BHARATHIAR UNIVERSITY: COIMBATORE 641 046

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

(For the students admitted during the academic year 2025-26 onwards)

Scheme of Examination

Sub. code	Course Code	Title of the Course		Credits	Hours		Maximum Marks		
					Theory	Practical	CIA	ESE	Total
FIRST SEMESTER									
13A	**25BIOBC01**	Core-1	Biochemistry	4	4	-	25	75	100
13B	**25BIOBC02**	Core-2	Cell and Molecular Biology	4	4	-	25	75	100
13C	**25BIOBC03**	Core-3	Microbiology	4	4	-	25	75	100
13D	**25BIOBC04**	Core-4	Genetics	4	4	-	25	75	100
1EA	**25BIOGE01A**	Elective-1	Biodiversity and Bioprospecting	4	4	-	25	75	100
1EB	**25BIOGE01B**		Bioinstrumentation						
13P	**25BIOBCP1**	Practical-1	Basic Biotechnology	4	-	6	25	75	100
1GS	**25BIOGS01**	Supportive	Tools in Biotechnology	2	2	-	12	38	50
1VA*	**25BIOBCV1**	VAC-1	Soft Skills and Business Communication Skills for Employability	2	2	-	50	-	50
			Total	**26**	**22**	**6**	**162**	**488**	**650**
SECOND SEMESTER									
23A	**25BIOBC05**	Core-5	Developmental Biology and Physiology	4	4	-	25	75	100
23B	**25BIOBC06**	Core-6	Immunology	4	4	-	25	75	100
23C	**25BIOBC07**	Core-7	Recombinant DNA Technology	4	4	-	25	75	100
23D	**25BIOBC08**	Core-8	Plant Physiology and Metabolic Engineering	4	4	-	25	75	100
2EA	**25BIOGE02A**	Elective-2	Molecular Diagnostics and Clinical Testing	4	4	-	25	75	100
2EB	**25BIOGE02B**		Environmental Biotechnology						
23P	**25BIOBCP2**	Practical-2	Advanced Biotechnology	4	-	6	25	75	100
2GS	**25BIOGS02**	Supportive	Medical Biotechnology	2	2	-	12	38	50
2JA*	**25BIOBCJ1**	JOCC-1	SAS Programming for Clinical Trials Management	4	2	-	100	-	100
			Total	**26**	**22**	**6**	**162**	**488**	**650**
THIRD SEMESTER									
33A	**25BIOBC09**	Core-9	Animal Biotechnology and Stem Cell Biology	4	4	-	25	75	100
33B	**25BIOBC10**	Core-10	Plant Biotechnology	4	4	-	25	75	100
33C	**25BIOBC11**	Core-11	Bioprocess Technology	4	4	-	25	75	100
33D	**25BIOBC12**	Core-12	Bioinformatics and Systems Biology	4	4	-	25	75	100
3EA	**25BIOGE03A**	Elective-3	Nanobiotechnology	4	4	-	25	75	100
3EB	**25BIOGE03B**		Pharmaceutical Biotechnology						
33P	**25BIOBCP3**	Practical-3	Applied Biotechnology	4	-	6	25	75	100
3GS	**25BIOGS03**	Supportive	Food Biotechnology	2	2	-	12	38	50
37V*	**25BIOBCS1**	Internship	One Month Summer Internship	2	-	-	50	--	50
3JA*	**25BIOBCJ2**	JOCC-2	Downstream Processing by Conventional Chromatography	4	2	-	100	-	100
			Total	**26**	**22**	**6**	**162**	**488**	**650**
FOURTH SEMESTER									
43A	**25BIOBC13**	Core-13	Bioethics, Biosafety, IPR and Entrepreneurship	4	4	-	25	75	100
47V	**25BIOBCPW**	Project	Project Work	8	-	-	50	150	200
4NS*	**25BIOBCo1**	Swayam	Professional Certification Course	2	2	-	-	-	-
4VA*	**25BIOBCV2**	VAC-2	Training in Sophisticated Instruments	2	2	-	50	-	50
			Total	**12**	**-**	**-**	**75**	**225**	**300**
			Grand Total	**90**	**-**	**-**	**-**	**-**	**2250**

FIRST SEMESTER

<table>
<tr><td>Course code</td><td>25BIOBC01</td><td colspan="2">BIOCHEMSTRY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td colspan="2">Core Paper -1</td><td>4</td><td>✓</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="2">A Basic Knowledge, Principles in Biochemistry</td><td colspan="3">Syllabus Version</td><td>2025-26</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">The main objectives of this course are to:
1. Get an overall understanding of the structure and functions of biomolecules, enzyme kinetics, bio polymers 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</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Expected Course Outcomes:</td></tr>
<tr><td colspan="8">On the successful completion of the course, student will be able to:</td></tr>
<tr><td>1</td><td colspan="5">Recognize the structures and functions of biomolecules such as carbohydrate that form the basis of what we understand to be living organisms.</td><td colspan="2">K1&K2</td></tr>
<tr><td>2</td><td colspan="5">Provide with a firm foundation in the biochemical aspects of cellular functions with different proteins and proteomics</td><td colspan="2">K1&K2</td></tr>
<tr><td>3</td><td colspan="5">Get information pertaining to role of enzymes, co-enzyme and cofactor in catalytic reaction as a properties of biochemical pathways regulation.</td><td colspan="2">K1&K2</td></tr>
<tr><td>4</td><td colspan="5">Acquire knowledge base of metabolic pathways occurring inside living cells in respect to lipids and fat.</td><td colspan="2">K1&K2</td></tr>
<tr><td>5</td><td colspan="5">Understand the limitations of biomolecules in regulation of molecular functions in mammals especially in humans.</td><td colspan="2">K1&K4</td></tr>
<tr><td colspan="8">K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Unit:1</td><td colspan="3">Glycobiology and Bioenergetics</td><td colspan="4">14 hours</td></tr>
<tr><td colspan="8">Carbohydrates 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.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Unit:2</td><td colspan="3">Chemistry of Amino Acid and Proteins</td><td colspan="4">14 hours</td></tr>
<tr><td colspan="8">Proteins: Classification and physico-chemical properties of amino acids and peptides; Peptide and covalent bond; Primary, secondary, tertiary and quaternary structures of proteins; Ramchandranplot; Silkfibroin, 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.</td></tr>
</table>

Unit:3	**Enzyme and Enzyme kinetics**	**14 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	**Lipid Metabolism**	**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 and functions of DNA, RNA and Nucleic Acids**	**11 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	**65 hours**

Text Book(s)

1	Biochemistry (3rd Edition) - Christopher K. Mathews, Kensal E. van Holde, Kevin G. Ahern (2006). Pearson Education.
2	Schaum's easy outline of biochemistry: revised edition (1st Edition) – Gregory B. Ralston, Philip W. Kuchel (2011). McGraw-Hill Education.
3	Biochemistry (9th Edition) – Berg JM, Tymoczko JL and Stryer L (2019). WH Freeman and Company, NY.

Reference Books

1	Lehninger Principles of Biochemistry (7th Edition) - David L. Nelson and Michael Cox (2017). International Edition. WH Freeman and Company.
2	Harper’s illustrated Biochemistry (31st Edition) –Roadwell et al., (2018). McGraw-Hill Professional.

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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	L	M	L	L	L	L	L	L
CO2	S	S	L	L	L	L	M	L	L	L
CO3	S	S	L	L	L	L	L	L	L	L
CO4	S	S	L	L	L	L	L	L	L	L
CO5	S	S	L	M	L	L	L	L	L	L

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

Course code	25BIOBC02	CELL AND MOLECULAR BIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 2	4	✓	-	4
Pre-requisite		A basic knowledge in cell biology	Syllabus Version		2025-26	

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

Expected Course Outcomes:

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

1	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
2	Exhibit a knowledge base in cell and molecular biology, anatomy and physiology and biomedical sciences	K2
3	Advanced laboratory practices in cell and molecular biology will render them chose their techniques in molecular biology research and further will help them to get job opportunities	K3
4	To conduct independent work in a laboratory with basis of cell biology	K4
5	The theoretical knowledge gained from this paper will help the student to apply these concepts in their future research	K5, K6

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

Unit:1	Structure and Function of Biological membranes	11-- hours

Structure and function of biological membranes: Structural models; Composition and dynamics; Glyco conjugates and proteins in membrane systems. Transport of ions and macromolecules; Pumps, carriers and channels; Active and passive transport, Channels and Sodium- Potassium pumps, Calcium pump, Proton pump. Endo and Exocytosis; Cellular junctions and adhesions. Cellular junctions and adhesion.; Selectins, Integrins, Cadherins molecules based cell adhesions. Extra cellular matrix.

Unit:2	Molecular Structure and Functions of Cell Organelle Cellular cytoskeleton , motility	11-- 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**	**13-- 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**	**11-- 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**	**14-- 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 (TAF); assembly of pre-initiation complex for nuclear enzymes, interaction of transcription factors with the basal transcription machinery and with other regulatory proteins, mediator, TAFs; Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing of RNAs and polyadenylation; loop model of translation; 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, Helix-loop- helix, Zing Finger. 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	Expert lectures, online seminars - webinars	**5 hours**
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994
2	Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition. Gerald Karp, Janet Iwasa Wallace Marshall.2015
3	Cell biology D E Sadava CBS Publishers & Distributors, 2009
Reference Books	
1	Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993
2	Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	L	L	L	L	L	L
CO3	S	S	S	L	L	L	L	L	L	L
CO3	L	L	L	S	S	L	L	L	L	L
CO4	L	L	L	L	S	S	L	L	L	M
CO5	L	L	L	L	L	L	M	M	M	L

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

Course code	25BIOBC03	MICROBIOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 3	4	✓	-	4
Pre-requisite		A Basic knowledge, Principles in Microbiology	Syllabus Version		2025-26	

Course Objectives:

- To impart knowledge on Microbial diversity and Molecular taxonomy with special reference to Bacteria, besides fungi and viruses.
- To introduce the concept polyphasic taxonomy which eventually lead to report a novel organism.
- To enlighten on culture independent techniques and anaerobic cultivation.
- To 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:

1	Learn the importance of microbiology at basic level with laboratory level understanding.	K1
2	Get introduced to terms related to Polyphasic taxonomy and apply them during reporting them as a novel species.	K6
3	Obtain knowledge on NGS and culture independent techniques	K3
4	Understand on cultivation of Anaerobic organisms	K4
5	Critically think on the role of Soil, Agriculture, Food and Medical Microbiology	K1
6	Apply the knowledge towards Molecular Diagnostics	K5
7	Get holistic picture on Microbiology as a whole with Biotechnologist perspective	K2

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

Unit:1	Microbial Diversity	6 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 centers – India and International organizations.

Unit:2	Molecular Taxonomy	8 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	8 hours

Molecular methods to study complex microbial communities: Next Generation Sequencing: Microbiomes – Cloning for functional metagenomics: Construction of small insert and large insert metagenomic libraries – Significance of study: Extremophiles and yet to be cultured organisms

Culturing Techniques for Anaerobes: Roll tube method, Culture conditions in Glove box - requirements - prospects		
Unit:4	**Food and Agricultural Microbiology**	**8 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**	**8 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 Diseases:** Malaria, Leishmaniasis and Ascaris infection		
Unit:6	**Contemporary Issues**	**2hours**
Expert lectures, Assignments, Student Seminar and Webinars		
	Total Lecture hours	**40 hours**
Text Book		
1 2 3 4 5 6 7 8	Lansing M. Prescott. Microbiology. McGraw-Hill Higher Education. OladeleOgunseitan. Microbial Diversity - Form and Function in Prokaryotes. Wolfgang R. Streit and Rolf Daniel. Metagenomics: Methods and Protocols. A. Mark Osborn and Cindy J. Smith. Molecular Microbial Ecology.Taylor and Francis Group. Robert L Tate III. 1995. Soil Microbiology. John Wiley & Sons, New York Subbarao N. S. 2006. Soil Microbiology. (4th Edition of Soil microbiology and Plant growth).Oxford & IBH, New Delhi. Paul EA (2007) Soil Microbiology, Ecology and Biochemistry. III Edition. Academic Press,Oxford, UK. Stephen H. Gillespie and Kathleen B. Bamford. Medical Microbiology and Infection at a Glance. Anaerobic Microbiology: A Practical Approach by P.N. Levett 1992.	
Reference Books		
1 2 3	Bergey's Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins. ErkoStackebrandt. Molecular identification, systematics, and population structure of prokaryotes. Springer-Verlag Berlin Heidelberg.Madigan, M.T., Martinko, j. M., Stahl, D.A., and Clark, D.P. 2012. Brock"s Biology of Microorganisms. 13th Edition. Benjamin Cummings, San Francisco, CA.	

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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	M	M	L	M	L
CO2	S	S	M	M	M	L	S	L	M	L
CO3	S	S	M	M	M	S	M	L	M	L
CO4	S	S	M	M	M	L	S	L	M	L
CO5	S	S	M	M	M	S	M	L	M	L
CO6	S	S	M	M	M	M	M	L	M	L
CO7	S	S	M	M	M	M	M	M	M	M

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

<table>
<tr><td>Course code</td><td>25BIOBC04</td><td>GENETICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td>Core Paper - 4</td><td>4</td><td>✓</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td>Basic Knowledge and Principles in Genetics</td><td colspan="3">Syllabus Version</td><td>2025-26</td></tr>
</table>

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**	**12 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 & Non Mendelian genetics**	**12 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**	**12 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**	**12 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**	**12 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**	**5 hours**
Guest lectures by academic/industry experts , online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Gardner et al (1991). Principles of Genetics. John Wiley.
2	Hartl. D.L. A primer of population genetics. III edition, Sinauer associates inc. Sunderland, 2000
3	Human genetics, A. Gardner, R. T. Howell and T. Davies, Published by Vinod Vasishtha for Viva Books private limited, 2008.
4	The science of Genetics by Alan G. Atherly, Jack. R, Girton, Jhon. F, Mc Donald. Sounders college publishers.
Reference Book(s)	
1	Gardner et al (1991). Principles of Genetics. JohnWiley.
2	Hartl. D.L. A Primer of population genetics.III Edition, Sinauerassociatesinc. Sunderland, 2000

3	Human genetics, A.Gardner, R.T.Howell and T.Davies, Published by VinodVasishtha for Viva Books private limited, 2008.
4	The science of Genetics by Alan G. Atherly, Jack. R, Girton, Jhon. F, Mc Donald. Sounders college publishers.
5	Strachan and Read (2003).Human Molecular Genetics. Wiley.
6	Pasternak (2005).An Introduction to Molecular Human Genetics. Fritzgarald.
7	Prichard &Korf (2004).Medical Genetics a ta Glance. Blackwell.
8	Manu L Lothari, Lopa A Mehta, sadhana S Roy Choudhury (2009). Essential of Human Genetics (Universities Press India ltd)
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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	L	L	L	L	L	M	S	M	L
CO2	L	L	M	L	L	M	S	L	L	L
CO3	S	L	L	L	L	S	L	L	L	L
CO4	L	M	M	L	M	L	L	L	M	L
CO5	L	L	L	L	L	M	S	M	L	L

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

Course code	25BIOGE01A	BIODIVERSITY AND BIOPROSPECTING	L	T	P	C
Core/Elective/Supportive	Elective - 1		4	✓	-	4
Pre-requisite	Basic knowledge in Bioresources		Syllabus Version		2025-26	

Course Objectives:

The main objectives of this course are to:

1. Impart students an in-depth knowledge and make them competent in the field of biodiversity and bioprospecting.
2. Impart sufficient information and scientific knowledge about natural products from plant and microbes
3. To facilitate the students to understand about the bioprospecting aspects related to product development and their regulation.

Expected Course Outcomes:

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

1	Familiarize the students in major areas of bioprospecting and biodiversity.	K1
2	Obtain a comprehensive knowledge about natural products from plants.	K2
3	Apprehend the bioprospecting aspects related to microorganisms and plants	K3
4	Gain information's on drug discovery, product development, and modern tools involved in drug discovery.	K2,3,4
5	Familiar with regulatory legislation and convention in bioprospecting for commercialization.	K5

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

Unit:1	Bioprospecting Concepts and Benefits	12 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	12 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	12 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**	**12 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 Bioprospected Products**	**12 hours**
Safety, Toxicity, and regulations: Factors affecting the safety of bioprospected 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), colors (Carrot, Mulberry) perfumes (Sandal wood, Javadhu) and preservatives (Rosemary, Garlic)		
Unit:6	**Contemporary Issues**	**5 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)

1	Russell Paterson and Nelson Lima. 2017. Bioprospecting: success, potential and constraits. Cham, Switzerland : Springer. Springer e Books
2	K. V. Krishnamurthy. 2018.An advanced text book on biodiversity: principles and practices. Oxford & IBH Publishing Co Pvt. Ltd. ISBN-10 : 9788120416062
3	Mohammed Sayeed Akhtar and Mallappa Kumara Swamy.2018.Anti-cancer plants: natural products and biotechnological implements. volume 2.ISBN978-981-10-8064-7
4	Subash Mandal, Vivekananda Mandal and Tetsarya Konishi. 2018.Natural products and drug discovery integrated approach. Elsevier publisher.pp.1632. ISBN:9780081021040
5	Nudupa and Krishnamurthy Bhat 2015. A concise text book of drug regulatory affairs. Manipal university press.

6	Chawla H.S .2021.Introduction to intellectual property rights, Oxford IBH publishing,312, ISBN-13 : 978-8120417977
Reference Books	
1	Veronique Seidel. 2020.Plant derived chemicals a source of inspiration for new drugs. MDPI Plants.9(11).
2	Akshada Amit Koparde, Rajendra Chandrashekar Doijad and Chandrakant Shripal Magdum.2019.Natural products in drug discovery. open access peer review chapter.
3	Reuben Maghebe, Donath Damian, Abdalah Makaranga, Stephen Samwel Nyandoro, Sylvestr Lonard lyantagaye and Rajini Hatti-Kaul. 2021.Omics for bioprospecting and drug discovery from bacteria and microalgae. MDPI Antibiotics.9(5),229
4	Atanas g Atnasov, Sergey b Zotchev and Verena m Dirsch. 2020.Natural products in drug discovery advances and opportunities. nature review drug discovery.20,200-216
5	Managing Intellectual Property in the Book Publishing Industry A business-oriented information booklet Creative industries – Booklet No. 1
6	Veronique Seidel.2020.Plant derived chemicals a source of inspiration for new drugs. MDPI Plants. 9(11).
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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	M	S	S	L	L	S
CO3	S	S	S	M	M	L	L	L	L	S
CO3	S	S	S	M	S	S	S	L	L	S
CO4	S	S	S	S	S	L	S	L	L	S
CO5	S	L	L	L	L	S	L	L	L	S

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

<table>
<tr><td>Course code</td><td>25BIOGE01B</td><td colspan="2">BIO-INSTRUMENTATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td colspan="2">Elective -1</td><td>4</td><td>✓</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="3">Basic knowledge and principles in Bioinstrumentation</td><td colspan="2">Syllabus Version</td><td colspan="2">2025-26</td></tr>
</table>

Course Objectives:

The main objectives of this course are to:

1. Enrich the student intelligentsia in all the biological observations which are explainable in terms of physical principles.
2. Emphasize the working skill in basic and advanced analytical instruments
3. Enhance the ability of understating and working methods of various instruments.

Expected Course Outcomes:

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

1	Understand the analytical techniques and the principles of equipment used in different fields.	K1
2	Have complete insight in these techniques for the possible applications in various research areas.	K2&K4
3	Handle basic and advanced instruments with trouble shooting in the biological and medical industries.	K3
4	Increase the knowledge on result output analysis and interpretations.	K1,K2&K3
5	Comprehend the impact of hazardous material and handling of the materials.	K1&K2

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

Unit:1	**Basics**	**12 hours**

Units of measurement of solutes in solution: Normality, molality, molarity, millimol and ppm; Water-structure and properties; Principles of glass and reference electrodes, types of electrodes, complications of pH measurement (dependence of pH on ionic strength, pH, pOH, Hendersen-Hasselbach equations, buffers preparation; Basic thermodynamics; Theory of chemical reactions.

Unit:2	**Basic Principles of Electromagnetic Radiation and Related Spectroscopic Techniques**	**12 hours**

Electromagnetic Radiation: Energy, wavelength, wave number and frequency; Absorption and emission spectra, Beer-Lambert’s law, light absorption and its transmittance; UV and visible spectrophotometry-principles, instrumentation and applications on enzyme assay and kinetic assays.

Spectrophotometry: Protein structural studies, nucleic acid structural studies; Basic principles, instrumentation and applications of UV-visible, IR, fluorimetry; Basic principles, instrumentation and applications of ESR, NMR; Biochemical applications of fluorescence, emission, Fluorescence life-times, Anisotropy, time-resolved fluorescence methods and their applications, IR-Raman Spectroscopic applications in biology.

Unit:3	Hydrodynamic Methods, Radioactivity and Radioisotopic Techniques	12 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 & 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	12 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.

Polymerase Chain Reaction; PCR types; Gel electrophoresis; DNA sequencing; Molecular hybridization: Southern blot; Northern blot. Protein analyses: Western blot & Immunoprecipitation; **Cytophotometry**, Flow Cytometry, FACS, MACS and 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	12 hours

Single-molecule measurements: Atomic Force microscopy, surface-enhanced Raman scattering, Near-field Microscopy- Principles & applications. Force measurements at single molecule to cell level using optical tweezers- Principles & 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**	**5 hours**
	Guest lectures by academic/industry experts, onlineseminars - webinars	
	Total Lecture hours	**65 hours**

Text Book(s)

1	Instrumental methods of chemical analysis – P.K. Sharma
2	Physical Biochemistry, 2nd edition, W.H. Freemanand Co., USA - David Friefelder, (1983),
3	Vogel's Textbookof Quantitative Chemical Analysis, 5th Edition, ELBS, England- G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney, (1991),
4	The Elements of Physical Chemistry, Oxford University Press-P.W. Atkins, (1996),
5	Biophysical chemistry – Upadhyay Upadhyay and Nath (2009)
6	Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata (2003). McGraw Hill

Reference Books

1	A Biologist's guide to principle and techniques of practical biochemistry – Brigan L. Williams.
2	Experimental methods in Biophysical chemistry- Nicolau, C.
3	PCR - The Basics (Garland Science, 2nd Edition). McPherson. M. J. & Moller S. G. (2006). Taylor & Francis
4	Introduction to Spectroscopy- DonaldL.Pavia Gary M.Lipman, George S Kriz
5	Principles and Techniques of PracticalBiochemistry, 4th edition, Cambridge Univ.Press- K Wilson and J Walker (eds.), (1999).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://epgp.inflibnet.ac.in/
2	http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=944
3	https://onlinecourses.swayam2.ac.in/ugc19_bt16/preview
4	https://nptel.ac.in/courses/102/107/102107028/
5	https://nptel.ac.in/courses/102/103/102103044/
6	https://www.slideshare.net/ArunimaSur/analytical-techniques-in- biochemistry-and-biophysics-for-macro-molecule
7	https://www.biophysics.org/education-careers/education- resources/selected-topics-in-biophysics/biophysical-techniques
Course Designed By: **Dr. M. A. Shibu, Assistant Professor (DBT-RRF), Dept. of Biotechnology**	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	S	L	L	L	L	L	L	L
CO2	L	L	S	L	L	L	L	L	L	L
CO3	L	L	L	S	S	L	L	L	L	L
CO4	L	L	L	L	L	L	L	S	L	L
CO5	L	L	L	L	L	M	L	L	L	L

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

<table>
<tr><td>Course code</td><td>25BIOBCP1</td><td>BASIC BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Practical</td><td>Practical - 1</td><td>6</td><td>-</td><td>✓</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td>Skills in Biotechnology</td><td colspan="2">Syllabus Version</td><td colspan="2">2025-26</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">The main objectives of this course are to:
1. Train the students on basic tools and techniques required to understand biotechnology.
2. Provide them a base on diverse areas like microbiology, plant and animal science related advanced biology.
3. Ascertain them that subsequent practical would be understandable based on these experiments.</td></tr>
<tr><td colspan="7">Expected Course Outcomes:</td></tr>
<tr><td colspan="7">On the successful completion of the course, student will be able to:</td></tr>
<tr><td>1</td><td colspan="5">Understand how to cultivate microorganism from environmental samples and calculate the diversity index.</td><td>K2, K5, K5</td></tr>
<tr><td>2</td><td colspan="5">Learn to cultivate lymphocytes and separate PBMC.</td><td>K2, K3, K4</td></tr>
<tr><td>3</td><td colspan="5">Prepare DNA from various sources like plant and animal systems.</td><td>K2, K4, K5, K6</td></tr>
<tr><td>4</td><td colspan="5">Estimate various biological like protein, FRAP, citric acid etc</td><td>K1, K3, K4</td></tr>
<tr><td>5</td><td colspan="5">Work with Blood, plant parts and proteins – Separation, purification, etc.</td><td>K2, K4, K5</td></tr>
<tr><td colspan="7">K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Preparation of cell free lysates from recombinant and quantification
2. Purification of recombinant protein by affinity chromatography.
3. Demonstration of gene cloning by Gateway cloning technology.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Molecular Toxicology Laboratory (Dr. P. Ekambaram)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Observation of animal cell culture under the microscope. Measurement of cell size by Oculometer and Stage micrometer.
2. Haematology-RBC-and WBC total counts, differential count.
3. Mounting of Polytene Chromosome from Chironomus Larvae.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Molecular Microbiology Laboratory (Dr. S. R. Prabagaran)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Isolation of anaerobic Microorganisms from various environmental sources.
2. Bacterial tests based on staining (Gram staining) and biochemical characteristics (citrate utilization).
3. Cultivation of Bacteria, Actinomycetes and Fungi from soil samples.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Plant Metabolic Engineering Laboratory (Dr. S. Girija)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Determination of Free radical scavenging activity by DPPH assay.
2. Micropropagation and callus induction in radish (Raphanus sativus L.).
3. Observation of leaf sample under bright field, phase contrast, dark field and differential interference</td></tr>
</table>

contrast (DIC) microscope and determination of stomatal index.	
Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**
1. Extraction of total protein from the given tissue sample and estimation of protein concentration by Lowry's method. 2. Determination of protein molecular weight by SDS-PAGE. 3. Determining the cellular expression level of a specific protein by Western Blotting- Enhanced chemiluminescence (ECL) method.	
Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)	**9 hours**
1. Estimation of blood glucose by GOD - POD method. 2. Estimation of SGOT and SGPT 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 to improve salt tolerance in plants and assessment on morphological attributes. 2. Extraction and quantification of total chlorophyll content in primed and salt stressed plants. 3. Quantification of proline content in primed and salt stressed plants.	
Regenerative Engineering and Translational Research (Dr. M. A. Shibu)	**9 hours**
1**.** Isolation of peripheral blood mononuclear cells and determine their cryopreservation. 2. Mitochondrial DNA Isolation from mammalian cells. 3. Mitochondrial staining to study distribution and membrane potential with TMRM staining.	
Total practical hours	**72 hours**

Text Book(s)	
1	Harold J. Benson (2002) Microbiological Applications. McGrawHill Publications.
2	Kan wang (2015).Agrobacterium protocols. Methods in Molecular biology, springer protocols, 2(3): 372
3	Danillo Lucas Alves Esposito Benedito Antonio Lopes da Fonseca (2017) Sensitivity and detection of chikungunya viral genetic material using several PCR-based approaches, Rev. Soc. Bras. Med. Trop. vol.50
4	Sumit kumar verma, Himanshi Singh and Prakash C Sharma(2017) An improved method suitable for isolation of high-quality metagenomics DNA from diversesoils.3 biotech,7(3):171
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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	S	M	S
CO2	S	S	S	S	S	S	S	L	S	S
CO3	S	M	M	S	S	M	L	S	M	S
CO4	S	S	S	S	L	L	M	M	L	S
CO5	S	S	S	S	S	S	M	S	S	S

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

Course code	25BIOGS01	TOOLS IN BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive	Supportive - 1		2	✓	-	2
Pre-requisite	Any discipline		Syllabus Version		2025-26	

Course Objectives:

The main objectives of this course are to:

1. Introduce the concepts of gene and genomics, and familiarize student's about gene cloning vectors and current methods.
2. Train student's about tools used for gene manipulation and enhance students' knowledge about selection strategies and screening of transformants.
3. Impart the knowledge about applications of cloning and its current development.

Expected Course Outcomes:

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

1	Obtain a comprehensive knowledge about the concepts of gene and genomics and apply those in gene manipulation techniques.	K2, K3
2	Gain an in-depth understanding about rDNA technology to develop gene cloning skills.	K1, K6
3	Know about the information's on tools used for gene manipulation with suitable examples and apply those while designing recombinant DNA experiments.	K3, K4
4	Plan the selection strategies for screening of transformants.	K5
5	Understand the principal applications of different biotechnology tools used in modern era.	K2

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

Unit:1	Gene and Genomes	6 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	6 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	6 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**	**6 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**	**6 hours**
Application of rDNA Tools: Cloning of insulin gene in bacteria, gene therapy, GMO -application and biosafety issues.		
Unit:6	**Contemporary Issues**	**5 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**35 hours**

Text Book(s)	
1	Primrose. S.B., Twyman R.M. (2014) Principles of Gene Manipulation and Genomics,7th Edition, Blackwell Science Limited.
2	Primrose .S.B (1994) Molecular Biotechnology., Blackwell Scientific Publishers, Oxford.
3	Alberts. B., Johnson. A.D., Lewis. J., Morgan. D (2014) Molecular Biology of the Cell.
4	Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
5	Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
Reference Books	
1	Micklossnd D.A.., Freyar G.A. (1990) DNA Science – A first course in rDNA technology, Cold Spring Harbor laboratory Press, New York.
2	Glick. B.J., Pasternak j. J., Patten C.L (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA.
3	Das H. K (2004) Textbook of Biotechnology 4 ed.,Wiley India.
4	Brown T. A. (2016) Gene Cloning and DNA Analysis. An Introduction, 7th Edition Blackwell Scientific Publications.
5	Theiman W.J., Palladino. M.A., (2014) Introduction to Biotechnology,3rd Edition.
6	Cooper G. M., & Hausman R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
7	Green M. R., & 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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	M	S	L	L	M
CO2	S	S	S	S	S	M	S	L	L	L
CO3	S	S	S	S	S	M	M	L	L	L
CO4	S	M	M	M	S	M	M	L	L	L
CO5	S	S	S	S	S	S	M	L	L	S

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

VALUE ADDED CERTIFICATE COURSES - 1

Course : **Soft Skills and Business Communication Skills for Employability**
Course Code : 25BIOBCV1
Number of hours : 40 hours
Credits : 2 Credits (50 Marks)
Ideal Days : During the 1^{st} semester

SOFT SKILLS AND BUSINESS COMMUNICATION SKILLS FOR EMPLOYABILITY	
Name of the Department	**Biotechnology**
Name of the Faculty Member i/c With Complete Address with Phone and e-mail	Dr. S. Girija Associate Professor Department of Biotechnology
Inter / Intra Department Course	Intra Department
Duration of the Course	40 Hours
Eligibility	Only for I MSc Biotechnology students
Number of Candidates to be Admitted	25 (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	
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	Impart Experiential Learning for Students to become Effective Communicators
2	Activity based Engagement to explore student's Innate talent and abilities to excel Professionally
3	Enhance Employability Skills of Students in a Competitive Environment
Course Content	Lecture / Practical / Project / Internship

CO1	Increase the soft skills and behavioural attitude	K4
CO2	Developing the importance of team work	K5
CO3	To train them in inhibition free communication by increasing their self confidence	K6

CO4	To help the student to manage the Glossophobia	K6
CO5	To prepare for their presentation for the job interviews	K6
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**.**	**8 hours**
Unit 2	**Leadership and Decision Making and Business Etiquettes:** Qualities of a Leaders and the need for Leadership i**n** Organisations. Decision making to enhance professional excellence. Business etiquettes mentors participants on Workplace Behaviour and Healthy relations for Professional success.	**8 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**.**	**8 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.	**8 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.	**8 hours**
Unit 6	**Contemporary**	
	Total	**40 Hours**
Book(s) for Study		
1	Student Work Book shall be provided	
Book(s) for reference		
1	How to Influence People and Make Friends.-Dale Carnegies	
Related Online Contents		
1	ALISON Courses	
2	Supportive topic based Videos shall be screened during the Training Session	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	M	S	M	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	M
CO4	S	S	M	S	M	M	S	M	S	S
CO5	S	S	S	S	S	M	M	M	M	S

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

SECOND SEMESTER

Course code	25BIOBC05	DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY	L	T	P	C
Core/Elective/Supportive	**Core Paper - 5**		**4**	✓	**-**	**4**
Pre-requisite	**A Basic Knowledge in Developmental Biology & Physiology**		**Syllabus Version**		**2025-26**	

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:		
1	Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.	K1
2	Identify several unifying themes and differences in developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.	K5
3	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 e.g. *Drosophila melanogaster* and Sea Urchin.	K2
4	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.	K4
5	To be able to communicate scientific information about key concepts in developmental biology.	K3
6	To describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body to help prepare you for a career in your chosen field (e.g. to gain content knowledge and comprehension in Biotechnology and Healthcare).	K3
7	Describe and apply theory to explain the physiology of: individual systems and/or an integrated system response.	K2
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit:1	**Introduction To Developmental Biology**	**12 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**	**12 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.		
Unit:3	**System Physiology: Digestion And Haematology**	**12 hours**
Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscles, haemopoiesis, 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**	**12 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**	**12 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.		
Unit:6	**Contemporary Issues**	**5 hours**
Expert lectures, online seminars– webinars		
	Total Lecture hours	**65 hours**

Text Book	
1	Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert.
Reference Books	
1	Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson.
2	Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.
3	Essentials of Animal Physiology (2019)4th edition by Rastogi.
4	Ganong's Review of Medical Physiology (2019), 26th edition by Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason Yuan, Scott Boitano.

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/
Course Designed By: **Dr. P. Ekambaram, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	M	M	L	M	L
CO2	S	S	M	M	M	L	S	L	M	L
CO3	S	S	M	M	M	S	M	L	M	L
CO4	S	S	M	M	M	L	S	L	M	L
CO5	S	S	M	M	M	S	M	L	M	L
CO6	S	S	M	M	M	M	M	L	M	L

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

Course code	25BIOBC06	IMMUNOLOGY	L	T	P	C
Core/Elective/Supportive	Core Paper - 6		4	✓	-	4
Pre-requisite	A Basic Knowledge of Immunology		Syllabus Version		2025-26	

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	8 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	14 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**	**14 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**	**12 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**	**12 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**	**5 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Parham, P. (2014). The Immune System (4th edition). W. W. Norton &Company.
2	Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). *Janeway's Immunobiology*. New York: Garland Science.
3	Paul, W. E. (1993). Fundamental Immunology. New York: Raven Press. Goding, J. W. (1986). Monoclonal Antibodies: Principles and Practice
Reference Books	
1	I. R. Tizard, 1995, Immunology: An Introduction , 4th edition , Saunders College Publishers, New York.
2	A. Bul and K. Abbas, 1994, Cellular and Molecular immunology
3	I. Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	L	L	L	L	L	L	L
CO2	S	S	M	L	L	L	L	L	L	L
CO3	S	S	S	S	M	L	L	L	L	L
CO4	S	S	S	M	L	M	L	L	M	L
CO5	S	S	S	L	M	M	L	L	M	L

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

Course code	25BIOBC07	RECOMBINANT DNA TECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core Paper - 7	4	✓	-	4
Pre-requisite		Basic knowledge of Molecular Biology	Syllabus Version		2025-26	

Course Objectives:

The main objectives of this course are to:

1. Expose the students to the latest advances in recombinant DNA technology, which is a powerful tool needed for modern biotechnology research.
2. Impart adequate knowledge about tools and techniques in genetic engineering and enzymes in molecular biology.
3. Expedite the students to understand the techniques involved in gene cloning, library construction, and screening.
4. Impart sufficient information about expression strategies for heterologous genes and expand their understanding towards the latest technologies in DNA sequencing and PCR.
5. Enrich the students' knowledge with respect to recent advancements and applications in gene silencing and genome editing.

Expected Course Outcomes:

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

1	Obtain an in-depth knowledge on tools and techniques in rDNA technology and perform nucleic acid isolation, hybridization, and blotting techniques.	K1, K3, K4
2	Understand the importance of enzymes and vectors used in molecular biology and use such acquaintance to carry out gene cloning and library construction.	K2, K6
3	Acquire a complete knowledge about different expression systems and know the strategies with respect to efficient expression of heterologous genes for the production of recombinant proteins.	K1, K4
4	Operate PCR and know about its variations and most recent advancements.	K3, K5
5	Know the latest information on sequencing methods and their application.	K1, K5, K6
6	Gain information about important strategies like gene silencing and genome editing technologies and apply those tools in relevant research areas.	K1, K3, K6

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

Unit:1	Tools and Techniques - Enzymes in Molecular Biology	12 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**	**12 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**	**12 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**	**12 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**	**12 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**	**5 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Primrose, S. B., Twyman, R. M., & Old, R. W. (2006). Principles of gene manipulation and genomics, Vol. 6, 7th edition, Blackwell Science, Oxford.
2	Cseke, L. J., Kirakosyan, A., Kaufman, P. B., & Westfall, M. V. (Eds.). (2012). Handbook of molecular and cellular methods in biology and medicine, 3rd edition, CRC press.
3	Glick, B. R., & Patten, C. L. (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34), 5th edition, John Wiley & Sons.
4	Bernard, R. G., & Jack, J. P. (2003). Molecular biotechnology, Asm Press.
5	Glick, B. R., & Patten, C. L. (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons.
6	Das, H. K. (2007). Textbook of biotechnology, John Wiley & Sons.
Reference Books	
1	Gellissen, G. (Ed.). (2006). Production of recombinant proteins: Novel microbial and eukaryotic expression systems. John Wiley & Sons.
2	Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
3	Snyder, L. (2001). Introduction to Genetic Engineering 5th Edition. Blackwell Scientific.
4	Primrose, S. B., & Twyman, R. (2009). Principles of genome analysis and genomics. John Wiley & Sons.
5	Nicholl, D. S. (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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	S	S	M	L	L	M
CO2	S	M	S	S	S	S	S	L	L	M
CO3	S	S	S	S	S	S	S	L	L	S
CO4	S	S	S	S	S	L	S	L	L	S
CO5	S	S	S	S	S	M	S	L	L	S
CO6	S	S	S	S	S	S	S	L	L	S

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

Course Code	25BIOBC08	PLANT PHYSIOLOGY AND METABOLIC ENGINEERING	L	T	P	C
Core	Core Paper - 8		4	✓	-	4
Pre-requisite	A basic knowledge in Plant systems		Syllabus Version	2025-26		

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, 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:

1	Know importance and scope of plant physiology. Understand the process of translocation of solutes in plants	K1
2	Learn about the movement of sap and absorption of water in plant body	K2
3	Understand about the role of stress physiology in crop improvement	K3
4	Acquaintance in secondary metabolism of plants	K4, K5
5	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	12 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	12 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: Phytochromes, cryptochromes. The Photo physiology of Blue-Light Responses, The Regulation of Blue Light–Stimulated Responses, Blue-Light Photoreceptors. Embryogenesis and development of plants. Light signaling in plants. Stomatal movement. Circadian Rhythms. **Morphogenesis**: 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**	**12 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, Temperature Stress, High Light Stress, Response of plants towards abiotic stress. Adaptation mechanism: Developmental and Physiological Mechanisms that Protect Plants against Environmental Extreme. **Biotic stress**: Pathogen and Insects. Effect of Virus, Bacteria and Fungal and Nematode diseases on physiology of the plants. Plant resistance mechanism towards pathogenic attack- PR proteins and other signaling strategies.		
Unit:4	**Secondary Metabolism**	**12 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**	**12 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**	**5 hrs**
Guest Lecturer, Webinars, Seminars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Introduction to Plant physiology- William G. Hopkins and Norman P. A. H ¨uner, Fourth Edition, Wiley
2	Plant Physiology Fifth Edition, by Lincoln Taiz and Eduardo Zeiger, Sinauuer Associates, USA
3	Plant Physiology by Arumugam et al, 219, Saras Publication
Reference Books	
1	Plant Physiology, Devlin
2	Plant Secondary Metabolites, Mohammed and Kamlesh, 2017, 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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	M	S	M	S		
CO3	S	M	S	S	S	S	S	M		
CO3	S	M	S	S	S	S	S	M		
CO4	S	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	S	S	M	S		

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

<table>
<tr><td>Course code</td><td>25BIOGE02A</td><td colspan="2">MOLECULAR DIAGNOSTICS AND CLINICAL TESTING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td colspan="2">Elective - 2</td><td>4</td><td>✓</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="2">Basic knowledge in Diagnostics</td><td>Syllabus Version</td><td colspan="3">2025-26</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Expected Course Outcomes:</td></tr>
<tr><td colspan="8">On the successful completion of the course, student will be able to:</td></tr>
<tr><td>1</td><td colspan="5">Understanding of disease types and their diagnosis. Obtain knowledge about ethical and regulatory aspects of conducting diagnostic tests.</td><td colspan="2">K3</td></tr>
<tr><td>2</td><td colspan="5">Learn the technical aspects of various diagnostic methods which will help in application of these techniques to design and develop new clinical tests.</td><td colspan="2">K4</td></tr>
<tr><td>3</td><td colspan="5">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.</td><td colspan="2">K5</td></tr>
<tr><td>4</td><td colspan="5">Develop skills to interpret the results of molecular techniques when performing them practically.</td><td colspan="2">K6</td></tr>
<tr><td>5</td><td colspan="5">Know about how important diseases are diagnosed using molecular diagnostic methods. Learn practical applications of precision diagnostics in disease management.</td><td colspan="2">K4</td></tr>
<tr><td colspan="8">K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Unit:1</td><td colspan="5">Introduction to Molecular Diagnostics</td><td colspan="2">12 hours</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

Unit:2	DNA Based Molecular Techniques for Diagnosis	12 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**	**12 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**	**12 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 engrafment analysis. Diagnosis of inherited diseases- Thalassemia, Cystic Fibrosis. Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Noninvasive: 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**	**12 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, Chickgungunya and SARS. Direct detection & 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**	**5 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Tietz textbook of clinical chemistry and molecular diagnostics. Carl Burtis, Edward Ashwood, David Bruns, Elsevier Press. 5th Edition 2012.
2	Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker. 2010
3	Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. Lela Buckingham and Maribeth L. Flaws. 2011

Reference Books		
1	Modern Blood Banking & Transfusion Practices. Denise M. Harmening. 2018	
2	Fundamentals of Molecular Diagnostics. David E. Bruns MD (Author), Edward R. Ashwood MD (Author), Carl A. Burtis PhD. 2007	
3	Proteomics in Diagnostics. Veenstra, T.D. 2004	
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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	L	S	L	S	M	L
CO2	S	S	S	M	S	L	S	S	S	S
CO3	S	S	S	S	S	L	S	S	S	S
CO4	M	S	S	S	S	L	S	M	M	S
CO5	S	M	S	S	M	S	M	S	S	M

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

Course code	25BIOGE02B	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
Core/Supportive/Elective		Elective - 2	4	✓	-	4
Pre-requisite		Undergraduate in Biological sciences	Syllabus Version		2025-26	

Course Objectives:

The main objectives of this course are to:

1. The course objective was framed- to impart adequate information to the students about bio-fuel and bio-energy and its future needs; to expedite students to recognize the dangerous effects of environmental pollution and its methods of control and management;
2. To impart appropriate information and adequate knowledge about environmental impact assessment and environmental acts; to acquaint students in the area of disasters management.
3. To understand the energy sources, environmental pollution and remediation using biotechnology and its control

Expected Course Outcomes:

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

1	Acquire a complete knowledge about bio-fuel and bio-energy and its future needs	K1
2	Understand dangerous effects of environmental pollution and its methods of control and management which make them to create more remediation methods in future.	K1, K2
3	Familiarize the different methods of environmental pollution using biotechnological approaches.	K3
4	Obtain a comprehensive knowledge about global environmental problem and disasters management which help to think about environmental protection	K4
5	This course is important in the era of industrialization leading to environmental hazards and hence will help students to take up a career in tackling industrial pollution	K5, K6

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

Unit:1	Biofuels- Sources and Production	12 hours

Bio-Fuels and Bio-Energy: Biofuels First, Second, Third and Fourth generation andtheir 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	12 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, green house effect and acid rain. Solid waste: Sources and management-Composting, Vermiculture

Unit:3	**Pollution Detection Methods**	**12 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:**	**12 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. Biowarefares.		
Unit:5	**Bio resources and Disaster Management**	**12 hours**
Bioresource, Uses and types of biodiversity conservation. Disasters Management: Disaster, Hazard, Vulnerability, Resilience, Risks. Disaster Risk Management in India Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements.		
Unit:6	Expert lectures, online seminars - webinars	**5 hours**
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Introduction to Environmental Biotechnology by A. K Chatterji, PHI Learning publishers , 2011.
2	Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England
3	Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press
4	Environmental Biotechnology: Principles and Applications, Second Edition 2nd Edition byby Bruce Rittmann and Perry McCarty , 2020
Reference Books	
1	Environmental Biotechnology, Concepts and Applications. Hans-JoachinJordening and Josef Winter. Winter-VCH. 2005
2	Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	L	L	L	L	L	L	L	L
CO3	L	S	L	L	L	L	L	L	L	L
CO3	L	L	S	L	L	L	L	L	L	L
CO4	L	L	L	S	L	L	L	L	L	L
CO5	L	L	L	S	S	S	M	S	M	M

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

Course code	25BIOBCP2	ADVANCED BIOTECHNOLOGY	L	T	P	C
Core/Supportive/Elective		PRACTICALS – 2	6	-	✓	4
Pre-requisite		Skills in Biotechnology	Syllabus Version	2025-26		

Course Objectives:

The main objectives of this course are to:

1. Learn the principles of advanced techniques in biotechnology
2. Obtain hands-on experience to perform complex and sensitive biological assays
3. Understand the potential of molecular assays to solve biological problems

Expected Course Outcomes:

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

1	Isolate pure DNA from various sources and utilize it as source material for DNA based assays. Perform advanced nucleic acid tests that are routinely used in clinical applications and plant authentication.	K6
2	Carryout gene manipulation and gene transfer using recombinant DNA technology	K6
3	Identify, detect and quantitate antigens using electrophoretic and biochemical assays.	K5
4	Acquire skills to handle experimental animals to conduct reproductive tests and microscopic identification of microbes and sex chromosomes.	K5
5	Attain skills to immunize mice and apply them for antibody production	K6

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

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

1. Plant Genomic DNA extraction by CTAB method and quantification.
2. DNA barcoding for herbal plant authentication.
3. Particle gene gun mediated genetic transformation of GFP in Tobacco.

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

1. Isolation and Quantification of DNA from animal tissue.
2. Identification of Barr bodies from buccal smear.
3. Handling of small animals-Mice and Rat.

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

1. ARDRA analysis to determine diversity/ similarity of bacterial isolates from a sample.
2. Qualitative and quantitative estimation of bacterial enzyme production.
3. Transfer of genetic material through transposon mutagenesis.

Plant Metabolic Engineering (Dr. S. Girija)	**9 hours**

1. Screening of major secondary metabolites from medicinal plant.
2. Estimation of Malanoldihyde in plant samples.
3. *Agrobacterium* mediated plant genetic transformation.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**
1. Analysis of DNA damage by COMET assay. 2. Estimation of Alkaline Phosphatase activity (ALP) to assess the extent of differentiation in mammalian cells. 3. Demonstration on protein-ligand interaction and calculate its binding affinity through molecular docking studies.	
Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)	**9 hours**
1. Human pregnancy test by Agglutination method. 2. Biomarker detection in body fluids: Detection of C reactive protein (CRP) using agglutination methods. 3. Isolation and purification of IgG	
Plant Molecular Biology (Dr. M. Arun)	**9 hours**
1. Isolation of plasmid DNA and quantification using AGE and UV-Visible spectrophotometer. 2. Identification of optimum restriction site for gene cloning and restriction digestion of plasmid vectors. 3. DNA ligation for developing recombinant vectors.	
Regenerative Medicine and Translational Research (Dr. M. A. Shibu)	**9 hours**
1. Determination of antigen concentration by Rocket Immunoelectrophoresis. 2. Detection of hydrolytic enzymes on the basis of substrate degradation by Zymography 3. Primer designing and gene expression analysis by RT-PCR.	
Total training hours	**72 hours**
Reference Books	
1. Molecular Cloning: A Laboratory Manual. Michael R. Green. 2014, Fourth Edition	
2. Nucleic Acid Detection: Methods and Protocols (Methods in Molecular Biology) Dmitry M. Kolpashchikov and Yulia V. Gerasimova, 2013.	
3. PCR Primer Design. Basu and Chhandak. 2015.	
3. Measurement of Antioxidant Activity & Capacity: Recent Trends and Applications. Resat Apak Esra Capanoglu Fereidoon Shahidi, 2017.	
4. Cytogenetics. P.K. Gupta. Rastogi publications. 2018.	
Related Online Contents [Websites]	
1. Methods to Transfer Foreign Genes to Plants. Yoshihiro Narusaka, Mari Narusaka, Satoshi Yamasaki and Masaki Iwabuchi. 2012 https://www.intechopen.com/books/transgenic-plants-advances-and-limitations/methods-to-transfer-foreign-genes-to-plants	
2. Pregnancy Test https://fpnotebook.com/ob/lab/PrgncyTst.htm	
3. Pregnancy Tests, A review, T.Chard 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**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	M	S	S	M	S
CO2	M	S	S	S	S	S	S	M	S	S
CO3	M	S	S	S	S	M	S	S	M	S
CO4	S	S	S	S	S	S	S	S	L	S
CO5	S	S	S	M	S	S	S	M	S	S

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

Course code	25BIOGS02	MEDICAL BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Supportive -2	2	0	0	2
Pre-requisite		Any discipline	Syllabus Version	2025-26		

Course Objectives:

The main objectives of this course are to:

1. Enrich the student skills in handling the advanced instruments for validation of various clinical disorders.
2. Understand the importance of various biomedical instruments in diagnosis
3. Improve the knowledge on basic medical science

Expected Course Outcomes:

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

1	Understand broad theoretical knowledge and critical understanding of advanced principles in biotechnology.	K1
2	Gain the practical knowledge required to support a career in biomedical research environment.	K2
3	Have a sound platform for setting up basic clinical laboratory.	K2
4	Develop new ideas for disease diagnosis	K2& K4
5	Expand the knowledge on biomarker for various diseases	K2

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

Unit:1	Introduction to Biotechnology and Medicine	6 hours

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

Unit:2	Molecular Diagnostics	6 hours

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

Unit:3	Cell And Gene Mediated Therapy	6 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 theraoy; outline and methods.

Unit:4	Assisted Reproductive Techniques	6 hours

Introduction - causes of infertility - methods; IVF-Intra uterine insemination-cryopreservaton of germ cells – IVM and ICSI.

Unit:5	Tissue Engineering	6 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	**32 hours**

Text Book(s)

1	Medical Biotechnology - P.C.Trivedi (2008)
2	Medical Biotechnology - V V Rao (2010)

Reference Books

1	Medical Biotechnology - Cheryl L. Patten (2013).
2	Medical Biotechnology (1st edition**) -** Judit Pongracz Mary Keen (2008). Elseiver.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	S	L	L	L	L	L	L	L
CO2	L	L	L	L	S	L	L	L	L	L
CO3	L	S	L	L	L	L	L	L	L	L
CO4	L	L	M	L	S	S	L	L	L	L
CO5	M	M	L	L	L	L	L	L	L	L

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

Job Oriented Certificate Course – 1

Course code	25BIOBCJ1	SAS Programming for Clinical Trials Credits Management	L	T	P	C
Core/Elective/Supportive		Supportive -II		✓	0	4
Pre-requisite		Any discipline	Syllabus Version	2025-26		

Name of the Department	**Biotechnology**
Name of the Faculty Member i/c **With Complete Address with Phone and e-mail**	**Dr. V. Thirunavukkarasu,** Associate Professor, Dept. of Biotechnology, Bharathiar University thirunavukkarasu@buc.edu.in
Eligibility	PG students of Medical Biotechnology, Biotechnology, Microbiology, Biochemistry students
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:

1. Gain basic knowledge about drug discovery
2. Understand the workflow of clinical trials and importance of management of clinical data and interpretation.
3. Gain basic knowledge of SAS programming
4. Acquire knowledge about applying SAS programming for CT management
5. Understand CDISC SDTM and ADaM rules for data standardization

Expected Course Outcomes:

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

CO1	In-depth learning about work flow of new drug discovery.	K1, K2
CO2	Understanding the importance of clinical research in drug discovery	K2, K4

CO3	Learning and understanding the applications of SAS programming for clinical trial data management	K2, K4
CO4	Learning SAS programming and applying it using model clinical data	K3, K4
CO5	Understand the needs for data standardization and evaluating its application in CT	K2, K5
K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create		

Module 1	**4 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	**3 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	**6 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	**5 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	**6 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	**5 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	**4 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	**5 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	**3 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	**4 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	**45 hours**

Reference

1	SAS® Certification Prep Guide: Statistical Business Analysis Using SAS®9; Joni N. Shreve, Donna Dea Holland; Publisher: SAS Institute
2	SAS® Certification Prep Guide: Advanced Programming for SAS®9 Second Edition; Publisher: SAS Institute
3	SAS® Programming in the Pharmaceutical Industry, second edition; Jack Shostak; Publisher: SAS Institute
4	Basic Principles of Drug Discovery and Development; Benjamin E. Blass; 2021; 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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	M	S	L	M	M	L	M	L	L
CO2	M	L	L	M	L	S	L	M	L	M
CO3	L	M	L	L	M	L	S	L	S	S
CO4	L	S	L	L	L	S	L	L	L	L
CO5	M	L	S	L	L	L	S	S	S	L

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

THIRD SEMESTER

Course code	**25BIOBC09**	**ANIMAL BIOTECHNOLOGY AND STEM CELL BIOLOGY**	**L**	**T**	**P**	**C**
Core		**Core Paper - 9**	**4**	✓	**-**	**4**
Pre-requisite		**A basic knowledge in cell biology, developmental biology and physiology at UG level**	**Syllabus Version**		**2025-26**	

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 development and transplantation.
Expected Course Outcomes:
On the successful completion of the course, student will be able to:

1	Gain fundamental knowledge in stem cell biology and tissue engineering.	K1
2	Describe sources, selection, potential manipulations and challenges of using stem cells for tissue engineering.	K2
3	Explain significance, current status and future potential of tissue engineering.	K3
4	Identify key challenges in tissue engineering of different human tissues.	K4
5	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**	**12 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**	**12 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**	**12hours**
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**	**12 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**	**12 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.		
Unit:6	**Contemporary Issues**	**5 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	**65 hours**

Text Book(s)

1	Ed. Robert Lanza et al.; Principles of Tissue Engineering – 5th Edition (2020); Academic Press
2	Lanza R., Atala A.; Essentials of Stem Cell Biology 3rd Edition (2013); Academic Press

Reference Books

1	Boer JD et al.; Tissue Engineering – 2nd Edition (2014); Academic Press

2	Pallua N, Suschek CV; Tissue Engineering: from Lab to Clinic (2011); Springer
3	Barnes SJ, Harris LP; Tissue Engineering: Roles, Materials and Applications – 1st Edition (2008); Nova Science Publishers Inc
4	Minuth WW. Strehl R. Schumacher K; Tissue Engineering: from Cell Biology to Artificial Organs (2017); Wiley VCH
5	Zhao RC; Stem Cells: Basics and Clinical Translation (Translational Medicine Research) (2015); Springer
6	Knoepfler; Stem Cells: An Insider's Guide (2013); World Scientific Publishing Company
7	Harris J. Quigley M. Chan S.; Stem Cells: New Frontiers in Science & Ethics (2012); World Scientific Publishing Co Pte Ltd
8	Attala & Lana; Methods of Tissue Engineering (2002); Academic Press
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
Course Designed By: **Dr. P. Ekambaram, Professor, Dept. of Biotechnology**	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	L	L	L	L	L
CO2	S	S	M	M	L	L	L	L	L	M
CO3	S	S	S	S	S	S	L	L	M	L
CO4	S	M	M	M	M	S	L	L	L	M
CO5	S	S	S	S	S	S	L	L	M	M

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

Course code	25BIOBC10	PLANT BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		**Core Paper - 10**	**4**	**✓**	**-**	**4**
Pre-requisite		**Basic knowledge of Plant Science**	**Syllabus Version**	**2025-26**		

Course Objectives:

The main objectives of this course are to:

1. Equip students with knowledge on molecular markers and marker-aided breeding.
2. Expedite the students to understand the techniques involved in plant tissue culture.
3. Make them better understand the genetic engineering approach for enhancing efficiency, precision, and proper expression of the nucleic acid molecules in the plant system.
4. Introduce advanced technologies employed for crop improvement.
5. Enrich the students' knowledge with respect to different applications of transgenic technology.

Expected Course Outcomes:

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

1	Acquire a complete knowledge about molecular marker-aided breeding and apply that for effective crop improvement.	K3, K6
2	Obtain comprehensive knowledge about the concepts of plant tissue culture and its applications.	K1, K2
3	Understand the methods of plant genetic transformation and use such acquaintance to develop transgenic plants with improved traits.	K2, K3, K6
4	Know and apply advanced technologies for improving plant performance	K1, K5
5	Demonstrate the application of transgenic technology and apply that knowledge effectively in relevant areas.	K3, K4

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

Unit:1	**Molecular Markers and Marker – Assisted Breeding**	**12 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**	**12 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**	**12 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**	**12 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**	**12 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**	**5 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**65 hours**

Text Book(s)	
1	Plant Biotechnology: The genetic manipulation of plants. Second edition. Slater, Scott, and Fowler, 2008, Oxford University Press, UK.
2	Plant cell culture. A practical approach. Second edition. Edited by R.A. Dixon and R.A. Gonzales.1994. Oxford University Press. UK.
3	An Introduction to Plant Tissue Culture, Third Edition, M.K. Razdan, Oxford and IBH Publishing Co., 2003.
4	Introduction to plant biotechnology, Third edition, H S Chawla, 2009.
5	Cassells, A. C 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	Adrian Slater, Nigel Scott and Mark Fowler. (2008). Plant Biotechnology – the Genetic Manipulation of Plants. Second Edition. Oxford University Press.
7	Paul Christou and Harry Klee. (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, S.S and Razdan. M.K. (2009). Plant Tissue Culture-Theory and Practice. Elsevier India Pvt. Ltd.
Reference Books	
1	An introduction to genetic engineering in plants, Mantel, Mathews, and Mickee, 1985. Blackwell Scientific Publishers. UK.
2	*In Vitro* Culture of higher plants, Pierik, 1987. Martinus Nijhoff Publisher, Germany.
3	Plant Molecular Biology by Grierson and Convey.1984. Blackie and Son Limited. USA.
4	Plant Biotechnology by Mantell and Smith, 1983. Cambridge University Press, UK.
5	Plants, genes, and agriculture by Chrispeels and Sadava, 2000.The American Scientific Publishers, USA.
6	Practical Application of Plant Molecular Biology, Henry,1997. Chapman and Hall. UK.
7	Plant Biotechnology, Hammond, Mc Garvey and Yusibov, 2000, Springer Verlag, UK.
8	Plant Biotechnology and Transgenic Plants, Edited by Kirsi-MarjaOksman-Caldentey and Wolfgang Barz. 2002, Marcel Dekker, Inc. USA.
9	Molecular Plant Biology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, 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., & Mysore, K. S. (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., &Papadopoulou, K. K. (2020). GMO-free RNAi: exogenous application of RNA molecules in plants. *Plant Physiology*, pp-00570.
13	Gilchrist, E., &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, K. E., Mahas, A., & Mahfouz, M. (2019). Plant genome engineering for targeted improvement of crop traits. *Frontiers in plant science*, *10*, 114.
15	Horn, M. E., Woodard, S. L., & Howard, J. A. (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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	L	L	S
CO2	S	M	S	S	S	M	S	L	L	S
CO3	S	S	S	S	S	S	M	L	L	M
CO4	S	S	S	S	S	S	S	L	L	S
CO5	S	S	S	S	S	S	S	L	L	S

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

<table>
<tr><td>Course code</td><td>25BIOBC11</td><td>BIOPROCESS TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td>Core Paper -11</td><td>4</td><td>✓</td><td>-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td>A Basic Knowledge in Bioprocess Technology in Undergraduate level</td><td colspan="2">Syllabus Version</td><td colspan="2">2025-26</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">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 enlighten on downstream processing to convert them as value added products.
4. To obtain overall holistic knowledge on fermentation technology to produce various biologicals of economic value.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Expected Course Outcomes:</td></tr>
<tr><td colspan="7">On the successful completion of the course, student will be able to:</td></tr>
<tr><td>1</td><td colspan="5">Learn the importance of microbiology at industrial perspective rather restricting with laboratory level understanding.</td><td>K1</td></tr>
<tr><td>2</td><td colspan="5">Get introduced to Bioprocess technology terms and understand tools to apply them during larger scale for practical applications.</td><td>K2</td></tr>
<tr><td>3</td><td colspan="5">Derive the kinetic models for cell growth and multiplication; growth rate; doubling time.</td><td>K3</td></tr>
<tr><td>4</td><td colspan="5">Based on input parameters, output would be worked out standard models available to predict through equations</td><td>K4</td></tr>
<tr><td>5</td><td colspan="5">Learn the methods of cell harvesting methods and disruption techniques; Choose the best for the system which they are going to employ.</td><td>K4</td></tr>
<tr><td>6</td><td colspan="5">Based on previous knowledge, student would be able to select the best methods to purify the fraction to develop as commercial purpose.</td><td>K5</td></tr>
<tr><td>7</td><td colspan="5">From a profile of biological products, student will learn about the methods of production and imbibe variants through innovations.</td><td>K6</td></tr>
<tr><td colspan="7">K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Unit:1</td><td colspan="5">Basics of Bioprocess technology</td><td>6 hours</td></tr>
<tr><td colspan="7">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; filter sterilization.
Inoculum development: Inoculum source – Seed culture; development of inocula for yeast, bacteria and fungi.</td></tr>
</table>

Unit:2	**Microbial Growth Kinetics and Production Kinetics**	**8 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**	**8 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 off line control, Controlling systems: Temperature, flow rate, pressure, pH, DO, gas analysis.		
Unit:4	**Downstream processing**	**8 hours**
Biomass removal: 8eparation 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**	**8 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	40 hours

Text Book

1. Principles of Fermentation technology by P.F. Stanbury and A.Whitaker, Pergamon press. Second edition. 2005.
2. Introduction to Biochemical engineering by D.G.Rao, McGraw-Hill publications, I edition, 2010.
3. Industrial Microbiology by Prescott and Dunns 4th edition edited by Gerald Reed, Chapman & Hall publications 2007.
4. Bioprocess Engineering Principles by Paulie M. Doran, Academic Press. 2005.
5. Industrial Microbiology by Michel J. Waites Neil L. Morgan, JonS. Rockey and Gary Higton, Blacwell Science, 2002.

Reference Books

1	Fermentation microbiology and Biotechnology. Second edition, edited by El-.Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman. Taylor and Francis, 2007.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	L	M	L
CO2	S	S	M	M	M	L	S	L	M	L
CO3	S	S	M	M	M	S	M	L	M	L
CO4	S	S	M	M	M	L	S	L	M	L
CO5	S	S	M	M	M	S	M	L	M	L
CO6	S	S	M	M	M	M	M	L	M	L
CO7	S	S	M	M	M	M	M	M	M	M

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

Course code	25BIOBC12	BIOINFORMATICS AND SYSTEMS BIOLOGY	L	T	P	C
Core/Elective/Supportive		**Core Paper - 12**	**4**	**✓**	**-**	**4**
Pre-requisite	Basic operations of computers, proteomics, genomics, cellular function and signalling.		**Syllabus Version**		**2025-26**	

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:

1	Explain the importance of bioinformatics in systems biology	K1, K2 & K3
2	Discuss the use of genes and genomes data in systems biology	K1 & K3
3	Construct the metabolic pathway networks	K2, K3,K4 & K5
4	Integrate the omics data for networking	K3, K5 & K6
5	Apply the appropriate tools in systems biology for modelling	K3, K4, K5 & K6

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 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	Bioinformatics and Functional Genomics. Third edition. Pevsner, J. A. John Wiley & Sons, Inc., USA (2015).
2	Introduction to Systems Biology. First edition. Choi, S. Humana Press, USA (2007).
3	Bioinformatics, Fourth edition, Andreas D. Baxevanis, B.F. Francis Ouellette. John Wiley & Sons, Inc., USA (2020).
Reference Books	
1	Kitano, Systems Biology: A Brief Overview. Science, 2002, 295: 1662-1664.
2	Ideker et al. A new approach to decoding life: Systems Biology. Annual Review on Genomics and Human Genetics 2001, 2: 343-372.
3	Ideker et al. Integrated Genomic and Proteomic Analyses of a Systematically Perturbed Metabolic Network. Science, 2001, 292: 929-934.
4	Ge et al. Integrating “omics” information: a bridge between genomics and systems biology. Trends in Genetics, 2003, 19, 10: 551-560.
5	Chong et al. Wholistic Biology, Science, 2002, 295:1661.
6	Catherine et al. The European Bioinformatics Institute’s data resources: towards systems biology. Nucleic Acids Research, 2005, 33:46-53.

7	Garst, A. D., Edwards, A. L., & Batey, R. T. (2011). Riboswitches: structures and mechanisms. *Cold Spring Harbor perspectives in biology*, *3*(6), a003533.
8	Kanehisa, M., Sato, Y., Furumichi, M., Morishima, K., & 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., & Fletcher, L. (2019). Future Trends in Synthetic Biology–A report. *Frontiers in bioengineering and biotechnology*, *7*, 175.
10	Kantarjian, H., & Yu, P. P. (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., &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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	L	M	L	L	L	L	L	L
CO3	S	L	L	L	M	L	L	L	L	L
CO3	S	L	L	L	L	L	M	L	L	L
CO4	L	S	L	L	L	L	L	M	M	L
CO5	L	M	S	L	L	L	L	L	L	L

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

Course code	25BIOGE03A	NANOBIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		**Elective - 3**	**4**	**✓**	**-**	**4**
Pre-requisite		**Basic knowledge in biological and chemical structures.**	**Syllabus Version**		**2025-26**	

Course Objectives:

The main objectives of this course are to:

1. The course aims at providing general and broad introduction to multi-disciplinary field of nanotechnology.
2. It will familiarize students with combination of top-down approach of microelectronics and micro- mechanics with bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies.
3. The course will also give an insight into complete systems where nanotechnology can be used to improve everyday life.

Expected Course Outcomes:

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

1	Describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.	K4, K5
2	Understand the concepts related to nano-films and their characterization.	K2, K6
3	Obtain a comprehensive knowledge about nanoparticles and its applications.	K1, K3
4	Know about the detailed insight on nanomaterials	K2, K3
5	Gain information's about basics of nanotoxicity	K1

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

Unit:1	**Introduction to Nanobiotechnology**	**12 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**	**12 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**	**12 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**	**12 hours**
Nanoparticles for diagnostics and imaging (theranostics); concepts of smartstimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. Nanosensors for neuronal disorders.		
Unit:5	**Toxicity – Regulations and Herbal Products**	**12 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**	**5 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	**65 hours**

Text Book(s)

1	GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential AssemblyofNanocompositeMaterials,Wiley-VCHVerlagGmbH&Co.KGaA
2	DavidS.Goodsell,(2004);Bionanotechnology:LessonsfromNature, Wiley-Liss
3	Neelina H. Malsch, Biomedical Nanotechnology, CRCPress
4	Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition);Elsevier
5	Risal singh and shipra mithal gupta (2016). Introduction to Nanotechnology. First edition. PP:604.ISBN:9780199456789
6	Charles p pool (2020). Introduction to Nanoscience and Nanotechnology. wiley publisher.PP.508
7	Narendra kumar and Sunita Kumbhat (2016). Essentials in Nanoscience and Nanotechnology.wiley publisher. PP.465. ISBN: 978-1-119-09611-5
8	Abdel Salam Hamdy Makhlouf Ahmed Barhoum (2018). Fundamentals of Nanoparticles.1st Edition. Elsevier. PP.666. Paperback ISBN: 978032351255
9	Deborah M. Kane, Adam Micolich Peter Roger (2016). Nanomaterials Science and Applications.1st Edition Jenny Stanford Publishing, PP.418 .ISBN 9789814669726.
10	Kumar V. Guleria P. Shivendu R.Dasgupta N. Lichtfouse, E. (2021). Nanotoxicology and Nanoecotoxicology. Springer International publisher. Vol. 1 .pp:318. ISBN 978 3030632410

11	Alain Nouailhat (2006). An Introduction to Nanoscience and Nanotechnology. France by Hermes Science/Lavoisier. DOI: https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf
12	A.Ranzoni and M.A.Cooper (2017).Chapter One – The Growing Influence of Nanotechnology in Our Lives. Micro and Nanotechnology in Vaccine Development.PP:1-20.
13	Aliof khazraei, Mahmood (Ed.)(2015). Handbook of Nanoparticles. Springer publisher. ISBN: 978 3319153391
14	IbrahimKhan , KhalidSaeed , IdreesKhan (2019). Nanoparticles: Properties, applications and toxicities. The Arabian journal of chemistry.12(7). PP:908-931.
15	Susai Rajendran Anita Mukherjee Tuan Nguyen Chandraiah Godugu Ritesh Shukla (2020). Nanotoxicity. 1st Edition. Elsevier.pp;504 .ISBN: 9780128199442
Reference Books	
1	Pragi Arora and Varun Arora (2019) Text book of herbal drug technology, PV Books publishing.
2	Pulok k Mukheerjee (2019) Quality Control and Evaluation of Herbal Drugs: Evaluating Natural Products and Traditional Medicine, publisher elsiever.
3	Arman dekebo (2019) Introductory chapter : plant extracts, DOI: 10.5772/intechopen.85493 pp-48.
4	Haidan Yuan , Qianqian Ma , Li Ye and Guangchun Piao (2016) The Traditional Medicine and Modern Medicine from Natural Products, Molecules, 21-559, DOI: 10.3390 /molecules 21050559.
5	Rohit Kumar Bijauliya, Shashi Alok, Dilip Kumar Chanchal and Mayank Kumar (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**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	M	S	S	L	L	S
CO2	S	M	S	S	S	M	S	L	L	S
CO3	S	S	S	S	S	M	S	L	L	S
CO4	S	S	S	S	S	S	S	L	L	S
CO5	S	S	M	S	S	S	S	L	L	S

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

Course code	25BIOGE03B	PHARMACEUTICAL BIOTECHNOLOGY		L	T	P	C
Core/Supportive/Elective		Elective - 3		4	✓	-	4
Pre-requisite		A Basic Knowledge in Pharmaceutical Biotechnology		Syllabus Version	2025-26		

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:

1	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
2	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
3	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
4	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
5	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	14 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**	**14 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**	**14 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**	**14 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**	**14 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	**65 hours**

Text Book(s)

1	Gary Walsh (Ed) (2011). Pharmaceutical Biotechnology – Concepts and Application.
2	Vyas SP, Dixit VK (2019) Pharmaceutical Biotechnology
3	Kolkate, Jalapure, Hurakadle. (2011).Text book of Pharmaceutical Biotechnology,

4	Graham P Bunn. (2019) Good Manufacturing Practices For Pharmaceuticals -7ED
Reference Books	
1	Crommelin DJA, Sindelar RD, Meibohm B. 2019. Pharmaceutical Biotechnology Fundamentals And Applications. 5th Edition
2	Orlilcki R, Cienciala C, Krylova LP, Pielichowski J, Zaikov GE.2013.Pharmaceutical And Medical Biotechnology New Perspectives
3	Antoine Al-Achi, Mali Ram Gupta, William Craig Stagner. 2013. Integrated Pharmaceutics-Applied Preformulation, Product Design, and Regulatory Science
4	Shyam S Mohaptra, Shivendu Ranjan, Nandita Dasgupta, Raghavendra Kumar Mishra, Sabu Thomas. 2018. Applications of targeted Nano drugs and Delivery systems.
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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	M	L	S	L	S	S
CO2	S	M	S	M	S	L	S	L	S	S
CO3	S	S	S	S	S	S	M	M	S	S
CO4	S	S	S	M	S	L	S	L	S	S
CO5	S	S	M	M	S	S	M	S	S	L

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

<table>
<tr><td>Course code</td><td>25BIOBCP3</td><td>APPLIED BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Core/Elective/Supportive</td><td>Practical -3</td><td>6</td><td>-</td><td>✓</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td>Basic Skills in Biotechnology</td><td colspan="3">Syllabus Version</td><td>2025-26</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">The main objectives of this course are to:
1. Expose the students to recent advances in tools and techniques of applied biotechnology.
2. Expedite the students to understand and develop skill sets in diverse areas such as microbiology, plant, and animal biotechnology.
3. Prepare skilled workers to carry out research in frontier areas of applied biotechnology.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Expected Course Outcomes:</td></tr>
<tr><td colspan="7">On the successful completion of the course, student will be able to:</td></tr>
<tr><td>1</td><td colspan="5">Perform several assays using cell lines, prepare primary cells, and develop skill sets to work with Zebrafish model system.</td><td>K2, K4</td></tr>
<tr><td>2</td><td colspan="5">Work on Agrobacterium mediated transformation system for crop improvement and perform screening of secondary metabolites from medicinal plants.</td><td>K1, K3, K4</td></tr>
<tr><td>3</td><td colspan="5">Understand about different marker systems employed for screening of transformed tissues and perform blotting techniques for different applications.</td><td>K2, K4</td></tr>
<tr><td>4</td><td colspan="5">Isolate metagenomic DNA from different microbial populations and know how to optimize bacterial media through RSM.</td><td>K6</td></tr>
<tr><td>5</td><td colspan="5">Diagnose virus infected samples using PCR, perform qualitative PCR analysis of different mutant gene expression, immunological assays, and membrane receptor identification.</td><td>K4, K5</td></tr>
<tr><td colspan="7">K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Transient gene expression of GFP in Tobacco by Agroinfiltration
2. Nucleotide and Protein sequence analysis - Blast, MSA and Phylogenetic tree construction.
3. PCR-RFLP analysis for detection of adulteration in aromatic rice</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Molecular Toxicology Laboratory (Dr. P. Ekambaram)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Preparation of primary cells from animal tissue, cell counting and viability.
2. Analysis of F-actin based cellular cytoskeleton by Phalloidin staining to the given sample.
3. Immunohistochemistry of Zebrafish embryo</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="6">Molecular Microbiology Laboratory (Dr. S.R. Prabagaran)</td><td>9 hours</td></tr>
<tr><td colspan="7">1. Metagenomic DNA isolation from soils and nested PCR amplification of 16S rRNA genes.</td></tr>
</table>

2. Determination of generation time of bacteria by standard growth curve 3. Optimization of bacterial media through Response Surface Methodology (RSM)	
Plant Metabolic Engineering Laboratory (Dr. S. Girija)	**9 hours**
1. Analysis of Antimicrobial activity of medicinal plant extract 2. Quantification of Drug molecule from medicinal plants using HPLC 3. *Agrobacterium rhizogenes* for hairy root culture and estimation of phenolic compound	
Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)	**9 hours**
1. Total RNA isolation and quantification using Spectrophotometer and cDNA preparation from total RNA and qualitative PCR analysis of a mutant gene expression. 2. Diagnosis of virus (dengue, chikungunya) infected samples using PCR. 3. Demonstration of Northern blotting.	
Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)	**9 hours**
1. Biomarker detection in body fluids: Estimation of blood Bilirubin by biochemical colorimetric method. 2. Examine number and morphology of nucleus in given tissue sample by 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 of recombinant vector by heat shock/electroporation methods. 2. Colony PCR for identifying the transformed bacterial colonies having gene of interest. 3. Designing guide RNA using bioinformatic tools, and developing knock down construct for CRISPR based genome editing.	
Regenerative Engineering and Translational Research (Dr. M. A. Shibu)	**9 hours**
1. Cytotoxicity screening of chemotherapy drugs in cultured cells using MTT analysis. 2. Estimation of LDH leakage in culture supernatant to measurement chemical induced cellular damage using LDH assay. 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	Terry L Riss, Richard A Moravec, Andrew L Niles, Helene A Benink, Lisa Minor (2013) Cell Viability Assays manual. NCBI.
2	Kan wang (2015). Agrobacterium protocols. Methods in Molecular biology, springer protocols,2(3): 372.
3	Katarzyn glowacka, Johannes kromdijk, Lauriebeth leonelli, Krishna k niyogi, Tom e clemete and Stephen p long (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	Danillo Lucas Alves, Esposito Benedito, Antonio Lopes, and da Fonseca (2017) Sensitivity and detection of chikungunya viral genetic material using several PCR-based approaches, Rev. Soc. Bras. Med. Trop. vol.50.
2	Sumit kumar verma, Himanshi Singh and Prakash C Sharma(2017) An improved method suitable for isolation of high-quality metagenomics DNA from diverse soils.3 biotech,7(3):171.
3	Selvaraju Gayathri Devi, Anwar Aliya Fathima, Sudhakar Radha, Rex Arunraj, Wayne R. Curtis and Mohandass Ramya (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, A. C. (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**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	L	S	S	S	M	S	L	L
CO2	S	S	S	S	S	S	S	L	L	S
CO3	S	L	L	S	S	L	L	S	L	L
CO4	S	S	S	S	L	L	L	L	L	L
CO5	S	S	S	S	S	S	M	S	L	S

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

Course code	25BIOGS03	FOOD BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Supportive - 3	2	0	0	2
Pre-requisite		A Basic Knowledge in Food Biotechnology	Syllabus Version	2025-26		

Course Objectives:

The main objectives of this course are to:

1. Designed to provide a theoretical knowledge on the available raw materials for food industry.
2. Create background information on conversion of raw materials into processed, packaged, shelf-stable food products.
3. Give an idea on the effective utilization of intermediate products as food supplements.
4. Learn technologies involved in food preservation and explore in-depth about the concept.
5. Motivate the importance of food industry and future prospective.

Expected Course Outcomes:

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

1	Understand the principles and concepts of technology to overcome the problems in food handling and processing.	K1
2	Acquire the information about role of microbes in food processing	K2
3	Provide the opportunities to be an entrepreneur in food processing companies /Agricultural fields.	K2& k3
4	Comprehend the interrelationships between the properties of raw materials and the changing methods of producing them in cost effective manner.	K2& k3
5	Distinguish the ethical and unethical production of food products.	K2

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

Unit:1	Introduction to Food Technology	6 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	6 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	6 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	6 hours

Principles and methods of food preservation: Asepsis removal, High temperature, Low temperature, Drying, Irradiation, Chemical and Biopreservatives.

Unit:5	**Food Packaging Technology**	**6 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	**32 hours**

Text Book(s)

1	Advances in Food Biotechnology, - Ravishankar Rai V (2016). Wiley- Blackwell
2	Food Biotechnology – Kalidas shetty (2005). Taylor & Francis group.

Reference Books

1	Fundamentals of food Biotechnology – Byong H Lee. (2016). 2nd Edition, Wiley – Blackwell.
2	Food Processing Technology Principles and Practice – P. Fellows (2000). 2nd Edition, Woodhead Publishing Limited.

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

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	L	L	M	L	L	L
CO2	L	L	S	L	L	L	L	L	L	L
CO3	S	L	L	L	M	L	M	L	L	L
CO4	S	L	L	L	L	M	L	L	L	L
CO5	S	L	L	L	L	S	L	L	L	L

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

Course code	25BIOBCS1	One Month Summer Internship	L	T	P	C
Marks: 50		**Internship**	**2**	**0**	**0**	**2**
Course profile		**Short term internship course for a minimum period of 30 days**	**Syllabus Version**	**2025-26**		

Course Objectives:

The main objectives of this course are to:

1. Apply knowledge and perform skills in a potential future work field, for example in a company, a public institution, a research organisation, another public university/Institution, or an established non-governmental research organisation.
2. Emphasis on practical training in Biotechnology Industry/service/research sectors.
3. Develop interest and familiarize on the duties and qualifications for the chosen career.
4. Understand how a professional workplace operates.

Expected Course Outcomes:

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

1	Evaluate career interests and ambitions in relation to the internship project and reflect on professional ambitions and capabilities.
2	Perform a set of general professional skills at Master's level.
3	Transfer knowledge acquired during MSc education to a professional context and conduct work tasks and projects at the level of an MSc graduate.
4	Evaluate the scientific and societal context and relevance of the internship project tasks
5	Define personal learning goals, which could include domain-specific skills, and reflect on development therein

Programme Highlights:

Internship training only in a professional or research field.
Institution selected in consultations with Course coordinator/Mentor.
Minimum period of 30 days during semester break following the second semester.
A detail report submitted at the end of the Internship.

JOB ORIENTED CERTIFICATE COURSE – 2

Downstream Processing by Conventional Chromatography	
Name of the Department	**Biotechnology**
Course code	**25BIOBCJ2**
Name of the Faculty i/c in the proposed Department	Dr. S. Velayuthaprabhu Associate Professor Department of Biotechnology
Inter / Intra Department Course	Intra department course
Duration of the Course	30 hours
Eligibility	For the I year MSc biotechnology students
Number of Candidates to be Admitted	Maximum 25
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.)	Course handle by Dr. R. Boopathy, Mentor Professor, Department of Biotechnology
Registration Procedure	

Job Opportunities: The conventional chromatographic techniques are the best options available today in Biotech/Pharma –industries, provided they are scaled up to industrial level.

The objectives of the Course are:

The main objectives of this course are:

1	Helping to eliminate unwanted materials that can be hazardous or compromise drug efficacy
2	Understanding of the methods and optimization of experimental conditions
3	To deliver a robust and effective process leading to a high purity product
4	Active Pharmaceutical Ingredient (API) purification

Course Content	Lecture / Practical / Internship	
Module 1	*Isolation, separation techniques:* Analysis of carbohydrate and lipid molecules; Simple bio-physical separation of proteins. Analysis of proteins by one dimensional gel electrophoresis *Histochemical and Immuno-techniques:* Principle of Antibody generation, Ag-Ab-Interaction; Identification of Antigens using antibodies; Application of immunological principles; Detection of protein molecules using ELISA, RIA, western blot, Immunoprecipitation. *Biophysical method:* Bio-Molecular analysis using light scattering.	**6 hours**
Module 2	Production of AH-Sepharose: Carbo-di-imide Activation of Sepharose, *for developing Affinity Columns.* Protein-A/ any antigen Coupling to AH-Sepharose for antibody	**5 hours**

	purification, *for any ligand coupling.* Epox-activation of Sepharose, *for coupling IED/TED to Sepharose.*	
Module 3	DEAE- Cellulose chromatography *for Negatively charged (at pI) proteins purification.* CM- Cellulose Chromatography *for Positively charged (at pI) protein purification.*	**4 hours**
Module 4	Blue- Sepharose Chromatography *for Purification of Biomolecules having PO4 groups.* Con-A/RCA -Sepharose Affinity Column Chromatography *for Glyco-protein purification.* Phenyl / Octyl -Sepharose Hydrophobic Column chromatography *for membrane protein purification*.	**5 hours**
Module 5	Protein-A Sepharose Affinity Chromatography *for IgG purification.* Antibody Sepharose Affinity chromatography, *for antigen purification.*	**5 hours**
Module 6	Gel-Filtration Column chromatography, *for small biomolecules purification.* Construction of Purification Table, using Enzyme purification with multiple steps. Checking the Purification Profile and Interpretation: *Analysis of proteins by one dimensional gel electrophoresis*	**5 hours**
		30 hours.

Book(s) for reference

1. Chemical modification of the bifunctional human serum pseudocholinesterase: Effect on the pseudocholinesterase and aryl acylamidase activities; R Boopathy, AS Balasubramanian (1985): European journal of biochemistry 151 (2), 351-360.

2. Purification and characterization of sheep platelet cyclo-oxygenase Acetylation by aspirin prevents haemin binding to the enzyme; R Boopathy, AS Balasubramanian (1986): Biochemical journal 239 (2), 371-377

3. Purification and characterization of lipase from Rhizomucor miehei; G Uvarani, L Jaganathan, P Shridas, R Boopathy (1998): Journal of scientific & industrial research 57 (10-11), 607-610.

4. Chemical modification studies of Rhizomucor miehei protease: evidence for the role of basic amino acids in enzyme catalysis. P Shridas, R Boopathy (1998): Indian journal of biochemistry & biophysics 35 (6), 339-345

5. A direct method to visualise the aryl acylamidase activity on cholinesterases in polyacrylamide gels; L Jaganathan, R Boopathy (2000):BMC biochemistry 1 (1), 1-5.

6. Phosphatidylinositol-specific phospholipase C production from Bacillus thuringiensis serovar. kurstaki using potato-based media; T Palvannan, R Boopathy (2005): World Journal of Microbiology and Biotechnology 21 (6), 1153-1155.

7. Interaction of aminoglycoside antibiotics with surface Asp and Glu residues of phosphatidylinositol-specific phospholipase C. T Palvannan, R Boopathy (2006): Enzyme and microbial technology 38 (7), 899-90

8. Purification and characterization of peroxidases from liquid endosperm of Cocos nucifera (L.):

Biotransformation; M Balasubramanian, R Boopathy (2013): Journal of Molecular Catalysis B: Enzymatic 90, 33-42.

FOURTH SEMESTER

Course code	25BIOBC13	BIOETHICS, BIOSAFETY, IPR AND ENTREPRENEURSHIP	L	T	P	C
Core/Elective/Supportive		**Core Paper – 13**	**4**	✓	**-**	**4**
Pre-requisite		**A Basic knowledge on intellectual property**	**Syllabus Version**		**2025-26**	

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 aspects related to biological, biomedical, health care and biotechnology research	K1, K2
CO2	Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research environment release of genetically modified organisms.	K2, K3, K4
CO3	Understand the rationale for and against IPR and especially patents.	K2, K5, K6
CO4	Familiarize national and international regulations and to understand why India has adopted National IPR Policy and be familiar with broad outline of patent regulations	K1
CO5	Understand the basic concepts of entrepreneurship and business opportunities for biotech products.	K2, K6

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

Unit:1	**Bioethics**	**12 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**	**12 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**	**12 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**	**12 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**	**12 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	**Expert lectures, online seminars - webinars**		**5 hours**
Expert lectures, online seminars - webinars			
	Total Lecture hours		**65 hours**
Text Book(s)			
1	The basics of bioethics (2019), 4th edition by Guidry-Grimes, Laura; Veatch, Robert.		
2	IPR, Biosafety and Bioethics (2013), by Deepa Goel, Shomini Parashar		
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		
2	https://nptel.ac.in/courses/109/106/109106092/		
3	https://onlinecourses.nptel.ac.in/noc20_hs18/preview		
4	https://nptel.ac.in/courses/102/104/102104068/		
5	https://www.futurelearn.com/courses/biosecurity		
6	https://www.h2020.md/sites/h2020/files/adaptivetheme/at_h2020_files/Horizon%20Europe%20Work%20Programme.pdf		
7	https://www.dodmrl.com/MRL%20Deskbook%20V2020.pdf		
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										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	S	L	M	S	M
CO2	S	S	M	M	M	M	L	M	S	M
CO3	S	S	M	M	M	S	L	M	S	M
CO4	S	S	M	M	M	M	L	M	S	M
CO5	S	S	M	M	M	S	L	M	S	M

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

VALUE ADDED CERTIFICATE COURSES - 2

Course	**Hands on Training in Sophisticated Instruments**
Course Code	**25BIOBCV2**
Number of hours	2 Credits (50 Marks)
Credits	40 hours
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:

1	To impart hands on skill sets in the advanced instrumentations
2	To run the instruments
3	To interpret the obtained data

Hands on training in,

1. HPLC
2. Gene gun
3. Flowcytometry
4. Real-Time PCR
5. DNA sequencer (Sanger)
6. Anaerobic chamber