BHARATHIAR UNIVERSITY:: COIMBATORE 641 046
UD- Department of Biotechnology, M.Sc. Medical Biotechnology Scheme
(DBT Curriculum)

(For the students admitted during the academic year 2024-25 onwards)

Subject Code	Course Code	Title of the Course		Credits	Hours		Maximum Marks		
					Theory	Practical	CIA	ESE	Total
FIRST SEMESTER									
13A	**24MB1C01**	Core-1	Biochemistry	4	4	-	25	75	100
13B	**24MB1C02**	Core-2	Cell and Molecular Biology	4	4	-	25	75	100
13C	**24MB1C03**	Core-3	Medical Devices	2	2	-	12	38	50
13D	**24MB1C04**	Core-4	Genetics	4	4	-	25	75	100
13E	**24MB1C05**	Core-5	Biostatistics	4	4	-	25	75	100
13F	**24MB1C06**	Core-6	Biophysical Principles and Analytical Techniques	4	4	-	25	75	100
13P	**24MB1P01**	Practical-1	Cell Biology, Microscopy, Biochemistry and Analytical Techniques	4	-	6	25	75	100
1VA*	**24MB1V01**	VAC-1	Soft Skills and Business Communication Skills for Employability Training	2	2	-	50	-	50
			Total	**26**	**22**	**6**	**162**	**488**	**650**
SECOND SEMESTER									
23A	**24MB1C07**	Core-7	Developmental Biology and Physiology	4	4	-	25	75	100
23B	**24MB1C08**	Core-8	Immunology	4	4	-	25	75	100
23C	**24MB1C09**	Core-9	Omics Concepts and Data Integration	4	4	-	25	75	100
23D	**24MB1C10**	Core-10	Bioinformatics	4	4	-	25	75	100
23E	**24MB1C11**	Core-11	Molecular Diagnostics and Clinical Testing	4	4	-	25	75	100
2EA	**24MB1E1A**	E1ective-1	Plant Molecular Pharming	2	2	-	12	38	50
2EB	**24MB1E1B**		Indian Systems of Medicine						
23P	**24MB1P02**	Practical-2	Immunotechnology, Molecular Diagnostics, Microbiology and Molecular Biology - I	4	-	6	25	75	100
2JA*	**24MB1J01**	JOCC-1	SAS Programming for Clinical Trials Management	4	2	-	100	-	100
			Total	**26**	**22**	**6**	**162**	**488**	**650**
THIRD SEMESTER									
33A	**24MB1C12**	Core-12	Animal Biotechnology and Stem Cell Biology	4	4	-	25	75	100
33B	**24MB1C13**	Core-13	Clinical Biochemistry and Disease Metabolism	4	4	-	25	75	100
33C	**24MB1C14**	Core-14	Medical Microbiology and Infection Biology	4	4	-	25	75	100
33D	**24MB1C15**	Core-15	Genetic Engineering and Genome Editing Technologies	4	4	-	25	75	100
33E	**24MB1PR1**	Project-1	Research Project Proposal Preparation and Defense	2	-	2	25	25	50
3EA	**24MB1E2A**	E1ective-2	Nanobiotechnology	4	4	-	25	75	100
3EB	**24MB1E2B**		Pharmaceutical Biotechnology						
33P	**24MB1P03**	Practical-3	Microbiology, Molecular Biology - II, Clinical Biochemistry and Disease Metabolism, Animal Cell culture	4	-	6	25	75	100
37V*	**24MB1So1**	Internship	One Month Summer Internship in Hospital/ Biomedical Industries/Research Institute	2	-	-	50	-	50

3JA*	**24MB1J02**	JOCC-2	Lead Molecule Discovery and Preclinical Development	4	2	-	100	-	100
			Total	**26**	**20**	**8**	**175**	**475**	**650**
			FOURTH SEMESTER						
43A	**24MB1C16**	Core-16	Bioethics, Biosafety, IPR and Entrepreneurship	4	4	-	25	75	100
47V	**24MB1PR2**	Project-II	Research project with a mandatory Co-guide from other Department(s) / Industries	8	-	-	50	150	200
4NS*	**24MB1O01**	Swayam	Professional Certification Course	2	2	-	-	-	-
4VA*	**24MB1V02**	VAC -2	Training in Sophisticated Instruments	2	2	-	50	-	50
			Total	**12**	**-**	**-**	**75**	**225**	**300**
			Grand Total	**90**	**-**	**-**	**-**	**-**	**2250**

**Co-Scholastic Courses*

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

SEMESTER ONE

Biochemistry

Credits 4

Marks: 100

Course Code	24MB1C01	Course Type	Core 1	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A basic knowledge on biomolecules and metabolic pathways								

Course Objectives:

1. To obtain fundamental understanding of cell biology research and its importance in human diseases
2. To provide an overview about morphological features of cells and relate them in the context of healthy and diseased human body
3. To develop knowledge about advanced microscopy including live cell imaging, correlative light and electron microscopy, confocal microscopy and underlying biophysics. Obtain operational skills to handle few of them

Course Outcomes:

CO1	Learn in detail about structural properties of proteins that are building blocks of life. Clear understanding about factors that determine the structure and functions of a protein by equipping them to apply the knowledge in biopharmaceutical industry.	**K4**
CO2	Obtain a comprehensive knowledge about enzymes as modulators of biochemical reactions. Enable students to apply their critical thinking to evaluate applications of enzymes in therapeutics and commercial applications.	**K5**
CO3	Understand the biochemical events that lead to production of energy and the functional importance of energy reserves of the body. Improve their ability to understand the direct relationship between physiology and metabolism.	**K2**
CO4	Understand the central dogma of molecular biology. Develop insights into the structural importance of DNA in health and disease. Strong basics will be very useful for developing clinical tests involving biomolecules.	**K6**
CO5	Acquire strong theoretical knowledge about bioenergetics and pathways that tightly regulate energy metabolism. Detailed	**K4**

	understanding of various signaling pathways involved, will be helpful in understanding the pathological importance of these pathways in disease biology.	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Protein Structure

10 Lectures

Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth, pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies; Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.

Self-learning: structure-function relationships in model proteins like ribonuclease A, myoglobin, haemoglobin, chymotrypsin, etc.

Unit II

Enzyme Kinetics

10 Lectures

Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate

	enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase; isozymes; role of covalent modification in enzymatic activity; zymogens. *Self-learning*: Enzyme characterization and Michaelis-Menten kinetics
Unit III **Glycobiology** **8 Lectures**	Sugars-mono, di, polysaccharides and complex carbohydrates with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules-glycoproteins and glycolipids; lipids-structure and properties of important members of storage and membrane lipids; lipoproteins.
Unit IV **Structure and functions of DNA & RNA** **8 Lectures**	Nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure, importance of DNA as the genetic material in evolution of disease diagnosis
Unit V **Bio-energetics** **10 Lectures**	Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; Introduction to GPCR, *myo*-Inositolcontaining phospholipids/DAG//PKC and Ca++ signaling pathways; reciprocal regulations and non-carbohydrate sources of glucose; citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F_1-F_0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; *Self-learning:* Glycolysis, Gluconeogenesis, Citric acid cycle, entry to citric acid cycle, Photosynthesis –

	chloroplasts and two photosystems; proton gradient across thylakoid membrane.
Unit V **Role of Vitamins & Cofactors in Metabolism** **12 Lectures**	Roles of epinephrine and glucagon and insulin in glycogen metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation; TOR (target of rapamycin) & autophagy regulation in relation to C & N metabolism *Self-learning:* Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, Fatty acid metabolism, starvation responses and insulin signaling.
Unit VI **Contemporary issues**	Guest lectures by academic/industry experts, online seminars - webinars
Total Lectures – 46	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Stryer,L.(2015).*Biochemistry*.(8thEd.) NewYork: Freeman.
2. Lehninger, A. L. (2012).*Principles of Biochemistry*(6th ed.).New York
3. Voet,D. & Voet, J. G.(2016).*Biochemistry*(5thEd.). Hoboken, NJ J. Wiley & Sons.
4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426 (6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63.doi:10.1038/scientificamerican0191-54

Related Online Contents:

1. https://onlinecourses.swayam2.ac.in/cec20_bt12/preview
2. https://nptel.ac.in/courses/104/105/104105076/

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. S. Velayuthaprabhu** **Assistant Professor**

SEMESTER ONE

Cell and Molecular Biology

Credits 4

Marks: 100

Course Code	24MB1C02	Course Type	Core 2	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A basic knowledge in cell and molecular biology								

Course Objectives:

1. The aim of this course is to obtain and understand fundamental knowledge of molecular and cellular processes:
2. 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
3. To impart the molecular biology knowledge in applications of various aspects of human health care

Course Outcomes:

CO1	Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.	**K1**
CO2	To obtain strong knowledge base in cell and molecular biology in biomedical sciences	**K2**
CO3	Advanced laboratory practices in cell and molecular biology will make the students choose their career in molecular biology research and further will help them to get job opportunities	**K3**
CO4	To conduct independent work in a laboratory with basis of cell biology	**K4**
CO5	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 I **Structure and Function of**	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

Biological membranes **10 Lectures**	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 II **Molecular Structure and Functions of Cell Organelle Cellular cytoskeleton , motility** **10 Lectures**	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 III **Organization and functions of DNA Cell cycle Regulation and Cell Signalling** **10 Lectures**	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 IV **Transcription, RNA processing and regulation in Prokaryote** **10 Lectures**	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 V **Transcription, RNA processing and regulation in Eukaryotes** **10 Lectures**	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; 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 VI	
Contemporary issues	Expert lectures, online seminars - webinars

Total Lectures – 50

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

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 by D. E.Sadava, CBS Publishers & Distributors, 2009
4. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993
5. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991

Related Online Contents:

1. Swayam- Molecular biology course by Dr. Nayan K. Jain
2. Swayam- Cell Biology by Dr. K. Sanatombi
3. NPTEL - Molecular Cell Biology by Prof.D. Karunagaran – IIT Madras

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. S. Girija** **Associate Professor**

SEMESTER ONE

Medical Devices

Credits 2

Marks 50

Course Code	24MB1C03	Course Type	Core 3	L	T	P	C	Syllabus version	2024-2025
				1	1	-	2		
Pre-requisite	Basic knowledge in health sciences.								

Course objectives:

1. The course aim is to familiarize students with emerging trends in medical devices for early detection and selection of appropriate treatment.
2. The course will also give an insight about monitoring treatment effectiveness and disease surveillance.

Course Outcomes:

CO1	Know about the detailed insights on sensors, transducers, and optical sensors	**KI, K4**
CO2	Understand the concepts related to bio-recognition systems, electrodes and immobilization	**K2, K5**
CO3	Obtain a comprehensive knowledge about fundamentals and applications of microfluidics	**K1, K3**
CO4	Extend principles of engineering to the development of medical devices and design of sensors	**K6**
CO5	Appreciate basic configuration and distinction among biosensor systems	**K5**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Sensors

4 Lectures

Rationale of electronic biosensors; Essence of three types of electronic biosensors (*i.e.*, potentiometric, amperometric, and cantilever-based sensors); Three essential metrics that define modern electronic sensors; detection time, sensitivity, and selectivity; Physics of detection time that allows one to organize every available sensor in a systematic way; Fundamental limits of detection of various classes of sensors;

	Opportunities and challenges of integrating sensors in a system platform.
Unit II **Transducers** **4 Lectures**	Principles and applications of Calorimetric, Piezoelectric, semiconductor, impedimetric, based transducers; Biochemical Transducers: Electrode theory: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface, electrode impedance, electrical conductivity of electrode jellies and creams.
Unit III **Optical sensors** **4 Lectures**	Photo detectors, optical fiber sensors, indicator mediated transducers; General principles of optical sensing, optical fiber temperature sensors; Pulse sensor: photoelectric pulse transducer, strain gauge pulse transducer.
Unit IV **Bio recognition systems** **4 Lectures**	Enzymes; Oligonucleotides Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Immunoreceptors; Chemoreceptors.
Unit V **Electrodes and immobilization** **4 Lectures**	Microelectrodes, body surface electrodes, needle electrodes, pH electrode, specific ion electrodes/ Ion exchange membrane electrodes, enzyme electrodes; Reference electrodes: hydrogen electrodes, silver-silver chloride electrodes, Calomel electrodes; Enzyme immobilization; Peptide immobilization; Antibody immobilization; Oligonucleotides and Nucleic Acid immobilization; Cell immobilization; Mono-enzyme electrodes; Bi-enzyme electrodes: enzyme sequence electrodes and enzyme competition electrodes.
Unit VI **Fundamentals and applications of microfluidics** **4 Lectures**	Capillary flow and electro kinetics; Micro pump, Micro mixers, Micro reactors, Micro droplets, Micro particle separators; Micro fabrication techniques (different types of lithography methods); Application of micro-fluidics (*eg*. Lab-in –Chip).

Unit VII **Applications** **4 Lectures**	Biomarkers: Disease and pathogen specific information, availability by sample type (blood, serum, urine, sputum, saliva, stool, mucus); Specificity, sensitivity, shelf life, portability; Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable Sensors for long-term monitoring; Drug development and detection; Environmental monitoring; Examples of various diseases (Cancer, HIV/AIDS, Tuberculosis, Malaria, Lymphatic Filariasis, Schistosomiasis, Dengue, Chikungunya).
Unit VIII **Contemporary Issues**	Guest lectures by academic/industry experts, online seminars - webinars

Total Lectures – 28

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Alice Cunningham, (1998), Introduction to Bioanalytical Sensors, John Wiley & Sons.
2. Jiri Janata, (2009), Principles of Chemical Sensors, 2nd Ed., PlenumPress.
3. F. Schellr, F. Schubert, J.Fedrowitz, (1997), Frontiers in Biosensors, Birkhauser.
4. Brian Eggins, (2002), Chemical Sensors and Biosensors, JohnWilley & Sons.
5. Graham Ramsay, (1998), Commercial Biosensors, JohnWiley & Sons.

6. Ursula Spichiger-Keller, (1998), Chemical Sensors and Biosensors for Medical and Biological Applications,Wiley-VCH
7. Berthier Jean, and Silberzan Pascal, (2010), Microfluidics for Biotechnology, 2nd Ed. Artech House.
8. Frank A Gomez, (2008), Biological Applications of Microfluidics,Wiley.
9. JG.Webster, (1998), Encyclopedia of Medical Devices and Instrumentation. Vol I, II, III, IV,Wiley-Blackwell.

Related online contents:

1. F.Ligler, C.RoweTaitt, (2002), Optical Biosensors. Present &Future. Elsevier.
2. Gareth Jenkins, ColinD.Mansfield, (2013), Microfluidic Diagnostics: Methods and Protocols, Springer.

Course adapted from DBT curriculum and handled by Dept. of Nanoscience and Technology	**Dr. N. Ponpandian, Professor**

SEMESTER ONE

Genetics

Credits 4

Marks 100

Course Code	24MB1C04	Course Type	Core 4	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A basic knowledge in genetics								

Course objectives:

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:

CO1	Students will gain knowledge about the genetics of prokaryotic and phage genetics	**K1, K2**
CO2	Gain knowledge on Drosophila 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 I Concept of a gene in pre-DNA era ; mapping of genes in bacterial and phage chromosomes by classical genetic

Genetics of bacteria and bacteriophage **10 Lectures**	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 II **Principles of Mendelian & Non Mendelian genetics** **10 Lectures**	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 III **Human Genetics** **10 Lectures**	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 IV **Cytogenetics, Developmental Genetics and Immunogenetics** **10 Lectures**	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 V **Mutagenesis and Epigenetics** **10 Lectures**	Mutations; kinds of mutation; agents of mutation; genetic polymorphism; uses of polymorphism; The epigenome, epigenetic modifications: DNA methylation, histone modification, chromatin remodeling and non-coding RNAs; cellular maintenance of the epigenome; epigenetic control of gene expression, and epigenetics and development. Transgenerational epigenetic inheritance.
Unit VI **Contemporary issues**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 50	

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

Recommended Textbooks and References:

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.
5. Strachanand Read (2003). Human Molecular Genetics. Wiley.
6. Pasternak (2005). A Introduction to Human Genetics.
7. Prichard & Korf (2004). Medical Genetics at a 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:

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 adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. V. Thirunavukkarasu** **Associate Professor**

SEMESTER ONE

Biostatistics

Credits 4

Marks 100

Course Code	24MB1C05	Course Type	Core 5	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic understanding on the objectives of statistics and computations								

Course objectives:

1. Introduce the basics of biostatistics
2. Instil knowledge to compute statistical measures for analysing data
3. Instruct the applications of statistical methods for biological problems

Course Outcomes:

CO1	Understand the theory and applications of basic statistics	**K1-K6**
CO2	Compute statistical measures for decision making	**K2-K3**
CO3	Formulate hypotheses and perform statistical analysis for biological problems	**K1-K6**
CO4	Perform analysis of variance for experimental designs	**K1-K6**
CO5	Make interpretations of results from the derived results	**K1-K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Descriptive Statistics

10 Lectures

Nature of Biological, Clinical and Experimental Data – Graphical and Diagrammatic Representation of Data – Line Diagram - Box Plots – Histogram - Grouped Data – Frequency Distribution - Frequency Curve. Measures of Location: Mean, Median and Mode. Measures of Spread: Range, Standard Deviation, Quartile Deviation - Coefficient of Variation – Measures of Skewness and Kurtosis.

Unit II

Definition of Probability – Addition and Multiplication Laws of Probability – Conditional Probability – Bayes' Rule and Applications - Random Variables: Discrete and

Probability and Probability Distributions **10 Lectures**	Continuous Random Variables – Probability Function: Mass and density Functions – Permutations and Combinations – Bernoulli, Binomial, Poisson and Normal Probability Distributions – Properties and Problems. Basics of Exact Distributions.
Unit III **Hypothesis Testing: One-sample, Two-sample Multi-sample Inference** **10 Lectures**	Fundamental notions of estimation and hypothesis testing of population parameters - Null and alternative hypothesis, simple and composite hypothesis, critical region, type I and type II errors, level of significance, power function – Confidence interval for population parameters, mean and variance = Parametric Tests: One Sample Tests for the Mean and Variance of a Normal Distribution Based on normal, t and chi-square tests - One Sample Inference for the Binomial and Poisson Distributions. Two-sample t – Tests for Independent Samples – Paired t- Tests - Tests for the Equality of Two Variances – Analysis of Variance for One-Way and Two-Way Classified Data – Kruscal – Wallis Test. Nonparametric Tests – Sign, Wilcoxon Signed Rank, Wilcoxon Rank-Sum and Friedman Tests.
Unit IV **Regression and Correlation Methods** **10 Lectures**	General Concepts – Fitting Regression Lines: Method of Least Squares – Goodness of Fit - Inferences about Parameters from Regression Lines – Interval Estimation for Linear Regression. Fitting Quadratic and Exponential Functions - Correlation Coefficient – Simple, Partial and Multiple Correlation – Inference for Correlation Coefficients – Rank Correlation.

Unit V **Statistical Computation using R Programming** **10 Lectures**	Computation Of Probability – Permutations – Combinations – Data Visualization – Line Plot, Bar Plot, Pie Chart, Box Plot, Histogram, Scatter Plot – Descriptive Statistics – Sum, Mean, Median, Mode, Range, Standard Deviation, Variation, Coefficient Of Variation – Inferential Statistics Based On Z-Test, T-Test, F-Test, Chi-Square Test, ANOVA, Sign Test, Wilcoxon Signed Rank Test, Wilcoxon Rank Sum Test, Kruskal-Wallis Test and Friedman Test - Fitting of Linear Regression, Quadratic and Exponential Functions – Computation of Simple, Partial And Multiple Correlation and Regression Coefficients.
Unit VI (Co-scholastic Component) **Basic Notions of R Programming** **5 Lectures**	Introduction to R Programming – Features of R – Data Types: Vectors, List, Matrix, Array, Data Frame and Factors – Conditional Structures – Functions: Built-In and User Defined Functions – Data Management – R Packages.
Total Lectures – 55	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Rosner, B. (2016). Fundamentals of Biostatistics, Eighth Edition, Cengage Learning, Boston, MA, US.

2. Daniel, W. W., and Cross, C. L. (2013). Biostatistics: A Foundation for Analysis in the Health Sciences, Tenth Edition, John Wiley & Sons, Inc., NY, US.
3. Zar, A. H. (2010). Biostatistical Analysis, Fifth Edition, Pearson, London, UJ.
4. Campbell, R. C. (1967): Statistics for Biologists, University Press, Cambridge, UK.
5. Lewis, A. E. (1984). Biostatistics, Van Nostrand Reinhold Publications.
6. Pagano, M., and Gauvrean, K. (2018). Principles of Biostatistics, Second Edition, Chapman and Hall/CRC Press, NY.
7. Crawley, M.J. (2013). The R Book, Second Edition, John Wiley & Sons, Ltd., Chichester, UK
8. Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2008). Statistics Using R, Narosa Publishing House, New Delhi, India

Related online contents:

1. https://nptel.ac.in/courses/102/106/102106051/
2. https://nptel.ac.in/courses/102/101/102101056/
3. https://cran.r-project.org
4. https://cran.r-project.org/doc/contrib/Seefeld_StatsRBio.pdf

Remarks:

1. The contents in Unit 6 shall be considered as Co-scholastic and there shall be no examination.

Course adapted from DBT curriculum and handled by Dept. of Statistics	**Dr. R. Jaisankar, Professor**

SEMESTER ONE

Biophysical Principles and Analytical Techniques

Credits 4

Marks 100

Course Code	24MB1C06	Course Type	Core 6	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic principles of analytical techniques and instrumentation								

Course objectives:

1. Provide a broad exposure to all basic techniques (Biochemical and Biophysical) used in contemporary modern biology research.
2. Impart a basic conceptual understanding of principles of these techniques and emphasize on the biochemical utility of the same and underlying biophysics.
3. Impart an understanding of all the analytical techniques such that the barrier to implement the same is abated to a great extent.
4. Transform students to skilled workers for executing research with the aid of modern analytical instruments.

Expected Course Outcomes:

CO1	Learn how to combine previously acquired knowledge of physical chemistry and biochemistry to understand biochemical processes at the molecular level.	**K1, K2**
CO2	Obtain a comprehensive knowledge about electromagnetic radiation and different spectroscopic techniques	**K2, K4**
CO3	Gain an in-depth understanding of various forms of centrifugation techniques, radioactivity, and radio isotopic techniques.	**K2, K4**
CO4	Understand the working principle and application of important separation and identification techniques that are widely applied in the field of molecular biology and chemical biology.	**K2, K3, K4, K5**
CO5	Operate microscopic and spectroscopic devices for advanced research activities.	**K4, K5**
CO6	Ability to make new advanced instruments in the field of biotechnology.	**K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Basics** **10 Lectures**	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 II **Basic Principles of Electromagnetic Radiation and Related Spectroscopic Techniques** **12 Lectures**	**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 III **Hydrodynamic Methods, Radioactivity and Radioisotopic Techniques** **14 Lectures**	**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. **Radioisotopic 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 IV **Electrophoresis, Chromatography, X-Ray Crystallography,**	**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

Molecular and Chemical Biology **15 Lectures**	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 V **Optical Tweezers, Optical Microscopy Methods, and Mass Spectroscopy** **14 Lectures**	**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 VI **Contemporary issues**	Guest lectures by academic/industry experts, online seminars - webinars
Total Lectures – 65	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	-	-	M	S	-	M	L	L
CO2	S	-	-	-	-	-	-	-	-	L
CO3	-	-	-	-	-	-	S	-	-	M
CO4	-	-	S	-	-	-	S	-	M	-
CO5	-	S	-	L	-	-	-	L	-	-
CO6	-	-	-	-	M	S	-	-	S	-
***S-Strong; M-Medium; L-Low**										

Recommended Textbooks and References:

1. David Friefelder, (1983), Physical Biochemistry, 2nd edition, W.H. Freeman and Co., USA.
2. G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney, (1991), Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, ELBS, England.
3. P.W. Atkins, (1996), The Elements of Physical Chemistry, Oxford University Press.
4. Brigal.L. Williams, A biologist guide to principle and techniques of practical biochemistry.
5. K Wilson and J Walker (eds.), (1999). Principles and Techniques of Practical Biochemistry, 4th edition, Cambridge Univ.Press.
6. R.A. Day, A.L. Underwood, Quantitative Analysis, (1999), 6th Edition; Prentice-Hall of India Pvt. Ltd., New Delhi.
7. Plummer, (2002). An Introduction to Practical Biochemistry, 3rd edition, Tata Mc Graw Hill.
8. Jack A. Tuszynski Michal Kurzynski, Introduction to Molecular Biophysics,

CRC Press.

9. Sharma. BK. Instrumental methods of chemical analysis.
10. Upadhyay, Upadhyay and Nath, Biophysical chemistry.
11. Khandpur R.S. Handbook of biomedical instrumentation, Tata Mc Graw Hill.

Related online contents:

1. https://onlinecourses.swayam2.ac.in/ugc19_bt16/preview
2. https://nptel.ac.in/courses/102/107/102107028/
3. https://nptel.ac.in/courses/102/103/102103044/
4. https://www.slideshare.net/ArunimaSur/analytical-techniques-in-biochemistry-and-biophysics-for-macro-molecules
5. https://www.biophysics.org/education-careers/education-resources/selected-topics-in-biophysics/biophysical-techniques

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. M. A. Shibu,** **Assistant Professor (DBT-RRF)**

SEMESTER ONE

Laboratory I: Cell Biology, Microscopy, Biochemistry and Analytical Techniques

Credits 4

Marks 100

Course Code	24MB1P01	Course Type	Practical-1	L	T	P	C	Syllabus version	2024-2025
				-	-	6	4		
Pre-requisite	Basic knowledge in microscopy and biochemistry								

Course objectives:

1. To obtain practical understanding of cell biology and its importance in human disease.
2. To provide an overview about morphological features of cells in context to healthy and diseased conditions.
3. To learn advanced microscopic technique, which includes live cell imaging, correlative light and electron microscopy, confocal microscopy and its underlying biophysical principles. To gain operational skills.
4. To understand biochemical principles by performing experiments.

Expected Course Outcomes:

CO1	Learn the basic principles of microscopy. Develop application knowledge to employ appropriate microscopes for studying complexities of disease biology.	**K2, K4**
CO2	Obtain an overview about the morphological features of animal and plant cell. Develop skills to identify these cells using microscopy and determine the morphological changes that occur during stress and diseased conditions.	**K1, K5**
CO3	Develop skills to isolate cells to determine the viability. Provides hands-on experience that could be used to handle clinical samples.	**K5, K6**
CO4	Clear understanding and rigorous training to assess the features of cell organelles using staining procedures and monitor their changes during physiological and pathological conditions using microscopy.	**K2, K6**

CO5	Comprehensive practical knowledge about structural components of cell and their importance in cell viability and function. Monitor the behaviour of cells using live cell imaging under normal and stressed conditions to provide appropriate interpretations.	**K5, K6**
CO6	Understanding the concepts of biochemistry by designing experiments	**K1, K3**
CO7	Familiarization with the basic laboratory instruments and understand the biochemical principles and analysis.	**K1, K2**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Experiments: Cell Biology and Microscopy

Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)

1. Isolation of total RNA and gel separation of all ribosomal RNA species.
2. Transient expression of Green Fluorescence Protein (GFP) by agroinfiltration and analysis of GFP expressed cells/tissue under fluorescence microscope.

Translational Research Laboratory (Dr. V. Vijayapadma)

3. Isolation of peripheral blood mononuclear cells and determining their counts from human blood and their cryopreservation.
4. Mitochondrial staining to study distribution and membrane potential with TMRM staining.
5. Mitochondrial DNA Isolation from cryopreserved human peripheral blood mononuclear

Metabolic Engineering Laboratory (Dr. S. Girija)

6. Quantification of Flavonoid Content in Fruit Sample
7. Determination of Free radical scavenging activity by DPPH assay.
8. Observation of Leaf under bright field, phase contrast, dark field and differential interference contrast (DIC) microscope – Calculate the Stomatal index

Molecular Toxicology Laboratory (Dr. P. Ekambaram)

9. Measurement of cell size by Ocular and Stage micrometer.
10. Identification of Barr bodies from squamous epithelial cells by buccal smear.
11. Analysis of F-actin based cellular cytoskeleton by Phalloidin staining.

Molecular Microbiology Laboratory (Dr. S. R. Prabagaran)

12. Pure culture technique *e.g.,* streaking, colony purification and sub-culturing. Identification of microbes in a local sample (soil/water/skin *etc.*).
13. Determination of generation time of given bacteria using standard growth curve.
14. Staining techniques and microscopy.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)

15. Determination of cellular osmosis in animal blood
16. Extract total protein from the given tissue sample and estimate the unknown protein concentration by Lowry's method.

Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)

17. Examine number and morphology of nucleus in given tissue sample by DAPI/PI staining.
18. Localization of specific protein in the tissue sample by immunohistochemistry (IHC)

Experiments: Biochemistry and Analytical Techniques

Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)

19. Purification of an enzyme / protein from a recombinant source
    a) Preparation of cell-free lysates.
    b) Affinity Chromatography (Immobilized Metal Affinity Chromatography) and analysis by SDS-PAGE.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)

20. Detection of a specific cellular protein using immunoblotting (Western Blotting)-Enhanced chemiluminescence (ECL) method.

Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)

21. Titration of amino acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.

Plant Molecular Biology (Dr. M. Arun)

22. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.
23. Assessment of catalase enzyme activity.
24. Estimation of antioxidant potential in the given sample using ABTS assay.

Mapping with Programme Outcomes

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

Course adapted from DBT curriculum and handled by all faculty from Dept. of Biotechnology

SEMESTER ONE

Soft Skills and Business Communication Skills for Employability Training

Credits 2

Marks 50

Course Code	24MB1V01	Course Type	Value Added Course 1	L	T	P	C	Syllabus version	2024-2025
				1	1	-	2		
Pre-requisite	Basic interest to showcase their biotechnology knowledge in interviews, discussions and in entrepreneurships.								

Name of the Department	**Department of 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 Medical Biotechnology students
Number of Candidates to be Admitted	20 (maximum number)
Mode of the Course	Both Regular and Online
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 Kalverampalayam Coimbatore - 641046 Ph:9842685547 arivazhagank1@yahoo.co.in
Job Opportunities: Research Laboratories, Pharmaceutical Companies, Knowledge Process Outsourcing Companies, Analytical Lab Equipment Service Companies	

Course objective

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

Expected Course outcome

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**	**-- hours**
	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**										

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. S. Girija** **Associate Professor**

SEMESTER TWO

Developmental Biology and Physiology

Credits 4

Marks 100

Course Code	24MB1C07	Course Type	Core 7	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic understanding in cell development and differentiation								

Course objectives:

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:

CO1	Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.	**K1**
CO2	Identify several unifying themes and differences in developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.	**K5**
CO3	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**
CO4	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**
CO5	To be able to communicate scientific information about key concepts in developmental biology.	**K3**
CO6	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	**K3**

	in your chosen field (e.g. to gain content knowledge and comprehension in Biotechnology and Healthcare).	
CO7	Describe and apply theory to explain the physiology of: individual systems and/organ integrated system response.	**K2**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction to Developmental Biology** **12 Lectures**	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 II **Basic concepts of development** **12 Lectures**	Overview of homeotic genes, axis formation in sea urchin,*C.elegans*,*D.melanogaster*,amphibiansandmammals;for mationofvulva 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 III **System physiology: digestion and hematology** **12 Lectures**	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 IV **Respiration and excretion**	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,

12 Lectures	urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.
Unit V **Nervous system** **12 Lectures**	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 VI **Contemporary issues**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 60	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert.
2. Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson.
3. Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.
4. Essentials of Animal Physiology (2019) 4th edition by Rastogi.

5. 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:

1. https://nptel.ac.in/courses/102/106/102106084/
2. https://nptel.ac.in/courses/102/104/102104058/
3. https://onlinecourses.nptel.ac.in/noc20_bt35/preview
4. https://onlinecourses.swayam2.ac.in/cec20_bt19/preview

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. P. Ekambaram** **Professor**

SEMESTER TWO

Immunology

Credits 4

Marks 100

Course Code	24MB1C08	Course Type	Core 8	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic concepts in immune system								

Course objectives:

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:

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 I **Immunology: Fundamental concepts and anatomy of the immune system** **12 Lectures**	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 II **Immune responses generated by B and T cells** **14 Lectures**	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 III **Antigen-antibody interactions**	Antigens - immunogens, haptens; characteristics of antigen, adjuvants. Superantigens. The epitopes seen by B Cells and T Cells. Immunoglobulins-basic structure, classes &

14 Lectures	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 IV **Clinical Immunology** **14 Lectures**	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 V **Vaccinology** **13 Lectures**	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 VI **Contemporary issues**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 65	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

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.

Related online contents:

1. https://nptel.ac.in/courses/102/105/102105083/

2.https://www.coursera.org/specializations/immunology

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. S. Velayuthaprabhu** **Assistant Professor**

SEMESTER TWO

OMICS CONCEPTS AND DATA INTEGRATION

Credits 4

Marks 100

Course Code	24MB1C09	Course Type	Core 9	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic exposure in Bioinformatics, Molecular biology and Recombinant DNA technology								

Course objectives:

1. To learn the omics concepts and emerging technologies.
2. To learn how to, integrate large data sets, its challenges and its applications.
3. To impart working knowledge and to appreciate the global understanding of biological systems and its implications on human health and disease.

Expected Course Outcomes:

CO1	Understanding the concepts of Systems Biology and OMICS	**K1, K2**
CO2	Understanding the Genomics and Transcriptomics	**K2, K3**
CO3	Understanding the Proteomics	**K2, K3**
CO4	Understanding the Metabolomics and other emerging Omics	**K3, K4,**
CO5	Handling the Multiomics data and its applications	**K5, K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction to OMICS** **6 Lectures**	Background, Overview of OMICS, Overview of Systems Biology, Model Organisms, High throughput Technologies, Emerging OMICS, Computational Biology and Tools, Biological Databases.
Unit II	Genomics: Human Genome Project, DNA sequencing Technologies, Annotations, Functional Genomics, Comparative

Genomics and Transcriptomics **10 Lectures**	Genomics, Epigenome and Epigenetics, Non-Coding RNAs, GWAS, Clinical Genomics, Genomic Databases and Tools. Transcriptomics: Transcriptome and Transcriptomics, Technological Approaches- ESTs, SAGE/CAGE, Microarray, RNA seq, Alternative Approaches, Metatranscriptome, Gene Expression Analysis, Applications, Gene Function Annotation, Dedicated databases and Tools
Unit III **Proteomics** **10 Lectures**	Understanding and Need, Various Categories of Proteomics, Proteogenomics, Detection Methods- Bradford, Lowry, Specific Detections- ELISA, Western Blot, Without Antibody- SDS-PAGE, 2DE, Mass Spectrometry, Isotope-Coded Affinity Tag Peptide Labelling (ICAT), Multidimensional Protein Identification Technique (MudPIT), Protein Microarrays/Protein Chips, Bioinformatics in Proteomics- Identification, Structural Studies, Post Transcriptional Modifications, Post Translational Modifications, Applications and Challenges.
Unit IV **Metabolomics and Other Emerging OMICS** **10 Lectures**	Metabolites to Metabolome, Advancements in Technologies, Data Resources, Computational Approaches, Network Analysis and Network Pathway Integration, Metabolic Engineering Strategies, Applications- Toxicology, Functional Genomics, Nutrigenomics, Health and Environment, Biomarker Discovery, Agriculture etc., Lipidomics, Glycomics, Epigenomics, Foodomics, Pharmacogenomics, Phenomics, Ionomics, Microbiomics etc.
Unit V **Introduction to Multi-Omics Data Integration** **4 Lectures**	Concepts to Applications: Introduction to Multi-Omics, Importance of Integrating Multi-Omics Data in Biological Research, Challenges and Opportunities in Multi-Omics Data Integration, Types of Multi-Omics Data and Their Characteristics, Strategies for Data Normalization and Pre-processing in Multi-Omics Data Analysis, Tools and Software for Multi-Omics Data Integration, Introduction to Popular Tools for Multi-Omics Data Integration, Network Analysis in Multi-Omics Data: Introduction to Biological

	Networks (e.g., Gene Regulatory Networks, Protein-Protein Interaction Networks), Case Studies: Network Analysis in Disease Biomarker Discovery, Applications, Practical Challenges and Considerations.
Unit VI **Contemporary issues**	Guest lectures by academic/industry experts, online seminars – webinars
Total Lectures – 40	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Arivaradarajan, P and Misra, G (Eds.) (2018): Omics Approaches, Technologies And Applications: Integrative Approaches For Understanding OMICS Data, Springer Publishers, Singapore
2. Lesk, A. M. (2017). Introduction to Genomics. Oxford University Press.
3. Brown, T. A. (2018). Genomes 4. Garland science.
4. Campbell A.M and Heyer L.J (2007) Discovering Genomics, Proteomics, and Bioinformatics. 2nd Edition. Benjamin Cummings.
5. Twyman R.M. (2013) Principles of Proteomics, Second Edition by Garland Science Taylor & Francis Group New York and London.
6. Griffiths W.J, Metabolomics, Metabonomics and Metabolite Profiling, (The Royal Society of Chemistry UK) (2008) ISBN 978-0-85404-299-9
7. Teresa Whei-Mei Fan, Andrew M. Lane, Richard M. Higashi (Eds.) (2012) The Handbook of Metabolomics, Springer ISBN 978-1-61779-618-0.
8. Daniel C. Liebler (2002) Introduction to Proteomics: Tools for the New Biology., Humana Press Inc. ISBN-10: 0896039919
9. David W. Mount (2004) Bioinformatics – Sequence and Genome Analysis –Cold Spring Harbor Laboratory Press, U.S.; 2nd Edition. ISBN-10: 9746520709
10. Pandey, A., & Mann, M. (2000). Proteomics to study genes and genomes. Nature, 405(6788), 837-846.

11. Stoughton, R. B. (2005). Applications of DNA microarrays in biology. Annu. Rev. Biochem., 74, 53-82.
12. Monti, M., Orru, S., Pagnozzi, D., & Pucci, P. (2005). Functional proteomics. Clinica Chimica Acta, 357(2), 140-150.
13. Han, X., Aslanian, A., & Yates III, J. R. (2008). Mass spectrometry for proteomics. Current opinion in chemical biology, 12(5), 483-490.
14. Furey, T. S. (2012). ChIP–seq and beyond: new and improved methodologies to detect and characterize protein–DNA interactions. Nature Reviews Genetics, 13(12), 840-852.
15. Metzker, M. L. (2010). Sequencing technologies—the next generation. Nature reviews genetics, 11(1), 31-46.
16. Hendry, J. I., Dinh, H. V., Foster, C., Gopalakrishnan, S., Wang, L., &Maranas, C. D. (2020). Metabolic flux analysis reaching genome-wide coverage: lessons learned and future perspectives. Current Opinion in Chemical Engineering, 30, 17-25.
17. Pinu, F. R., Beale, D. J., Paten, A. M., Kouremenos, K., Swarup, S., Schirra, H. J., & Wishart, D. (2019). Systems biology and multi-omics integration: viewpoints from the metabolomics research community. Metabolites, *9*(4), 76.
18. Kitano, H (2001) Foundations of Systems Biology. The MIT Press, England.

Related online contents:

1. https://omicstutorials.com/introduction-to-multi-omics-data-integration-from-concepts-to-applications/#google_vignette
2. NPTEL - Computational Systems Biology - Prof. Karthik Raman – IIT Madras - https://nptel.ac.in/courses/102/106/102106068/
3. NPTEL - Introduction to Proteogenomics - Prof. Sanjeeva Srivastava – IIT Bombay - https://nptel.ac.in/courses/102/101/102101076/
4. NPTEL - Applications of interactomics using Genomics and proteomics technologies - Prof. Sanjeeva Srivastava – IIT Bombay - https://nptel.ac.in/courses/102/101/102101072/

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. R. Sathishkumar** **Professor**

SEMESTER TWO

Bioinformatics

Credits 4

Marks 100

Course Code	24MB1C10	Course Type	Core 10	L	T	P	C	Syllabus version	2024-2025
				2	-	2	4		
Pre-requisite	Basic knowledge in Biology								

Course objectives:

1. Make the students understand the both theory and practical aspects of Bioinformatics.
2. Know the computational methods for Sequence Alignment, Multiple Sequence alignment and Evolutionary analysis.
3. Understand the steps in Protein modeling and structure predication
4. Genome sequencing technologies and analysis methods

Expected Course Outcomes:

CO1	Gain working knowledge of these computational tools and methods	**K1**
CO2	Develop an understanding of the basic theory of these computational tools	**K2**
CO3	Interpret the algorithms, scoring functions involved in the sequence alignment.	**K3**
CO4	Evaluate the phylogenetic relationship of an organism from sequences using bioinformatics tools.	**K4**
CO5	Model 2D and 3D structure of a target from the sequence.	**K5**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Bioinformatics basics

Bioinformatics basics: Computers in biology and medicine; Importance of Unix and Linux systems and its basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; databases and search tools: biological background for sequence

12 Lectures	analysis; Identification of protein sequence from DNA sequence; searching of databases for similar sequences; NCBI; publicly available tools; resources at EBI; resources on the web; database mining tools.
Unit II **DNA sequence analysis** **12 Lectures**	DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing - Multiple sequence alignment; similarity searching with the FASTA3 programme package; use of CLUSTAL W and CLUSTAL X for multiple sequence alignment; methods of phylogenetic analysis
Unit III **Protein modelling** **13 Lectures**	Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing
Unit IV **Protein structure prediction and docking** **14 Lectures**	Protein structure prediction: protein folding and model generation; secondary structure prediction; Chou-Fasman, GOR method, Neural Network; analyzing secondary structures; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; Threading and Fold recognition; RAPTOR; Validation of the Model; Ramachandran Plot;

	PROCHECK; Elements of *in-silico* drug design; Virtual library; AutoDock; Drug-receptor interaction. Pymol, Rasmol viewer
Unit V **Genome analysis** **14 Lectures**	Genome Projects; Genome sequencing technologies and analysis methods; Microarrays; Next Generation Sequencing; Next Generation Sequencing technologies; Analysis of gene expression data; Function, gene set enrichment and pathway analysis; BiNGO and DAVID tools.
Unit VI **Contemporary issues**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 65	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press
3. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
4. Andrew R. Leach Molecular Modeling: Principles and Applications.
5. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function,

and Genomics. Oxford: Oxford University Press
6. Genomes T.A Brown, 2001, Taylor and Francis Group.
7. Understanding Bioinformatics, Jeremy O. Baum, Marketa J. Zvelebil. 2007, Garland Science, USA
8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, 1998, Wiley Publishers
9. Textbook of Drug Design and Discovery, Kristian Stromgaard, PovlKrogsgaard-Larsen, Ulf Madsen, 2009, CRC Press.
10. Comparative Genomics Ann Gibbons, 1998, Science.

Related online contents:

1. SWAYAM - Bio-Informatics: Algorithms and Applications- Prof. M. Michael Gromiha – IIT Madras
2. https://nptel.ac.in/courses/102/103/102103044/

Course adapted from DBT curriculum and handled by Dept. of Bioinformatics	**Dr. N. Jeyakumar** **Professor**

SEMESTER TWO

Molecular Diagnostics and Clinical Testing

Credits 4

Marks 100

Course Code	24MB1C11	Course Type	Core 11	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic knowledge in Diagnostics								

Course objectives:

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

Expected Course Outcomes:

CO1	Understanding of disease types and their diagnosis. Obtain knowledge about ethical and regulatory aspects of conducting diagnostic tests.	K3
CO2	Learn the technical aspects of various diagnostic methods which will help in application of these techniques to design and develop new clinical tests.	K4
CO3	Obtain comprehensive knowledge about various biotechnological investigations done to monitor changes happening at different molecular levels. Understand the uniqueness and pitfalls of biological assays to analyse and apply them to develop clinical tests.	K5
CO4	Develop skills to interpret the results of molecular techniques when performing them practically.	K6
CO5	Know about how important diseases are diagnosed using molecular diagnostic methods. Learn practical applications of precision diagnostics in disease management.	K4
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction to Molecular Diagnostics** **10 Lectures**	Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Clinical specimens: National and International guidelines for Sample collection- method of collection, transport and processing of samples, Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.
Unit II **DNA Based Molecular Techniques for Diagnosis** **10 Lectures**	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 III **Proteomic and Metabolomics Assays for Diagnostics** **10 Lectures**	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 IV **Applications of Molecular Diagnostics**	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.

12 Lectures	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 V **Applications In Molecular Oncology And Microbial Diseases** **12 Lectures**	Molecular oncology testing in malignant disease- Acute and Chronic leukemias, Melanoma, colon, lung and breast cancers. Circulating tumour cell testing (CTC). Molecular diagnosis of various viral diseases: Dengue, Chikungunya and SARS. Direct detection & 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 VI **Molecular Therapeutics** **11 Lectures**	Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors; Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers; Types of recombinant vaccines and clinical applications; Gene silencing technology; Antisense therapy; siRNA
Total Lectures – 65	

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**										

Recommended Textbooks and References:

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

Related online contents:

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 adapted from DBT and handled by Dept. of Biotechnology	**Dr. V. Thirunavukkarasu** **Associate Professor**

SEMESTER TWO

Plant Molecular Pharming

Credits 2

Marks 50

Course Code	24MB1E1A	Course Type	Elective 1	L	T	P	C	Syllabus version	2024-2025
				1	1	-	2		
Pre-requisite	Basic understanding of plant systems								

Course objectives:

1. Impart adequate knowledge on Plant Molecular Pharming.
2. Expedite the students to understand the techniques involved in production of plant derived recombinant proteins.
3. To understand the advantages and limitations of using plant systems for recombinant protein production.
4. Enrich the students' knowledge with respect to challenges, bio-safety, and public acceptance towards molecular pharming.

Expected Course Outcomes:

CO1	Understand the methods of gene delivery into plant cells and use such acquaintance in plant molecular pharming.	**K2, K3**
CO2	Acquire a complete knowledge about production of plant derived recombinant proteins.	**K1**
CO3	Know the latest information on different technologies used in production of pharmaceutical proteins	**K2, K6**
CO4	Gain information's about plant expressed biopharmaceuticals and their applications	**K1, K5**
CO5	Know about biosaftey aspects, regulatory information's and public acceptance pertaining to plant molecular pharming.	**K4**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Totipotency. Plant tissue culture media and hormones. Regeneration system – Direct organogenesis, Indirect organogenesis and somatic embryogenesis. Plant

Plant Tissue Culture and Methods of Gene Delivery into Plant Cells **6 Lectures**	Transformation: Stable and transient expression system. Indirect DNA delivery method - *Agrobacterium* mediated transformation. Direct DNA delivery method - particle bombardment. Agroinfiltration technique and its advantages.
Unit II **Host Plants and Downstream Processing** **6 Lectures**	Host plants – Tobacco, Cereals and legumes, Fruit and vegetables. Strategies for improving expression technology. Downstream processing of plant-derived recombinant therapeutic proteins. Novel downstream strategies – Rhizosecretion, Guttation, Oleosin fusion technology.
Unit III **Production Technologies** **6 Lectures**	Production of pharmaceutical proteins in plants, suspension and root cultures. Chloroplast expression system. Monocot expression systems for molecular farming. Efficient and reliable production of pharmaceuticals in alfalfa. Novel sprouting technology for recombinant protein production.
Unit IV **Pharmaceuticals** **6 Lectures**	Plant expressed biopharmaceuticals and edible vaccines. Production of secretory IgA in transgenic plants. Production of active human glucocerebrosidase in carrot cells. Plant biologics and case studies.
Unit V **Biosafety Aspects, Regulations, and Public Acceptance** **6 Lectures**	Biosafety aspects of molecular farming in plants - Ethical issues and regulations. Public acceptance towards molecular pharming. Advantages and limitations of using plant systems for recombinant protein production.
Unit VI **Contemporary issues** **5 Lectures**	Guest lectures by academic/industry experts. Online seminars – webinars.
Total Lectures – 35	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Kimmo, K. (2004) Novel Sprouting Technology for Recombinant Protein Production. Wiley.
2. Abrahamian, P., Hammond, R. W., & Hammond, J. (2020). Plant Virus–Derived Vectors: Applications in Agricultural and Medical Biotechnology. Annual Review of Virology, 7.
3. Reng, Q., Gang, T., & Qike, L. (2009). Transient gene expression mediated by agroinfiltration and its application. Molecular Plant Breeding.
4. Fischer, R., Vaquero-Martin, C., Sack, M., Drossard, J., Emans, N., & Commandeur, U. (1999). Towards molecular farming in the future: transient protein expression in plants. Biotechnology and applied biochemistry, 30(2), 113-116.
5. Schiermeyer, A., Dorfmuller, S., & Schinkel, H. (2004). Production of pharmaceutical proteins in plants and plant cell suspension cultures. Molecular Farming.
6. Yagi, Y., & Shiina, T. (2014). Recent advances in the study of chloroplast gene expression and its evolution. Frontiers in Plant Science, 5, 61.
7. Chargelegue, D., Drake, P. M., Obregon, P., & Ma, J. K. C. (2004). Production of secretory IgA in transgenic plants. Molecular Farming. Plant-Made Pharmaceuticals and Technical Proteins, 159-169.
8. Twyman, R. M. (2004). Host plants, systems, and expression strategies for molecular farming. Molecular Farming, 191-216.
9. Ahmad, K. (2014). Molecular farming: strategies, expression systems, and bio-safety considerations. Czech Journal of Genetics and Plant Breeding, 50(1), 1-10.

10. Sharma, R., & Sathishkumar, R. (2017). Rapid production of therapeutic proteins using plant systems. Defence Life Science Journal, 2(2), 95-102.
11. Drossard, J. (2004). Downstream processing of plant-derived recombinant therapeutic proteins. Molecular Farming, 217-231.
12. Commandeur, U., & Twyman, R. M. (2004). Biosafety aspects of molecular farming in plants. Molecular Farming.

Related online contents:

1. NPTEL - Downstream Processing - Prof. Mukesh Doble – IIT Madras
2. NPTEL - Plant Biotechnology - Dr. Rakhi Chaturvedi – IIT Guwahati
3. NPTEL - Organic Farming for Sustainable Agricultural Production - Prof. Dilip Kumar Swain – IIT Kharagpur

Course adapted from DBT and handled by Dept. of Biotechnology	**Dr. M. Arun, Assistant Professor**

SEMESTER TWO

Indian Systems of Medicine

Credits 2

Marks 50

Course Code	24MB1E1B	Course Type	Elective1B	L	T	P	C	Syllabus version	2024-2025
				1	1	-	2		
Pre-requisite	Basic knowledge on traditional medicines								

Course objectives:

1. Make the students understand thoroughly the principles and concepts of various Indian systems of medicine.
2. Make the students to understand the industrial requirements, good manufacturing practice (GMP), and new drug documentations.
3. Impart knowledge on the guidelines, methods of preparation, and standardization of formulations in various systems of medicines.
4. Impart sufficient information about quality assurance, quality control and expand their understanding towards regulatory aspects.
5. Enrich the students' knowledge with respect to scientific validations of ISM and related examples of case studies.

Expected Course Outcomes:

CO1	Understand the basic principles of various Indian systems of medicine	**K2**
CO2	Know the industrial infrastructural requirements, current good manufacturing practice of Indian systems of medicine, and new drug documentations	**K1**
CO3	Obtain a comprehensive knowledge about quality assurance, quality control, and their regulatory aspects	**K2, K3**
CO4	Know about the detailed insight on drug preparation and standardization of drug formulation	**K2, K6, K5**
CO5	Gain information's on scientific validation of ISM drugs and know about the current studies in the pharmacological and toxicological screening of ISM.	**K1, K2, K4**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction to Various Indian Systems of Medicine** **4 Lectures**	History and development of ISM. Fundamental concepts of Ayurveda, Siddha, Unani, Homoeopathy, Naturopathy, Yoga, Sowa-Rigpa, and Tribal Medicine. Treatment types. Different dosage forms, merits, and demerits of the ISM.
Unit II **Good Manufacturing Practice, Industrial requirements &Drug documentation** **4 Lectures**	Components of GMP (schedule T), GAP, GLP, and its objectives. Infrastructural Requirements: working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation, and records. Preparation of documents for new drug application and export registration.
Unit III **Guidelines, Preparations, and Standardization of Drug Formulations** **4 Lectures**	General guidelines for ISM drug development. Salient features of the techniques for preparation of some of the important class of formulations as per Ayurveda, Siddha, Homeopathy, and Unani Pharmacopoeia. Standardization, Shelf life, and Stability studies of ISM formulations. Problems of standardization in ISM.
Unit IV **Quality Control, Quality Assurance, and Regulatory Aspects** **5 Lectures**	Quality assurance and control in ISM formulation industry. Regulatory aspects. National/Regional Pharmacopoeias. Analysis of formulations and bio-crude drugs with references to Identity, purity, and quality
Unit V	Scientific evidence validating different products and practices of the Indian system of medicine. Case-studies with suitable examples (Pharmacological and

Scientific validations of ISM **5 Lectures**	toxicological screening of drugs used in the Indian system of medicine).
Unit VI	
Contemporary issues **2 Lectures**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 24	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Ayurvedic Pharmacopoeia, The Controller of Publications, Civil Lines, Govt. of India, New Delhi.
2. H. Panda, Hand Book on Ayurvedic Medicines, National Institute of Industrial Research, New Delhi.
3. KavirajNagendranathSengupata, Ayurvedic System of Medicine, Sri Satguru Publications, New Delhi.
4. Pulok K Mukharjee, GMP for Botanicals - Regulatory and Quality issues on Phytomedicine, Business Horizons, New Delhi.
5. Indian System of Medicine and Homeopathy in India, Planning and Evaluation Cell,Govt. of India, New Delhi.

6. Ayurvedic Pharmacopoeia. Formulary of Ayurvedic Medicines, IMCOPS, Chennai.
7. Homeopathic Pharmacopoeia. Formulary of Homeopathic Medicines, IMCOPS, Chennai.

Related online contents:

1. https://www.ayush.gov.in/docs/guideline-drug-development.pdf
2. https://www.slideshare.net/tusharkedar2/indigenous-system-of-medicine
3. https://www.slideshare.net/TriAngels/indian-medicine-by-triangels-medical-group-history-of-medicine
4. https://main.ayush.gov.in/sites/default/files/Introduction_2.pdf
5. https://books.google.co.in/books/about/Ayurveda.html?id=ZFYAAQAACAAJ&redir_esc=y
6. https://nptel.ac.in/courses/121/106/121106003/

Course adapted from DBT and handled by Dept. of Biotechnology	**Dr. M. A. Shibu** **Assistant Professor (DBT-RRF)**

SEMESTER TWO

Laboratory II: Immunotechnology, Molecular Diagnostics, Microbiology and Molecular Biology - I

Credits 4

Marks 100

Course Code	24MB1P02	Course Type	Practical 2	L	T	P	C	Syllabus version	2024-2025
				-	-	6	4		
Pre-requisite	Basic knowledge in immunology, microbiology, and molecular biology								

Course objectives:

1. Develop an understanding the practical aspects of components of immune system as well as their function.
2. Familiarize the students with basic as well as advanced methods to detect different antigen and antibody interactions. Provide hands-on for isolation of different lymphocyte cells etc. and analysis.
3. Provide the students with practical skills on basic microbiological and genetic engineering techniques

Expected Course Outcomes:

CO1	Basic immunology concepts and applications	**K2, K4**
CO2	Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses.	**K1, K3, K4**
CO3	Understanding the immune responses during infections (viral or bacterial) by looking at cytokine profile.	**K2, K4**
CO4	First-hand practical experience that will supplement the theoretical knowledge.	**K2, K3**
CO5	Acquire basic microbiology techniques and its principles. Gain hands-on experience on gene cloning molecular markers	**K2, K3, K4, K5**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Experiments: Immunotechnology and Molecular Diagnostics

Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)

1. Confirmation of recombinant protein by immunoblotting technique using chromogenic substrate
2. Demonstration of gateway cloning technology

Translational Research Laboratory (Dr. V. Vijayapadma)

3. Detection of hydrolytic enzymes on the basis of substrate degradation by Zymography
4. Determination of antigen concentration by Rocket immunoelectrophoresis.
5. Primer designing and gene expression analysis by RT-PCR

Molecular Toxicology Laboratory (Dr. P. Ekambaram)

6. Blood smear preparation and determination of differential leucocyte count.
7. Isolation of primary cells from the given animal tissue sample and determination of its viability.
8. Handling of small animals – Mice and Rat

Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)

9. Isolation and purification of IgG antibody from serum using Protein G column
10. Biomarker detection in body fluids: Estimation of blood Bilirubin by biochemical colorimetric method.
11. Biomarker detection in body fluids: Detection of C reactive protein (CRP) using agglutination methods.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)

12. Detection of genetic mutation using allelic PCR.
13. Culture of HeLa/ J774 cells and phagocytosis detection
14. Lecture demonstration of recognized genetic aberrations in clinical samples from cancer patients and detail a test-case using next-generation sequencing of a patient sample using web-tutorials and online content.

Experiments: Microbiology and Molecular Biology

Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)

15. GMO detection by PCR

Metabolic Engineering Laboratory (Dr. S. Girija)

16. Expression of gene of interest using *Agrobacterium tumefaciens* mediated transformation.
17. Screening of secondary metabolites from medicinal plants.
18. Analysis of Antimicrobial activity of medicinal plant extract.

Molecular Microbiology Laboratory (Dr. S. R. Prabagaran)

19. Isolation of bacterial genomic DNA by CTAB method and 16S rRNA nested PCR.

20. Mutagenesis of bacteria by UV rays and screening of antibiotic resistant mutants.
21. Antibiotic sensitivity test by Kirby-Bauer method.

Plant Molecular Biology (Dr. M. Arun)

22. Isolation of plasmid DNA and quantification using AGE and UV-Visible spectrophotometer.
23. Identification of optimum restriction site for gene cloning and restriction digestion of plasmid vectors.
24. DNA ligation for developing recombinant vectors.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	S	M	L	S	S	S	S	L
CO2	S	l	M	L	M	S	S	S	S	L
CO3	S	L	S	L	L	S	S	S	S	L
CO4	S	L	S	S	M	S	S	S	S	M
CO5	S	L	S	L	L	S	S	S	S	L
***S-Strong; M-Medium; L-Low**										

Course adapted from DBT curriculum and handled by all faculty from Dept. of Biotechnology

SEMESTER TWO

SAS Programming for Clinical Trials Management

Credits 4

Marks 100

Course Code	24MB1J01	Course Type	Job Oriented Certificate Course 1	L	T	P	C	Syllabus version	2024-25
				3	1	-	4		

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:

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 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Course Content	Lecture / Practical / Internship
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 – 45 hours	

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**										

Recommended Textbooks and References:

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.

Dept. of Biotechnology with Relevant Industry Partner	**Dr. V. Thirunavukkarasu Associate Professor**

SEMESTER THREE

Animal Biotechnology and Stem Cell Biology

Credits 4

Marks 100

Course Code	24MB1C12	Course Type	Core 12	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic knowledge in Animal sciences								

Course objectives:

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:

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

Unit I	Introduction to Stem Cells – Definition, Classification, characteristics; Stem cell Vs Somatic cells; Differentiation, dedifferentiation and

Introduction to Stem cells and Basics of Stem cell culture **12 Lectures**	transdifferentiation. Cellular signaling and maintenance of stem cells. Mechanism of pleuripotency 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 II **Types of Stem Cells** **12 Lectures**	Different kinds of stem cells – Embryonic stem cells, Embryonic Germ cells; Stem cell Niche. Adult Stem Cells: heamtopoietic 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 III **Stem Cell Therapy** **12 Lectures**	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 IV **Introduction to Tissue Engineering, Biomaterials and Scaffolds** **12 Lectures**	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 V	Tissue and organ transplantation. Bio-artificial organs: Skin Tissue engineering, Liver tissue engineering,

Tissue Engineering Applications **14 Lectures**	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 VI	
Contemporary issues **3 Lectures**	Guest lectures by academic/industry experts, online seminars - webinars
Total Lectures – 65	

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**										

Recommended Textbooks and References:

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
3. Boer JD et al.; Tissue Engineering – 2nd Edition (2014); Academic Press
4. Pallua N, Suschek CV; Tissue Engineering: from Lab to Clinic (2011); Springer
5. Barnes SJ, Harris LP; Tissue Engineering: Roles, Materials and Applications – 1st Edition (2008); Nova Science Publishers Inc

6. Minuth WW. Strehl R. Schumacher K; Tissue Engineering: from Cell Biology to Artificial Organs (2017); Wiley VCH
7. Zhao RC; Stem Cells: Basics and Clinical Translation (Translational Medicine Research) (2015); Springer
8. Knoepfler; Stem Cells: An Insider's Guide (2013); World Scientific Publishing Company
9. Harris J. Quigley M. Chan S.; Stem Cells: New Frontiers in Science & Ethics (2012); World Scientific Publishing Co Pte Ltd
10. Attala & Lana; Methods of Tissue Engineering (2002); Academic Press

Related online contents

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/

Course adapted from DBT and handled by Dept. of Biotechnology	**Dr. P. Ekambaram** **Professor**

SEMESTER THREE

Clinical Biochemistry and Disease Metabolism

Credits 4

Marks 100

Course Code	24MB1C13	Course Type	Core 13	L	T	P	C	Syllabus version	2024-2025	
				3	1	-	4			
Pre-requisite	Basic biochemistry knowledge									

Course objectives:

1. To build upon previous knowledge of biochemical pathways and immunology to develop an appreciation of applications of this knowledge in clinical diagnostics and treatment.
2. To make students aware about various disease diagnostic techniques
3. To understand disease pathologies and clinical case studies within the context of each topic
4. To get the knowledge on the biochemical parameters on disease biology
5. To know the organ functions and dysfunctions with respect to biochemical changes

Expected Course Outcomes:

CO1	Understand applications of clinical biochemistry in diagnostics	**K1, K2**
CO2	Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.	**K2, K3**
CO3	Acquire knowledge on marker enzymes in diagnosis and treatment of human diseases.	**K2, K3**
CO4	Understand the importance of metabolism in various disease pathophysiology	**K3, K4,**
CO5	Evaluate the usefulness of cellular mechanism for the diagnosis of diseases	**K5, K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I	Clinical specimen Considerations - Types of Samples, Sample Processing, Sample Variables, Chain of Custody; Infection control, the vascular system, composition and

Introduction to Clinical Biochemistry **12 Lectures**	types of blood specimens, venepuncture, paediatric and geriatric venepuncture, capillary specimen collection, capillary puncture procedures. Place and time of sample collection, preservation, influence of nutrition, drugs, posture, etc. Choice and correct use of anticoagulants; Care of the specimens, identification, transport, storage, influence of temperature, freezing/thawing; Laboratory safety and regulations – Safety awareness, safety equipment, biological, chemical, fire and radiation safety; Method evaluation and quality management, Basic concepts, Reference interval study, Diagnostic efficiency, Method evaluation, Quality Control and quality management.
Unit II **Amino acids and Protein Biochemistry** **12 Lectures**	Amino acids - Basic Structure, Metabolism, Essential Amino Acids, Non-essential Amino Acids, Body amino acid pool, Aminoacidopathies, Amino Acid Analysis, glutathione hyperglycinemias, formation of taurine, homocystinuria, cystinuria and cystinosis, phenyl ketonuria and alkaptonuria, albinism, tyrosinemia; Proteins – Importance, Molecular Size, Catabolism and Nitrogen Balance, Structure, Classification, Dynamic state of body proteins; Plasma proteins - Prealbumin (Transthyretin), Albumin, Globulins; Total Protein abnormalities – Hypoproteinemia, Hyperproteinemia; Methods of analysis – Total nitrogen, Total proteins, Fractionation, Identification and Quantification of specific proteins, Serum protein electrophoresis, High-resolution protein electrophoresis, Immunochemical methods; Proteins in other body fluids – Urinary proteins and Cerebrospinal fluid proteins; Non-protein nitrogen compounds (Physiology, clinical application, methods and pathophysiology) – Urea, Uric acid, Creatine, Creatinine, Ammonia, Synthesis of thyroid hormones, Synthesis and catabolism of catecholamines.

Unit III **Clinically Important Enzymes and Related Pathophysiology** **12 Lectures**	Enzymes of clinical significance - Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, Glutamyl transferase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug-Metabolizing Enzymes, Tumour markers, Bone markers, Cardiac markers, liver markers, Inborn errors associated with carbohydrate metabolism; Inborn errors of metabolism- Glycogen storage diseases, Fructosuria, Fructose intolerance, Pentosuria, Galactosuria, Urine screening.
Unit IV **Diagnosis and Treatment of Carbohydrate Disorders** **10 Lectures**	Blood glucose regulation (fasting/pp/random) – hormones influencing carbohydrate utilization, Insulin, glucagon, glucocorticoids, epinephrine, growth hormone. Hyperglycemia, Diabetes Mellitus - Aetiology and pathophysiology of Diabetes Mellitus, Symptoms and complications, Criteria for Testing for Prediabetes diabetes, Criteria for the Diagnosis of Diabetes Mellitus, Criteria for the Testing and Diagnosis of Gestational Diabetes Mellitus, Hypoglycemia - Genetic Defects in Carbohydrate Metabolism.
Unit V **Transport Mechanism and Associated Disorders** **12 Lectures**	Transport of plasma lipids, lipoprotein metabolism, lipid profile and diet, PUFA and dietary fiber, Serum triglycerides; Diagnosis and treatment of lipid disorders –Arteriosclerosis, Hyperlipoproteinemia, Hypercholesterolemia, Hypertriglyceridemia, Combined Hyperlipoproteinemia, Lipoprotein(a) Elevation, Hypolipoproteinemia, Hypoalphalipoproteinemia; Lipid and lipoprotein analyses - Lipid Measurement, Cholesterol Measurement, Triglyceride Measurement, Lipoprotein Methods, High- Density Lipoprotein Methods, Low-Density Lipoprotein Methods, Compact Analyzers, Apolipoprotein Methods, Phospholipid Measurement, Fatty Acid Measurement.
Unit VI	Pituitary function - Introduction to Hormones and Pituitary Function - hypophysiotropic or hypothalamic hormones; Anterior pituitary hormones; Pituitary tumors; Growth hormone; Actions of growth hormone; Testing; Acromegaly; Growth hormone deficiency;

Assessment of Organ System Function

10 Lectures

Prolactin; Prolactinoma; Other causes of hyperprolactinemia; Clinical evaluation of hyperprolactinemia; Management of prolactinoma; Idiopathic galactorrhea; Hypopituitarism - Etiology of hypopituitarism; Treatment of panhypopituitarism; Posterior pituitary hormones – Oxytocin and Vasopressin.

Liver Function - Anatomy - Gross Anatomy, Microscopic Anatomy, Biochemical functions - Excretory and Secretory, Synthetic, Detoxification and Drug Metabolism, Liver function alterations during disease – Jaundice, Cirrhosis, Tumors, Reye Syndrome, Drug- and Alcohol-Related Disorders Assessment of liver function/liver - Function tests: Bilirubin, Urobilinogen in Urine and Faeces, Serum Bile Acids, Enzymes, Tests Measuring Hepatic Synthetic Ability, Tests Measuring Nitrogen Metabolism, Hepatitis. Cardiac Function - Anatomy and function of the heart - Anatomy Function, Pathologic conditions of the heart, Cardiovascular Disease, Congenital Cardiovascular Defects, Heart Failure, Acute Coronary Syndromes, Hypertensive Heart Disease, Infective Heart Disease, Diagnosis of heart disease - Laboratory Diagnosis of Myocardial Infarction, Markers of Inflammation and Coagulation Disorders, Markers of Congestive Heart Failure, Patient-Focused Cardiac Tests, Disease.

Renal Function - Renal anatomy, Renal physiology - Glomerular Filtration, Tubular Function, Elimination of Nonprotein Nitrogen Compounds, Water, Electrolyte, and Acid-Base Homeostasis, Endocrine Function, 1,25-Dihydroxy Vitamin D3, Analytic procedures, Clearance Measurements, Urine Electrophoresis, 2-Microglobulin, Myoglobin, Microalbumin, Urinalysis, Pathophysiology – Glomerular Diseases, Tubular Diseases, Urinary Tract Infection/Obstruction, Renal Calculi, Renal Failure.

	Pancreatic Function and Gastrointestinal Function - Physiology of pancreatic function, Diseases of the pancreas, Tests of pancreatic function - Secretin/Cholecystokinin Test, Fecal Fat Analysis, Sweat Electrolyte Determinations, Serum Enzymes, Physiology and biochemistry of gastric secretion, Clinical aspects of gastric analysis, tests of gastric function - Measuring Gastric Acid in Basal and Maximal Secretory Tests, Measuring Gastric Acid, Plasma Gastrin, Intestinal physiology, Clinicopathologic aspects of intestinal function, Tests of intestinal function - Lactose Tolerance Test, D-Xylose Absorption Test, Serum Carotenoids, Other Tests of Intestinal Malabsorption.

Total Lectures – 68

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Michael L. Bishop, Edward P. Fody and Larry E. Schoeff; (2013). Basic Principles and Practice of Clinical Chemistry, (7th Ed). Lippincott Williams and Wilkins.
2. Stryer, L. (2002). Biochemistry, (8th Ed). Freeman.
3. D.M. Vasudevan and Sreekumari, S, (2010). Textbook of Biochemistry for Medical Students, (6th Ed). Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar; (2010). Concise Medical Biochemistry, (3rd ed), Elsevier Health.
5. Satyanarayana and Chakrapani, (2013), Biochemistry; (4th Ed). Elsevier.

Related online contents:

1. https://onlinecourses.swayam2.ac.in/cec20_ag01/preview

Course adapted from DBT and handled by Dept. of Biotechnology	**Dr. S. Velayuthaprabhu** **Assistant Professor**

SEMESTER THREE

Medical Microbiology and Infection Biology

Credits 4

Marks 100

Course Code	24MB1C14	Course Type	Core 14	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A basic knowledge in microbiology and infectious diseases								

Course objectives:

1. To impart knowledge on Medical Microbiology with special reference to Bacteria, viruses, fungi, protozoan and sexually transmitted diseases.
2. To understand, epidemiology, pathogenesis, prevention and treatment of various diseases.
3. To enlighten on sexually transmitted diseases and congenital diseases.
4. To obtain overall holistic knowledge on host-parasite relationship.

Expected Course Outcomes:

CO1	Learn the importance of microorganisms and their association with human health	**K1, K2**
CO2	Get introduced to clinical terms related to diseases	**K2, K3**
CO3	Obtain knowledge on diseases caused through bacteria, viruses, fungi, protozoan, sexually transmitted and congenital diseases.	**K2, K3, K4**
CO4	Understand on diagnosis and therapy.	**K4, K5**
CO5	Critically think on the role of those in medical profession in combating microbes.	**K5, K6**
CO6	Apply the knowledge towards Molecular Diagnostics	**K6**
CO7	Get holistic picture on Microbes as a whole with Biotechnologist perspective	**K2**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Bacterial Diseases

Pathogenesis and virulence factors - Koch's postulates, Adherence and invasion, Toxins, Enzymes, Antiphagocytic factors, Antigenic heterogeneity,

14 Lectures	Ironacquisition; *Bacillus anthracis, Clostridium* spp., *Corynebacteriumdiptheriae; E. coli, Vibrio cholerae, Helicobacter pylori, Salmonella typhi and paratyphi, Shigelladysenteriae; Listeria monocytogenes, Mycobacterium* spp., Rickettsial diseases; *Haemophilusinfluenzae, Bordetella pertussis*, Brucellosis, Streptococcal and Staphylococcal infections; Chlamydial infections (*Chlamydia trachomatis*); Antibacterial chemotherapy (with examples of antibiotics) - Inhibition of cell wall synthesis, inhibition of cell membrane function, inhibition of protein and nucleic acid synthesis, antimetabolites
Unit II **Viral and sexually transmitted diseases** **14 Lectures**	Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection), Viral persistence (chronic and latent infection); Polio, Chicken pox, Mumps, Measles, Rubella; Viral hemorrhagic fever, viral encephalitis, Dengue and Yellow fever; Influenza virus infection(emphasis on Avian and swineflu), Rabies and Priondiseases; Hepatitis and Human Cancer viruses; Emerging viral diseases – Ebola, Marburg, SARS, Hanta, Chikungunya, Zika, Chandipura; Antiviral chemotherapy and Viral vaccines; Nucleotide and nucleoside analogs, Reverse transcriptase inhibitor, protease inhibitor, fusion inhibitor, etc., Interferons, Killed and attenuated vaccines. Sexually transmitted diseases and congenital infections:Syphilis and Gonorrheal infections; AIDS and Lentiviral infection; Herpes infections; Congenital viral infections – Cytomegalovirus, Varicella zoster, HBV, Enterovirus, Parvovirus B19, etc.
Unit III **Fungal and Protozoan Diseases**	Types of Mycoses (with specific example of causative fungi) – Superficial, Cutaneous, Sub-cutaneous; Types of Mycoses (with specific example of causative fungi) - Endemic and Opportunistic; Mycotoxins and Antifungal chemotherapy – Mycetismus, Aflatoxins, classes of

14 Lectures	currently available drugs and new inhibitors in the pipeline; Protozoan diseases - Giardiasis, Amoebiasis; Leishmaniasis, African sleeping sickness; Malaria, Cryptosporidiosis; InfectionbyHelminths – Nematodes, Trematodes, Cestodes. Mycoplasma and Ureaplasma infection; Toxoplasmosis.
Unit IV **Host-pathogen interaction** **13 Lectures**	Intracellular and extracellular pathogens, Principles of microbial pathogenesis, host damage, inflammatory responses, adaptation strategies of pathogen- impact of host and pathogen metabolism on immunity and pathogen survival; Chronic pathogens and mechanisms of persistence; Evasion mechanisms of pathogens; Bacterial – host interaction- *Mycobacterium tuberculosis, Borreliaburgdorferi*; Viruses – host interaction: HIV,Influenza; Protozoan – hostinteraction: *Plasmodium* sp., *Leishmania major*. Drug resistance - origin (genetic and non-genetic), mechanisms, antimicrobial activity *in vitro* and *in vivo*, Multi-drug resistance and its mechanisms *e.g.* MDR-TB; Nosocomial infection
Unit V **Human Microbiome** **10 Lectures**	Normal microflora (microbiome) of human body and its role – Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Beneficial organisms of human microbiome mechanism of action, role in health, Human microbiome project. Prebiotics-Concept, definition, criteria, types and sources of prebiotics, prebiotic and gut microflora, health benefits
Unit VI **Contemporary issues**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 65	
Self-study	• Applications of Artificial Intelligence in Clinical Microbiology Diagnostic Testing

AI in Medical Microbiology	https://www.sciencedirect.com/science/article/abs/pii/S0196439920300258 • Artificial intelligence: Applications for the clinical microbiology lab today https://asm.org/Webinars/AI-Webinar • Artificial intelligence in Microbiology for faster actionable results https://www.mlo-online.com/information-technology/artificial-intelligence/article/13009222/artificial-intelligence-in-microbiology-for-faster-actionable-results • Image analysis and artificial intelligence in infectious disease diagnosis,https://www.clinicalmicrobiologyandinfection.com/article/S1198-743X(20)30155-5/abstract • Application of Artificial Intelligence to Predictive Microbiology https://www.researchgate.net/publication/290131735_Application_of_Artificial_Intelligence_to_Predictive_Microbiology

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016) Jawetz, Melnick and Adelbergs's*Medical Microbiology* 27th edition, McGraw Hill. W.H. Freeman and Co.
2. IT Kudva, NA. Cornick, PJ Plummer, Q Zhang, TL Nicholson, JP Bannantine and BH Bellaire. *Virulence Mechanisms of Bacterial Pathogens*, (2016) 5th edition, ASM Press.
3. V Kumar,AKAbbasandJCAster, (2015), *Robbins&Cotran Pathologic Basis of Disease.* 9th Edition, Elsevier.
4. AK Abbas, (2015), *Cellular and Molecular Immunology*. 8th Edition, Elsevier. Ananthanarayan and Paniker, *Textbook of Microbiology*, 8th Edition
5. Baveja CP, (2001) *Textbook of Microbiology*. 5th Ed., Mcgraw Hill Education.
6. J Owen, J Punt and Sharon Stranford, (2012), *Kuby Immunology*; 7th edition.

   K Murphy and K Weaver, (2016), *Janeway'sImmunobiology*, 9th Edition, Garland Science.

Related online contents:

1. https://www.news-medical.net/life-sciences/Human-Microbiome-Project-(HMP).aspx
2. https://www.news-medical.net/life-sciences/Microbiome-and-Disease.aspx
3. https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/20%3A_Immune_System/20.7%3A_Human_Microbiome
4. https://kids.frontiersin.org/article/10.3389/frym.2017.00035
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6463098
6. https://www.coursera.org/learn/bacterial-infections
7. https://www.coursera.org/learn/parasitology
8. https://www.udemy.com/course/medvirone/
9. https://www.classcentral.com/course/canvas-network-intro-to-medical-microbiology-1-bacteriology-12514

Course adapted from DBT and handled by Dept. of Microbial Biotechnology	**Dr. J. Angayarkanni** **Professor** **Dr. Brindha Priyadarshini** **Associate Professor**

SEMESTER THREE

Genetic Engineering and Genome Editing Technologies

Credits 4

Marks 100

Course Code	24MB1C15	Course Type	Core 15	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A basic knowledge in molecular biology								

Course Objectives:

1. Impart strong theoretical knowledge to explore the technologies of tools in genetic engineering.
2. Teach various approaches to conduct biological research in genetic engineering to expedite its applications in biotechnology industries.
3. Expedite the students to understand the diverse range of PCR techniques and their specialized applications in the field of modern biology.
4. Communicate sufficient information about the different methods to introduce foreign DNA to host cell and to expand their understanding in gene expression profiling studies.
5. Enrich the students' knowledge in recent advancements and applications in gene silencing and genome editing technologies.

Expected Course Outcomes:

CO1	Take up biological research as well as placement in the relevant biotech industry.	K3, K6
CO2	Understand the importance of tools used in the field of molecular biology and use such acquaintance to carry out gene cloning and library construction.	K2, K3
CO3	Operate PCR and know about its variations and most recent advancements.	K2, K5
CO4	Obtain a comprehensive knowledge of technique involved in introducing foreign DNA into the host cell, construct libraries, and perform hybridization techniques.	K1, K4
CO5	Gain information's about important strategies like genome sequencing, gene silencing and genome editing technologies	K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Impact of genetic engineering in modern society. General requirements for performing a genetic engineering experiment - restriction endonucleases and methylases, DNA ligase, Klenow

Tools for Genetic Engineering **12 Lectures**	enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase. Cohesive and blunt end ligation, linkers, adaptors, homopolymer tailing. Labelling of DNA - nick translation, random priming, radioactive and non-radioactive probes. Hybridization techniques - northern, southern, south-western, far-western, colony hybridization, and fluorescence in situ hybridization.
Unit II **Vectors and gene cloning** **12 Lectures**	Plasmids, Bacteriophages, M13mp vectors, pUC19 and pBluescript vectors, phagemids, Lambda vectors, Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs and BACs). pMal, GST, pET-based vectors. Intein-based vectors. Mammalian expression and replicating vectors, Baculovirus and *pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors. Principles for maximizing gene expression in vectors. Cloning methods: Restriction enzyme cloning, recombination cloning (Gateway), TA/TOPO cloning, Gibson assembly, Golden gate, Ligation independent cloning, Infusion cloning. Heterologous Protein purification - His-tag, GST-tag, MBP-tag *etc.* Inclusion bodies, methodologies to reduce formation of inclusion bodies.
Unit III **Introduction of foreign DNA into host cells and PCR Techniques** **12 Lectures**	Introduction of foreign DNA into host cells - transformation, electroporation, transfection. PCR: Principles of PCR, 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. Cloning of PCR products, T – vectors. PCR based site specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection. Mutation detection - SSCP, DGGE, RFLP. Chemical synthesis of oligonucleotides.
Unit IV **cDNA Analysis and Sequencing methods**	Construction of genomic and cDNA libraries, mRNA enrichment, Reverse transcription, Strategies for library screening, Yeast two and three hybrid systems, phage display. Sequencing methods - enzymatic DNA sequencing,

12 Lectures	chemical sequencing of DNA, automated DNA sequencing, RNA sequencing, methylation sequencing, Human genome project.
Unit V **Gene Silencing and Genome Editing Technologies** **12 Lectures**	Principle of gene silencing. RNAi - siRNA, miRNA, and antisense RNA technology. Gene silencing by homologous recombination. Epigenetic gene silencing. Applications of gene silencing. Introduction to genome editing: TALEN and Zinc-Finger-Nucleases, Genome editing by CRISPR-CAS - Cloning genomic targets into CRISPR/ Cas9 plasmids, *in vitro* synthesis of single guide RNA (sgRNA), purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing, Applications of CRISPR/cas9 technology. Methods and strategies for genetic manipulations, Transgenics, Applications of genetic manipulation in microbes, plants, humans and animals.
Unit VI **Contemporary issues** **5 Lectures**	Guest lectures by academic/industry experts, online seminars - webinars
Total Lectures – 65	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation and Genomics*, 7th Edition: Oxford: Blackwell Scientific Publications.

2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. George M., and church (2018).Genome editing and engineering. Cambridge university press. Edited by Krishnarao Appasani.
4. Morgan and Mikhails (2008).An introduction to genetic engineering .3rd edition. University of Paisely.
5. Huang, P.C., Kuo, T.T. and Ray wu (2012). Genetic engineering techniques recent development.Academic publishers. ISBN: 1299554245 (ISBN13: 9781299554245).
6. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
7. Desmond S.T Nicholl (2019). An introduction to genetic engineering (3rd). ISBN-13: 978- 0521615211
8. Anjanabha Bhattacharya, Vilas Parkhi and Bharat Char (2020). CRISPR/Cas genome editing. Strategies And Potential for Crop Improvement. 1stedition. Editors: Bhattacharya, Anjanabha, Parkhi, Vilas, Char, Bharat (Eds.). ISBN 978-3-030-42022-2

Related Online Contents:

1. Doudna, J. A., & Charpentier, E. (2014). *The New Frontier of Genome Engineering with CRISPR-Cas9*. Science, 346(6213), 1258096-1258096. doi:10.1126/ science.1258096.
2. Hala, T.E, Bassyouni, L and Maysoon Ahmed Mohammed (2018).Genome editing: A Review of literature.Lap Lambert Academic Publishing. ISBN: 9786138387534
3. Maeder, M. L., & Gersbach, C. A. (2016). *Genome-editing Technologies for Gene and Cell Therapy*. Molecular Therapy, 24(3), 430-446. doi:10.1038/mt.2016.10
4. Genome Editing Resource Library (Thermo Fisher) https://www.thermofisher.com/in/en/home/life-science/genome-editing/genome-editing-learning-center/genome-editing-resource-library.html
5. Cox, D. B., Platt, R. J., & Zhang, F. (2015). *Therapeutic Genome Editing: Prospects and Challenges*. Nature Medicine, 21(2), 121-131. doi:10.1038/nm.3793
6. Sander JD Joung JK. (2014) *CRISPR-Cas Systems for Editing, Regulating and Targeting Genomes*. Nature Biotechnology 32, 347–355 doi:10.1038/nbt.2842
7. Mohini joshi and Deshpande (2010).Polymerase chain reaction: Methods, principles and application. International Journal of Biomedical Research.5:81-97
8. https://www.wcrj.net/wp-content/uploads/sites/5/2020/03/e1510-A-review-on-genome-editing-by-crispr-cas9-technique-for-cancer-treatment
9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4343198/
10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5733845/

Course adapted from DBT curriculum and handled by Dept. of Biotechnology	**Dr. M. Arun, Assistant Professor**

SEMESTER THREE

Nanobiotechnology

Credits 4

Marks: 100

Course Code	24MB1E2A	Course Type	Elective 3	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic knowledge in biological and chemical structures.								

Course objectives:

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:

CO1	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**
CO2	Understand the concepts related to nano-films and their characterization.	**K2, K6**
CO3	Obtain a comprehensive knowledge about nanoparticles and its applications.	**K1, K3**
CO4	Know about the detailed insight on nanomaterials	**K2, K3**
CO5	Gain information's about basics of nanotoxicity	**K1**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction to Nanobiotechnology** **5 Lectures**	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 II Synthesis **5 Lectures**	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. SelfAssembly,Nanovesicles;Nanospheres;Nano-capsules
Unit III **Nano-particles in drug delivery** **5 Lectures**	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 IV **Nanoparticles in disease diagnosis.** **5 Lectures**	Nanoparticles for diagnostics and imaging (theranostics); concepts of smartstimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. Nanosensors for neuronal disorders.
Unit V **Nano-material applications**	Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in synthesis, applications of nanobiocatalysis in the production of drugs and drug

5 Lectures	intermediates. Nanoparticles applications in Agriculture, Food, Environment and cosmetic Industry.
Unit VI **Nano-toxicity** **5 Lectures**	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.
Unit VII **Contemporary Issues** **5 Lectures**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 35	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

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. Recent review papers in the area ofNanomedicine.
6. Risal singh and shipra mithal gupta (2016). Introduction to Nanotechnology. First edition. PP:604.ISBN:9780199456789
7. Charles p pool (2020). Introduction to Nanoscience and Nanotechnology. wiley publisher.PP.508
8. Narendra kumar and sunita kumbhat (2016). Essentials in Nanoscience and Nanotechnology.wiley publisher.PP.465. ISBN: 978-1-119-09611-5

9. Abdel Salam Hamdy Makhlouf Ahmed Barhoum (2018). Fundamentals of Nanoparticles.1st Edition. Elsevier. **PP.666.** Paperback ISBN: 978032351255
10. Deborah M. Kane, Adam MicolichPeter Roger (2016). Nanomaterials Science and Applications.1st Edition Jenny Stanford Publishing, **PP.418** .ISBN 9789814669726
11. Kumar V. Guleria P. Shivendu R.Dasgupta N. Lichtfouse, E. (2021). Nanotoxicology and Nanoecotoxicology. Springer International publisher. Vol. 1 .pp:318. ISBN 978 3030632410
12. Alain Nouailhat (2006). An Introduction to Nanoscience and Nanotechnology. France by Hermes Science/Lavoisier. Doi: https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf
13. 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
14. Aliof khazraei, Mahmood (Ed.)(2015). Handbook of Nanoparticles.Springer publisher. ISBN: 978 3319153391
15. IbrahimKhan , KhalidSaeed , IdreesKhan (2019). Nanoparticles: Properties, applications and toxicities. The Arabian journal of chemistry.12(7).PP:908-931
16. Susai Rajendran Anita Mukherjee Tuan Nguyen Chandraiah Godugu Ritesh Shukla (2020). Nanotoxicity. 1st Edition. Elsevier.pp;504 .ISBN: 9780128199442

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 adapted from DBT curriculum and handled by Dept. of Nanoscience and Technology and Department of Biotechnology	**Dr. N. Ponpandian, Professor and Dr. S. Girija, Associate Professor**

SEMESTER THREE

Pharmaceutical Biotechnology

Credits 4

Marks 100

Course Code	24MB1E2B	Course Type	Elective 2B	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	Basic understanding in Pharmaceuticals								

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:

CO1	Acquire knowledge about natural sources of drugs, interaction of drugs with different types of biological molecules to mediate physiological effects, metabolism and removal of drugs from the system. Learn about intricate aspects of drug development that need to be implied during new drug development	K2
CO2	The students will get an insight about how various biological systems can be used for biopharmaceutical production. Learn key aspects and methodologies which can transform into their skills. Understanding the advantages and pitfalls of these systems will support them during analysis and decision making during practical application.	K5
CO3	Obtain comprehensive knowledge about vital facets of clinical testing in obtaining approval for new drugs. Improve their prudent skills to be employed in drug discovery efforts.	K4

CO4	Learn about emerging powerful tools employed for efficient and safe delivery of drugs into the host system. Enhance their decision making capacity to choose right system for drug delivery	K6
CO5	Understand the roles, responsibilities and organizational structure of regulatory bodies. Obtain in depth knowledge which can be useful for practical applications while preparing drug approval applications	K5
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Unit I **Introduction To Pharmaceuticals** **14 lectures**	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 II **Drug Targets and Pharmacogenomics** **14 Lectures**	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 III **Production of Biopharmaceuticals** **14 Lectures**	**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 IV **Drug Manufacturing Principles and Regulatory Aspects** **14 Lectures**	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 IV **Drug Development Process and Delivery Systems** **14 Lectures**	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 Lectures – 70	

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										

Recommended Textbooks and References:

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
5. Crommelin DJA, Sindelar RD, Meibohm B. 2019. Pharmaceutical Biotechnology Fundamentals And Applications. 5th Edition
6. Orlilcki R, Cienciala C, Krylova LP, Pielichowski J, Zaikov GE.2013.Pharmaceutical And Medical Biotechnology New Perspectives
7. Antoine Al-Achi, Mali Ram Gupta, William Craig Stagner. 2013. Integrated Pharmaceutics-Applied Preformulation, Product Design, and Regulatory Science
8. Shyam S Mohaptra, ShivenduRanjan, NanditaDasgupta, Raghavendrakumar Mishra, Sabu Thomas. 2018. Applications of targeted Nano drugs and Delivery systems.

Related online contents:

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 adapted from DBT and handled by Department of Biotechnology	**Dr. V. Thirunavukkarasu, Associate Professor**

SEMESTER THREE

Laboratory III: Microbiology, Molecular Biology - II, Clinical Biochemistry and Disease Metabolism, Animal Tissue Culture

Credits 4

Marks 100

Course Code	24MB1P03	Course Type	Practical 3	L	T	P	C	Syllabus version	2024-2025
				-	-	6	4		
Pre-requisite	Basic knowledge in microbiology, molecular biology, biochemistry, and cell culture								

Course objectives:

1. To build upon existing knowledge of biochemical and immunological principles for its application in clinical diagnostics and treatment.
2. The course shall equip students with basic skills in clinical biochemistry.
3. Providing hands-on experience in handling animal cell cultures.
4. To impart important microbiology and advanced molecular biology practical knowledge and related instrumentation.

Expected Course Outcomes:

CO1	Hands-on skills for blood and urine biochemical analysis and applications of clinical biochemistry in diagnostics	**K2, K3**
CO2	Understand the molecular basis of various pathological conditions through practical case studies.	**K2, K5**
CO3	Handle and maintain various animal cell lines.	**K1, K6**
CO4	Toxicity testing using animal cells.	**K1, K4**
CO5	Hands-on experience in microbiological and molecular biology techniques.	**K3, K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Experiments: Microbiology and Molecular Biology-II

Plant Genetic Engineering Laboratory (Dr. R. Sathishkumar)

1. Particle gene gun mediated gene delivery (GFP) in tobacco
2. DNA barcoding for herbal plant and product authentication
3. In silico design of multiepitope antigen for disease diagnosis

Metabolic Engineering Laboratory (Dr. S. Girija)

4. *Agrobacterium rhizogenes* for hairy root culture and estimation of phenolic compound
5. Determination of Malondialdehyde (MDA) content in Plant Tissues
6. Quantification of Drug molecule from medicinal plants using HPLC.

Molecular Toxicology Laboratory (Dr. P. Ekambaram)

7. Serum total Cholesterol and HDL estimation by CHOD-POD Method.
8. Estimation of serum triglycerides by GPO-POD method & Counting of Erythrocytes and Leucocytes in human blood using Hemocytometer.
9. Whole mount fluorescence immunohistochemistry in Zebrafish larvae.

Molecular Microbiology Laboratory (Dr. S. R. Prabagaran)

10. Isolation of anaerobic bacteria from biological samples.
11. 16S rRNA gene library preparation for sequencing studies.
12. 16S rRNA gene sequencing and phylogenetic tree construction.

Translational Genomics and Proteomics (Dr. V. Thirunavukkarasu)

13. Estimation of Alkaline Phosphatase activity (ALP) to assess the extent of differentiation in mammalian cells.
14. Detection of apoptosis by dual Acridine Orange/ Ethidium Bromide (AO/EB) fluorescent staining in cultured cells.
15. Lecture demonstration on detection of contamination (Mycoplasma) in animal cell cultures.

Plant Molecular Biology (Dr. M. Arun)

16. Bacterial transformation of recombinant vector by heat shock/electroporation methods.
17. Colony PCR for identifying the transformed bacterial colonies having gene of interest.
18. Designing guide RNA using bioinformatic tools, and developing knock down construct for CRISPR based genome editing.

Experiments: Clinical Biochemistry and Disease Metabolism

Reproductive Immunology and Molecular Pathology (Dr. S. Velayuthaprabhu)

19. Estimation of Blood glucose by GOD-POD method
20. Liver Function Test: Estimation of SGOT and SGPT in serum.
21. Case Studies

Case history-1: Nephrotic Syndrome: A five-year-old child was brought in paediatric OPD with complaints of weakness and polyuria. On physical examination it was observed that he was having periorbital oedema and swelling over legs. Perform suitable tests in blood/urine sample provided and interpret your findings.

Experiments: Animal Tissue Culture

Translational Research Laboratory (Dr. V. Vijayapadma)

22. Cytotoxicity screening of chemotherapy drugs in cultured cells using MTT analysis.
23. Estimation of LDH leakage in culture supernatant to measurement chemical induced cellular damage using LDH assay.
24. Quantitative analysis of reactive oxygen species in human RBCs at different concentration of drug treatment by DCFDA assay.

Mapping with Programme Outcomes

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

Course adopted from DBT curriculum and handled by all the faculty,
Dept. of Biotechnology

SEMESTER THREE

Lead Molecule Discovery and Preclinical Development

Credits 4

Marks 100

Course Code	24MB1J02	Course Type	Job Oriented Certificate Course 2	L	T	P	C	Syllabus version	2024 - 2025
				3	1	-	4		
Name of the Faculty Member i/c With Complete Address with Phone and e-mail			**Dr. R. Sathishkumar,** Professor, Dept. of Biotechnology, Bharathiar University rsathish@buc.edu.in						
Mode of the Course			Hybrid						
Collaboration if any with Companies (if Yes, Full Address of the Company Address , Name of the Contact Person)			**Dr. K. Vijayachandra,** EX-MD, Ixora Biosciences, Bengaluru and Mentor Professor Email: vijaychandra07@gmail.com						
Job Opportunities: Pharma industries and CRO's									

Course objectives:

1. Understand the drug development process both conventional and emerging systems approach
2. Understand the challenges in drug development
3. Understand the significance of translational medicine in drug development
4. Understand the risk and strategy in drug development
5. Understand the studies required to bring a Lead/discovered compound from target identification through preclinical development

Expected Course Outcomes:

CO1	Critically evaluate the drug discovery pipeline	**K1, K2**
CO2	Applying bioinformatics and omics concepts in the drug discovery	**K2, K3**
CO3	Updating the importance of high-throughput-screening in the drug discovery	**K2, K3**
CO4	Understanding the drug safety assessment process	**K3, K4,**
CO5	Studying how drugs are evaluated in pre-clinical trials	**K5, K6**
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Course Content	**Lecture / Practical / Internship**
Module 1 **5 hours**	Introduction to drug discovery 1. History of drug discovery 2. Roles of natural chemistry, synthetic chemistry, and biology in drug discovery 3. Evolution of pharmaceutical/biotech industry
Module 2 **5 hours**	Drug discovery process 1. Target identification 2. Drug screening assays, lead identification 3. Preclinical development 4. Clinical development
Module 3 **5 hours**	Drug Targets 1. G-protein coupled receptors 2. Kinases 3. Proteases 4. Ion channels 5. Undruggable protein targets

Module 4 **5 hours**	Preclinical models for drug discovery 1. Development of preclinical models, transgenic mouse models, knockout mouse models 2. Preclinical models of cancer 3. Preclinical models of neurodegenerative diseases, infectious diseases, metabolic diseases and cardiovascular diseases
Module 5 **5 hours**	Biological drugs 1. Protein and antibody drugs, CHO cell expression system 2. DNA-based therapeutics, mRNA therapeutics 3. Gene therapy 4. Cell-based therapies 5. Vaccines
Module 6 **5 hours**	Emerging trends in drug discovery 1. Epigenetic drugs 2. Protein degraders (PROTACs) 3. Oncolytic viruses 4. Exosomes 5. Gene editing 6. Microbiome 7. SARS-CoV-2 drug targets, preclinical models, drugs, and vaccines
Module 7 **5 hours**	Case studies 1. Drug discovery in academia 2. Drug discovery in pharmaceutical/biotech industry
Module 8 **10 hours**	Student Presentations and discussion on career in drug discovery industry
Total – 45 hours	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

Book(s) for Study:

1. Drugs-From Discovery to Approval, Second Edition by Rick Ng. Wiley-Blackwell, 2009
2. Optimizing the "Drug-Like" Properties of Leads in Drug Discovery by Borchardt, R., Kerns, E., Hageman, M., Thakker, D., Stevens, J. (Eds.), Springer Publishers, 2006
3. Hit and Lead Profiling: Identification and Optimization of Drug-like Molecules: 43 (Methods & Principles in Medicinal Chemistry), Bernard F., and Laszlo U. (Eds.), 2009
4. Systems Biology in Drug Discovery and Development, by Daniel L.Y, Seth M, Wiley Publisher, 2011

Book(s) for Reference:

1. Preclinical Drug Development, by Mark R., David R.T., (Eds.), CRC Press, 2010
2. Systems Biology in Drug Discovery and Development by Yan Q., (Ed.), Springer Publishers 2010
3. Drug Discovery and Development E-Book: Technology in Transition, by Raymond G.H, Duncan R (Eds.), Elsevier Press, 2021

Related online contents:

1. https://journals.sagepub.com/doi/abs/10.1177/24725552211000669
2. https://wyss.harvard.edu/technology/using-systems-biology-to-find-and-test-new-drugs-faster/
3. https://www.nature.com/nrd/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6237143/
5. https://www.nature.com/articles/nj6921-456a
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3058157/
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5443413/
8. https://www.tandfonline.com/doi/full/10.3109/10717544.2016.1170247
9. https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-018-0804-2
10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2782548/
11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7396720/

Course handled by Dept. of Biotechnology with Industry	**Dr. R. Sathishkumar,** Professor with Industry Partner

SEMESTER FOUR

Bioethics, Biosafety and IPR

Credits 4

Marks: 100

Course Code	24MB1C16	Course Type	Core 16	L	T	P	C	Syllabus version	2024-2025
				3	1	-	4		
Pre-requisite	A Basic knowledge on intellectual property rights								

Course objectives:

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:

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 - Analyze; K5 - Evaluate; K6 - Create		

Unit I

Introduction to IPR

12 Lectures

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.; Review of Government of India's "National Intellectual Property Rights Policy".

Unit II

Patenting

12 Lectures

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, 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; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.
Unit III **Biosafety** **12 Lectures**	Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.
Unit IV	International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents,

National and International regulations **12 Lectures**	regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).
Unit V **Bioethics** **12 Lectures**	Introduction, ethical conflicts in biological sciences - interference with nature, 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, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.
Contemporary issues **5 Lectures**	Guest lectures by academic/industry experts , online seminars - webinars
Total Lectures – 65	

Mapping with Programme Outcomes

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

Recommended Textbooks and References:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences
7. Case Studies of Policy Challenges from New Technologies, MIT Press
8. World Trade Organisation. http://www.wto.org
9. World Intellectual Property Organisation. http://www.wipo.int
10. International Union for the Protection of New Varieties of Plants. http://www.upov.int
11. National Portal of India. http://www.archive.india.gov.in
12. National Biodiversity Authority. http://www.nbaindia.org
13. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
14. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
15. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3)853-880. doi:10.1007/s10681-007-9643-8
16. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.

17. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris. nic.in/guidelines1.asp

19. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments. Retrieved from http://biosafety.icgeb.org/inhousepublications/ collection biosafety reviews.

Related online contents:

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

Course adapted from DBT and handled by Dept. of Biotechnology	**Dr. S. R. Prabagaran, Professor and Dr. M. A. Shibu, Assistant Professor (DBT-RLS)**

SEMESTER FOUR

Training in Sophisticated Instruments

Credits 2

Marks 50

Course Code	24MB1VO2	Course Type	Value added Course 2	L	T	P	C	Syllabus version	2024-2025
				-	-	2	2		
Pre-requisite	Basic instrumentation								

Name of the Department	Department of Biotechnology
Name of the Faculty Member	All faculty
Collaboration if any with Companies	Relevant industry partners
Job Opportunities: Academic and research laboratories, Pharmaceutical and Biotechnology industries	
The **objectives of this course are,**	
1	To impart hands on skill sets in the advanced instrumentations
2	To operate the instrument
3	To interpret the obtained data
Course Content	Offline

Hands on training in,

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

Handled by all the faculty, Dept. of Biotechnology and Central Instrumentation Centre, BU