue-Light Photoreceptors. Light signaling in plants. Stomatal movement. Circadian Rhythms or biological clocks. **Morphogenesis**: Embryogenesis and development of plants. Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy: transition to flowering, floral meristems and floral development. Flower development Model in Arabidopsis and Antirrhinum.: Signaling involved in Flowering. Role of Florigen.		
Unit:3	**Stress Physiology**	**10 hours**
Abiotic stress: Water, temperature, cold, salt stress and heavy metal stress: The abiotic environment and its Biological Impact on Plants, Water Deficit and Flooding, Drought and Temperature Stress, High Light Stress, Response of plants towards abiotic stress. Adaptation mechanism: Developmental and Physiological Mechanisms that Protect Plants against Environmental Extreme. Innate immunity. **Biotic stress**: Pathogen and Insects. Effect of Virus (Tobacco mosaic virus, Cucumber Mosaic virus) Bacteria (eg. bacterial blights), and Fungal (eg. late blight) and Nematode (root knot diseases) diseases on physiology of the plants. Plant resistance mechanism towards pathogenic attack- PR proteins and other signaling strategies.		
Unit:4	**Secondary Metabolism**	**10 hours**
Secondary Metabolites: Biosynthesis of Terpenes, Phenolic Compounds, Nitrogen-Containing Compounds and their role in plant metabolism. Secondary Metabolites and Plant Defense: Induced Plant Defenses against Insect Herbivores, Plant Defenses against Pathogens. Metabolic Profiling: Methods used for metabolic profiling, Metabolic flux - Integration of anabolism and catabolism, metabolic flux analysis. Isotope labeling based metabolic flux analysis.		
Unit:5	**Metabolic Engineering**	**10 hours**
Metabolic Engineering Strategies: Metabolic engineering of plant secondary metabolites. Metabolic engineering for biofortification in food crops - Golden rice, Crop improvement for economically important traits – diseases resistant and resilient crops. Recent advances of CRISPR - Cas 9 in plant biosynthetic pathway. **Bioinformatics in Metabolic engineering**: Analysis of metabolic control and structure, metabolic network. Computation prediction of plant metabolic pathways.		
Unit:6	**Contemporary Issues**	**2 hours**
Guest Lecturer, Webinars, Seminars		
	Total Lecture hours	**52 hours**

Text Book(s)	
1	Hopkins WG and Huner NPA (2009). Introduction to Plant Physiology. John Wiley and Sons, 4th edition.
2	Taiz L and Zeiger E (2010). Plant Physiology. Sinauer Associates USA, 5th edition.
Reference Books	
1	Devlin RM and Witham FH (1983). Plant Physiology. Grant Press, 4th edition.
2	Siddiqui M W and Prasad K (2017). Plant Secondary Metabolites. Apple Academic Press.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Plant Physiology and Metabolism Dr. Sudeshna Shyam Choudhury Swayam course
2	Dr. S. Girija, You Tube contents
3	Plant Physiology by Mohmad Arief Zargar, University of Zargar, Swayam course
Course Designed By: **Dr. S. Girija, Associate Professor, Department of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	S	S	S	M
CO2	S	S	M	S	S
CO3	S	S	M	S	S
CO4	S	S	S	S	S
CO5	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGE02A	MOLECULAR DIAGNOSTICS AND CLINICAL TESTING	L	T	P	C
Core/Elective/Supportive		Elective - 2	4	✓	-	4
Pre-requisite		Basic Knowledge in Diagnostics	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Understand the vantages of molecular diagnostics in precision diagnosis and learn about state-of-the-art techniques that are used in clinical diagnosis of diseases.
2. Develop skills by understanding technical details of the assays to be applied for developing novel tests for improved diagnosis.
3. Learn about existing examples which promotes critical thinking that can help in developing tests. Comprehensive knowledge about ethical and regulatory aspects of handling and conducting tests in clinical samples.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understanding of disease types and their diagnosis. Obtain knowledge about ethical and regulatory aspects of conducting diagnostic tests.	K3
CO2	Learn the technical aspects of various diagnostic methods which will help in application of these techniques to design and develop new clinical tests.	K4
CO3	Obtain comprehensive knowledge about various biotechnological investigations done to monitor changes happening at different molecular levels. Understand the uniqueness and pitfalls of biological assays to analyse and apply them to develop clinical tests.	K5
CO4	Develop skills to interpret the results of molecular techniques when performing them practically.	K6
CO5	Know about how important diseases are diagnosed using molecular diagnostic methods. Learn practical applications of precision diagnostics in disease management.	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Molecular Diagnostics	10 hours

Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Clinical specimens: National and International guidelines for Sample collection- method of collection, transport and processing of samples, Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

Unit:2	DNA Based Molecular Techniques for Diagnosis	10 hours
PCR based assays: Real-time PCR, ARMS, allele specific, multiplex, methylation analysis, MLPA, single-stranded conformational polymorphism analysis, heteroduplex analysis, competitive oligonucleotide priming, DHPLC, DGGE, CSCE. Mutation screening panels (xTAG, Luminex). Micro arrays: SNP chromosomal microarrays, EST, SAGE, Nanostring gene expression analysis.		
Unit:3	**Proteomic and Metabolomics Assays for Diagnostics**	**10 hours**
Diagnostic proteomics: SELDI-TOF MS; LC-MS, MALDI-TOF, Isotope coated affinity tag (ICAT), SILAC, i-TRAQ, Protein microarray, Lateral flow devices. Metabolite profile for biomarker detection in the body fluids/tissues under various metabolic disorders by making use of LCMS & NMR technological platforms.		
Unit:4	**Applications of Molecular Diagnostics**	**10 hours**
Major Histocompatibility Complex (MHC), HLA typing- RFLP, PCR based methods, SSO, SSP and SBT methods. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation. Bone marrow transplant engraftment analysis. Diagnosis of inherited diseases- Thalassemia, Cystic Fibrosis. Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Non-invasive: Triple test, Ultrasonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling. Molecular diagnosis for early detection of cerebral palsy, Down syndrome. Fragile X syndrome.		
Unit:5	**Applications In Molecular Oncology and Microbial Diseases**	**10 hours**
Molecular oncology testing in malignant disease- Acute and Chronic leukemias, Melanoma, Colon, lung and Breast cancers. Circulating tumour cell testing (CTC). Molecular diagnosis of various viral diseases: Dengue, Chikungunya and SARS. Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics- 16s rRNA typing.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**

Text Book(s)

1	Buckingham L (2019). Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. FA Davis. 3rd Edition.
2	Patrinos GP and Ansorge W (2009). Molecular Diagnostics. Academic Press. 3rd Edition.

Reference Books

1	Sulaiman IM (2024). Recent Advancements in the Diagnosis of Human Disease. CRC Press. 3rd

	Edition.
2	Rifai N, Horvath AR Wittwer CT and Park J (2018). Principles and Applications of Molecular Diagnostics. Elsevier. 1st Edition.
3	Bruns DE, Ashwood ER, and Burtis CA (2007). Fundamentals of Molecular Diagnostics. Elsevier Health Sciences. 1st Edition.
4	Pan S and Tang J (2021). Clinical molecular diagnostics. Springer Nature. 1st Edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Biomolecules: Structure, function in Health and Disease-CEC
2	Fabrication Techniques for MEMs-based sensors: clinical perspective- NPTEL
3	Economics of Health and Healthcare- NPTEL
Course Designed By: **Dr. V. Thirunavukkarasu, Associate Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	L	S	S
CO2	S	S	L	M	M
CO3	M	S	M	M	M
CO4	M	S	M	S	S
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGE02B	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
Core/Supportive/Elective		Elective - 2	4	✓	-	4
Pre-requisite		Basic Knowledge in Biological Sciences	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide comprehensive knowledge of biofuels, bioenergy, biodiversity, environmental pollution, and their significance for sustainable development.
2. Develop an understanding of environmental pollution, waste management, pollution detection, bioremediation, phytoremediation, and other biotechnological approaches for environmental protection.
3. Equip students with knowledge of environmental impact, disaster management, environmental regulations, and emerging biotechnological strategies for addressing global environmental challenges.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the concepts of biofuels, bioenergy, biodiversity, environmental pollution, and waste management systems.	K1, K2
CO2	Apply biotechnological principles and techniques for pollution detection, monitoring, wastewater treatment, and environmental management.	K3, K4
CO3	Analyze the role of bioremediation, phytoremediation, biosensors, and molecular tools in mitigating environmental pollution.	K3, K4, K5
CO4	Evaluate global environmental issues, biogeographical concepts, xenobiotic degradation, and disaster management strategies for environmental sustainability.	K4, K5
CO5	Design sustainable biotechnological approaches for bioresource conservation, pollution control, renewable energy production, and environmental protection.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Biofuels- Sources and Production	10 hours

Bio-Fuels and Bio-Energy: Biofuels First, Second, Third and Fourth generation and their sources, biodiesel, Advantages of Biofuels, Plant and Bacterial and Algal sources for biofuel. Genetic improvement through metabolic engineering in Bacteria and Algae and Plants for biofuel production.

Unit:2	Pollution and Management Systems	10 hours

Environmental pollution: Types of pollution, water pollution, Air pollution, Land pollution, oil pollution. Waste water treatment Primary, secondary and Tertiary treatment. activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors. Ozone depletion,

greenhouse effect and acid rain. Solid waste: Sources and management-Composting, Vermiculture		
Unit:3	**Pollution Detection Methods**	**10 hours**
Biotechnological methods of pollution detection: Genotoxicity, plant test system- algal bioassay. DNA gene probe PCR based system detection for Shigella, Salmonella in water. Techniques in pollution detection - Remote sensing, bioindicators and biosensors for detection of pollution. Types of Biosensors – Enzyme electrode, Optical biosensors, H2O2 biosensor. Microbial biosensor.		
Unit:4	**Biogeography and Global Environmental Problems**	**10 hours**
Major terrestrial biomes, theory of island biogeography; bio geographical zones of India. Xenobiotics: Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, bioremediation and Phytoremediation. Transgenic plants for phytoremediation. Biowarfare.		
Unit:5	**Disaster Management**	**10 hours**
Bioresource, Uses and types of biodiversity conservation. Disasters Management: Disaster, Hazard, Vulnerability, Resilience, Risks. Disaster Risk Management in India. Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management and Institutional arrangements.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**
Text Book(s)		
1	Chatterji AK (2011). Introduction to Environmental Biotechnology. PHI Learning Pvt. Ltd, 3rd edition.	
2	Scragg AH (1999). Environmental Biotechnology. Harlow, England: Pearson Education Limited.	
3	Abbasi SA and Ramasami E (1999). Biotechnological Methods of Pollution Control. Hyderabad: University Press (India) Limited.	
4	Rittmann BE, McCarty PL (2020). Environmental Biotechnology: Principles and Applications. New York: McGraw Hill Education, 2nd edition.	
Reference Books		
1	Jordening HJ and Winter J (2005). Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag GmbH & Co. KGaA.	
2	Cheremisinoff NP (1997). Biotechnology for Waste and Wastewater Treatment. Park Ridge, NJ: Noyes Publications.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		

1	Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.
2	Environmental Science NPTEL
3	Environmental Biotechnology: Achievements, Opportunities and Challenges by Maria Gavrilescu.
Course Designed By: **Dr. S. Girija, Associate Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	M	M
CO2	S	S	M	S	M
CO3	S	S	M	S	M
CO4	M	S	M	S	S
CO5	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBCP2	ADVANCED BIOTECHNOLOGY	L	T	P	C
Core/Supportive/Elective		PRACTICALS – 2	6	-	✓	4
Pre-requisite		Basic Skills in Biology	Syllabus Version	2026-27		

Course Objectives:

The main objectives of this course are to:

1. Provide hands-on training in advanced molecular, microbiological, immunological, biochemical, and plant biotechnology techniques used in biotechnology research.
2. Develop technical competence in performing, optimizing, and interpreting advanced laboratory experiments involving recombinant DNA technology, molecular diagnostics, protein analysis, immunological assays, and bioinformatics tools.
3. Enable students to integrate advanced biotechnology techniques and experimental approaches to investigate biological systems and solve research problems while adhering to laboratory safety and ethical practices.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Perform isolation, purification, quantification, and analysis of nucleic acids and utilize them in advanced molecular techniques, including restriction digestion, ligation, RT-PCR, and DNA-based assays.	K1, K2, K3, K4
CO2	Apply recombinant DNA technology, *Agrobacterium*-mediated transformation, gene transfer methods, and bioinformatics tools for gene manipulation and molecular analysis.	K3, K4, K5
CO3	Perform immunological, biochemical, and proteomic assays to identify, quantify, and characterize biomolecules and evaluate experimental outcomes.	K2, K3, K4, K5
CO4	Analyze biological samples using cytogenetic, microbiological, molecular, and animal-based experimental techniques to investigate biological processes and disease markers.	K2, K3, K4, K5
CO5	Design and optimize experimental strategies by integrating advanced biotechnology techniques and laboratory safety practices to solve biological research problems.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Molecular Toxicology (Dr. P. Ekambaram) — **9 hours**

1. Identification of Barr bodies from buccal smear.
2. Determination of Acetylcholinesterase (AChE) activity in Zebrafish.
3. Handling of small animals-Mice and Rat (Demo).

Plant Genetic Engineering (Dr. R. Sathishkumar) — **9 hours**

1. Nucleotide and Protein sequence analysis - Blast, MSA and Phylogenetic tree construction.
2. Demonstration of gateway cloning technology.

3. Purification of a recombinant protein using Affinity Chromatography and SDS-PAGE analysis.	
Molecular Microbiology (Dr. S. R. Prabagaran)	**9 hours**
1. Qualitative and quantitative estimation of bacterial enzyme (amylase) production. 2. Bacterial diversity analysis through ARDRA. 3. Transposon-mediated mutagenesis through conjugative transfer of genetic material (pSC189).	
Plant Biotechnology (Dr. S. Girija)	**9 hours**
1. *Agrobacterium*-mediated plant genetic transformation. 2. Estimation of malonaldehyde (MDA) content in plant samples. 3. Screening of major secondary metabolites from medicinal plants.	
Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**
1. Analysis of the extent of DNA damage in a given sample using COMET assay. 2. Assessing the extent of differentiation in mammalian cells by estimating the marker Alkaline Phosphatase (ALP). 3. Evaluation of protein-ligand interaction and their binding affinity through molecular docking studies- Demonstration.	
Reproductive Immunology and Molecular Pathology (Dr. S.Velayuthaprabhu)	**9 hours**
1. Detection of C reactive protein (CRP) using agglutination method. 2. Estimation of Creatinine by Jaffe's Colorimetric method. 3. Isolation and purification of IgG antibody from serum using Protein G column.	
Plant Molecular Biology (Dr. M. Arun)	**9 hours**
1. Isolation of plasmid DNA and quantification using UV-Visible spectrophotometer and nano-drop. 2. Restriction digestion of plasmid vectors. 3. Optimization of DNA ligation.	
Regenerative Engineering and Molecular Medicine (Dr. M. A. Shibu)	**9 hours**
1. Determination of antigen concentration by Rocket immunoelectrophoresis. 2. Mitochondrial DNA Isolation from mammalian cells. 3. Primer designing and gene expression analysis by RT-PCR.	
Total training hours	**72 hours**

Reference Books	
1	Green MR (2014). Molecular Cloning: A Laboratory Manual, 4th edition.
2	Kolpashchikov DM, Yulia V and Gerasimova YV (2013). Nucleic Acid Detection: Methods and Protocols (Methods in Molecular Biology).
3	Basu and Chhandak (2015). PCR Primer Design.
4	Apak R, Capanoglu E and Shahidi F (2017). Measurement of Antioxidant Activity & Capacity: Recent Trends and Applications.
5	Gupta PK (2018). Cytogenetics, Rastogi Publications.
Related Online Contents [Websites]	
1	Narusaka Y, Narusaka M, Yamasaki S and Iwabuchi M (2012). Methods to Transfer

	Foreign Genes to Plants.
2	Pregnancy Test https://fpnotebook.com/ob/lab/PrgncyTst.htm
3	Chard T. Pregnancy Tests, A review, https://academic.oup.com/humrep/article-abstract/7/5/701/631514?redirectedFrom=fulltext
Course Designed By: All Faculty, Dept. of Biotechnology	

Mapping with Programme Outcomes					
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	L	M	M
CO2	S	S	M	M	M
CO3	S	S	M	M	M
CO4	S	S	M	S	M
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGS02	MEDICAL BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Supportive -2	2	✓	-	2
Pre-requisite		Basic Knowledge in Biology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide fundamental knowledge of medical biotechnology and its applications in disease diagnosis, therapeutics, and healthcare.
2. Develop an understanding of molecular diagnostics, stem cell technology, gene therapy, assisted reproductive technologies, and tissue engineering.
3. Familiarize students with the principles and applications of advanced biotechnological tools and biomedical techniques used in modern medicine and clinical research.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the principles and applications of biotechnology in medicine, including recombinant DNA technology, vaccines, monoclonal antibodies, and therapeutic proteins.	K1, K2
CO2	Apply the concepts of molecular diagnostics and biotechnology-based approaches for the detection of infectious diseases, genetic disorders, and cancer.	K2, K3
CO3	Analyze the principles, applications, and ethical considerations of stem cell technology, gene therapy, and assisted reproductive techniques.	K3, K4, K5
CO4	Evaluate the significance of tissue engineering, bioartificial organs, and regenerative medicine in disease treatment and healthcare.	K4, K5
CO5	Assess recent advances in medical biotechnology and propose appropriate biotechnological strategies for disease diagnosis, therapy, and biomedical research.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction to Biotechnology and Medicine	5 hours

Medicine field of 21st century, Role of Biotechnology in medicine - rDNA technology, Vaccines, MoAb and insulin production.

Unit:2	Molecular Diagnostics	5 hours

Important of diagnosis-PCR based diagnosis for infectious diseases (HIV, Hepatitis, Typhoid, Filariasis), Cancer and genetic disorders.

Unit:3	Cell And Gene Mediated Therapy	5 hours

Introduction to stem cells-History of stem cell research-Classification of stem cells –Stem cell banking-applications of stem cells-importance of stem cells- regulations of stem cell research - Gene therapy; outline and methods.

Unit:4	Assisted Reproductive Techniques	5 hours
Introduction - causes of infertility - methods; IVF-Intra uterine insemination-cryopreservation of germ cells – IVM and ICSI.		
Unit:5	**Tissue Engineering**	**4 hours**
Introduction-Bioartificial Organs-Historical background-liver-kidney-skin-pancreas-Urinary bladder-bone-Challenges and advantages.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**26 hours**

Text Book(s)	
1	Trivedi PC (2008). Medical Biotechnology.
2	Rao VV (2010). Medical Biotechnology.
Reference Books	
1	Patten CL (2013). Medical Biotechnology.
2	Pongracz J and Keen M (2008). Medical Biotechnology, Elsevier, 1st edition.
3	Silva AC (2026). Handbook of Medical Biotechnology, Springer.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://epgp.inflibnet.ac.in/
2	https://www.youtube.com/c/SumanBhattacharjeeShomusBiologyOnline/videos

Course Designed By: **Dr. S. Velayuthaprabhu, Assistant Professor, Dept. of Biotechnology**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	M	L	M
CO2	S	S	M	M	M
CO3	S	S	M	S	M
CO4	S	S	M	S	M
CO5	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBCJ1	SAS Programming for Clinical Trials Management	L	T	P	C
Core/Elective/Supportive		Job Oriented Certificate Course – 1	2	✓	✓	2
Pre-requisite		Basic Knowledge in Biostatistics	Syllabus Version		2026-27	

Name of the Department	**Biotechnology**
Name and Address of the Faculty Member	Dr. V. Thirunavukkarasu, Associate Professor, Dept. of Biotechnology, Bharathiar University
Eligibility	PG students of Biotechnology
Mode of the Course	Hybrid
Collaboration if any with Companies (if Yes, Full Address of the Company Address, Name of the Contact Person)	**Mr. Nishanth Nalan** Practice Head, Life Sciences (India) ACL Digital, ESPEE IT Park, 1st & 2nd Floor, No. 5, Jawaharlal Nehru Road, Ekkatuthangal, Chennai, Tamil Nadu 600032 Office: +91 44 4595 9208 | Mobile: +91 8402 53443 E: nishanth.n@acldigital.com Website: https://www.acldigital.com/industries/life-sciences LinkedIn: https://www.linkedin.com/in/nishanthnalan
Registration Procedure	Through department office (offline/online)

Job Opportunities: Contract Research Organisations and Research and Development of Pharmaceutical Industries

Course objectives:

The main objectives of this course are to:

1. Provide fundamental knowledge of drug discovery, clinical trial processes, and clinical data management in the pharmaceutical industry.
2. Develop programming skills in SAS for data handling, statistical analysis, reporting, and clinical trial data processing.
3. Familiarize students with CDISC standards (SDTM and ADaM) and their applications in clinical data standardization and regulatory submissions.
4. Equip students with practical skills to manage, validate, analyze, and report clinical trial data using SAS programming.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the principles of drug discovery, clinical trial phases, clinical documentation, and clinical data management processes.	K1, K2
CO2	Apply SAS programming concepts to create, manage, manipulate, and analyze clinical datasets using appropriate procedures and programming techniques.	K3, K4
CO3	Analyze clinical trial datasets using SAS procedures, SQL, macros, and reporting tools for effective clinical data management.	K3, K4, K5

CO4	Evaluate and implement CDISC standards (SDTM and ADaM) for clinical data standardization, validation, and regulatory compliance.	K4, K5
CO5	Design and generate standardized clinical trial datasets, tables, listings, and reports using SAS programming for pharmaceutical and clinical research applications.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Module 1	**3 hours**
Drug development process. History of Drug Development. Types of drugs. Target identification. Drug Discovery – New entities (Chemical, Biological). In vitro and In vivo studies. Nonclinical studies and IND. Basics of pharmacokinetics and pharmacodynamics	

Module 2	**2 hours**
Clinical trials – Terminology, 4 phases and Documentation (SOPs, Protocols and SAPs. CRFs and Annotated CRFs. NDA, BLA). Cross functional teams and roles in clinical trials.	

Module 3	**3 hours**
Introduction to SAS. Libraries and Datasets, Variables and Observations. Types of data - raw vs. sas data; numeric vs. character. sas files -. sas, sas7bdat, log, lst. SAS program structure - Data and Proc steps, Keywords, Statements, Global statements. Syntax rules - dataset and variable names and their attributes, semicolon and comments. SAS dates and Global Options	

Module 4	**3 hours**
Data step iterative processing. Compilation and execution. Informats and formats. Dataset combining - set and merge. Read and write data. Conditional execution of statements - If-Then-Else. Do loop processing Array processing. SAS functions - character, numeric and date. Assignment, Retain, Sum, Output and Global statements. Automatic variables.	

Module 5	**3 hours**
Basic SAS procedures. General - Contents, Sort, Print, Format, Transpose, Import, Export, Compare. Statistical - Freq, Means. Reporting - Report. Graph - Gplot, Gchart. Where, Var, Id and Class Statements. Output Delivery System - Trace, Output, RTF, EXCEL. Debugging SAS programs. Compilation and Execution errors. Data, Syntax and Logic errors.	

Module 6	**2 hours**
Macro programming. Advantages of Macro programming. Macro variables - Global and local. Macro routines and macro code. Keyword and positional parameters. Macro debugging. Writing macros with conditional logic. Methods of creating macro variables.	

Module 7	2 hours
Proc SQL. Creating and modifying datasets. labels and formats. Combining data using union and join statements. Case expression. Sorting - Order by clause. Except and Intersect statements. Separated by and having clauses.	
Module 8	**3 hours**
CDISC Standards. Purpose of SDTM and ADaM datasets. SDTM – Introduction, Fundamentals, submitting standard data, Assumptions for domain models, Special purpose domains, General observation classes, Trial design datasets, Representing relationships	
Module 9	**2 hours**
ADaM – Introduction, Fundamentals, Standard ADaM variables – Conventions, Analysis Dataset – Subject Level (ADSL), Basic data structure (BDS) datasets; Occurrence data structures. Common implementation issues and solutions	
Module 10	**3 hours**
SAS in the Pharmaceutical Industry. Role of a SAS programmer. Attributes of a good programmer. SOPs, Protocols and SAPs. CRFs and Annotated CRFs. Importing raw clinical data. Edit checks and cleaning clinical data. Transforming data and creating analysis datasets. Continuous vs. categorical data. LOCF, windowing, Transposing data. Dataset specifications and Mock tables. Creating Tables, listing and Graphs.	
Total Lecture hours	**26 hours**

Reference

1	Shreve NJ and Holland DD. SAS® Certification Prep Guide: Statistical Business Analysis Using SAS®9, Publisher: SAS Institute.
2	SAS® Certification Prep Guide: Advanced Programming for SAS®9, Publisher: SAS Institute, 2nd edition.
3	Shostak J. SAS® Programming in the Pharmaceutical Industry, Publisher: SAS Institute, 2nd edition.
4	Blass EB (2021). Basic Principles of Drug Discovery and Development, Elsevier Science.
5	CDISC Implementation Guides and Model documents – SDTM and ADaM; CDISC.

Course Designed By: **Dr. V. Thirunavukkarasu, Associate Professor, Dept. of Biotechnology with Industry Partner**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	M	M	L
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	M	S	M
CO5	S	S	S	M	S

*S-Strong; M-Medium; L-Low

THIRD SEMESTER

Course code	26BIOBC09	ANIMAL BIOTECHNOLOGY AND STEM CELL BIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 9	4	✓	-	4
Pre-requisite		A Basic Knowledge in Cell Biology, Developmental Biology and Physiology	Syllabus Version	2026-27		

Course Objectives:

The main objectives of this course are:

1. To provide students with knowledge of wide-ranging topics related to stem cells, regenerative medicine and tissue engineering.
2. To offer the student state of the art education of stem cells and how the pluripotent and multipotent cells can be used to treat the neurodegenerative disorders, cardiovascular disorders and diabetes.
3. To review the current scenario of tissue engineering applications in bioartificial organs construction and transplantation.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Gain fundamental knowledge in stem cell biology and tissue engineering.	K1, K2
CO2	Describe sources, selection, potential manipulations and challenges of using stem cells for Regenerative medicine.	K2, K3
CO3	Explain significance, current status and future potential of Stem cells and tissue engineering.	K3, K4
CO4	Identify key challenges in tissue engineering of different human tissues.	K3, K4, K5
CO5	Describe design, fabrication and biomaterials selection criteria for tissue engineering scaffolds	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Stem cells and Basics of Stem cell culture	10 hours

Introduction to Stem Cells – Definition, Classification, characteristics; Stem cell Vs Somatic cells; Differentiation, dedifferentiation and transdifferentiation. Cellular signalling and maintenance of stem cells. Mechanism of pluripotency in stem cells. Instrumentations in stem cell culture/research; Basics of animal cells/stem cells culture; Isolation, expansion, genetic manipulation, genetic reprogramming, and cloning of Stem cells. Stem cell markers, role of feeder layer in stem cell culture. Stem Cells cryopreservation.

Unit:2	Types of Stem Cells	10 hours

Different kinds of stem cells – Embryonic stem cells, Embryonic Germ cells; Stem cell Niche. Adult Stem Cells: hematopoietic stem cells, neural stem cells, muscle and cardiac stem cells, umbilical cord blood stem cells, cancer stem cells, mesenchymal stem cells, induced pluripotent Stem cells.

Unit:3	Stem Cell Therapy	10 hours
Therapeutic applications: stem cells and neurodegenerative disorders, stem cells and diabetes, stem cells and cardiac disorders, Stem cell therapy for kidney failure, liver failure, infertility and cancer. Stem cell banking. Success stories of stem cell therapy. Current status of Stem cell research. National and International Guidelines/Regulations for stem cell research. Ethical considerations in stem cells research.		
Unit:4	**Introduction to Tissue Engineering, Biomaterials and Scaffolds**	**10 hours**
Principles of Tissue Engineering – History, importance and scope, Basics/fundamentals of Tissue Engineering, Tissue dynamics/homeostasis. Tissue Engineering triangle, Role of growth factors, Biomaterials and Scaffolds in Tissue Engineering. Requirement of biomaterials as tissue engineering scaffold. properties and types of scaffolds, tissue specific scaffolds; Methods of scaffold design/preparation. Cell-ECM/Scaffold interactions, Animal cell culture on scaffolds. Tissue Engineering Bioreactors.		
Unit:5	**Tissue Engineering Applications**	**10 hours**
Tissue and organ transplantation. Bio-artificial organs: Skin Tissue engineering, Liver tissue engineering, Bladder reconstruction, Kidney tissue engineering, Muscle tissue engineering, Neural tissue engineering, Bone and cartilage tissue engineering, Cardiovascular tissue engineering. Commercial products from tissue engineering. Ethical issues in tissue engineering. AI in tissue engineering and limitations.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
Self-Study: BSS and cell culture media. Contamination and Cross-Contamination. Cell Culture Maintenance and cytotoxicity assays. Production and applications of Transgenic Animals. Assisted Reproductive technology.		
	Total Lecture hours	**52 hours**

Text Book(s)

1	Lanza R, Langer R, Vacanti JP, Atala A (2020). Principles of Tissue Engineering, Academic Press,5th Edition.
2	Lanza R and Atala A (2026). Essentials of Stem Cell Biology, Academic Press, 4th Edition.

Reference Books

1	Blitterswijk CV, Boer JD (2022). Tissue Engineering, Academic Press, 3rd Edition.
2	Pallua N and Suschek CV (2011). Tissue Engineering: from Lab to Clinic, Springer.
3	Barnes SJ and Harris LP (2008). Tissue Engineering: Roles, Materials and Applications, Nova Science Publishers Inc, 1st Edition.
4	Minuth WW, Strehl R and Schumacher K (2017). Tissue Engineering: from Cell Biology to Artificial Organs, Wiley VCH.

5	Zhao RC (2015). Stem Cells: Basics and Clinical Translation (Translational Medicine Research), Springer.
6	Knoepfler P (2013). Stem Cells: An Insider's Guide, World Scientific Publishing Company.
7	Harris J, Quigley M and Chan S (2012). Stem Cells: New Frontiers in Science & Ethics, World Scientific Publishing Co Pte Ltd.
8	Atala A and Lana R (2002). Methods of Tissue Engineering, Academic Press.
9	Sharma CP, Chandy T and Thomas V (2023). Artificial intelligence in tissue and organ regeneration. Elsevier.
10	Plugmann P and Portius D (2025). Innovations in healthcare and outcome measurement. https://doi.org/10.1007/978-3-031-77302-0
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/102/106/102106036/
2	https://www.classcentral.com/course/stem-cells-10745
3	https://research.pasteur.fr/en/course/mooc-advances-in-stem-cell-biology/
4	http://ecoursesonline.iasri.res.in/course/view.php?id=733
5	Kong M, Zeng Y, Wu Z, Deng H, Zhang B, Feng D, Zhang Y, Zhang W, Fu X and Wang L (2025). Artificial intelligence for design strategies of tissue engineering materials. Fundamental Research. https://doi.org/10.1016/j.fmre.2025.09.010
6	Malviya R, Rajput S and Vaidya M (2024). Integrating AI With Tissue Engineering. In Artificial Intelligence for Bone Disorder. https://doi.org/10.1002/9781394230914.ch2
Course Designed By: **Dr. P. Ekambaram, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	M	S	M
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBC10	PLANT BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 10	4	✓	-	4
Pre-requisite		Basic Knowledge of Plant Science	Syllabus Version	2026-27		

Course Objectives:

The main objectives of this course are to:

1. Provide comprehensive knowledge of molecular markers, marker-assisted breeding, and plant tissue culture techniques for crop improvement.
2. Develop a thorough understanding of plant genetic transformation methods, transgene expression strategies, and genome engineering technologies.
3. Equip students with knowledge of advanced plant biotechnology approaches, including transgenic technology, molecular pharming, and biosafety considerations for sustainable crop improvement.

Expected Course Outcomes:

On the successful completion of the course, the student will be able to:

CO1	Explain the principles of molecular markers, marker-assisted breeding, and allele mining, and apply these approaches for crop improvement.	K2, K3, K4
CO2	Apply plant tissue culture techniques, including micropropagation, somatic embryogenesis, protoplast culture, somatic hybridization, and germplasm conservation for plant improvement.	K1, K3, K4, K6
CO3	Analyze plant genetic transformation methods, vector design, and transgene expression strategies for the development of transgenic plants.	K2, K3, K4, K5
CO4	Evaluate advanced plant biotechnology approaches, including RNAi, genome editing, CRISPR/Cas systems, and biosafety aspects for crop improvement.	K3, K4, K5
CO5	Design appropriate transgenic strategies to improve agronomic traits, nutritional quality, stress tolerance, molecular pharming, and other agricultural applications.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Molecular Markers and Marker - Assisted Breeding	10 hours

Introduction. Genetic markers in plant breeding. Classical markers: Morphological markers, cytological markers, biochemical/protein markers. DNA markers: Restriction Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), Simple Sequence Repeat (SSR), Single Nucleotide Polymorphisms (SNP), Sequence-Tagged Sites (STS) markers. Marker-assisted breeding. Marker-assisted selection. Allele mining for crop improvement.

Unit:2	Plant Cell and Tissue Culture - Applications	10 hours

Concepts and techniques in plant tissue culture: Totipotency, Tissue culture media, Plant hormones. Micropropagation, Direct and indirect organogenesis, Direct and indirect somatic embryogenesis, Transfer and establishment of whole plant in the soil, greenhouse technology. Cell suspension culture and root culture. Applications of plant tissue culture. National certification and Quality management of TC plants. Virus elimination by meristem culture, meristem tip culture and micrografting. Embryo

culture and embryo rescue techniques. Ovule, ovary culture and endosperm culture. Artificial seeds. Androgenesis and gynogenesis - production of androgenic and gynogenic haploids, diploidization. Protoplast culture - isolation and purification, Protoplast fusion. Somatic hybridization - Production of Somatic hybrids and Cybrids - Applications. Somaclonal and gametoclonal variations - causes and applications. *In vitro* germplasm storage and cryopreservation.

Unit:3	**Plant Genetic Transformation Techniques**	**10 hours**

DNA delivery methods: *Agrobacterium* mediated method - crown gall and hairy root disease, Ti and Ri plasmids, Ti plasmid-based transformation, mechanism of T-DNA transfer, T-DNA genes, chromosomal and Ti plasmid virulence genes and their functions, *vir* gene induction, Ti plasmid vectors, vir helper plasmid, super virulence, binary vector, borders and overdrive. Ri plasmid-based transformation and development of hairy roots. Direct DNA delivery methods - protoplasts using PEG, electroporation, particle bombardment. Chloroplast transformation, Agroinfiltration and floral dip transformation.

Unit:4	**Design of Gene Construct and Advanced Technologies**	**10 hours**

Factors influencing transgene expression. Designing of plant transformation vector - Promoters and polyA signals, signal peptides, Plant selectable markers, Reporter genes. Positive selection, Selectable marker elimination, Transgene silencing, Strategies to avoid transgene silencing, Analysis of transgenic plants. Advanced technologies - cis genesis and intragenesis, RNAi technology, genome editing technology, CRISPR/Cas. Bio-safety concerns of transgenic plants. Global status of transgenic plants.

Unit:5	**Application of transgenic technology**	**10 hours**

Applications of transgenic crop technology: Herbicide resistance. Pest resistance - Bt toxin, synthetic Bt toxin, Protease inhibitor, and other plant derived insecticidal genes. Nematode resistance. Crop engineering for disease resistance. Genetic improvement of abiotic stress tolerance. Genetic engineering for male sterility- Barnase-Barstar. Delayed fruit ripening - polygalacturanase, ACC synthase, ACC oxidase. Engineering for nutritional quality - Improved seed storage proteins, Improving and altering the composition of starch and plant oils, Enhancement of micro-nutrients - beta carotene, vitamin E, iron. Molecular pharming - production of antibodies and pharmaceuticals in plants.

Unit:6	**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars

	Total Lecture hours	**52 hours**

Text Book(s)

1	Slater, Scott and Fowler (2008). Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, UK, 2nd edition.
2	Dixon RA and Gonzales RA (1994). Plant cell culture. A practical approach, Oxford University Press. UK, 2nd edition.
3	Razdan MK (2003). An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. 3rd edition.

4	Chawla HS (2009). Introduction to plant biotechnology, 3rd edition.
5	Cassells AC and Peter B Gahan (2006). Dictionary of Plant Tissue Culture. Food Products Press, an Imprint of the Haworth Press, Inc., New York-London-Oxford.
6	Slater A, Scott N and Fowler N (2008). Plant Biotechnology – the Genetic Manipulation of Plants, Second Edition, Oxford University Press.
7	Christou P and Klee H (2004). Handbook of Plant Biotechnology, 2nd volume set, Wiley publisher.
8	Bhojwani and Dantu (2013). Plant Tissue Culture: an Introductory Text, Springer, New Delhi.
9	Bhojwani SS and Razdan MK (2009). Plant Tissue Culture-Theory and Practice, Elsevier India Pvt. Ltd.
Reference Books	
1	Mantel, Mathews, and Mickee (1985). An introduction to genetic engineering in plants, Blackwell Scientific Publishers. UK.
2	Pierik (1987). In Vitro Culture of higher plants. Martinus Nijhoff Publisher, Germany.
3	Grierson and Convey (1984). Plant Molecular Biology, Blackie and Son Limited, USA.
4	Mantell and Smith (1983). Plant Biotechnology, Cambridge University Press, UK.
5	Chrispeels and Sadava (2000). Plants, genes, and agriculture, The American Scientific Publishers, USA.
6	Henry (1997). Practical Application of Plant Molecular Biology, Chapman and Hall, UK.
7	Hammond, Garvey Mc and Yusibov (2000). Plant Biotechnology, Springer Verlag, UK.
8	Caldentey KMO and Barz W (2002). Plant Biotechnology and Transgenic Plants, Marcel Dekker, Inc. USA.
9	Gilmartin and Bowler (2002). Molecular Plant Biology: A practical approach (Vol. I and II), Oxford University Press, UK.
10	Song et al. (2016). CRISPR/Cas9: A powerful tool for crop genome editing, The Crop Journal, 4: 75-82.
11	Senthil-Kumar M and Mysore KS (2010). RNAi in plants: recent developments and applications in agriculture, Gene silencing: theory, techniques, and applications, 183-199.
12	Dalakouras A, Wassenegger M, Dadami E, Ganopoulos I, Pappas M and Papadopoulou KK (2020). GMO-free RNAi: exogenous application of RNA molecules in plants, Plant Physiology, pp-00570.
13	Gilchrist E and Haughn G (2010). Reverse genetics techniques: engineering loss and gain of gene function in plants, Briefings in functional genomics, 9(2), 103-110.
14	Sedeek KE, Mahas A and Mahfouz M (2019). Plant genome engineering for targeted improvement of crop traits, Frontiers in plant science, 10, 114.
15	Horn ME, Woodard SL and Howard JA (2004). Plant molecular farming: systems and products, Plant cell reports, 22(10), 711-720.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]	
1	https://nptel.ac.in/courses/102/103/102103016/
2	https://www.mooc-list.com/tags/biotechnology
3	https://www.coursera.org/courses?query=biotechnology
4	http://www.intechopen.com/books/genetic-transformation
5	https://link.springer.com/book/10.1007% 2F978-3-662-07424-4
6	https://link.springer.com/book/10.1007%2F978-81-322-1026-9
7	http://www.ebook777.com/plant- tissue-culture-development-biotechnology/
8	http://www.fao.org/3/i1905e/i1905e00.pdf
Course Designed by **Dr. M. Arun, Assistant Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	L	L	M
CO2	S	S	M	L	M
CO3	S	S	M	M	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBC11	BIOPROCESS TECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper -11	4	✓	-	4
Pre-requisite		A Basic Knowledge in Bioprocess Technology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are:

1. To impart knowledge on Bioreactors to mass multiply microorganisms at industrial scale.
2. To introduce the concept of growth kinetics and production kinetics with biologists' perspective.
3. To learn various types of bioreactors and specialized ones; also, to learn about their process controls.
4. To enlighten on downstream processing to convert output as value added products.
5. To obtain overall holistic knowledge on fermentation technology to produce various biologicals of economic value.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Learn microbiology at industrial perspective rather restricting with laboratory level understanding at larger scale.	K1, K2
CO 2	Get introduced to mathematical terms and use tools to forecast production in larger scale for industrial applications.	K2, K3, K4
CO 3	Understand simple and complex bioreactors used for scale-up; learning those control parameters and equipments to maximise production.	K1, K2, K3
CO 4	Learn the methods of cell harvesting, disruption techniques and further methods to purify the product for packing, shipping, storing and marketing.	K3, K4, K5
CO 5	Understand select biological products in market and to learn about the methods of production to imbibe such novel variants through innovations.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Basics of Bioprocess technology	10 hours

Introduction to Bioprocess Technology: History of fermentation industry - Fermentation process: General requirements and product range; Microbial biomass, microbial enzymes, microbial metabolites, recombinant products, transformation processes.

Media for industrial fermentation: Essential criteria for media, Media components, Media formulation, Media optimization.

Sterilization: Significance, Types of sterilization – Batch and continuous; Physical and Chemical sterilization.

Inoculum development: Inoculum source – Seed culture; development of inocula for yeast, bacteria and fungi.

Unit:2	Microbial Growth Kinetics and Production Kinetics	10 hours

Microbial growth kinetics: Phases of cell growth, Factors affecting cell growth, Kinetic model for cell growth: Monod's model, Mass balances for bioreactors, Design equations.

Production Kinetics: Multiple reactions: Simple reaction, parallel reaction, series reaction, series-parallel reactions; homologous and heterologous reaction system, Stoichiometry – Order of reactions.

Unit:3	Bioreactor types and Upstream essentials	10 hours

Bioreactors: Introduction to bioreactors - Aerobic and anaerobic fermentation; solid state and submerged fermentation; Types of Bioreactors: Batch, continuous and fed-batch (variants), Specialized bioreactors (fluidized bioreactors, photo bioreactors, immobilized cell reactors, airlift bioreactor, packed bed bioreactor);

Design and construction of Bioreactors: Monitoring and control of bioreactor: Online and offline control, Controlling systems: Temperature, flow rate, pressure, pH, DO, gas analysis.

Unit:4	Downstream processing	10 hours

Biomass removal: Separation of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration

Disintegration of microorganism: Sonication; Bead mills, Homogenizers, Chemical lysis, Enzymatic lysis.

Purification methods: Ultrafiltration, Reverse osmosis, Dialysis, Diafiltration, Adsorption and chromatography: size, charge, shape, hydrophobic interactions, biological affinity; Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Extraction (solvent, aqueous two phase, super critical), **Drying:** spray driers, drum driers and freeze driers.

Unit:5	Microbial products in pharmaceutical, food and agriculture industry	10 hours

Production, harvest, recovery and uses: Enzymes, Antibiotics (penicillins, tetracycline, streptomycin), vitamins (B_2, B_{12}), Aminoacids (lysine, glutamic acid, arginine, threonine), Organic solvents (acetone, butanol, ethanol, glycerol); Organic acids (acetic acid, citric acid, lactic acid). Use of microbes in mineral beneficiation and oil recovery; Bioconversion of Methane or CO_2 to edible protein production.

Production, harvest, recovery and uses: Baker's yeast, milk products, edible mushrooms, Single Cell Protein (algae/fungi), beverages (Beer, Wine and Brandy).

Formulation of Biofertilizer (Rhizobium, Pseudomonas) and Biopesticides (*Bacillus thruingiensis*).

Unit:6	Contemporary Issues	2 hours

Expert lectures, Assignments, Student Seminar and Webinars

	Total Lecture hours	52 hours

Text Book(s)

1	Waites MJ, Morgan NL, Rockey SJ and Higton G (2002). Industrial Microbiology, Blacwell Science.
2	Doran PM (2005). Bioprocess Engineering Principles, Academic Press.

3	Stanbury PF and Whitaker A (2005). Principles of Fermentation technology, Pergamon press. 2nd edition.
4	Rao DG (2010). Introduction to Biochemical engineering, McGraw-Hill publications, 1st edition.
5	Prescott and Dunns (2007). Industrial Microbiology, Chapman & Hall publications, 4th edition.
Reference Book	
1	Mansi E, Bryce CFA, Demain AL and Allman AR (2007). Fermentation microbiology and Biotechnology. Taylor and Francis, 2nd edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/102/106/102106084/ (Industrial Biotechnology)
2	https://nptel.ac.in/content/syllabus_pdf/102106053.pdf (Bioreactors)
3	https://swayam.gov.in/nd1_noc20_bt25/preview (Downstream Processing)
4	Bioprocess Technology - NPTEL
Course Designed By: **Dr. S. R. Prabagaran, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	L	S	L	M
CO2	S	S	L	L	M
CO3	S	M	S	L	L
CO4	S	S	M	M	M
CO5	S	L	S	M	S

*S-Strong; M-Medium; L-L

Course code	26BIOBC12	BIOINFORMATICS AND SYSTEMS BIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 12	4	✓	-	4
Pre-requisite		Basic Operations of Computers; Knowledge in Proteomics, Genomics, Cellular Function and Signalling	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. To gain basic knowledge in the concept of systems biology and essential of bioinformatics.
2. To understand the network behaviour of the biological system and in particular their dynamic aspects, which requires the utilization of mathematical modelling tightly linked to the experiment.
3. To understand some of the larger questions and issues with systems biology and large-scale data collection and analysis.

Expected Course Outcomes:

On the successful completion of the course, the student will be able to:

CO1	Analyze molecular databases for systems biology research.	K1, K2, K3, K4
CO2	Examine gene expression data using molecular regulatory frameworks and discuss their use in systems biology.	K1, K3
CO3	Appraise metabolic pathways and linear biochemical network models.	K2, K3, K4, K5
CO4	Assess multi-omics integration strategies and synthetic biology applications.	K3, K4, K5
CO5	Select appropriate computational platforms for biological systems modelling.	K3, K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Databases and Retrieval tools	10 hours

Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis. Molecular databases: accessibility, compatibility, comprehensive database, portability, quality, and navigability. Systems Biology: Definition, Hypothesis-driven research in systems biology, Wet Experiments-Dry experiments: predictions and simulations. Reductionist and Integrative approach.

Unit:2	Genes and Genomes	10 hours

Interpreting expression data using Gene Ontology; Evolution of modularity and transcriptional networks, Riboswitches, metabolite sensing, and translational control; Microarrays: types, Data analysis and applications; Importance of non-coding sequence.		
Unit:3	**Pathway Bioinformatics**	**10 hours**
Protein-carbohydrate metabolism; Biochemical cycles; Interconnection of pathways-metabolic regulation; Translating biochemical networks into linear algebra; KEGG: theory and practice.		
Unit:4	**OMICS Concepts**	**10 hours**
Genomics, Proteomics, Metabolomics, Transcriptomics, Interactomics, Phenomics, Localizomics; Gene networks - Integration of Networks. Combination of omics approaches: data integration, modelling; Synthetic biology, Artificial Intelligence (AI): Methodology, tools, and its application in agriculture, drug discovery.		
Unit:5	**Introduction to Tools used in Systems Biology**	**10 hours**
SimTK; Gaggle; Systems Biology Workbench; Systems Biology Markup Language; The CellML language; The little b Modelling Language; COPASI (Version 4 of Gepasi); E-Cell System; StochSim; Virtual Cell; JigCell (John Tyson Lab); Python Simulator for Cellular Systems; Ingenuity Pathways Analysis; BIOREL; SAVI Signalling Analysis and Visualization; JSim; BioNetGen; SBML-PET.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**52 hours**

Text Book(s)	
1	Pevsner JA (2015). Bioinformatics and Functional Genomics. John Wiley & Sons, Inc., USA, 3rd Edition.
2	Choi S (2007). Introduction to Systems Biology, Humana Press, USA, 3rd Edition.
3	Baxevanis AD, Ouellette BFF (2020). Bioinformatics, John Wiley & Sons, Inc., USA, 4th Edition.
Reference Books	
1	Kitano (2002). Systems Biology: A Brief Overview. Science, 295: 1662-1664.
2	Ideker et al. (2001). A new approach to decoding life: Systems Biology. Annual Review on Genomics and Human Genetics, 2: 343-372.
3	Ideker et al. (2001) Integrated Genomic and Proteomic Analyses of a Systematically Perturbed Metabolic Network. Science, 292: 929-934.

4	Ge et al. (2003). Integrating "omics" information: a bridge between genomics and systems biology. Trends in Genetics,19, 10: 551-560.
5	Chong et al. (2002). Wholistic Biology, Science, 295:1661.
6	Catherine et al. (2005). The European Bioinformatics Institute's data resources: towards systems biology. Nucleic Acids Research, 33:46-53.
7	Garst AD, Edwards AL, and Batey RT (2011). Riboswitches: structures and mechanisms. Cold Spring Harbor perspectives in biology, 3(6), a003533.
8	Kanehisa M, Sato Y, Furumichi M., Morishima K. and Tanabe M (2019). A new approach for understanding genome variations in KEGG. Nucleic acids research, 47(D1), D590-D595.
9	El Karoui M., Hoyos-Flight M and Fletcher L (2019). Future Trends in Synthetic Biology–A report. Frontiers in bioengineering and biotechnology, 7, 175.
10	Kantarjian H and Yu PP (2015). Artificial intelligence, big data, and cancer. JAMA oncology, 1(5), 573-574.
11	Shanmuganathan S (2016). Artificial neural network modelling: An introduction. In Artificial neural network modelling (pp. 1-14). Springer, Cham.
12	Urban J, Cisar P, Pautsina A, Soukup J and Barta A (2013). Artificial Intelligence in Biology. Technical Computing Prague, 326.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]	
1	https://www.mooc-list.com/tags/biotechnology
2	https://onlinecourses.nptel.ac.in/noc20_bt08/preview
3	https://swayam.gov.in/explorer?category=Domain_41

Course Designed By: **Prof. R. Sathishkumar, Professor, Department of Biotechnology**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	M	L	L	M
CO3	S	S	L	L	M
CO4	M	S	M	M	S
CO5	S	M	M	L	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGE03A	NANOBIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Elective - 3	4	✓	-	4
Pre-requisite		Basic Knowledge in Biological and Chemical Structures	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide fundamental knowledge of nanobiotechnology, nanomaterials, and their synthesis, characterization, and functional properties.
2. Develop an understanding of nanotechnology-based approaches in drug delivery, diagnostics, biosensing, catalysis, and other biomedical and industrial applications.
3. Equip students with knowledge of nanomaterial safety, nanotoxicity, environmental impacts, and emerging applications of nanobiotechnology in healthcare, agriculture, food, and environmental sciences.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the principles, classification, synthesis, characterization, and physicochemical properties of nanomaterials used in nanobiotechnology.	K2, K3, K4
CO2	Apply nanotechnology principles to the design and evaluation of nanoparticles for drug delivery, diagnostics, imaging, biosensing, and therapeutic applications.	K1, K3, K4, K5
CO3	Analyze the preparation, functionalization, and biomedical applications of nanomaterials, including nanovesicles, nano capsules, quantum dots, carbon nanotubes, and related nanostructures.	K2, K3, K4
CO4	Evaluate the applications of nanomaterials in catalysis, agriculture, food, cosmetics, environmental biotechnology, and other industrial sectors.	K3, K4, K5
CO5	Assess the safety, nanotoxicity, environmental fate, and regulatory considerations associated with nanomaterials for their responsible and sustainable applications.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Nanobiotechnology	10 hours

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Types of nanomaterials and their classifications (1D, 2D and 3D). Nanocrystal, Nanoparticle, Quantum dot, Polymer, Carbon, Inorganic, Organic and Biomaterials.

Unit:2	Nanoparticle Synthesis	10 hours

Synthesis and characterization of different nanomaterials. Synthesis and characterization of metal, polymeric nanoparticles. Physical and chemical methods. And Biological synthesis. Colloidal

nanostructures; Quantum dots, Carbon nanotubes. Self-Assembly, Nanovesicles; Nanospheres; Nano-capsules		
Unit:3	**Nano-particles in drug delivery**	**10 hours**
Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers. Methods of drug loading in nano materials. Methods used to study cellular internalization of nanomaterials.		
Unit:4	**Herbal Formulation**	**10 hours**
Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. Nanosensors for neuronal disorders.		
Unit:5	**Toxicity – Regulations and Herbal Products**	**10 hours**
Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in synthesis, applications of nanobiocatalysis in the production of drugs and drug intermediates. Nanoparticles applications in Agriculture, Food, Environment and cosmetic Industry.		
Unit:6	**Contemporary Issues**	**2 hours**
Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for nanotoxicity assessment; Fate of nanomaterials in different state of environment; Eco- toxicity models and assays; Life cycle assessment, containment.		
	Total Lecture hours	**52 hours**

Text Book(s)

1	Decher G and Schlenoff JB (2003). Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA.
2	Goodsell DS (2004). Bionanotechnology: Lessons from Nature, Wiley-Liss.
3	Malsch NH. Biomedical Nanotechnology, CRC Press
4	Hermanson GT (2013). Bioconjugate Techniques, Elsevier, 3rd edition.
5	Singh R and Gupta SM (2016). Introduction to Nanotechnology, PP:604. ISBN:9780199456789, 1st edition.
6	Pool PC (2020). Introduction to Nanoscience and Nanotechnology. Wiley publisher. PP.508.
7	Kumar N and Kumbhat S (2016). Essentials in Nanoscience and Nanotechnology. Wiley publisher. PP.465. ISBN: 978-1-119-09611-5.
8	Hamdy AS, Barhoum MA (2018). Fundamentals of Nanoparticles.1st Edition. Elsevier. PP.666. Paperback ISBN: 978032351255.
9	Kane DM and Roger AMP (2016). Nanomaterials Science and Applications.1st Edition Jenny Stanford Publishing, PP.418. ISBN 9789814669726.

10	Kumar V, Guleria P, Shivendu R, Dasgupta N and Lichtfouse E (2021). Nanotoxicology and Nanoecotoxicology. Springer International publisher. Vol. 1. pp:318. ISBN 978 3030632410.
11	Nouailhat A (2006). An Introduction to Nanoscience and Nanotechnology. France by Hermes Science/Lavoisier. DOI: https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf
12	Ranzoni A and Cooper MA (2017). Chapter One – The Growing Influence of Nanotechnology in Our Lives. Micro and Nanotechnology in Vaccine Development.PP:1-20.
13	Aliof khazraei and Mahmood (2015). Handbook of Nanoparticles. Springer publisher. ISBN: 978 3319153391.
14	Khan I , Saeed K , Khan I (2019). Nanoparticles: Properties, applications and toxicities. The Arabian journal of chemistry.12(7). PP:908-931.
15	Rajendran S, Mukherjee A, Nguyen T, Godugu C and Shukla R (2020). Nanotoxicity. 1st Edition. Elsevier.pp;504. ISBN: 9780128199442
Reference Books	
1	Arora P and Arora V (2019). Text book of herbal drug technology, PV Books publishing.
2	Mukheerjee PK (2019). Quality Control and Evaluation of Herbal Drugs: Evaluating Natural Products and Traditional Medicine, Elsiever.
3	Arman dekebo (2019). Introductory chapter: plant extracts, DOI: 10.5772/intechopen.85493 pp-48.
4	Yuan H, Ma Q, Li Ye and Piao G (2016). The Traditional Medicine and Modern Medicine from Natural Products, Molecules, 21-559, DOI: 10.3390 /molecules 21050559.
5	Bijauliya RK, Alok S, Chanchal DK and Kumar M (2017). A comprehensive review on standardization of herbal drugs. International journal of pharmaceutical sciences and research. DOI: 10.13040/IJPSR.0975-8232.8(9).3663-77.
Related Online Contents	
1	https://www.slideshare.net/kirtisingh2011/nanotechnology-ppt
2	http://home.iitk.ac.in/~anandh/MSE694/Introduction_to_Nanomaterials-3.pdf
3	https://travelmantratechnologies.blogspot.com/2021/03/nanofilms-ppt-ppt-nanofilm-technology.html
4	https://application.wiley-vch.de/books/sample/3527331972_c01.pdf
5	https://www.slideshare.net/ganapati123/nanoparticle
6	https://www.slideshare.net/ShrihithRao/application-of-nanotechnolog 71235555
7	https://www.eolss.net/Sample-Chapters/C05/E6-152-35-00.pdf
8	https://nptel.ac.in/courses/118/102/118102003/
9	https://ndl.iitkgp.ac.in/homestudy/science
Course Designed By: **Dr. N. Ponpandian, Professor, Department of Nanotechnology and Sciences**	

Mapping with Programme Outcomes					
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	S	M	L	M
CO3	S	S	M	L	M
CO4	S	S	M	M	S
CO5	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGE03B	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
Core/Supportive/Elective		Elective - 3	4	✓	-	4
Pre-requisite		A Basic Knowledge in Pharmaceutical Biotechnology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. To provide an overview about identifying drug targets and strategies to develop drugs.
2. To learn about basic and essential qualities of a candidate drug and testing methods.
3. To understand the prerequisites of obtaining drug approval, important aspects of commercialization.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Acquire knowledge about natural sources of drugs, interaction of drugs with different types of biological molecules to mediate physiological effects, metabolism and removal of drugs from the system. Learn about intricate aspects of drug development that need to be implied during new drug development.	K2
CO2	The students will get an insight about how various biological systems can be used for biopharmaceutical production. Learn key aspects and methodologies which can transform into their skills. Understanding the advantages and pitfalls of these systems will support them during analysis and decision making during practical application.	K5
CO3	Obtain comprehensive knowledge about vital facets of clinical testing in obtaining approval for new drugs. Improve their prudent skills to be employed in drug discovery efforts.	K4
CO4	Learn about emerging powerful tools employed for efficient and safe delivery of drugs into the host system. Enhance their decision-making capacity to choose right system for drug delivery.	K6
CO5	Understand the roles, responsibilities and organizational structure of regulatory bodies. Obtain in depth knowledge which can be useful for practical applications while preparing drug approval applications.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Pharmaceuticals	10 hours

Pharmaceutical Biotechnology: Pharmacology, Clinical pharmacology, Drug Legislation & safety, Drugs, Types of drugs- Pharmaceuticals, Biopharmaceuticals, Drug-Nomenclature, Source of drugs – plant, animals, microbes and minerals. Extraction of phytochemicals and evaluation in plants. Drug metabolism – Pharmacokinetics – Absorption, Distribution, Metabolism and Excretion (ADME), Drug

efficacy & toxicity- Therapeutic window, Therapeutic Index. Pharmacodynamics – Mechanism of drug action. Drug doses.		
Unit:2	**Drug Targets and Pharmacogenomics**	**10 hours**
Impact of genomics and proteomics on drug discovery. Biomarkers in early drug development. Pharmacogenomics; Pharmacogenetics; Benefits; Practical applications of pharmacogenomics; Human genetic variation examples of CYP gene variations leading to variable metabolism of drugs. Personalized medicine, example of TPMT and DPD gene mutation and their impact in treatment strategy.		
Unit:3	**Production of Biopharmaceuticals**	**10 hours**
Prokaryotic and Eukaryotic Cells in Biotech Production: Use of Bacteria and Actinomycetes in Biotech Production, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in Biotech Production, Plants and Plant Cell Culture as Bioreactors for pharmaceuticals. Use of animal cell culture system in biopharmaceutical production. Biopharmaceutical products – Hormones, enzymes, antibiotics, blood products, nucleic acids and antibodies of therapeutic interest. Biosimilars.		
Unit:4	**Drug Manufacturing Principles and Regulatory Aspects**	**10 hours**
Good Manufacturing Practice (GMP): Chemical reactions that affect pharmaceutical products – Oxidation, reduction, hydrogenation, dehydrogenation. Preservatives and phenolic compounds in drug formulations. Manufacturing principles –. Quality control. Guidelines for packing procedure and use of different techniques. Regulatory authorities –Central drug standards control organisation, food and drug administration, European regulations.		
Unit:5	**Drug Development Process and Delivery Systems**	**10 hours**
Initial product characterization- Physico – chemical properties of the drugs. Pre-clinical studies. Toxicity studies – reproductive toxicity and teratogenicity, mutagenicity, carcinogenicity and other tests, clinical trials, clinical trial design, trial size design and study population. Delivery of biopharmaceuticals – oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery system. Targeted approaches: Applications of Nano-biotechnology in drug development and delivery. Polymeric and metallic nanoparticles for drug delivery. Nanotechnology for Cancer Diagnostics and Treatment.		
	Total Lecture hours	**52 hours**

Text Book(s)

1	Walsh G (2013). Pharmaceutical Biotechnology: Concepts and Applications. Wiley India Pvt Ltd. 1st Edition.
2	Crommelin DJ and Sindelar RD (2008). Pharmaceutical Biotechnology: Fundamentals and Applications. CRC Press. 5th Edition

Reference Books

1	Chavda VP and Chen ZSJ (2026). Advances in Pharmaceutical Biotechnology: Volume 1: Exploring Cutting-Edge Innovations and Applications. CRC Press. 1st Edition.
2	Kayser O and Warzecha H (2012). Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications. John Wiley & Sons. 2nd Edition
3	Sambamurthy K (2006). Pharmaceutical Biotechnology. New Age International. 3rd Edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Online Refresher course in Pharmacy for Higher Education- AICTE- Swayam
2	Spectroscopic techniques for pharmaceutical and Biopharmaceutical industries- NPTEL
3	Computer aided drug design- NPTEL
4	Drug Delivery: Principles and Engineering-NPTEL
Course Designed By: **Dr. V. Thirunavukkarasu, Associate Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	L	M	L
CO2	S	S	L	M	L
CO3	S	S	M	S	M
CO4	S	S	M	S	M
CO5	S	S	L	S	M

*S-Strong; M-Medium; L-Low

Course code	26BIOBCP3	APPLIED BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Practical -3	6	-	✓	4
Pre-requisite		Basic Skills in Biotechnology	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide hands-on training in advanced tools and techniques used in applied biotechnology across plant, microbial, animal, and molecular systems.
2. Develop technical competence in molecular diagnostics, cell and tissue culture, genetic transformation, bioanalytical techniques, and bioinformatics for biotechnology research.
3. Enable students to integrate multidisciplinary biotechnology approaches to investigate biological problems and conduct research using modern laboratory practices with due consideration for biosafety and ethical standards.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Perform cell culture, primary cell isolation, viability assays, immunohistochemistry, and zebrafish-based experimental techniques for biological investigations.	K2, K3, K4
CO2	Apply plant and microbial biotechnology techniques, including Agrobacterium-mediated transformation, bacterial transformation, DNA barcoding, genome editing, and metabolite analysis for research and crop improvement.	K3, K4, K5
CO3	Perform advanced molecular biology techniques, including RNA isolation, PCR, SNP detection, Northern blotting, reporter gene analysis, and molecular diagnostics for biological sample analysis.	K2, K3, K4, K5
CO4	Analyze microbial communities, optimize microbial processes using statistical approaches, and evaluate biochemical and molecular responses using advanced analytical techniques.	K3, K4, K5
CO5	Design and integrate advanced biotechnology methodologies for disease diagnosis, functional genomics, transgenic research, and applied biotechnology while adhering to laboratory safety and ethical practices.	K3, K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Molecular Toxicology (Dr. P. Ekambaram)	**9 hours**

1. Preparation of primary cells from animal tissue, cell counting and viability.
2. Visualization of F-actin by Phalloidin staining.
3. Whole mount immunohistochemistry in Zebrafish embryos/larvae

Plant Genetic Engineering (Dr. R. Sathishkumar)	**9 hours**
1. Demonstration of a photobioreactor for plant cell culture and secondary metabolite synthesis. 2. Detection of adulteration in herbal products by DNA barcoding technology. 3. Detection of Genetically Modified Organism (plant) by PCR.	
Molecular Microbiology (Dr. S.R. Prabagaran)	**9 hours**
1. Metagenomic DNA isolation from soil. 2. Transformation of plasmid in bacteria through the heat shock method. 3. Optimization of bacterial media through Response Surface Methodology (RSM).	
Plant Biotechnology (Dr. S. Girija)	**9 hours**
1. Analysis of antimicrobial activity of medicinal plant extract using the Kirby-Bauer disk diffusion method. 2. Quantification of plant secondary metabolites using HPLC. 3. Estimation of phenolic compounds using hairy root cultures.	
Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**
1. Isolation and quantification of total RNA using Spectrophotometer for cDNA preparation and Single Nucleotide Polymorphism (SNP) detection using allelic PCR. 2. Molecular Diagnosis of dengue and chikungunya virus infections by detecting their nucleic acids in biological samples using PCR. 3. Detection and analysis of RNA using Northern blotting.	
Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)	**9 hours**
1. Estimation of Blood Bilirubin by biochemical colorimetric method. 2. Enumeration of number and morphology of nucleus in tissue using DAPI/PI staining. 3. Localization of specific protein in the tissue sample by Immunohistochemistry (IHC).	
Plant Molecular Biology (Dr. M. Arun)	**9 hours**
1. Bacterial transformation by electroporation and colony PCR 2. Reporter gene (GUS) analysis in transformed tissues. 3. Designing guide RNA and developing knock-down construct for CRISPR based genome editing.	
Regenerative Engineering and Molecular Medicine (Dr. M. A. Shibu)	**9 hours**
1. Cytotoxicity screening of chemotherapy drugs in cultured cells using LDH assay. 2. Mitochondrial staining to study their membrane potential with TMRM staining. 3. Quantitative analysis of reactive oxygen species in human RBCs at different concentration of drug treatment by DCFDA assay.	
Total practical hours	**72 hours**

Text Book(s)

1	Riss TL, Moravec RA, Niles AL, Benink HA and Lisa Minor (2013). Cell Viability Assays manual. NCBI.

2	Wang K (2015). Agrobacterium protocols. Methods in Molecular biology, springer protocols,2(3): 372.
3	Glowacka K, Kromdijk J, Leonelli L, Niyogi KK, Clemete TE and Long SP (2016). An evaluation of new and established methods to determine T-DNA copy number and homozygosity in transgenic plants. Plant Cell Environ 39(4):908-917.

Reference Books

1	Alves DL, Benedito E, Lopes A and Fonseca (2017) Sensitivity and detection of chikungunya viral genetic material using several PCR-based approaches, Rev. Soc. Bras. Med. Trop. vol.50.
2	Verma SK, Singh H and Sharma PC (2017). An improved method suitable for isolation of high-quality metagenomics DNA from diverse soils. 3 biotech,7(3):171.
3	Devi SG, Fathima AA, Radha S, Arunraj R, Curtis WR and Ramya M (2015). A Rapid and Economical Method for Efficient DNA Extraction from Diverse Soils Suitable for Metagenomic Applications, PLoS ONE 10(7): e0132441.
4	Li X (2011). Infiltration of *Nicotiana benthamiana* Protocol for Transient Expression via *Agrobacterium*. *Bio-101*: e95. DOI: 10.21769/BioProtoc.95.
5	Narayanan R and Oates AC (2019). Detection of mRNA by Whole Mount *in situ* Hybridization and DNA Extraction for Genotyping of Zebrafish Embryos. *Bio-protocol* 9(6): e3193. DOI: 10.21769/BioProtoc.3193.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	http://histologia.ugr.es/pdf/cac012.pdf
2	https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics/cell-culture-protocols/freezing-cells.html
3	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6810642/
4	https://assets.fishersci.com/TFS-Assets/LSG/Methods-&-Protocols/D16961~.pdf
5	https://info.gbiosciences.com/blog/the-sandwich-elisa-process-and-practical-applications
6	https://images.novusbio.com/design/BR_IHCGuide_011017_web.pdf
7	https://assets.thermofisher.com/TFS-Assets/BID/Application-Notes/TR0067-Chemi-Western-guide.pdf
8	https://www.sciencedirect.com/book/9780122740107/gus-protocols
9	https://www.abcam.com/ps/products/102/ab102526/documents/ab102526%20LDH%20Assay%20Kit%20Colorimetric%20protocol%20v13d%20(website).pdf
10	https://protocols.scienceexchange.com/protocols/a-protocol-for-in-vivo-detection-of-reactive-oxygen-species
11	https://www.mybiosource.com/learn/testing-procedures/agrobacterium-mediated-gene-transfer/
12	https://onlinelibrary.wiley.com/doi/10.1002/9781119135388.ch5#:~:text=In%20the%20FRAP%20assay%2C%20a,across%20all%20samples%20and%20calibrators)

Course Designed By: **All Faculty**

Mapping with Programme Outcomes					
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	M	M	M
CO2	S	S	M	M	M
CO3	S	S	M	M	M
CO4	S	S	M	M	M
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOGS03	FOOD BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Supportive - 3	2	0	0	2
Pre-requisite		A Basic Knowledge in Food Science	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. Provide fundamental knowledge of food biotechnology, food constituents, food microbiology, and food processing technologies.
2. Develop an understanding of microbial applications, food preservation, fortification, packaging, and quality improvement in the food industry.
3. Familiarize students with modern biotechnological approaches, food safety regulations, and sustainable practices for food production and quality assurance.
4. Equip students with the knowledge required for entrepreneurship and career opportunities in food processing and allied industries.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the principles of food biotechnology, food constituents, food microbiology, and their significance in food production and nutrition.	K1, K2
CO2	Apply microbial and biotechnological approaches for food processing, fermentation, food fortification, and quality improvement.	K3, K4
CO3	Analyze food preservation, packaging technologies, and processing methods for enhancing food quality, safety, and shelf life.	K3, K4, K5
CO4	Evaluate food safety regulations, Good Manufacturing Practices (GMP), sanitation measures, and quality control systems in the food industry.	K4, K5
CO5	Propose sustainable and innovative biotechnological strategies for food production, value addition, entrepreneurship, and food security.	K5, K6

K1 – Remember; **K2** – Undestand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

Unit:1	Introduction to Food Technology	5 hours

The Importance and Source of Food. Classification of foods. Constituents of food and dietary sources of food – Carbohydrates, Lipids, Proteins, Water, Vitamins and Minerals.

Unit:2	Food Microbiology	5 hours

Food and beverage- yeast: Bread, Alcoholic beverages-wine, beer. Dairy products – cheese. Vegetable and fruit products – Sauerkraut, Pickles. Microbial Pigments, SCP-bacteria, algae and fungi.

Unit:3	Food Biotechnology	5 hours

Transgenic plants in quality modifications – Plants derived vaccines. Food fortification – Needs, objective. Methods for fortification – Iron, vitamins and zinc.

Unit:4	Basic Food Process Technology	5 hours

Principles and methods of food preservation: Asepsis removal, High temperature, Low temperature, Drying, Irradiation, Chemical and Biopreservatives.		
Unit:5	**Food Packaging Technology**	**4 hours**
Role and functions of food packaging. Food packaging materials –properties and types. Food sanitation, food control agencies and their regulations. Safety evaluation of novel food products. GMP.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**26 hours**

Text Book(s)	
1	Rai VR (2016). Advances in Food Biotechnology, Wiley- Blackwell.
2	Shetty K (2005). Food Biotechnology, Taylor & Francis group.
Reference Books	
1	Lee. BH (2016). Fundamentals of food Biotechnology, Wiley – Blackwell, 2nd edition.
2	Fellows P (2000). Food Processing Technology Principles and Practice, Woodhead Publishing Limited,2nd edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://epgp.inflibnet.ac.in/
2	https://www.nutritionintl.org/
3	http://ncert.nic.in/textbook/pdf/lehe105.pdf
Course Designed By: **Dr. S. Velayuthaprabhu, Assistant Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	M	M
CO2	S	S	M	M	M
CO3	S	S	M	S	M
CO4	S	S	M	S	S
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBCS1	One Month Summer Internship	L	T	P	C
Marks: 50		Internship	2	-	-	2
Course profile		Short Term Internship Course for a Minimum Period of 30 days	Syllabus Version	2026-27		

Course Objectives:

The main objectives of this course are to:

1. Provide students with practical exposure to professional, industrial, clinical, or research environments relevant to biotechnology.
2. Develop technical, analytical, communication, and professional skills by engaging in real-world biotechnology projects and workplace practices.
3. Enable students to apply biotechnology knowledge, demonstrate ethical and professional responsibility, and evaluate career opportunities through experiential learning.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Apply theoretical knowledge and laboratory skills acquired during the M.Sc. Biotechnology programme to perform assigned tasks in professional, industrial, clinical, or research environments.
CO2	Analyze workplace practices, organizational structure, project objectives, and professional responsibilities in biotechnology-related organizations.
CO3	Demonstrate professional competence, effective communication, teamwork, and ethical conduct while performing internship assignments.
CO4	Evaluate the scientific, technological, and societal significance of the internship project and interpret the outcomes in a professional context.
CO5	Prepare a comprehensive internship report, reflect on learning experiences, and propose future professional or research directions for continuous career development.

Programme Highlights:

- Internship shall be undertaken in a recognized biotechnology industry, research laboratory, academic institution, hospital, government organization, or other related organization.
- The internship organization shall be approved by the Course Coordinator/Mentor prior to commencement of the training.
- Students shall actively participate in research, industrial, technical, analytical, or professional activities relevant to the host organization.
- Students shall maintain an Internship Logbook/Work Diary documenting the activities carried out during the training period.
- At the completion of the internship, students shall submit a comprehensive Internship Report in the prescribed format.
- Students shall deliver a seminar/viva-voce presentation on the internship work before the departmental evaluation committee.
- The internship shall be evaluated based on the performance certificate from the host organization, internship report, seminar presentation, viva-voce, and overall professional conduct.

Course code	26BIOBCJ2	Assisted Reproductive Techniques	L	T	P	C
Core/Elective/Supportive		Job Oriented Certificate Course – 2	2	✓	✓	2
Pre-requisite		Basic Knowledge in Reproduction and Embryology	Syllabus Version		2026-27	

Name of the Department	**Biotechnology**
Name and Address of the Faculty Member i/c	Dr. S. Velayuthaprabhu Assistant Professor, Department of Biotechnology, Bharathiar University.
Inter / Intra Department Course	Intra Department Course
Duration of the Course	4 months
Eligibility	Only for II MSc Life science Students
Number of Candidates to be Admitted	35
Mode of the Course	Regular
Collaboration if any with Companies (if Yes, Full Address of the Company Address, Name of the Contact Person, Phone, e-mail etc.)	Chennai Fertility Centre and Research Institute, Department of clinical embryology and preimplantation genetics, Chennai - 600030

Job Opportunities: Successful candidate will get job in clinical laboratories and fertility centre.

The objectives of the Course are:

The main objectives of this course are to:

1	Provide fundamental knowledge of human reproductive biology, infertility, and the principles of assisted reproductive techniques (ART).
2	Develop an understanding of clinical andrology, embryology, cryopreservation, and in vitro fertilization (IVF) procedures used in fertility management.
3	Familiarize students with laboratory practices, quality assurance, safety, ethical considerations, and current guidelines in ART laboratories.
4	Equip students with the knowledge and practical skills required for employment in fertility centres, IVF laboratories, and assisted reproduction clinics.

Course Content	Lecture / Practical / Internship

Expected Course Outcomes:

On the successful completion of the course, student will be able to:		
CO1	Explain the principles of human reproductive physiology, infertility, clinical andrology, and embryology relevant to assisted reproductive techniques.	K1, K2
CO2	Apply the principles of semen analysis, sperm assessment, embryo evaluation, cryopreservation, and IVF laboratory procedures following established guidelines.	K3, K4
CO3	Analyze ART procedures, including IUI, IVF, ICSI, embryo implantation, and pregnancy assessment, for infertility management.	K3, K4, K5
CO4	Evaluate laboratory safety practices, quality assurance measures, ethical issues, and regulatory guidelines associated with assisted reproductive technologies.	K4, K5
CO5	Demonstrate professional competency in selecting appropriate ART procedures and propose suitable reproductive technologies for infertility management in clinical settings.	K5, K6

Module 1	**Andrology:** Physiology of the Male Reproductive System - Spermatogenesis	**3 hours**
Module 2	**Clinical Andrology:** Sperm morphology, structure and Function. Semen analysis – sperm motility and count; CASA systems. WHO and ESHRE guidelines.	**3 hours**
Module 3	**Embryology:** Oogenesis – Regulation, morphology and function.	**3 hours**
Module 4	**Clinical Embryology:** ovarian stimulation. Embryo selection - Embryo hatching - markers of competence.	**3 hours**
Module 5	**Cryobiology and Cryopreservation:** Principles of cryopreservation. Cryoprotectants and additives. Slow freezing. Cryopreservation of sperm, oocytes and embryos.	**3 hours**
Module 6	**IVF Techniques:** Oocyte retrieval. Sperm sample preparation - criteria; PESA, TESA, TESE. Fertilization techniques - IUI, IVF and ICSI.	**3 hours**
Module 7	**Post Implantation embryology:** Gastrulation. Embryo factors vs. uterine factors in implantation/implantation failure.	**3 hours**
Module 8	**Pregnancy:** Primary infertility and secondary infertility. Extra uterine pregnancies. Spontaneous abortions. Pregnancy test.	**3 hours**
Module 9	**Laboratory safety:** Minimal safety requirements - Contamination risk - Security. Ethics in IVF.	**1 hour**
Module 10	**Applications:** Effects of treatment - Advantages and disadvantages of IVF. Social impact.	**1 hour**
	Total	**26 hours**

Book(s) for Study

1	Peter RB (2005). A Textbook of In Vitro Fertilization and Assisted Reproduction: The Bourn Hall Guide to Clinical and Laboratory Practice, CRC Press, 3rd edition.
2	David KG, Ariel W, Colin MH and Zeev S (2015). Textbook of Assisted Reproductive Techniques, CRC Press, 4th edition.
Book(s) for reference	
1	Kamino AR and Deepika K (2018). Principles and practice of assisted reproductive technology, Yaypee brothers' medical publishers, 2nd edition.
2	Mukargee G (2018). Practical guide in Andrology & Embryology. Yaypee brothers' medical publishers.
Related Online Contents	
1	https://www.cdc.gov/art/whatis.html
2	https://www.eshre.eu/Guidelines-and-Legal

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	M	L	M
CO2	S	S	M	M	M
CO3	S	S	S	M	M
CO4	M	M	M	S	S
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

FOURTH SEMESTER

Course code	26BIOBC13	BIOETHICS, BIOSAFETY, IPR AND ENTREPRENEURSHIP	L	T	P	C
Core/Elective/Supportive		Core Paper – 13	4	✓	-	4
Pre-requisite		A Basic Knowledge on Bioethics, Biosafety, and IPR	Syllabus Version		2026-27	

Course Objectives:

The main objectives of this course are to:

1. To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.
2. To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
3. To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
4. To become familiar with national and international policies and institutions regulating Bioethics, Biosafety and IPR.
5. To introduce the concept of entrepreneurship and to provide conceptual exposure on converting idea to a successful entrepreneurial firm.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand ethical considerations in biotechnology and biomedical research.	K1, K2, K3, K4, K5
CO2	Apply biosafety principles and demonstrate risk assessment and management strategies in laboratory, healthcare settings, and for biotechnology products derived from recombinant DNA research, including evaluating the environmental release of genetically modified organisms.	K1, K2, K3, K4, K5
CO3	Understand the rationale both for and against intellectual property rights, with particular emphasis on patents.	K2, K5, K6
CO4	Gain familiarity with national and international institutions and regulations governing bioethics, intellectual property rights, and biosafety; understand the rationale behind adoption of the National IPR Policy.	K1, K2
CO5	Understand the fundamental concepts of entrepreneurship and identify business opportunities for biotechnology products.	K2, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

Unit:1	Bioethics	10 hours

Introduction, ethical conflicts in biological sciences - interference with nature, framework for ethical decision making; biotechnology and ethics – bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare; ELSI of human genome project. Biotechnology in agriculture

and environment: GM crops- benefits and risks of genetic engineering, Protection of environment and biodiversity – biopiracy. National Biodiversity Authority (NBA). Ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and bio warfare.

Unit:2	Biosafety	10 hours

Biosafety and Biosecurity - introduction; historical background; Biosafety issues in biotechnology – risk assessment and risk management – GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs, operation of Biosafety guidelines and regulations – food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan, risk assessment and containment of crops; genome editing tools, transgenic crops vs cisgenic plants or products derived from RNAi.

Unit:3	Intellectual Property Rights	10 hours

Introduction to intellectual property, Types: patents, copyrights, trade-marks, design rights, geographical indications – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – patent databases - country-wise patent searches (USPTO, EPO, India) – IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines; fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting- introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement-meaning, scope, litigation, case studies and examples; commercialization of patented innovations; collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Unit:4	National and International regulations	10 hours

Introduction and History of GATT, WTO, WIPO and TRIPS. Patent databases – USPTO, EPO; Budapest Treaty; Patent cooperation Treaty (PCT), Cartagena Protocol, OECD concensus, Codex Alimentarius. Indian Patent act (1970), National IPR Policy; Indian Patent offices; Publication of patent gazette of India. PPVFR Act, Registration Protection of Plant variety and Plant breeders' rights in India. Biosafety regulation in INDIA: RGCM, GEAC, IBSC and other regulatory bodies; FSSAI and its role.

Unit:5	Entrepreneurship	10 hours

Commercialization of Biotechnology Products: Technology transfer of innovation, challenges in innovation and translational of laboratory findings to market. Models of technology transfer-Government Interface, Funding Support, University technology transfer offices, Triple Helix Model. Good practices of technology commercialisation in India: CSIR, NRDC, BCIL, BIRAC, KIHT. Technology readiness- for Drugs, Vaccines, Biosimilars, Regenerative medicine, Medical Devices and Diagnosis, Big Data Analysis and Bioinformatics. Candidate Optimization and Non-GLP technology development. cGMP pilot scale and scale up. Marketing fundamentals and strategies:

communicating value proposition strategy, Freedom to Operate, start-up strategies, B2B & B2C marketing, and case studies for sales force development, branding, and promotion.		
Unit:6	**Contemporary issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**52 hours**

Text Book(s)	
1	Beauchamp TL and Childress JF (2019). Principles of biomedical ethics, Oxford University Press, 8th Edition.
2	Resnik DB (2012). Ethics of science: An introduction. Routledge.
3	WHO Laboratory Biosafety Manual (2020). World Health Organization. 4th edition.
4	Ganguli P (2001). Intellectual property rights: Unleashing the knowledge economy, Tata McGraw-Hill.
5	Mukherjee PK (2003). GMP for botanicals: Regulatory and quality issues on phytomedicine, Business Horizons.
6	Deb T (2014). Commercialization of biotechnology products, Academic Press.
7	National IPR Policy (2016). Department of Industrial Policy & Promotion.
8	FSSAI Manuals, Food Safety and Standards Authority of India
9	BIRAC (India), Annual reports and guidelines. Biotechnology Industry Research Assistance Council.
Reference Books	
1	Introduction to bioethics (2018), 2nd edition by J.A. Bryant
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://swayam.gov.in/nd1_noc20_hs18/preview
Published Articles	
1	Morrato EH, Hamer MK, Sills M, Kwan B, Schilling LM. Applying a Commercialization-Readiness Framework to Optimize Value for Achieving Sustainability of an Electronic Health Data Research Network and Its Data Capabilities: The SAFTINet Experience. EGEMS (Wash DC). 2019 Aug 29;7(1):48. doi: 10.5334/egems.295. PMID: 31523697.
2	Smanski MJ, Aristidou A, Carruth R, Erickson J, Gordon M, Kedia SB, Lee KH, Prather D, Schiel JE, Schultheisz H, Treynor TP, Evans SL, Friedman DC, Tomczak M. Bioindustrial manufacturing readiness levels (BioMRLs) as a shared framework for measuring and communicating the maturity of bioproduct manufacturing processes. J Ind Microbiol Biotechnol. 2022 Oct 13;49(5): kuac022. doi: 10.1093/jimb/kuac022. PMID: 36150719.
Course Designed By: **Dr. M. A. Shibu**, Assistant Professor (DBT-RLS) and Dr. **S.R. Prabagaran**, Professor, Dept. of Biotechnology.	

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	M	L	S	S	S
CO2	S	L	S	S	S
CO3	L	L	S	S	S
CO4	L	L	S	S	S
CO5	L	L	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIOBCV2	Advanced Instrumentation Training	L	T	P	C
Core/Elective/Supportive		Value added Course - 2	2	✓	-	2
Pre-requisite		A Basic Knowledge in Instrumentation	Syllabus Version		2026-27	

Course	Hands on Training in Sophisticated Instruments
Course Code	26BIOBCV2
Number of hours	26 hours
Credits	2 Credits (50 Marks)
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	All faculty
Inter / Intra Department Course	Intra Department course
Mode of the Course	Offline
Collaboration if any with Companies (if Yes, Full Address of the Company Address, Name of the Contact Person, Phone, e-mail etc.)	Relevant industry partners

Job Opportunities: Academic and research laboratories, Pharmaceutical and Biotechnology industries

Course Objectives:

The main objectives of this course are to:

1. Provide hands-on training in the operation and applications of advanced analytical and molecular biology instruments used in biotechnology research and industry.
2. Develop technical competence in instrument handling, experimental procedures, and standard operating practices for sophisticated laboratory equipment.
3. Enable students to analyze, interpret, and report experimental data generated from advanced instrumentation while adhering to laboratory safety and quality standards.

Expected Course Outcomes:

CO1	Explain the principles and applications of sophisticated analytical and molecular biology instruments used in biotechnology.	K2, K3
CO2	Operate advanced laboratory instruments by following standard operating procedures and laboratory safety guidelines.	K3, K4

CO3	Perform experiments using sophisticated instruments for molecular, cellular, and biochemical analyses.	K3, K4, K5
CO4	Analyze and interpret experimental data generated using advanced instrumentation for research and industrial applications.	K3, K4, K5
CO5	Demonstrate professional competency in handling advanced instrumentation for biotechnology research, diagnostics, and industrial applications.	K1, K4, K5, K6
Module 1	Bioreactor	3 Hours
Module 2	ELISA	3 Hours
Module 3	Flowcytometry	3 Hours
Module 4	Real-Time PCR	3 Hours
Module 5	DNA sequencer	3 Hours
Module 6	Fluorescence Microscope	3 Hours
Module 7	Micromanipulator	3 Hours
Module 8	GC-MS/MS	3 Hours
	Contemporary	2 Hours
	Total Training hours	**26 hours**

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	L	M
CO2	S	S	M	M	M
CO3	S	S	M	M	M
CO4	S	S	M	M	M
CO5	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	26BIODM01	Disaster Management	L	T	P	C
Core/Elective/Supportive		Special Programme - 1	2	✓	-	2
Pre-requisite		Basic Knowledge about Natural Calamities	Syllabus Version		2026-27	

Name of the Faculty Member	All faculty Department of Biotechnology, Bharathiar University.
Inter / Intra Department Course	Intra Department course
Mode of the Course	Offline
Collaboration if any with Companies (if Yes, Full Address of the Company Address, Name of the Contact Person, Phone, e-mail etc.)	NA

Course Objectives:

The main objectives of this course are to:

1. Provide fundamental knowledge of disasters, hazards, vulnerability, and disaster management principles.
2. Develop an understanding of disaster risk reduction, preparedness, mitigation, response, and recovery strategies.
3. Familiarize students with disaster management frameworks, policies, and institutional mechanisms in India.
4. Equip students with the knowledge and skills required for effective emergency response and community resilience during disasters.

Expected Course Outcomes:

CO1	Explain the concepts, types, causes, and impacts of natural and human-induced disasters.	K1, K2
CO2	Describe the disaster management framework, institutional mechanisms, and disaster management practices in India.	K2, K3
CO3	Apply the principles of disaster preparedness, mitigation, and disaster risk reduction in different disaster scenarios.	K3, K4
CO4	Analyze disaster response strategies, emergency management systems, and community resilience measures.	K4, K5

CO5	Evaluate disaster management plans and propose appropriate strategies for effective emergency response and sustainable disaster risk reduction.	K5, K6
Module 1	Introduction to Disaster Management	5 hours
Module 2	Types of Disasters	5 hours
Module 3	Disaster Management in India - An overview	5 hours
Module 4	Disaster Risk Reduction	5 hours
Module 5	Emergency Response and Management	6 hours
	Total Lecture hours	**26 hours**

Reference:

1	Gupta HK (2013). Disaster Management. Universities Press (India) Pvt. Ltd., Hyderabad.
2	Modh S (2010). An Introduction to Disaster Management, 2nd edition.
3	Ghosh GK (2006). Disaster Management. APH Publishing Corporation, New Delhi.

Course designed by: **Dr. M. Arun**, Assistant Professor, Department of Biotechnology

Mapping with Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	M	L	M	M
CO2	M	S	M	S	M
CO3	M	S	M	S	S
CO4	M	S	M	S	S
CO5	M	S	S	S	S

*S-Strong; M-Medium; L-Low