Annexure 8.1

Avinashilingam Institute for Home Science and Higher Education for Women

Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD (now MoE)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Department of Biochemistry, Biotechnology and Bioinformatics

M.Sc. BIOCHEMISTRY

Two years programme (with practical)

Programme Outcomes (PO)

On successful completion of M.Sc. Biochemistry programme, students will be able to

1. Gain fundamental and comprehensive knowledge in specific domain with interdisciplinary perspectives
2. Analyze and interpret data obtained from biological experiments done in practical courses and research projects following Good Laboratory Practices
3. Employ acquired scientific concepts and skills to identify and analyze complex problems by devising suitable protocols, using technical tools and software to achieve valid conclusions
4. Formulate and design appropriate technology-based solutions to tackle academic and industrial challenges and exhibit organizational skills for execution of need-based novel projects
5. Apply critical thinking and integrate innovative solutions from any relevant discipline to overcome local and global problems
6. Develop entrepreneurial skills by facilitating technology transfer and nurture Biopreneurs for sustainable development

Programme Specific Outcomes (PSO)

The M.Sc. Biochemistry programme will enable the students to

1. Enhance knowledge with fundamentals and emerging concepts of Biochemistry, to apply the acquired skills to undertake a successful career
2. Obtain hands-on training in basic and modern laboratory techniques, internships in research institutes and industries to develop entrepreneurial skills in multi-disciplinary fields
3. Understand the importance of bioethics, biosafety and IPR and translate experimental knowledge acquired to design innovative research proposals through mini-projects and dissertations to address societal and community needs.

1.8 Syllabus

M.Sc. Biochemistry
Scheme of instruction and Examinations
(For students admitted from 2025-2026 & onwards)

Part	Subject Code	Name of Paper / Component	Hours of Instruction / Week		Scheme of Examination				
			Theory	Practical	Duration of exam	CIA	CE	Total	Credit
First Semester									
I	25MBCC01	Biomolecules and Bioanalytical Tools	3	–	3	40	60	100	3
I	25MBCC02	Cell Biology, Membrane and Neuronal Biochemistry	3	–	3	40	60	100	3
I	25MBCC03	Bioenergetics and Intermediary Metabolism	3	–	3	40	60	100	3
I	25MBCC04	Microbial Biochemistry and Fermentation Technology	3	–	3	40	60	100	3
I	25MBCC05	Human Physiology and Nutritional Biochemistry	3	–	3	40	60	100	3
I	25MBCC06	Practical I – Analytical and Nutritional Biochemistry	–	6	6	40	60	100	3
I	25MBCC07	Practical II – Cell Biology and Microbial Techniques	–	6	6	40	60	100	3
II		CSS/Adult Education/ Community Engagement and Social Responsibility	2	–	–	–	–	–	–
		Library	1	–	–	–	–	–	–
Second Semester									
I	25MBCC08	Genetics and Molecular Biology	3	–	3	40	60	100	3
I	25MBCC09	Pharmaceutical and Endocrinal Biochemistry	3	–	3	40	60	100	3
I	25MBCC10	Genetic Engineering, Bioethics, Biosafety and IPR	3	–	3	40	60	100	3
I	25MBCC11	Enzymology and Immunology	3	–	3	40	60	100	3
I	25MBCC12	Practical III - Enzymology and Immunology	–	6	6	40	60	100	3
I	25MBCC13	Practical IV Molecular Biology	–	6	6	40	60	100	3
II		Interdisciplinary course	4	–	3	100	–	100	4
II		Professional Certification Course	–	–	–	–	–	–	2
II	23MXCSS1/ 23MXAED1/ 23MXCSR1	CSS/Adult Education / Community Engagement and Social Responsibility	2	–	2	–	–	100	2
Internship during Summer vacation for one month									

Part	Subject Code	Name of Paper/Component	Hours of Instruction / Week		Scheme of Examination				
			Theory	Practical	Duration of exam	CIA	CE	Total	Credit
Third Semester									
I	25MBCC14	Computational Biology and Artificial Intelligence	3	–	3	40	60	100	3
I	25MBCC15	Clinical Biochemistry and Molecular Diagnostics	3	–	3	40	60	100	3
I	25MBCC16	Physiology, Biochemistry and Biotechnology of Plants	3	–	3	40	60	100	3
I	25MBCC17	Biostatistics and Research Methodology	3	–	3	40	60	100	3
I	25MBCC18	Genomics, Proteomics and Big Data	3	–	–	40	60	100	3
I	25MBCC19	Practical V – Clinical Biochemistry and Computational Biology	–	6	6	40	60	100	3
I	25MBCC20	Practical - VI Tissue Culture and Big Data Analysis	–	6	6	40	60	100	3
I	25MBCC21	Environmental Sustainability and Climate Change (**Self Study**)	2*	–	3	40	60	100	2
I	25MBCC22	Mini Project	1*	–	–	100	-	100	2
I	25MBCC23	Internship	–	–	–	–	–	100	2
II		Multidisciplinary Course	2	–	3	100	–	100	2
Fourth Semester									
I	25MBCC24	Research Project / Thesis / Patent	–	30	–	100	100	200	20
		Total							96

- **1 hour – Out of class hours**

Minimum 96 + 2 credits to earn the degree

Other Course to be undergone by the students

MOOC Course (Any Semester before 4th Semester) - 2 to 4 Credits Credit transfer may be claimed.

Students who exit at the end of 1st year shall be awarded a **Postgraduate Diploma**.

Other courses offered by the Department:

Inter Disciplinary Course

25MBCI01 – Natural Antioxidants in Human Health and Diseases

Multi-Disciplinary Course

25MBCM01 – Home Remedies for Common Ailments

Professional Certificate Course

25MBCPC1 - Medical Coding

Biomolecules and Bioanalytical Tools

Semester I
25MBCC01

Hours of instruction/week: 3
No. of credits: 3

Objectives:

- To gain knowledge on the structure prediction and interaction of macromolecules.
- To enable students to understand the basic principles and applications of biochemical techniques
- To provide a strong theoretical base for employability of students in industries and research

Unit I Carbohydrates and Lipids **9 hrs**

Carbohydrates: The various building blocks (monosaccharides), configurations and conformations of the building blocks; formations of polysaccharides and structural diversity due to the different types of linkages.

Lipids: definition, classification of lipids on backbone structure. Structure and biological importance of glycosaminoglycans. Structure of fat- and water-soluble vitamins.

Selfstudy: Glyco-conjugates: various types of glycolipids and glycoproteins, lipoproteins.

Unit II Nucleic acids and Proteins **9 hrs**

Nucleic acids – Structure of bases and nucleotides. Level of organization. Types of base pairing in DNA and RNA. Watson- Crick and Hoogsteen; types of double helices (A, B, Z), triple and quadruple stranded DNA structures

Proteins – structure and classification of amino acids, level of organization. Motifs and domains. Conformational properties of proteins.

Protein folding - fundamental principles, methods to study protein folding – phi, psi and omega angles.

Ramachandran plot. Factors determining protein folds – helices, strands, turns, loops, disulfide linkages. Mechanism of protein folding, role of chaperons, factors determining protein stability.

Molecular interactions – protein-protein, protein-DNA, DNA-drug, protein-lipid, protein- ligand, protein-carbohydrate. Metal coordination in metalloproteins, inter- and intra- molecular interaction

Selfstudy: Water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis

Unit III Centrifugation and Electrophoresis **9 hrs**

Centrifuges – principle, types and application. Density gradient centrifugation, analytical and preparative ultracentrifugation. Applications of ultracentrifuge- separation of cell organelles.

Electrophoresis–principles, types and their applications for proteins, nucleic acids including gradient gel and pulse- field gel electrophoresis – agarose gel electrophoresis,

PAGE, 2D-PAGE – capillary electrophoresis and immune electrophoresis –EMSA.

Self study: Native page, Isoelectric focusing, PFGE

Unit IV Chromatography and Spectroscopy **9 hrs**

Chromatography–principle, methodology and applications of paper, thin layer, column (gel filtration, ion exchange, affinity), HPLC HPTLC and Gas chromatography, GC-MS, FPLC

Spectroscopy - Principle, Beer and Lamberts Law, regions of electromagnetic spectrum. Atomic

Spectroscopy - Principle, Beer and Lamberts Law, regions of electromagnetic spectrum. Atomic Absorption and UV-visible spectroscopy- principle, instrumentation and applications, FT-IR, NMR, ESR. MS and LC-MS Spectroscopy– Principle, Instrumentation and applications. Raman Spectroscopy, Flame Photometry.- Principles, method, applications with reference to biological macromolecules such as proteins and nucleic acids.

Self Study: Adsorption chromatography, Fluorimetry, COSY, NOSY and ROSY techniques

Unit V Microscopy and Radioisotopes **9hrs**

Microscopy – Principle, light, bright field, phase contrast, fluorescent microscopy, confocal microscopy. Electron microscopy- principle, instrumentation and applications of SEM and TEM.

X-rays - Introduction, production and properties of X-ray. X-ray diffraction, X-ray fluorescence, detection and applications

Radioisotope techniques- nature of radioactivity, measurement of radioactivity, Applications of radioactive and stable isotopes in biological research. Autoradiography

Self Study: super resolution microscopy, Radiation health hazards, FISH, ELISA

Total 45 hours

Text Books

1. **Negi A. S. and Anand, C. S.**(2023). **A Textbook of Physical Chemistry**, 3rd Edition New age international (p) ltd
2. **Nelson, D.L. and Cox, M.M.** (2021). **Lehninger's Principles of Biochemistry**, 8th Edition W.H. Freeman Publishers, New York.
3. **Wilson, K. and Walker, J.** (2018). **Practical Biochemistry – Principles and Techniques**, 8th edition, Cambridge University Press, India

References

1. **Upadhyay, A.** (2020). **Biophysical Chemistry**, Himalaya Publishing House Pvt. Ltd.
2. **Katoch, R.** (2011). **Analytical Techniques in Biochemistry and Molecular Biology**, Springer Science
3. **Bertozzi, C., Schwartz, J. and Ting, A.** (2021). **Biophysical Techniques,** 2nd edition.

Course Outcomes: After completing this course, the student will be able to

1. Define the structure of carbohydrate, lipids and its importance
2. Realize the structure of nucleic acids, proteins and its importance
3. Apply the principle, operation, and applications of various techniques for analyzingbiomolecules.
4. Analyse the microscopic and radioisotope techniques for their research work.
5. Design and interpret the results of analytical techniques

Mapping of COs with POs &PSOs

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO 1	H	M					H	M	M
CO 2	H	M					H	M	M
CO 3	H	H	H	M	H	H	H	H	H
CO 4	H	H	M	H	H		H	H	M
CO 5	M	M	M	M	H	H	H	H	H

Course Outcomes; PO-Programme Outcomes; PSO-Programme Specific Outcomes
H:High M:Medium L:Low

Cell Biology, Membrane and Neuronal Biochemistry

Semester I
25MBCC02
Hour of instruction/week: 3
No. of credits: 3

Objectives

- To understand the ultrastructure organization, function of cellular organelles, cellular communication and membrane transport
- To explore the molecular structure of biological membranes and the biochemical principles underlying membrane transport, receptor function, and membrane-related signalling.
- To understand the processes of neuronal development, to explore the role of neurotransmitters, secondary messengers, and neuropeptides in neuronal signalling and brain function.

Unit I Cell Structure and Organization **9hrs**

Cell and subcellular organization- Ultra structure of prokaryotic and eukaryotic cells. Subcellular organelles-mitochondria, ribosomes, ER, lysosomes, Golgi, peroxisomes, nucleus, chloroplast.Cytoskeleton- actin and myosin – intermediary filament, microtubules. Organization of genes and chromosomes, Fundamental processes of DNA. Cell signaling pathways- Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two- component systems. Cancer biology.

Self-study: variation in cell differentiation and progression.

Unit II Membrane Structure and Transport **9hrs**

Membrane structure- Models- membrane rafts. Membrane transport- types. Diffusion (passive, facilitated) Active ion pumps, channels, ionophores, aquaporins- transport of water, Transport of glucose, aminoacids, exocytosis, endocytosis. Cell cycle- phases, regulation, cell death- apoptosis, necrosis, autophagy.

Self-study: cell division- mitosis and meiosis.

UNIT III Neurobiochemistry **9hrs**

Developmental Neurobiology: Organogenesis and Neuronal Multiplication; Axonal and Dendritic Growth; Glial Multiplication and Myelination; Growth in Size, Regeneration, and Repair Mechanisms; Plasticity in the Nervous System. Neuromorphology and Neurocellular Anatomy:Central Nervous System (CNS) and Peripheral Nervous System (PNS); Autonomous Nervous System (ANS) and Somatic Nervous System: Structure and Functions of Dendrites, Axons, and Neurofilaments, Sensory Receptors and Effector Endings. Peripheral Nerves and Spinal/Cranial Nerves: Plexuses, Ganglia, Afferent Pathways, and Sense Organs.

Self-study: Spinal Cord Anatomy: Topographical Anatomy, Spinal Nerves, Grey and White Matter

Unit IV: Synaptic Transmission and Cellular Signalling **9 hrs**

Acetylcholine: Chemistry, synthesis, storage and release. Nicotinic and muscarinic receptors. Catecholamine: Biosynthesis, storage and release. Dopamine, adrenergic receptors. Serotonin: Synthesis, action and distribution; Role of serotonin receptors in behavior.

Self study: Excitatory amino acid transmitters: Synthesis, metabolism, distribution and receptor subtypes

UNIT V: Neurochemical Mechanisms and Disorders **9hrs**

Neurochemical and molecular mechanisms of peripheral Neuropathy; Diseases involving myelin. Multiple sclerosis and other demyelinated disorders Genetic disorders of Lipid, glycoprotein, and Mucopolysaccharide metabolism Molecular and genetic aspects and diagnostic characteristics of Duchenne Muscular dystrophy. Nutritional and metabolic Diseases: Disorders of amino acid metabolism. Wernicke-Korsakoft syndrome, Pellagra, Alcoholic Cerebellar Degeneration. Metabolic Encephalopathies and Coma. Neurotransmitters and disorders of basal ganglia. Molecular targets of abused drugs.

Self study: Ischemia and hypoxia. Epileptic seizures

Total 45 hours

Text Books:

1. **Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D.Johnson, Julian Lewis, Martin Raff, Keith Roberts. and Peter Walter.** (2014). **Essential Cell Biology**, 4th Edition, W.W. Norton and Company, New York, NY.
2. **Siegel, Brady, Albers. and Price.** (ed) (2011). **Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology**. Academic Press Inc; 8th edition (14 December 2011)

References:

1. **Tripurari Mishra. and Singh, B.D.** (2020). **Cell Biology**, 1st Edition, Mahaveer Publications, India.
2. **Gerald Karp, Janet Iwasa. and Wallace Marshall.** (2018). **Karp's Cell Biology**, 8th Edition, John Wiley and Sons, Inc, Newyork
3. **Deepak Sharma, Sangeeta Singh. and Rameshwar Singh.** (2021). **Textbook of Neurobiology**. Dream tech Press; Wiley India.

Course Outcomes: After completing this course, the student will:

1. Differentiate between prokaryotic and eukaryotic cell organization and its cellular components.
2. Comprehend the role of different cellular components involved in membrane structure, transport, and events in a cell's life cycle, cell division and cell death.
3. Understand the microbial diversity.
4. Recognize the bacterial growth and metabolism.
5. Establish the role of microbial world in genetic recombination.

Mapping of COs with POs & PSOs

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO 1	PSO 2	PSO3
CO 1	H		L	M	L	L	H	H	H
CO 2	H		L	M	L	L	H		M
CO 3	H		L	M	L	L		M	
CO 4	H		L	M	L	L	M		H
CO 5	H		L	M	L	M		H	

CO-Course Outcomes; PO-Program Outcomes; PSO-Program Specific Outcomes
H: High M:Medium L:Low

Bioenergetics and Intermediary Metabolism

Semester I
25MBCC03 **Hours of instruction/week: 3**
Objectives: **No. of credits: 3**

1. To understand the metabolic pathways
2. To gain in-depth knowledge about regulatory aspects
3. To learn the principles of bioenergetics

Unit I Bioenergetics and Electron Transport Chain **9hrs**

Bioenergetics-Concept of free energy, standard free energy. Relationship between standard free energy change and equilibrium constant. High energy compounds. Biological oxidation.
Mitochondrial Electron Transport Chain and Oxidative Phosphorylation: Mitochondrial Transport Systems; organization of the components of electron transport chain; electron flow from NADH and $FADH_2$ to O_2; sites of ATP production; inhibitors of electron transport chain; Coupling between oxidation and phosphorylation; Chemiosmotic hypothesis of oxidative phosphorylation; Mechanism of ATP synthesis: Structure of proton translocating ATP synthase; Binding Change Mechanism for proton-driven ATP synthesis; Uncoupling of oxidative phosphorylation
Self Study: Control of oxidative phosphorylation

Unit II Carbohydrate Metabolism **9hrs**

Reactions, energetic and regulation of Glycolysis, TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis. Reciprocal regulation of Glycolysis and Gluconeogenesis. Regulation of Pyruvate dehydrogenase and TCA cycle, anaplerotic reactions, Cori cycle, Biosynthesis of lactose and sucrose.
Glycoproteins, biosynthesis of N-linked and O-linked Oligosaccharides, Glycosaminoglycans, Microbial cell wall polysaccharides.
Self Study:Glyoxalate cycle, HMP shunt pathway and uronic acid pathway

Unit III Lipid Metabolism **9hrs**

Synthesis of Fatty acids - saturated and unsaturated, synthesis of essential fatty acids. Fatty acid oxidation – α, β and ω types, odd carbon and unsaturated fatty acids, Ketone bodies formation. Biosynthesis and degradation of triglycerides, phospholipids, glycolipids Metabolism of Cholesterol and its regulation. Metabolism of plasma lipoproteins, ethanol, isoprenoids, eicosanoids-prostanoids, thromboxanes and leukotrienes. Biochemical role of eicosanoids.
Self Study: Structure, classification and functions of lipids and fattyacids.

Unit IV Metabolism of Proteins and Aminoacids **9hrs**

General breakdown of proteins, deamination, transamination and urea cycle.Metabolism of Glycine, Phenylalanine, Tyrosine and Tryptophan.
Biosynthesis of catecholamines. Specialized products of amino acids (Glycine, Tyrosine and Tryptophan), Metabolism of one carbon compounds
Decarboxylation reactions and biogenic amines – Histamine, GABA and polyamines.
Self Study: Integration of Metabolism, metabolic profile of liver, Adipose tissue and brain. Altered metabolism in starvation.

Unit V Metabolism of Nucleic Acids **9hrs**

Biosynthesis and degradation of purine and pyrimidine nucleotides – conversion of

mononucleotides to di and tri nucleotides- De novo and salvage pathways. Role of nucleotide reductase. Degradation of purine and pyrimidine nucleotides. Disorders of nucleic acid metabolism

Self Study: Structure and properties of nucleic acids

Total 45 hours

Text Books:

1. **Nelson, D.L. and Cox, M.M.** (2020). **Lehninger Principles of Biochemistry**, 7th Ed, W.H.Freeman and Company, New York
2. **Murray, K.R., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, W.V. and Weil, P.A.** (2018). **Harper's Illustrated Biochemistry,** 30th Ed, The McGraw-Hill Companies
3. **Voet, D. and Voet, G.** (2012). **Fundamentals of Biochemistry**, John Wiley and Sons, New York.

References:

1. **Zubay, G. L.** (2017). **Principles of Biochemistry**, 5th edition, William C. Brown Publications.
2. **Bery, J.M., Tymoezko, J.L. and Stryer, L.** (2008). **Biochemistry,** 6th Ed, W.H. Freeman and Company, New York
3. **Devlin, T.M.** (2002). **Textbook of Biochemistry with Clinical correlations**, 5th edition, John Wiley and Sons Inc, Publications.

Course Outcomes: After completing this course, the student will be able to:

1. Describe the biosynthetic and oxidative process of carbohydrate metabolism and its regulation.
2. Recognize the metabolism and regulation of lipid
3. Correlate the metabolism of protein and amino acids and their specialized products.
4. Integrate the biosynthesis and degradative pathways of nucleic acids and their disorders.
5. Gain basic knowledge about the bioenergetics and Oxidative phosphorylation

Mapping of COs with POs & PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO3
CO 1	H		L				H	H	H
CO 2	H		L				H		M
CO 3	H		L	M	L	L		M	
CO 4	H		H	M	M	L	M		H
CO 5	H		H	H	H	M		H	

CO-Course Outcomes; PO-Program Outcomes; PSO-Program Specific Outcomes H: High M:Medium L:Low

Microbial Biochemistry and Fermentation Technology

Semester I
25MBCC04
Hours of instruction/week: 3
No. of credits: 3

Objectives:

1. To understand the basic concepts involved in microbial taxonomy, growth, nutrition, physiology and metabolism
2. To learn the role of microbial world in genetic recombination
3. To understand the large-scale production of commercially important products and enhance employability in industries.

Unit I Microbial Taxonomy **9hrs**

Scope, relevance, discovery and origin of microbial world, theories spontaneous generation and conflict, germ theory of diseases. Interaction of light with objects. Microscopy and applications. Types and applications of microscopy, Bright field, Dark field, Fluorescence, Phase contrast, Confocal microscopy, Scanning and Transmission electron microscopy. Classification of bacteria, algae and fungi. Discovery, classification and structure of viruses, DNA viruses; RNA viruses; Replication; Viroids and Prions.
Self study: Microbial nutrition

Unit II Host- Microbe Interactions **9hrs**

Microbial ecology, molecular plant microbe interaction, molecular biology of disease resistance, gene-for-gene interaction, plant chemicals and defense pathways. Biological control of microbes. Plant growth-promoting rhizobacteria and their mechanisms for growth promotion and antagonism. Microbial transformation. Carbon, Nitrogen, Phosphorous and Sulphur cycles
Self-study: Genetic recombination – Transformation, Transduction and Conjugation.

Unit-III Microbial Diseases **9hrs**

Normal microflora of skin, oral cavity, Gastrointestinal tract; Entry of pathogens into the host; colonization and factors predisposing to infections; types of toxins and their structure; Mode of actions; Virulence and Pathogenesis. Disease reservoirs; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals, insects and ticks, food and water borne diseases; Pathogenic fungi; Emerging and resurgent infectious diseases.
Self-study: Corona Virus – pathogenesis and diagnosis

Unit IV Basic principles in Fermentation technology **9 hrs**

Growth kinetics – Batch, Fed-batch and continuous culture, solid state and submerged fermentors. Screening of industrially important microbes-Isolation, preservation and improvement of strains for increased yield-primary metabolites and secondary metabolites. Media formulation and sterilization. Bioreactors: dynamics and stability – ideal bioreactors, types of reactors: CSTR, Tower, Jet Loop, Air Lift, PFR, Bubble column, Packed bed.
Self study: Production of antibiotics – penicillin, streptomycin

Unit V Aeration, Agitation, Bioprocess variable control and downstream processing **9hrs**

Transport in cells, Transfer resistances and mass transfer coefficients-rate of oxygen transfer, Determination of oxygen transfers coefficients, heat transfer coefficients. Bioprocess control

and monitoring variables: temperature agitation. pressure. and pH. Online measurement.ON/OFF control, PID control- computers in bioprocess control systems. Downstream processing – Steps involved in harvesting cellular bioproducts

Self study: Chromatography techniques

Total 45 hours

Text Books:

1. **Tortora., G. J., Funke, B. R., Christine L. Case, C. L, Weber, D. and Bair. W.** III. (2018). **Microbiology: An Introduction**, 13th Edition, Addison-Wesley, Boston, IL.
2. **Willey, J., Sherwood, L., Christopher J. and Woolverton.** (2016). **Prescott's Microbiology**, 10th Edition, McGraw Hill, New York, NY.
3. **Stanburry, P.F., Whitaker, A. and Hall, S.J.** (2018). **Principles of Fermentation Technology.**
4. **Doran, P**. (2005), **Bioprocess Engineering Principles**, Elsevier Publication, USA.
5. **Rana, Kumar, A.** (2018). **Downstream processing techniques in Biotechnology,** Global Academic Publishers

References:

1. **Mansi, E.M.T., Bryce, C.F.A., Demain, A.L. and Allman, A.R.** (2007). **Fermentation Microbiology and Biotechnology**, 2nd edition, Taylor and Francis.
2. **Doran Pauline M.** (2018). **Bioprocess Engineering Principles**, 2nd Ed., Elsevier

Course Outcomes: After completing this course, the student will:

1. Understand the microbial diversity.
2. Recognize the bacterial growth and metabolism.
3. Establish the role of microbial world in genetic recombination.
4. Elaborate the steps involved in large scale production of commercially important products
5. Compare the various processes involved in downstream processing and to know the significance of purified products.

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H		L	M	L	L	H	H	H
CO 2	H		L	M	L	L	H		M
CO 3	H		L	M	L	L		M	
CO 4	H		L	M	L	L	M		H
CO 5	H		L	M	L	M		H	

CO-Course Outcomes; PO-Program Outcomes; PSO-Program Specific Outcomes H: High M:Medium L:Low

Human Physiology and Nutritional Biochemistry

Semester I
25MBCC05 **Hours of instruction/week: 3**
Objectives: **No. of credits: 3**

1. To understand the physiological aspects of cardio-vascular and respiratory system in human
2. To gain knowledge of neuro-muscular and endocrinal physiology
3. To understand the concepts and applications of nutrition and their linkage with Biochemistry.

Unit I
Cardio-Vascular System and Respiratory system **9hrs**
Introduction to cardiovascular system Properties of cardiac muscle, Cardiac cycle, General principles of circulation, Regulation of cardiovascular system, Normal and abnormal Electrocardiogram (ECG), Cardiac output, Heart rate, Arterial blood pressure, Radial Pulse, Regional circulation- Cerebral, Splanchnic, Capillary, Cutaneous & skeletal muscle circulation, Physiological anatomy of respiratory tract, Mechanism of respiration: Ventilation, diffusion of gases, Transport of respiratory gases, Regulation of respiration Pulmonary Function Test, Artificial respiration,
Self-study: High altitude and space physiology, Deep sea physiology, Effects of exercise on respiration, Cardiovascular adjustments during exercise

Unit II Neuro-muscular and Endocrine system **9hrs**
Physiological properties of nerve fibres, Nerve fibre- types, classification, function, Structure and function of skeletal, cardiac, and smooth muscles, Mechanism of muscle contraction and excitation-contraction coupling
Neurons and Nerve Impulses: Structure of neurons, types, and functions. Mechanism of nerve impulse transmission, Synaptic Transmission: Synapse structure, types, and the process of synaptic transmission, Reflex Arc: Components and functioning of reflex arcs.
Hormones: Chemical nature and functions of hormones.
Endocrine Glands: Structure and function of pituitary, thyroid, parathyroid, adrenal glands, pancreas (Islets of Langerhans), testes, and ovaries.
Self-study: Hormonal Disorders: Hypo and hyperactivity disorders associated with each gland.

Unit III Digestive and Renal System **9hrs**
Introduction to digestive system, Composition and functions of digestive juices, Physiological anatomy of Stomach, Pancreas, Liver and Gall bladder, Small intestine, Large intestine, Movements of gastrointestinal tract, Gastrointestinal hormones, Digestion and absorption of carbohydrates, proteins and lipids
Physiological anatomy of kidneys and urinary tract, Fluid & electrolyte with acid base balance need to be include, Renal circulation, Urine formation: Renal clearance, glomerular filtration, tubular reabsorption, selective secretion, concentration of urine, acidification of urine.
Self-study: Renal functions tests, Micturition

Unit IV Assessment of Nutritional status **9hrs**
Fundamentals of human nutrition, concept of balanced diet, ICMR classification of five food groups and its significance food pyramid. Units of energy. Calorific and nutritive value of foods. Basal

metabolic rate (BMR) - definition, determination of BMR and factors affecting BMR. Respiratory quotient (RQ) of nutrients and factors affecting the RQ. SDA - definition and determination.- Anthropometric measurement and indices – Height, Weight, chest and waist circumference BMI. Effects of protein deficiency and excess protein intake. Evaluation of proteins by nitrogen balance method - Biological value of proteins - Digestibility coefficient, Biological value, Protein Energy Ratio and Net Protein Utilization

Self study: Malnutrition: Protein-calorie malnutrition (Marasmus), Protein malnutrition (Kwashiorkor) and their preventive and curative measures

Unit V Nutritional significance of Biomolecules **9hrs**

Nutritional Significance of carbohydrates, proteins and lipids. Recommended dietary allowances of nutrients for all age groups.

Minerals - sources, requirement, physiological function, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, chromium, Cobalt, copper, manganese, molybdenum, selenium, iodine and zinc. Vitamins - definition and types of vitamins, sources, requirement, biological functions, deficiency symptoms of thiamine, riboflavin, niacin, pyridoxine, panthothenic acid, folic acid, biotin, cyanocobalamine, vitamins C, A, D, E and K. Hypervitaminosis.

Self study: naturally occurring food toxicants, Protease inhibitors, hemagglutinins, glucosinolates, cyanogens, saponins, gossypol, lathyrogens, favism, allergens, carcinogens

Total 45 hours

Text Books:

1. **Sherman, J. and Luciano, D.** (2020). **Human Physiology**, 13th edition, McGraw Hill Publishing Company.
2. **Grabouski, T.** (2013). **Principles of Human Anatomy and Physiology**, 14th edition, John Wiley and Sons
3. **Srilakshmi, E.** (2017). **Nutrition Science**, New Age International Publishers.
4. **Gopalani, S.** (2008). **Diet and Nutrition**, Cyber Tech. Publication.
5. **Mahan, Kathleen, L.** (2004). **Krause's Food, Nutrition and Diet Therapy**, .W.B. Saunder's, 11th Edition.

References:

1. **Widmaier, E., Raff, H. and Strang, K**. (2008). **Vander's Human Physiology**, 11th edition, McGraw Hill Publishing Company
2. **Srilakshmi. E.** (2016). **Dietetics**, New Age International Publishers.
3. **Swaminathan, M.** (2010). **Essentials of Food and Nutrition**, Volume I and II Ganesh and Co., Madras.
4. **Gopalan, C., Ramasastry, B.V and Balasubramanian, S**. (2007. **Nutritive Value of Indian Foods**, National Institute of Nutrition, Hyderabad
5. **Rao, B. S., Deshpande, V** (2020). **Experimental Biochemistry – A Student Companion,** 1st Edition, Tech Sar Pvt Ltd

Course Outcomes: After completing this course, the student will:

1. Explain the physiological mechanisms of the cardiovascular and respiratory systems in maintaining homeostasis.
2. Describe the functions, and regulatory mechanisms of the neuro-muscular and endocrine systems in maintaining body homeostasis.
3. Explain the physiological aspects and regulatory mechanisms of the digestive and renal systems in nutrient processing and waste elimination.
4. Demonstrate knowledge of methods for assessing nutritional status

5. Explain the nutritional roles and significance of carbohydrates, proteins, lipids, vitamins, and minerals in human health.

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO3
CO 1	H		L	L	L	L	H	H	L
CO 2	H		L	M	L	L	H		L
CO 3	H		L	M	L	L	H	M	
CO 4	H	M	M	H	H	H	M	H	M
CO 5	H		L	M	M	M	H	H	

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes
H: High M: Medium L: Low

Practical I – Analytical and Nutritional Biochemistry

Semester I
25MBCC06

Hours of instruction/week: 6
No. of credits: 3

Objectives:

1. To inculcate a strong background and technical knowledge in clinical and nutritional biochemistry.
2. To give hands on training on clinical biochemistry techniques.
3. To give hands on training on nutritional biochemistry techniques.

Experiment

1. Buffer preparation, pKa value — **3 hrs**
2. Determination of pKa of weak acids and amino acids by pH metric titration. — **3 hrs**
3. Separation of polar and non polar lipids by TLC — **6 hrs**
4. Rf value calculation of various amino acids using Paper Chromatagraphy — **6 hrs**
5. Separation of plant pigments/ carotenoids by column chromatography — **6 hrs**
6. Separation of amino acids by ion exchange chromatography — **6 hrs**
7. Sub cellular fraction by centrifugation – Demo — **6 hrs**
8. Characterization of fats – estimation of saponification number, iodine number, acid number and R.M. Number — **12 hrs**
9. Spectrophotometry–Preparation of standard curves–linear regression – assessment of ranges and reliability — **2 hrs**
10. Estimation of inorganic phosphate by Fiske-Subbarao method. — **4 hrs**
11. Absorption spectra of proteins and nucleic acids and determination of molar extinction coefficient. — **6 hrs**
12. Estimation of reducing sugars (lactose in milk) by DNS method — **6 hrs**
13. Extraction and Estimation of Vitamin C in food sample — **6 hrs**
14. Extraction and estimation of vitamin A in serum and free amino acids in grean leafy vegetable — **6 hrs**
15. Anthropometric Measurements of Individuals and Calculate BMI — **6 hrs**
16. Extraction and estimation of thiamine and riboflavin in food samples using flourimetic method — **6 hrs**

Total 90 hours

References:

1. **Bairagee, D.** (2020). **Laboratory Manual in Biochemistry**, Notion Press ,India
2. **Jayaraman, J.** (2011). **Laboratory Manual in Biochemistry**, New Age International (P) Ltd.
3. **Gibson, R.S.** (2005). **Principles of nutritional assessment**, Oxford University Press.
4. **Charumathy Marimuthu** . (2023). **Practical Manual - Practical I Nutritional Biochemistry,** Published by Bodhivanam, Chennai
5. **Rao, B. S. and Deshpande, V.** (2020). **Experimental Biochemistry** – A Student Companion, First Edition, Tech Sar Pvt Ltd,

Course Outcomes: After completing this course, the student will:

1. Comprehend the concept of buffer preparation and pKa
2. Understand the basic concepts and principles of biochemical techniques namely Spectrophotometry, Fluorimetry, Chromatography and Centrifugation
3. Identify the components present in the food
4. Estimate different food components in food samples
5. Analyze the BMI through anthropometric Measurements

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M		H	H	
CO 2	H	H	H	M	M		H	H	
CO 3	H	H	H	M	M		H	H	
CO 4	H	H	H	M	M		H	H	
CO 5	H	H	H	M	M		H	H	

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes
H: High M: Medium L: Low

Practical II – Cell Biology and Microbial Techniques

Semester I **Hours of instruction/week: 6**
25MBCC07 **No. of credits: 3**

Objectives:

- To understand the basic techniques in cell biology, cell count determination and cell size determination
- To understand various methods involved in sterilization and preparation of media.
- To study the methods of isolation of microbes from various sources and their biochemical analysis.

	Experiment	
Cell Biology		
1	Use of simple, compound and phase-contrast microscopes	**3 hrs**
2	Squash stain – Observation of mitotic chromosomes in root tips and meiotic chromosomes in flower buds	**7 hrs**
3	Cell counting methods – use of hemocytometer – calibration of the ocular micrometer and measurement of average cell size and chromosome length	**5 hrs**
4	Chromosomal banding techniques	**5 hrs**
5	Identification of Barr body by buccal smear	**3 hrs**
6	Determination of total RBC count using Haemocytometry	**3 hrs**
7	Determination of total WBC count using Haemocytometry	**3 hrs**
Microbiology		
1	Principles and methods of sterilization	**5 hrs**
2	Staining Techniques- Gram, Acid fast, Negative, Simple, differential staining. Fungal staining- Spore and capsule staining	**10 hrs**
3	Preparation of media –Nutrient agar, Nutrient broth, plates, slants.	**5 hrs**
4	Isolation and enumeration of bacteria, fungi and algae by pure culture techniques from soil, water and air	**7 hrs**
5	Determination of viable count of yeasts – Haemocytometry	**5 hrs**
6	Identification of bacteria –IMViC Tests, catalase, oxidase, protease H_2S,	**10 hrs**
7	Determination of microbial growth –Turbidity method	**7 hrs**
8	Determination of antibiotic sensitivity of bacteria	**5 hrs**
9	Isolation of pathogenic bacteria using selective media	**7 hrs**
		Total: 90 hrs

References:

1. **Arora, B and Arora, D.R.** (2020). **Practical Microbiology**, 2nd Edition, CBS Publishers amd Distributors, India
2. **Jain, A., Agarwal, J. and Venkatesh, V.** (2018). **Microbiology Practical Manual,** 1st Edition, Elsevier India, New Delhi
3. **Cappuccino and Welsh,** (2018). **Microbiology A practical manual,** 11th Edition, Pearson Education Limited, Edinburg

Course Outcomes: After completing this course, the student will:

1. Attain skills of basic techniques such as cell counting, measuring cell size and chromosomal length.
2. Apply critical thinking and problem solving skills to understand the cell morphology.
3. Understand the concept of basic microbiology- Sterilization techniques.
4. Know about the isolation of microorganisms from various sources.
5. Discuss the staining techniques to study the morphology of microorganisms.

Mapping of COs with POs & PSOs

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO 1	PSO 2	PS O3
CO 1	H	H	M					H	H
CO 2	H	H	M	H	M		H		M
CO 3	H	H	M	H	M		M	M	
CO 4	H	H	M	H	M		M	H	H
CO 5	H	H	M	H	M		M		

CO-Course Outcomes; PO-Programme Outcomes;
PSO-Programme Specific Outcomes H:High M:Medium L:Low

Genetics and Molecular Biology

Semester II
25MBCC08

Hours of instruction/week: 3
No. of credits: 3

Objectives:

1. To understand the nature of the genetic material
2. To learn about the central dogma of molecular genetics and the details of the events – replication, transcription, and translation
3. To know about the expression of genes in prokaryotes and eukaryotes and the regulation of gene expression.

Unit I Mendelian and Non-Mendelian Inheritance **9 hrs**

Mendelian inheritance, Sex linked inheritance, interaction of gene and probability. Mendelism in human genetics: pedigree analysis, dosage compensation and sex determination, chromosome discovery, chromosomes as physical basis of inheritance, Chromosome structure – polytene and Lamp brush chromosomes. Types of chromosomes based on centromere position. Karyotyping non-Mendelian inheritance (episomes, mitochondria and chloroplasts), parental imprinting

Self Study: Life cycles of animals (Gametogenesis, Oogenesis and Spermatogenesis), plants (Diploid and Haploid life stages and Sexual reproduction in flowering plants) and fungi (Budding and Sexual Cycle).

Unit II Population Genetics **9 hrs**

Linkage, crossing over, and Chromosome mapping in eukaryotes
Gene pool, Gene frequency, Hardy Weinberg law, non random mating, factors influencing allele frequency, Heritability, Genetic variation at the molecular level, Polymorphism, Multiple alleles.,
Self Study: Legal and ethical issues in genetics

Unit III DNA Replication **9 hrs**

Structure, properties and functions of DNA (different forms of DNA) and RNA – types of RNA - The central dogma of molecular biology, E. coli chromosomes and plasmids. Role of nuclear matrix in chromosome organization, matrix binding proteins, DNA reassociation kinetics (Cot curve analysis), chromatin, epigenetics, nucleolus, DNA sequence elements – unique sequence and repetitive DNA. Nucleosome phasing
DNA replication in bacteria and eukaryotes, enzymes and proteins involved, mechanism. End replication problem, DNA damage, DNA repair mechanisms, Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination, Bacterial recombination– conjugation, transduction and transformation
Self Study: Inhibitors of DNA replication

Unit IV Transcription **9 hrs**

Transcription in E.coli – RNA polymerase, promoter, mechanism. Transcription in eukaryotes – RNA Pol I, II, III, structure. Transcription factors, Promoter. Mechanism of Transcription – pre-initiation complex formation, initiation, elongation, termination. Post-transcriptional processing of prokaryotic and eukaryotic mRNA. RNA editing.
Transposable elements, molecular basis of disease and epigenetics
Self study: Reverse transcription, transcriptional regulation

Unit V Genetic code and translation **9 hrs**

Genetic code – Universal and mitochondrial. Mutations- point and frame shift. Translation- AA activation, Initiation, elongation, and termination in prokaryotes and eukaryotes. Post translational modifications. Protein targeting, folding and degradation. Regulation of gene expression in prokaryotes. Lac and Trp operons. Regulation of gene expressions in eukaryotes by steroid hormones, alternative splicing, RNA interference. Proteolysis: ubiquitin-dependent proteolysis, the proteasome and other proteolytic pathways

Self study: Brief outline of epigenetic regulation- DNA methylation & imprinting, and histone modifications.

Total 45 hours

Text Books:

1. **James D. Watson, Tania A. Baker, and Stephen P. Bell.** (2023). **Molecular Biology of the Gene,** 8th Edition
2. **Benjamin A. Pierce**. (2020). **Genetics: A Conceptual Approach**, 7th Edition, Publisher: W.H. Freeman and Company, New York
3. **Jocelyn E. Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick**. (2017). **Lewin's GENES XII**, 12th Revised Edition, Publisher: Jones and Bartlett Publishers, Inc.
4. **William Klug, Michael Cummings, Charlotte Spencer, Michael Palladino, and David Killian.** (2020). **Concepts of Genetics,** 12th Edition, Pearson Higher Education and Professional Group

References:

1. **David L. Nelson and Michael M. Cox.** (2021). **Lehninger Principles of Biochemistry** , 8th Edition, Publisher: Worth Publishers, New York
2. **Daniel L. Hartl and Elizabeth W. Jones.** (2019). **Genetics: Analysis of Genes and Genomes**, 9th Edition, Publisher: Jones and Bartlett Publishers, Inc.
3. **Gupta, P.K.** (2018). **Genetics**, 5th Edition, Publisher: Rastogi Publications, Meerut, India
4. **Scott F. Gilbert.** (2023). **Developmental Biology**, 13th Edition, Publisher: Sinauer Associates Inc.
5. **Ricki Lewis.** (2023),**Human Genetics: Concepts and Applications**, 14th Edition, Publisher: McGraw-Hill Education

Course Outcomes: After completing this course, the student will:

1. Explain the laws of inheritance and the nature of the hereditary material at the cell, individual and population levels
2. Understand the role of genetic mechanisms in evolution diploid and haploid life stages, sexual reproduction and human genetics.
3. Predict changes in population and distinguish genetic polymorphism and know the legal issues in genetics, professional ethics and behavior.
4. Acquire in-depth knowledge on the central dogma of molecular biology and provide possible translational opportunities for healthcare and industrial applications.
5. Explore the regulation of genomes and associated challenges in dealing with human diseases

Mapping of COs with POs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	M			H	H	H
CO 2	H	H		L					
CO 3		H	M	H	H		H	H	
CO 4		H	M	H	H	M		M	H
CO 5			M	M	H		H		H

CO-Course Outcomes; PO-Program Outcomes;
PSO- Programme Specific Outcome H:High M:Medium L:Low

Pharmaceutical and Endocrinal Biochemistry

Semester II
25MBCC09

Hours of instruction/week: 3
No. of credits: 3

Objective:

1. To understand the nature of drugs used and its importance.
2. To gain knowledge about the mechanism of action and metabolism of drugs.
3. To help the students to understand the groups of hormones and their mode of action, metabolism and the disorders associated with it.

Unit I

Introduction to Pharmacology **9 hrs**

Classification of drug, sources, nature and nomenclature of drug, schedule of drugs, dosage forms and routes of drug administration.

Absorption, distribution, Metabolism and elimination of drugs - Absorption – Drug absorption across biological membranes-active transport of drugs bio pharmaceutical factors influencing drug absorption – effects of surface active agents on drug absorption. Distribution of drugs and biological action - Pathways of metabolism - drug biotransformation pathways - Detoxification of xenobiotics – cytochrome p450 enzymes - pesticides and cyanides. Drug Dependence – Drug abuse and addiction. Drug withdrawal reactions.

Drug-resistance: Effect and methods to overcome the usage and resistivity

Self Study: Adverse drug reactions and drug interactions.

Unit II Mechanism of action and Toxicity of Drugs **9hrs**

Receptor theory of drug action, non-receptor theory of drug action, Mechanism of action of drugs- Penicillin, sulfonamides and antimalarial drugs- Chloroquine, analgesics and anti-inflammatory. Biochemical basis of toxicity – mechanism of toxicity, genotoxicity – dose – response relationship – determination of ED50 and LD50. Acute and chronic toxicity. Teratogenicity, Carcinogenicity, Mutagenicity. Drug induced Diseases. Overview of the list of banned drugs in India and WHO recommendations.

Self Study: Detoxification of carcinogens/mutagens, Factors influencing toxicity,

Unit III Introduction to Hormones **9hrs**

Definition of hormone, Classification based on secreting glands, solubility and chemical nature. General mechanism of action of Group I and Group II hormones; Role of second messengers- cAMP, cGMP, inositol phospholipids, receptor tyrosine kinase, calcium and others. Regulation of hormone action. Cell signalling and regulation in health and disease.

Self Study: Basic characteristics of cell signalling-autocrine, paracrine, endocrine and juxtracrine

Unit IV Biochemical action of Group I hormones **9hrs**

Chemistry, biosynthesis, secretion, biochemical actions and disorders of the hormones of thyroid glands, adrenal cortex, ovary and testes.

Self Study: Diseases associated with gonadal hormones

Unit V Biochemical action of Group II hormones **9 hrs**

Chemistry, biosynthesis, secretion, biochemical actions of the hormones of hypothalamus, anterior, posterior pituitary, parathyroid, pancreas, adrenal medulla. Pineal hormones – Melatonin and serotonin

Self Study: Gastrointestinal tract hormones- leptin, ghrelin and resistin

Total hours 45

Text Books

1. **De, A.K.** (2020). **'Environmental Chemistry'** 8th edition, New age international (p) Ltd. Publishers, New Delhi.
2. **Nirmala, N., Rege, R.S., Santoskar, S.D. and Bhandarkar.** (2011). **Pharmacology and Pharmacotherapeutics**, 23rd edition, CBS Publishers and Distributors Pvt. Ltd.
3. **Sharma, P.D.** (2012). **'Toxicology'**, 3rd edition, Rastogi publications, Meerut.
4. **References:**
5. **Tripathi, K.D.** (2013). **'Essentials of Medical Pharmacology'** 7th edition, Jaypee brothers, Medical publishers, New Delhi.
6. **Prakash and Lohar.** (2005). **Endocrinology: Hormones and Human health**, MJP Publishers.
7. **Hardley, E.Mc.** (2010). **Endocrinology**, 4th Edition, Prentice Hall.
8. **Harbans Lal.** (2019) **'Essentials of Pharmaceutical biochemistry including practical exercises'**.
9. **Charles P. Woodbury.** (2011). **'Biochemistry for the pharmaceutical sciences'**.

Course Outcomes: After completing this course, the student will:

1. Understand the ADME properties of drugs.
2. Obtain basic knowledge about mechanism of action of drugs in the cellular and molecular level.
3. Understand the basic concepts of action of hormones.
4. Will study the chemistry, synthesis, physiological and biochemical effects of group I hormones and the disorders related to hormone action
5. Will learn the chemistry, synthesis, physiological and biochemical effects of group II and gastrointestinal hormones

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PS O2	PS O3
CO 1	H	L	M	L			H		
CO 2	H	H	M	M	L		H		
CO 3	H	M	L	L				M	
CO 4	H		L	L	L		H		
CO 5	H		L	L	L		H		

CO – CourseOutcomes; PO – ProgrammeOutcomes:PSO- Programme Specific Outcomes; H - High; M - Medium; L – Low

Genetic Engineering, Bioethics, Biosafety and IPR

Semester II
25MBCC10
Hours of instruction/week: 3
No. of credits: 3

Objectives:

1. To understand the principles of recombinant DNA technology
2. To study the techniques and gene transfer methods of genetic engineering
3. To comprehend various aspects of biosafety regulations, IPR and bioethical concerns

Unit I Introduction to Gene Cloning

9 hrs

Gene cloning – Manipulation of purified DNA, DNA manipulative enzymes – nucleases, ligases, polymerases, topoisomerases, restriction enzymes – performing restriction digests, restriction mapping, ligation – joining DNA molecules together – random labelling, nick translation and end filling – importance of gene cloning.

Expression vectors - Plasmids – pBR322, pUC vectors, bacteriophages (M13 and λ), phagemids, cosmids, yeast vectors, YAC, BAC, Ti Plasmid, Ri Plasmid, Advanced vector: GATEWAY cloning vector.

Self study: Isolation and Purification of DNA – genomic DNA, Plasmid DNA and Plant genomic DNA, Viral vectors

Unit II Gene transfer methods

9 hrs

Identification and expression of cloned genes Biolistics, electroporation, microinjection, liposome, calcium phosphate method, *Agrobacterium* mediated gene transfer, Viral mediated gene Transfer – Transgenic plants. Studying gene and genome structure, construction of libraries, blotting techniques, *in situ* hybridization, DNA sequencing, chromosome walking and jumping, DNA foot printing, DNA finger printing, RFLP, RAPD, HRT and HART,

Self study: His tag proteins, PCR and its applications

Unit III Applications of Genetic Engineering

9hrs

Applications of genetic engineering - in medicine: pharmaceutical compounds, insulin production, recombinant vaccine, gene therapy; in agriculture: gene addition, Antisense RNA technology, insect and virus resistant plants- herbicide tolerant plants in environmental management and industry. Transgenic animals and birds (any two), Ethical, legal and socioeconomic aspects of gene therapy. Issues in genetic engineering on biosafety of transgenic organisms, Food Safety of GMO's, GMO release procedure in India (regulatory agencies and their role).

Self study: Gene therapy

Unit IV Bioethics and Biosafety

9 hrs

Definition and scope of bioethics, Key ethical principles, Ethical issues in medical biotechnology, genetic modification, stem cell research, Social implications and public perception, Clinical Ethics – Informed consent, Patient autonomy and decision-making capacity, Confidentiality and privacy, End-of-life issues (e.g., advance directives, palliative care, euthanasia) research ethics, genetic and reproductive ethics, public health ethics, global and environmental bioethics.

Introduction, Definition and scope of biosafety, Importance of biosafety in research and healthcare, Historical development of biosafety practices, Biosafety Levels (BSL)- Description of the different biosafety levels (BSL-1 to BSL-4) risk assessment and management, Laboratory Safety Practices-

Standard operating procedures (SOPs) for handling biological agents, Personal protective equipment (PPE) and its proper use, Good laboratory practices (GLP) and safety protocols, Design and operation of containment laboratories (e.g., BSL-3 and BSL-4 labs), Biosafety guidelines and regulations, emerging issues in biosafety. Regulatory agencies in India – CCSEA, ICMR, RCGM

Self study: Cartagena Protocol on Biosafety, Bioterrorism and Biosafety

Unit V Intellectual Property Rights **9 hrs**

Definition and scope of IPR, Importance of IPR in protecting innovation and creativity, types of intellectual property, types – patent, trademarks, trade secrets, copy rights and industrial design. Traditional Knowledge and Geographical Indications,

International IPR frameworks, Overview of international treaties and agreements , Role of the World Intellectual Property Organization (WIPO), IPR Enforcement and Dispute Resolution, Emerging Issues in IPR -Impact of digital technologies and the internet on IPR, Challenges in protecting IP in the digital age- digital piracy, online infringement, IPR and artificial intelligence, Biotechnology and IPR

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions.

Self Study: Protection of plant variety and farmers right act; Examples of Patents in Biotechnology.

Total 45 hours

Text Books:

1. **Brown, T.A.** (2020). **Gene Cloning and DNA Analysis: An Introduction**, 8th edition Wiley- Blackwell.
2. **Tamarin, R.H.** (2007). Principles of Genetics, 7th Ed., TMH Publishing Company, New Delhi.
3. **Jones, R., Ougham, H., Thomas, H., Waaland, S**, (2013). **The Molecular Life of Plants**, Wiley Blackwell publishers.
4. **Batista, J. and Ramos, M.** (2021). **Genetic Engineering: Principles, Procedures and Consequences**. Nova Science Publishers.
5. **Sibi, G.** (2020). **Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology**, Krishan Makhijani Publishers

References:

1. **Russell, P.** (2013). **Genetics**, 5th Edition, Pearson Benjamin Cummings, New York.
2. **Holdrege, B. C. and Talbott, S.** (2008). **Beyond Biotechnology: The Barren Promise of Genetic Engineering**, The University press of Kentucky.
3. **Rajagopal, K.** (2012). **Recombinant DNA Tech and Genetic Engg,** McGraw Hill.
4. **Gardner, E.J., Simmons, M.J. and Snusted, D.P.** (2006). **Principles of Genetics,** Eighth Ed, John Wiley & Sons, New York.
5. **Nicholl, D. S. T.** (2010). **Introduction to genetic engineering** 3rd edition, Cambridge India
6. **Glick, B., Patten, C. and Maple, T.** (2021). **Molecular Biotechnology: Principles and Applications of Recombinant DNA**, ASM Press
7. **Wooley, B. P. and Byers, K. B.** (2020). **Biological Safety: Principles and Practices**, Wiley Publishers

Course Outcomes: After completing this course, the student will:

1. Understand the role of enzymes in genetic engineering and suitable methods for cloning of DNA using various vectors.
2. Comprehend the different types of gene transfer methods.
3. Use the knowledge gained about the principle and applications of genetic engineering.
4. Explore the concepts of Bioethics and Biosafety
5. Comprehend the idea of Intellectual Property Rights in genetic engineering and their relevant applications

Mapping of COs with POs & PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	M			M		H		
CO 2	H	M			M		H		
CO 3	H	M			M		H		H
CO 4	H	M			M	M	H	L	H
CO 5	H	M			M	M	H	L	H

CO- Course Outcomes; PO- Programme Outcomes; PSO- Programme Specific Outcomes
H: High M: Medium L: Low

Enzymology and Immunology

Semester II **Hours of instruction/week:3**
25MBCC11 **No.ofcredits:3**

Objectives

1. Tohelp the students understand the enzymes' mechanism of action.
2. To understand the components of the immune system, their functions and interactions.
3. To apply knowledge of the immunological and enzymological techniques in the laboratory and R&D

Unit I Classification and Enzyme kinetics **9 hrs**

Nomenclature and classification of enzymes, Purification of enzymes: Methods to isolate and purify enzymes, enzyme assays, activity units, specific activity. Active site - determination of active site amino acids - Classification of multi-substrate reaction, the kinetics of multi-substrate reaction, methods for measuring kinetics and rate constants expression, expression for Ping Pong and ordered Bi-Bi reaction mechanism and random order. Methods of studying enzyme-substrate complexes, Enzyme turnover and its significance. Enzyme specificity and types. Mechanism of Enzyme Action. Mechanism of action of ribonuclease, triose phosphate isomerase, lysozyme and chymotrypsin.

Enzyme inhibitions: reversible inhibition - kinetics of competitive - non-competitive and uncompetitive inhibition, Dixon Plot. Irreversible inhibition.

Allosteric enzymes – mechanism, regulation and kinetics- sigmoidal kinetics and their physiological significance, symmetric and sequential modes for action allosteric enzymes and their significances, half site reactivity.

Self-study: Kinetics of single substrate - Michaelis-Menten equation, Line weaver Burk plot, Eadie- Hofstee plot, Eisenthal and Cornish - Bowden plot and Hanes plot.

Unit II Enzyme Regulation and Applications **9hrs**

General mechanisms of enzyme regulation: Feedback inhibition and Feedforward stimulation, enzyme repression, induction and degradation. Reversible (glycogen phosphorylase) and irreversible (protease) covalent modification of enzymes, monocyclic and multicyclic cascade. Multienzyme system: occurrence and their properties, polygenic nature of multienzyme systems – Application of Enzymes - Immobilized enzymes and their industrial applications. Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity. Clinical enzymology: enzymes as thrombolytic agents, anti-inflammatory agents, debriding agents, and digestive aids. Therapeutic enzymes. Enzymes in diagnosis. Industrial applications: Food, leather, detergent, textiles, paper industry and environment concern. The rationale of enzyme engineering: basic assumptions of protein engineering, Rational and irrational design approach - site-directed and random mutagenesis - fusion proteins containing enzymes and their application.

Self-study: Mechanism of action and regulation of Pyruvate dehydrogenase and fatty acid synthetase complex – enzyme immobilization methods - biosensors.

Unit III The Immune System and Immunogenetics **9 hrs**

History of immunology- Cells and Organs of the immune system- structure and functions of the cells of the lymphoid and myeloid lineages and primary and secondary lymphoid organs. B-cell

receptors and T-cell receptors. Stem cells - sources, types, properties & applications. Antigens – types and characteristic features; Antibodies–basic structure, types of immunoglobulins- structure, properties and functions, immunoglobulin superfamily. Complement cascades- components, mechanism of Classical, alternative, biological consequences of complement cascades and their fragments. Types of immunities- innate and Acquired.

Immune response-Humoral and Cellular immune responses-their characteristics & effector mechanisms. Regulation of immune response. Immune response to infections-bacterial, viral, fungal and others. Immunodeficiency diseases – primary and secondary. Immunogenetics- antibody diversity- theories of antibody formation, organization of immunoglobulin genes and their expression, class switching. Major Histocompatibility Complex- organization, structure and functions of MHC and HLA genes and non-MHC molecules. Gene products. Role in antigen processing and presentation.

Self-study: Differentiation and Generation of T-cells and B-cells from bone marrow.

Unit IV Immune response and Transplantation Immunology **9 hrs**

Hypersensitivity–classification, causes, mechanism, clinical manifestations, diagnosis and treatment of Types I – IV hypersensitivities. Autoimmunity- classification, spectrum of autoimmune diseases, overlap, pathogenesis, diagnosis and treatment of autoimmune diseases.

Transplantation types of grafts, principles involved and mechanism of transplantation of various organs, immunosuppressive therapy, graft rejection.

Self-study: Role of MHC in transplantation, disease susceptibility and resistance

Unit V Immunotechniques **9 hrs**

Principles of antigen-antibody interactions - characteristics features. Precipitation techniques- immunodiffusion and immunoelectrophoresis. Agglutination techniques- haemagglutination, ABO blood grouping & Rh typing. Tagged assays - RIA, ELISA, immunofluorescence, immunoblotting, immunoelectron microscopy.

Isolation of pure antibodies, Assays for complement, FACS, Flow cytometry. Antibody engineering - Hybridoma technology - polyclonal and monoclonal antibody production and their applications. Recombinant antibody production.

Vaccine production- types of vaccines, principles of vaccine production, production of conventional and modern vaccines, new vaccine strategies and vaccines under development. Adjuvants - types and properties. Vaccination strategies, immunization schedules.

Self-study: New vaccine strategies and vaccines under development.

Total hours -45

Text Books: Enzymology

1. **Bowden, A.** (2012). **Fundamentals of Enzyme Kinetics**, Wiley-VCH Verlag GmbH, Germany.
2. **Price, N.C. and Steven, L.** (2000). **Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins**, 3rd Edition, Oxford University Press
2. **Khan, M.Y. and Khan, F.** (2015). **Principles of Enzyme Technology,** PHI Learning
3. **Singh, R., Singhania, R., Pandey, A. and Larroche, C.** (2019). **Advances Enzyme Technology**. 1st edition. Elsevier.
6. **Punekar, N.S.** (2018). **Enzymes: catalysis kinetics and mechanisms.**1st edition.Springer

Singapore.
7. **Arya, A., Kumar, A. and Jha. J.** (2018). **Understanding Enzymes**. 1st edition. Drawing Pin Publications.

References: Enzymology

1. **Leskovac, V.** (2003). **Comprehensive Enzyme Kinetics,** Springer Sciences
2. **Buchholz, K., Kasche, V. and Bornscheur, L.T.** (2012). **Biocatalyst and Enzyme Technology,** Wiley-VCH Verlag GmbH, Germany.
3. **Palmer, T. and Bonner, P.** (2008). **Enzymes: Biochemistry, Biotechnology, Clinical Chemistry,** 2nd Edition, East West Publishers.
4. **Nelson, D.L. and Cox, M.M.** (2021). **Lehninger Principles of Biochemistry,** 8thEd,W.H. Freeman and Company, New York
5. **Voet, D. and Voet, G.** (2012). **Fundamentals of Biochemistry, John Wileyand Sons,** New York.
6. **Phillips. J.** (2019). **Fundamentals of Enzymology**. Scientific -Resources.
7. **Kelly. J.** (2020). **Advances in Enzymology.**

TextBooks: Immunology

1. **Delves, P., Roitt, I., Martin, S. and Burton, D.** (2016). **Essential Immunology,** 13thedition,Wiley Blackwell Scientific Publications, London.
2. **Owen, J., Punt, J. and Stanford, S.** (2018). **Kuby Immunology**,8th edition, W.H.Freeman and Company, New York, USA.
3. **Tizard,I.** (2012).**Veterinary Immunology**, 9th edition,W.B.Saunders Co.,Philadelphia.

References: Immunology

1. **Latha, P.** (2012).**Textbook of Immunology**, 1st edition, S.Chand Publishers.
2. **Farhat, B.** (2012). **Textbook of Immunology**, 2nd edition, PHI Learning.
3. **Talaro, K.P, Chess, C. and Talaro, A**. (2011). **Foundations in Microbiology**, 8th edition, McGraw Hill Publishers, New York.

Course Outcomes: After completing the course, the student will be able to:

1. Comprehend the different classes of enzymes and enzyme kinetics and their measurements and explore the mechanism of enzyme action, role of allosteric enzymes and enzyme inhibition and enzyme regulation, and multienzyme complex.
2. Interpret the applications of enzymes in clinical and various industrial sectors.
3. Understand the characteristic features and interplay of the various components of the immune system
4. Identifyandcomparethemechanismsinvolvedindifferenttypesofimmunitiesandimmune responses in health and infections and to analyze the principles underlying hypersensitive and autoimmune reaction
5. Interpret the role of genetics in antibody synthesis and in transplantation and to apply knowledge gained in immunotechniques for better interpretation of results

Mapping of COs with POs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	M		L	L	H	H	
CO 2	H	H	M	M	M	L	H	H	
CO 3	H	H	M	H	M	M	H	H	H
CO 4	H	H	H	H	M	L	H	H	
CO 5	H	H	H	H	M	M	H	H	L

CO-Course Outcomes; PO-Program Outcomes; PSO-Program Specific Outcomes;
H:HighM:MediumL:Low

Practical III - Enzymology and Immunology

Semester II **Hours of instruction/week: 6**

25MBCC12 **No. of credits: 3**

Objectives

- To emphasize the strong technical skills in enzymology and immunological techniques
- To isolate, purify and study a selected enzyme like amylase.
- To apply the principles of immunology in studying antigen-antibody interactions.

Enzymology

1. Isolation of amylase from saliva/sweet potato **5 hr**
2. Partial purification of amylase by ammonium sulphate precipitation and dialysis **15 hrs**
3. Purification profile of the isolated/purified amylase. **5 hrs**
4. Characterization of amylase - effect of pH, temperature, substrate concentration and metal ions on the activity of amylase. **15 hrs**

Immunology

5. Preparation of antigen **5 hrs**
6. Isolation of lymphocytes **5 hrs**
7. Precipitation techniques - Single radial immunodiffusion, Double immunodiffusion, Rocket electrophoresis, Counter current immunoelectrophoresis, Immunoprecipitation and Precipitin ring test **20 hrs**
8. Agglutination techniques- Blood grouping and Haemagglutination **5 hrs**
9. Tagged assays - Enzyme Linked Immunosorbent Assay and Western blotting **15 hrs**

Total Hours 90

References:

1. **Eisenthal, R. and Danson, M.** (2020). **Enzyme Assays: A Practical Approach**, Oxford University Press.
2. **Tobili Y. and Sam-Yellowe.** (2021). **Immunology: Overview and Laboratory Manual**, Springer International Publishing.
3. **Sadasivam, S. and Manickam, A.** (2008). **Biochemical Methods**, 3rd Edition, New Age International (P) Ltd. Publishers.
4. **Hay, F. and Westwood, O.** (2008). **Practical Immunology**, 4th Edition, Blackwell Scientific Publishers.
5. **Arti, N. and Archana, A.** (2007). **Lab Manual in Biochemistry, Immunology and Biotechnology**, Tata McGraw Hill Publishing.

Course Outcomes: After completing this course, the student wi l:

1. Acquire skills in isolation, purification and characterization of salivary amylase
2. Explore the method of preparation of antigen and isolation of lymphocytes
3. Compare the various types of immunoprecipitation techniques
4. Interpret agglutination techniques
5. Analyze biomolecules by Immunoassay and western blotting

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M		H	H	
CO 2	H	H	H	M	M		H	H	
CO 3	H	H	H	M	M		H	H	
CO 4	H	H	H	M	M		H	H	
CO 5	H	H	H	M	M		H	H	

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes
H: High M: Medium L: Low

Practical IV Molecular Biology

Semester II **Hours of instruction/week: 6**

25MBCC13 **No. of credits: 3**

Objectives:

1. To train the students for isolation and estimation procedures used to quantify nucleic acids and proteins
2. To give hands - on - training to students on methods and techniques involved to identify DNA, RNA from different sources.
3. To understand PCR techniques and its applications

Experiments:

1. Isolation and estimation of DNA from Mammalian cells
   DNA estimation by Diphenylamine method and UV absorption method **6 hrs**
2. Isolation and estimation of RNA from mammalian cells **6 hrs**
3. RNA estimation by Orcinol method and UV absorption method
4. Isolation and estimation of Protein from mammalian cells **6 hrs**
5. Protein estimation by Lowry's method
6. Agarose gel electrophoresis of DNA **6 hrs**
7. Isolation of genomic DNA from plant cells **6 hrs**
8. Estimation by UV and agarose gel electrophoresis
9. Isolation of RNA from yeast cells **6 hrs**
10. Isolation and purification of plasmids **12 hrs**
    - Alkaline lysis method
    - Acid-phenol extraction for genomic DNA
    - c. Agarose gel electrophoresis of Plasmid DNA
11. Preparation of competent cells – DH5α 4 **6 hrs**
12. Transformation of E. coli cells and characterization of transformants **12 hrs**
    - Transfection of plasmid
    - Plating and selection of transformants
    - Slot lysis for confirmation of transformants
13. Restriction digestion of DNA (lambda DNA) **6 hrs**
14. Purification of DNA on LMP agarose **6 hrs**
15. Polyacrylamide gel electrophoresis (SDS and 2D PAGE) **6 hrs**
16. Polymerase Chain Reaction for amplification of DNA (demonstration) **6 hrs**

Total 90 hours

References:

1. **Tripathi, M., Ahuja, A., Bimal, Sharma,K., Singh, A., Kandalkar, V.** (2016). **Techniques in molecular biology practical manual,** Welcome Offset Printers, Lashkar, Gwalior (M.P.)
2. **Michel, R. and Sambrook, J.** (2014), **Molecular Cloning: A laboratory manual**, 4th Ed, Vol 1, 978- 1-621821- 04-5, Cold Spring Harbor Laboratory Press.
3. **Maniatis, T., Fritsch, E.F. and Sambrook, J.** (2012). **Molecular Cloning,** Vol, 1- Cold Spring Harbor, New York.

Course Outcomes: After completing this course, the student will:

1. Compare the various methods of isolating nucleic acids and proteins from different tissues.
2. Predict suitable methods for isolation, purification and characterization of transformants.
3. Predict suitable methods for isolation, purification and characterization of plasmids.
4. Understand the basics of gene amplification using PCR.
5. Detect DNA sequences by blotting techniques.

Mapping of COs with POs &PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M		H	H	
CO 2	H	H	H	M	M		H	H	
CO 3	H	H	H	M	M		H	H	
CO 4	H	H	H	M	M		H	H	
CO 5	H	H	H	M	M		H	H	

CO- Course Outcomes; PO- Program Outcomes;
PSO- Program Specific Outcomes H: High M: Medium L: Low

Computational Biology and Artificial Intelligence

Semester III **Hours of instruction/week: 3**
25MBCC14 **No. of credits: 3**

Objectives:

1. To build a strong background and potential in computational biology
2. To introduce the students to the biological databases and computational techniques used in biological sequence and structure analysis.
3. To gain knowledge about the basic concepts in artificial intelligence

Unit I - Introduction to Biological Database **9hrs**

Definition, aim, scope, branches and applications. Biological databases – features and layout - sequence databases - GenBank, EMBL, DDBJ,Uniprot-KB: SWISS-PROT, TrEMBL; structure databases - PDB, NDB, PubChem, ZINC, ChemBank. Literature database - PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore.

Self Study: Structural classification of proteins (SCOP, CATH and other classifications), carbohydrate database.

Unit II - Sequence Alignment and Analysis **9 hrs**

Sequence alignment – Measurement of sequence similarity; Similarity and homology. Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results. Multiple alignment – Clustal – NJ plot – phylogenetic trees – types and methods of construction, Phylogenetic software

Sequence Analysis – Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues. Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.

Self Study: Variations of BLAST – PSI-BLAST, PHI-BLAST, bl2seq.

Unit III - Structure Analysis **9 hrs**

Prediction of secondary structure of RNA. Prediction of secondary and tertiary structure of proteins. Obtaining atom coordinate files from databases, Molecular visualization tools – RasMol, Deep View and PyMol. Tools for 2D and 3D protein modeling. Introduction to molecular modelling (elementary concepts of force field, stereodynamics and energy minimization).- computer aided drug designing - Molecular docking – Molecular dynamics (basic concept)

Self Study: Other visualization tools – Chime, Web Lab Viewer, MolMol.

Unit IV – Fundamental Concepts of Artifical Intelligence **9 hrs**

Introduction to Artificial Intelligence – Fundamentals of AI – AI Platforms – AI in biology – Wearable devices - glucose monitoring, hypoglycemia predication, heart rate monitoring, gene expression analysis

Self Study: Application of AI in environment

Unit V – Machine learning algorithm **9 hrs**

Machine learning algorithms - (ML) - Supervised Vs Unsupervised Learning – Reinforcement-Learning - Regression - Classification - Clustering

Self Study: Modeling with random forests, PLS, SVM and Neural Network – drug designing

Total 45 hours

Text Books:

1. **Mount, D.** (2021). **Bioinformatics: Sequence and Genome Analysis,** Cold Spring Harbor Laboratory Press.
2. **Kappelmann-Fenzl, M.** (2021). **Next Generation Sequencing and Data Analysis**, Sprinker link.
3. **Gromiha, M.M.** (2010). **Protein Bioinformatics: From Sequence to Function**, Academic press, New Delhi.
4. **Lacroix, Z. and Critchlow, T.** (2009). **Bioinformatics: Managing Scientific Data** – Mayan Kaufmann publishers, San Francisco.

References:

1. **Lesk, A.** (2021). **Introduction to Bioinformatics**, Oxford University Press.
2. **Amjesh, R. and Vinodchandra, S.S.** (2019). **Bioinformatics for beginners**, LAP LAMBERT Academic Publishing.
3. **Ortutay, C. and Ortutay, Z.** (2017). **Molecular Data analsis using R,** Wiley Publisher
4. **Supratim Choudhuri.** (2014). **Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools**, 1st Edition, Academic Press.
5. **Polanski, A. and Kimmel, M.** (2010). **Bioinformatics**, Springer Pvt. Ltd.

Course Outcomes: After completing this course, the student will be able to

1. Explain the contents and layout of the important biological databases and to search and retrieve sequence and structural data using text-based and sequence based search tools.
2. Apply bioinformatics tools for sequence alignment and to find the evolutionary relationships.
3. Understand the steps involved in the analysis of structures of biomolecules, and predicting their secondary and tertiary structures with various bioinformatics tools.
4. Acquire knowledge on role of AI in biological applications
5. Understand the basic concept of machine learning algorithm for biological applications

Mapping of COs with POs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M	M	M	M	
CO 2		H	H	H		H	M	M	
CO 3	H	H	M		M	M	M	M	H
CO 4	H	H	M		H		H	M	
CO 5		H	H	H	M	H	H	M	L

CO-Course Outcomes; PO-Program Outcomes; PSO-Program Specific Outcomes;

H:High M:Medium L:Low

Clinical Biochemistry and Molecular Diagnostics

Semester III **Hours of instruction/week: 3**
25MBCC15 **No. of credits: 3**

Objectives:

1. To understand the basic concepts of laboratory techniques.
2. To understand the basic concepts of organ functions.
3. To gain knowledge about molecular diagnostic technique

Unit I Sample Collection Methods, Water and Electrolyte Balance **9 hrs**

Definition and scope of clinical biochemistry in diagnosis, collection and preservation of biological fluids (blood, urine and CSF), normal values of important constituents of blood, CSF and urine, handling of clinical samples, quality control, safety measures in clinical laboratory. Anticoagulants. Normal and abnormal constituents of urine.

Water and electrolyte homeostasis - renin angiotensin – aldosterone system. Pathological variations of water and electrolytes- diagnosis and Interpretations. Acid base balance and imbalance - Mechanism of regulations, Anion gap, Acidosis and Alkalosis.

Self study: Plasma proteins in health and diseases- albumin, globulin, fibrinogen and acute phase proteins.

Units II Diagnosis of Genetic disorders and Importance of Serum Enzymes **9 hrs**

Inborn errors of Metabolism: Patterns of inheritance - alkaptonuria, phenyl ketonuria, albinism, glycogen storage diseases and inherited disorders associated with urea cycle.

Abnormal hemoglobin and hemoglobinopathies- Sickle cell anemia and thalassemia, porphyria's and porphyrinurias and molecular diagnosis of genetic diseases

Enzymes and Isoenzymes of clinical importance - general principles of assay - Clinical significance of enzymes and isoenzymes, Serum enzymes in heart, liver, GI tract, muscle, bone disease.

Self study: Value of enzymes in Malignancies.

Units III Diagnosis of Renal and Gastric Functions **9 hrs**

Renal functions tests: Preliminary investigations, tests based on GFR, RPF and tubular function. Diseases related to kidney - nephritis, nephrosis, uremia, renal failure, renal calculi, renal hypertension, renal tubular acidosis, diabetes insipidus and molecular diagnosis methods. Dialysis - hemodialysis and peritoneal dialysis.

Gastric function tests: Examination of resting content, Fractional gastric analysis, Stimulation tests, Tubeless gastric analysis. Malabsorption syndrome, acidity, ulcers - gastric, duodenal and peptic, colon cancer, pancreatitis, gastric and pancreatic function tests and molecular diagnosis methods.

Self study: Pancreatic and thyroid function tests

Units IV Diagnosis of Liver and Metabolic Disorders **9 hrs**

Liver function tests: Tests based on abnormalities of bile pigment metabolism, detoxification and excretory functions. Diagnosis of different types of jaundice, pancreatic function tests and molecular diagnosis methods. Liver disorders

Carbohydrates: Blood glucose level - regulation and its clinical significance, Diabetes mellitus, Glycosuria and GTT. Glycosylated hemoglobin.

Lipid: Lipoproteinemia and atherosclerosis, coronary heart diseases and hypertension and markers of cardiovascular diseases.

Self study: Biochemical changes in cancer - detection of tumor markers

Unit V Molecular Diagnostics Methods for Disease Diagnosis **9 hrs**

Molecular diagnostic methods for diagnosis of - diabetes Mellitus, cardiovascular disease, infectious diseases and cancer- Protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis- Dot-blotting and micro array based techniques. RFLP, RFLP in DNA fingerprinting. PCR and types (Reverse transcriptase RT-PCR, Real time/quantitative PCR, inverse PCR, nested PCR, multiplex PCR, anchored PCR and asymmetric PCR), RAPD and AFLP techniques.

Self study: Nanotechnology in Clinical laboratory diagnosis

Total 45 hours

Text Books:

1. **Chatterjee. and Shindae.** (2012). **Text book of medical biochemistry**, 8th edition.
2. **Devlin, T.M.** (2010). **Text Book of Biochemistry with clinical correlations**, 7th edition. New York.
3. **Gans, G. and Murphy, J.M.** (2008). **Clinical Biochemistry**, 4th edition, Churchill, Livingstone, Elsevier.

References:

1. **Gowenlock, A.H. and Donald, J.** (2002). **Varley's practical clinical Biochemistry**, 6th edition, CBS publications and Distributors, New Delhi.
2. **Sembulingam, K. and Sembulingam, P.** (2018). **Essentials of Medical Physiology**, 7th edition. Jaypae Brothers (p) Ltd, New Delhi.
3. **Burtis. and Ashwood.** (2017). **Tietz Fundamentals of Clinical chemistry**, 8th edition, WB Saunders Company, Oxford Science Publications, USA.

Course Outcome: After completing this course, the student will:

1. Obtain basic knowledge about specimen collections, pathological variations of water, electrolytes
2. Understand the, patterns of inherited disorders and value of serum enzymes in diagnosis
3. Correlate the tests used for renal and gastric functions and their interpretations
4. Impart the diagnostic tests for liver function and metabolic disorders
5. Comprehend the recent molecular diagnostic methods

Mapping of COs with POs and PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3
CO 1	H	H	M		M	M	H		H
CO 2	H	M						M	
CO 3	H	H					M	H	M
CO 4	H	H					H	M	
CO 5	H	H						M	H

CO-Course Outcomes;PO-Program Outcomes;PSO-ProgramSpecificOutcomes;
H:HighM:MediumL:Low

Physiology, Biochemistry and Biotechnology of Plants

Semester III
25MBCC16

Hours of instruction/week: 3
No. of credits: 3

Objectives

1. To understand the functions and regulation of major biosynthetic pathways in plants.
2. To become familiar with the exciting topics in plant biotechnology research from agricultural genomics to IPR and patenting
3. To appreciate the relevance of plant physiology to industry and the survival of humanity

Unit I Photosynthesis and Electron Transport System in Plant **9hrs**

Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C_3, C_4 and CAM pathway of carbon reduction and its regulation, Photorespiration
ETC - oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory and ATP synthesis
Self study: CO_2 and green house gases and their effect on biodiversity, artificial leaves

Unit II Proximate Principles in Plants **9hrs**

Storage proteins - Classification and function; polysaccharides – sucrose, raffinose, starch and cellulose; lipids – classification and function, defense signals, Phytochromes, cryptochromes and phototrophins. Proximate analysis
Self study: Secondary metabolites and their functions

Unit III Biochemical Changes and Regulation of Gene Expression **9hrs**

With specific reference to floral development, seed development and germination, biotic and abiotic stresses.
Nitrogen fixation - Basic concepts, *nif genes* and their regulation, potential scope in crop improvement nitrate and ammonia assimilation: amino acid biosynthesis.
Self study: The Nitrogen cascade and its effect on environment

Unit IV Gene Mapping **9hrs**

Concept of linkage maps, physical maps and genetic maps. Molecular markers (RFLP, RAPD, AFLP, SSR, SNP, STS).
Rice genome sequencing, strategies used for sequencing. Applications of genome projects. New generation sequencing strategies.
Self study: DNA fingerprinting and Basmathi rice patent

Unit V Principles of Gene Manipulation in Plants **9hrs**

In vitro culture of plants. Concept of totipotency, types of in vitro culture – meristem culture, organ culture, protoplast culture and protoplast fusion, embryo culture and embryo rescue. Initiation and maintenance of in vitro cultures (callus and organ cultures). Embryogenesis and organogenesis.

Micropropagation and commercial tissue culture. Application of organ culture for secondary metabolite production

Genetic engineering in plants, plant transformation vectors, Ti plasmids, Direct transformation by physical methods. Transformation in *Oryza sativa* and *Arabidopsis thaliana*.

Self study: Steps involved in the development of golden rice

Case study: Status of BT cotton in India.

Total 45hrs

Text Books:

1. **Buchanan, B.B., Gruissem,W. and Jones, R.L.** (2002). **Biochemistry and Molecular Biology of Plants;**ISBN: 978-0-943088-39-6; American Society of Plant Physiologists, 2nd Indian Reprint (2007), I.K. International Pvt. Ltd. N. Delhi.
2. **Russell Jones, Helen Ougham, Howard Thomas. and Susan Waaland**. (2012). **The Molecular life of Plants,** ISBN 978-0-470-87011-2; Wiley-Blackwell Publishers
3. **Heldt Hans-Walter. and Birgit Piechulla**. (2011). **Plant Biochemistry**, 4th Edition, Elsevier Academic Press Publication, USA.

References:

1. **Lincoln Taiz. and Eduardo Zeiger**, (2010). **Plant Physiology: International Edition** (5th Edition); ISBN-13: 978-0123849861, Elsevier Academic Press Publication, USA.
2. **Jeyanthi, G.P.** (2009). **Molecular Biology**, MJP Publishers, Chennai.
3. **Sathyanarayana, B.N.** (2007). **Plant Tissue Culture : Practices and New Experimental Protocols**; I.K.International Pvt. Ltd.

Course Outcome: After completing this course, the student will:

1. Explain the functioning of plants as primary producers
2. Identify the changes taking place during plant development at a molecular level
3. Relate the importance of genome mapping and genome projects with IPR
4. List the potential areas of research in plant sciences
5. Justify the importance of genetically modified organisms as the future for food security

Mapping of COs with POs & PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H			M			H		
CO 2	H	H	M				M		
CO 3	H			M	H		H	M	H
CO 4	H	L			M	M	M	M	
CO 5	H		L			H	H		

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes H: High M: Medium L: Low

Biostatistics and Research Methodology

Semester III
25MBCC17

Hours of instruction/week: 3
No. of credits: 3

Objectives:

1. To understand the statistical tools commonly used in biological research
2. To assimilate the concepts of hypothesis testing and its importance in research
3. To know the aspects fundamental to research, to understand the methods of research and nuances of technical writing of scientific documents like thesis and journal articles

Unit I Statistical Survey and Data Collection **9hrs**

Statistical survey – Organization of a statistical survey, methods of data collection, data representation, Diagrammatical and graphical representation of data (Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram)

Fundamentals of statistics - population, sample, variable. Need for sampling, properties of an ideal sample, sampling procedures. Concepts of moments, skewness and kurtosis

Self study: Frequency distributions, sampling distributions, standard error

Unit II Measures of Central Tendency, Deviation, Correlation and Regression **9hrs**

Measures of central tendency – arithmetic mean, median, mode

Measures of deviation – range, quartile deviation, variance, standard deviation

Correlation and regression – correlation analysis and regression analysis

Self study: Relationship between mean, median and mode: pros and cons of the measures of central tendency and deviation; applications of correlation and regression

Unit III Probability and Hypothesis Testing **9hrs**

Probability and theoretical distributions – probability definition, types, addition and multiplication laws of probability, binomial, Poisson and normal distributions, Test for checking normal distribution;large and small samples, degrees of freedom

Hypothesis testing – Formulation of null and alternate hypotheses, testing the hypothesis, acceptance and rejection of hypothesis

Student's t test (one-sample, two-sample, and paired sample), Chi square test and goodness of fit, Analysis of Variance (one way and two way only)

Software packages for statistical analysis - MS-Excel.

Self study: Simple problems on probability, theoretical distributions, hypothesis testing; importance of hypothesis testing

Unit IV Research Methodology **9hrs**

Research methodology – meaning of research, objectives of research, types of research, research methodology and research designs, meaning, need and features of good research design, types of research designs, single blind and double blind trials

Research Problem: Definition, defining research problem, formulation of research problem, objectives of research problem.

Inclusion and exclusion criteria – importance of inclusion and exclusion criteria in animal and

human research with special reference to clinical research (elementary concepts only), examples and case studies
Self study: Random block design; importance of single blind and double blind studies

Unit V Report Writing **9 hrs**

Writing a thesis – layout of the thesis, preparing the components of the thesis – hypothesis, abstract, introduction, review of literature, methodology, results, discussion, summary and conclusion, references Writing a journal article – format of an article – journal requirements – differences between the thesis components and article components; abstract preparation, keywords; main article – introduction, materials and methods, results, discussion, presentation of tables, figures and graphs, conclusion, acknowledgement, references, conflicts of interest.
Citation and Acknowledgement, ISBN & ISSN. Peer review. Impact factor and H- index of journals. Presentation tools: oral and poster, Microsoft Power Point and PDF slides.
Avoiding plagiarism – definition of plagiarism, ethical issues, copyright issues
Self study: Different formats of thesis; plagiarism-detection software; Shodh Ganga and Shodh Gangotri

Total 45 hours

Text Books:

1. **Gupta, S.P.** (2022). **Statistical methods,** 48th ed. Sultan Chand and Sons, New Delhi.
2. **Gurimani, N.** (2014). **An introduction to Biostatistics**, M.J.P. Publishers, Chennai.
3. **Banerjee, P.K.** (2008). **Introduction to Biostatistics**, S. Chand and Co., New Delhi.
4. **Kothari, C.R.** (2015). **Research Methodology, Methods and Techniques**, II Edition, New Age International Publishers, New Delhi.

References:

1. **Day, R.A.** (2011). **How to write and publish a scientific paper**, Cambridge University Press, UK.
2. **Alred, G.J., Bursaw, C.T. and Oliu, W.E.** (2011). The Handbook of Technical Writing, McGraw Hill Publishers, New Jersey.
3. **Gupta, S.P.** (2012). **Statistical Methods**, 4th Edition- Sultan Chand &Son Publishers,

Course Outcomes: After completing this course, the student will:

1. Analyze biological data using the best-suited statistical tool and draw inferences from the results
2. Ascertain whether a given set of biological data are statistically significant or not by applying the appropriate hypothesis testing method
3. Devise the research methodology for their dissertation and design a project based on the search problem presented to them by their supervisor
4. Compile their results from the dissertation work and integrate the interpretation in relation to the published literature in their area of research
5. Conceive the best presentation mode for their results in the form of a thesis and journal article(s)

Mapping of COs with POs & PSOs

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3
CO 1	H	H	L		H	M			H
CO 2	H	H	L		H	M			H
CO 3	H	H	L		H	M			H
CO 4	H	H	L		H				H
CO 5	M	M	L		H				H

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes H: High M: Medium L: Low

Genomics, Proteomics and Big Data

Hours of Instruction/week: 3

Semester III

No. of credits: 3

25MBCC18

Objectives:

1. To provide abroad overview of the goals, methods and applications for OMICs in life sciences.
2. To familiarize the terminology underlying, principles and strategies and the technical methodologies involved
3. To gain knowledge about the basic concepts in big data

Unit I Genomics **9 hrs**

Introduction: Overview of Genomics and Genome Architecture (Genome maps), C value Paradox, Genome diversity, Genome sequencing strategies (Shotgun, massive parallel sequencing), -Genome Projects: Human Genome Project, HapMap Project, GWAS, Evolutionary Genomics, Metagenomics

Self study: ENCODE; Genome Browsers: Ensembl, UCSC

Unit II Transcriptomics and Metabolomics **9 hrs**

Transcriptomics: methods - EST, SAGE, Microarray, RNASeq

Metabolomics - Introduction to metabolites, Classic analysis method – capillary electrophoresis, chromatography, spectrophotometry, use of GC/MS NMR in metabolomics.

Self study: Database: GEO and Array Express

Unit III Introduction to Proteomics **9 hrs**

Classic approach in proteome research–gel based ,separation techniques, Protein sequencing– Chemical and enzymatic protein fragmentation, Amino acid sequence analysis - Edman degradation, Mass spectrometry in proteomics and description of mass spectrometer, Mass spectral analysis, Complex peptide mixture analysis: liquid chromatography coupled to mass spectrometer(LC-MS),

Self Study: de novo protein sequencing by mass spectrometry

Unit IV Methods in Proteomics **9 hrs**

Proteomic approach to posttranslational modification analysis, protein-protein interactions: experimental methods, Co-immune precipitation, affinity purification, yeast two-hybrid assays, FRET ,computational methods: gene neighbor and gene cluster methods, phylogenetic profile method, rosette stone method, sequence co-evolution method, classification methods, protein-protein interaction

Self study: database: STRING, 2D-PAGE, PDBrs.

Unit V – Basics in Big Data **9 hrs**

Introduction to Big data platform, challenges of conventional systems, intelligent data analysis, nature of data – analytic process and tools. Sources and Uses of Big data, Analyzing Big data-Cluster Computing, Map Reduce, Hadoop; Cloud Computing. Types of big data in biological science. Internet Based consumer health information – telehealth and telemedicine, biomedical data: acquisition, storage and use, Electronic health records, information retrieval form digital libraries, imaging systems in radiology and picture archiving.

Self Study: Big data Challenges in Bioinformatics.

Total hours 45 hr

TextBooks:

1. **Brown, T.A.** (2018). Genomes, Kindle Edition, Garland Science.
2. **Campbell, A.M. and Heyer, L.J .** (2006). **Discovering Genomics, Proteomics and Bioinformatics**, 2nd Edition,Cold Spring Laboratory Press
3. **Pevesner, J**. (2019). **Bioinformatics and Functional Genomics** ,2nd Editon,Wiley-Blackwell publisher

Referencebooks:

1. **Brown, T.A.** (2016). **Gene cloning and DNA analysis: An introdution**, 7th Ed.Wiley-Blackwell.
2. **Stryer, L.,** etal., (2019). **Biochemistry**, 9th Kindle edition, Backwell Scientific Publication, USA.
3. **Wilson. and Walker.** (2018). **Principles and Techniques of Biochemistry and Molecular Biology**, 8th Ed. Hofmann and Clokie

Course Outcomes: Students will be able to

1. Outline genomics and genome database and genome browsers;
2. Plan experiments with the knowledge gained;
3. Illustrate key technologies involved in metabolomics;
4. Explain key technologies in proteomics
5. Apply big data in understanding and the management of disease.

Mapping of COs with POs & PSOs

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO 1	H	M					M	H	
CO 2	H	M	H	H	H	H	M	H	M
CO 3	H	H	H	M	H	H	M	M	M
CO 4	H	H	M	H	H			M	M
CO 5	H		M	H	H	H	H	H	H

Course Outcomes; PO-Programme Outcomes; PSO-Programme Specific Outcomes
H:High M:Medium L:Low

Practical V – Clinical Biochemistry and Computational Biology

Semester III **Hours of instruction/week: 6**
25MBCC19 **No. of credits: 3**

Objectives:

1. To inculcate a strong background and technical knowledge in clinical and nutritional biochemistry
2. To give hands on training on clinical biochemistry techniques.
3. To give hands on training on nutritional biochemistry techniques.

Clinical Biochemistry

1.	Blood analysis: Iron and Hemoglobin, Glucose, GTT.	**10hrs**
2.	Serum and Urine analysis: Creatinine, chloride, phosphorus, calcium.	**10 hrs**
3.	Lipid profiles (Serum) – Total cholesterol, triglycerides, HDL, LDL	**10 hrs**
4.	Liver function tests - Total Bilirubin, total protein, albumin, globulin, albumin/globulin ratio, AST, ALT, ALP	**10 hrs**
5.	Kidney function tests – Urea, creatinine, uric acid.	10 **hrs**

Computational Biology

1.	Biological Databases	**5 hrs**
2.	Pairwise sequence alignment – Blastn, Blastp	**5 hrs**
3.	Multiple sequence alignment – ClustalW, Clustalx	**5 hrs**
4.	Construction of phylogentic trees	**5 hrs**
5.	Gene prediction tools – GenScan, GeneMark	**5 hrs**
6.	Protein analysis tools – Expasy	**5 hrs**
7.	Molecular visualization – Rasmol, spdbv, PyMol	**10 hrs**
		Total 90 hours

References:

1. **Gopalan, C., Ramasastry, B.V. and Balasubramanian, S**. (2021). **Nutritive Value of Indian Foods**, 1st Edition, National Institute of Nutrition, Hyderabad.
2. **Burtis. and Ashwood.** (2007). **Tietz Fundamentals of Clinical chemistry**, 6th edition, WB Saunders Company, Oxford Science Publications USA.
3. **Pushpa Sundaraj. and Anupa Sindhu.** (2006). **Qualitative tests and Quantitative procedures in Biochemistry – A Practical Manual,** 3rd Edition, Elite Publishing House Pvt. Ltd., New Delhi.
4. **Gibson, R.S.** (2005). **Principles of nutritional assessment**, Oxford University Press.
5. **Charumathy Marimuthu.** (2023). **Practical Manual - Practical I Nutritional Biochemistry**, Published by Bodhivanam, Chennai

Course Outcomes: After completing this course, the student will:

1. Quantify the levels of biochemical parameters in biological samples
2. Interpret the results to diagnose the abnormal functions of organs
3. Identify the components present in the food
4. To analyze the BMI through Anthropometric Measurements

Mapping of COs with POs & PSOs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H		M	L	H	H	H	
CO 2		H	H	M	M	H	H	H	
CO 3		H	M	L	L	M	H	H	
CO 4		H	M			M	H	H	
CO 5		H	M	M	L	H	H	H	M

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes H: High M: Medium L: Low

Practical - VI Tissue Culture and Big Data Analysis

Semester III
25MBCC20

Hours of instruction/week: 6
No. of credits: 3

Objectives:

1. To introduce the basic principles of in vitro culture techniques
2. Understand the differences between growth and differentiation of animal and plant cell culture
3. To introduce the principles of bigdata analysis

	Contents	**Hours**
	Plant Tissue culture	
1	Principles of tissue culture and media preparation	**5**
2	Influence of PGR on plant cell cultures	**10**
3	Influence of PGR on plant organ cultures	**10**
4	Large scale culture of plant organs in bioreactors	**5**
	Animal Tissue Culture	
5	Media preparation – filter sterilization – serum preparation - initiation and maintenance of primary cultures – maintenance of established cell lines	**10**
6	Staining of cells and observation under microscope	**5**
	Phytochemical analysis	
7	Qualitative analysis of phyto-chemicals	**10**
8	Quantitative analysis of secondary metabolites – saponins, flavonoids, phytosterols, alkaloids	**10**
	Separation of secondary metabolites by paper, thin layer and column chromatography	**5**
9	HPTLC analysis of secondary metabolites – Estimation of quercetin	**5**
	Big Data Analysis	
10	Install, configure and run python, numPy and Pandas	**5**
11	Install, configure and run Hadoop and HDFS	**5**
12	Visualize data using basic plotting techniques in python	**5**
	Total	**90 hrs**

References

1. **Vargas, V.M. and Flota, F.V.** (2006). **Plant cell culture protocols** 2nd Edition, Humana Press.
2. **Freshney, I.F.** (2010). **Culture of animal cells: A manual of basic techniques and specialized applications**. Wiley Blackwell publishers.

Course Outcome

After completing this course, the student will:

1. Have hands on experience of in vitro culture of plant and animal cells.
2. Demonstrate the differences between culture of animal and plant cells *in vitro*.
3. Justify and quantify the expression of secondary metabolites in plants.
4. Demonstrate the expertise to design experiments for Quality control at industrial level
5. Demonstrate the ability to apply Big Data analysis in biology

Mapping of COs with POs & PSOs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H		M	L	H	H	H	
CO 2		H	H	M	M	H	H	H	
CO 3		H	M	L	L	M	H	H	
CO 4		H	M			M	H	H	
CO 5		H	M	M	L	H	H	H	M

CO- Course Outcomes; PO- Program Outcomes; PSO- Program Specific Outcomes H: High M: Medium L: Low

Environmental Sustainability and Climate Change (Self Study)

Hours of instruction / week: 2

Semester III

No. of credits: 2

25MBCC21

Objectives

1. To understand the structure and importance of environment.
2. To learn about climate change and sustainability
3. To understand the effect of environment on human activity and natural disasters, its management

Unit I The Environment, Ecosystem and Biogeochemical cycles **6 hrs**

Environment: Structure and composition of atmosphere, Physico-chemical and biological factors in the environment, Concept of habitat and niche.
Ecosystem: Introduction –structure, components, types and functions, Food chain, food web, Ecological pyramids and energy flow.
Introduction: Carbon, nitrogen, sulphur, phosphorus and oxygen cycles.
Structure and function of terrestrial ecosystem

Unit II Impact of environmental Pollution **6 hrs**

Introduction –Types of pollution, Air pollution-sources, effects, air quality indices.
Water pollution-solid waste management causes, effects and control measures, of urban and industrial waters, Treatment of waste water.
Noise pollution-sources, effects, prévention. Noise quality indices
Environmental pollutants, their classification, sources and impact on living beings.
Effect of various pollutants on animal, plant and microbial metabolism; their detoxification mechanism in animals, plants and microbes.
Biochemical basis of pollutant tolerance. Soil enzymes, their source and role in environment

Unit III Climate Change and sustainability **6 hrs**

Global Climate System -Causes for Modern Climate Change, External Climate Forces: Greenhouse Gases, Orbital Variations, Solar Fluctuations, Volcanism, Plate Tectonics, Evidence and Measurement of Climate changes Consequences and Challenges - Impacts on Life, Vegetation, Fauna, Glaciers and Ice Sheets Melting, Sea Level Changes, Economics of Climate Change, Climate Change and Water Scarcity, Coastal Ecosystem and Vulnerability, Threats to Forest and Biodiversity, Agriculture and Food Security, Energy Generation and Climate Change Mitigation.

Unit IV Environmental Conservation and Sustainability **6 hrs**

Technical Skills in Environment and Sustainability , Vulnerability, Adaptation and Livelihoods, Preservation of Biological Diversity, Sustainable Forest Management, Environmental Governance and Sustainability, Environmental Economics and Sustainability, Water Conservation and Sustainable Development Urbanization and Sustainable Cities Challenges in Energy, Food and Agriculture Sustainability Measurement and Reporting Tools

Unit V Disaster management **6 hrs**

Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its managements - case studies (e.g) Earthquakes, Landside disasters. Social Economics and Environmental impact of disasters. Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warming Systems, Building design and construction in highly seismic zones, retrofitting of building

Total 30 hours

Text Books:

1. **H.S. Sharma S. Padmaja. and Ganesh Sharma**. (2013). **Climate Change Biodiversity and Green Economy,** Concept Publishing Company Pvt. Ltd.
2. **Fulekar, M.H., Bhawana Pathak, and Kale, R.K.** (2013). **Environment and Sustainable Development**, Springer Nature.
3. **Kumar, A. (2010). Disaster Management –Recent approaches**, Anmol publishers, New Delhi, India
4. **Gwendo, B., Singh B. R. and Theodore, L.** (2004). **Handbook of Environmental, Management and Technology**. 2nd Edition, John Wiley and Sons, New York, USA
5. **De, A.K. and De, A.K.** (2021). **Environmental Chemistry**, 10th edition. New Age International Publishers, New Delhi, India

References:

1. **Fisher, M.R.** (2021). **Environmental Biology**, Open Oregon Education Resources, USA.
2. **Manahan, S.** (2017). **Environmental Chemistry**, 10th Edition, CRC Press, New York, USA.

Course Outcomes

1. Understand the concepts of environment, ecosystem and geochemical cycles
2. Realize the impact of environmental pollution on living organisms.
3. Relate the implications of climate change and sustainability
4. Comprehend the importance of Environmental conservation and sustainability
5. Infer the various types of disasters and their management.

Mapping of COs with POs & PSOs

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M	M	H	H	
CO 2	H	H	H	H	M	M	M	H	
CO 3	M	H	H	H	M	M	H	H	
CO 4	H	H	M	M	M	M	H	H	
CO 5	H	H	M	M	M	M	H	H	

CO- Course Outcomes; PO- Programme Outcomes; PSO- Programme Specific Outcomes
H: High M: Medium L: Low