MASTER OF SCIENCE
BIOCHEMISTRY

SYLLABUS 2017-18 Onwards

Dr. N.G.P ARTS AND SCIENCE COLLEGE (Autonomous)
(Re-Accredited with A Grade by NAAC)
(Affiliated to Bharathiar University,)
Dr. N.G.P. Nagar - Kalapatti Road
Coimbatore - 641 048

MASTER OF SCIENCE IN BIOCHEMISTRY

ELIGIBILITY

The eligibility conditions for admission to M.Sc., in Biochemistry is candidates with B.Sc., in Biochemistry, Microbiology, Biotechnology, Chemistry, Industrial chemistry, Polymer chemistry, Bioinformatics, Life science, B.Sc., Clinical Lab Technology, B.Sc., Medical Lab Technology, Nutrition and Dietetics, Botany, Zoology or an Examinations accepted as equivalent there by Academic Council, subject to such conditions as may be prescribed there to are permitted to appear and qualify for the **Master of Science Degree in Biochemistry Examination** of this College after a programme of study of two academic years.

PROGRAMME EDUCATIONAL OBJECTIVES:

1. Instill inquisitiveness in students to explore realms of modern biology (Molecular genetics, Marine biochemistry, Pharmaceutical biochemistry, and Immunology, Enzymology and Clinical biochemistry) through interdisciplinary cutting edge research.

2. Empower students to acquire, develop and demonstrate skills in bio-instrumentation, bio-statistical and bio-informatic software and tools, and in the fields of Industrial Biochemistry, and Nanotechnology and Cancer biology to meet the relevant demands of traditional and emerging industries.

SCHEME OF EXAMINATIONS (Choice Based Credit System- CBCS)

Course Code	Course	Hours of Instruction	Exam Duration (Hrs)	Max Marks			Credit Points
				CA	CE	Total	
First Semester							
17PBC13A	Biopolymers	4	3	25	75	100	4
17PBC13B	Bioinstrumentation	4	3	25	75	100	4
17PBC13C	Enzymes and Enzyme Technology	4	3	25	75	100	4
17PBC13D	Cellular Biochemistry	4	3	20	55	75	4
17PBC13E	Molecular Biology	4	3	20	55	75	4
17PBC13P	Practical-I: Biochemistry-I	6	6	40	60	100	3
	Elective-I	4	3	25	75	100	4
		30				**650**	**27**
II-Semester							
17PBC23A	Immunology and Immuno-techniques	5	3	25	75	100	4
17PBC23B	Microbial Biochemistry	5	3	25	75	100	4
17PBC23C	Metabolism and Metabolic Regulation	5	3	25	75	100	4
17PBC23D	Plant Biochemistry	5	3	25	75	100	4
17PBC23P	Practical-II:	6	6	40	60	100	3

BoS Chairman/HoD
Department of Biochemistry
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

Dr. P. R. MUTHUSWAMY
PRINCIPAL
Dr NGP Arts and Science College
Dr. NGP - Kalapatti Road
Coimbatore - 641 048
Tamilnadu, India

	Biochemistry-II						
	Elective-II	4	3	25	75	100	4
		30				**600**	**23**
III-Semester							
17PBC33A	Biostatistics and Research Methodology	4	3	25	75	100	4
17PBC33B	Advanced Clinical Biochemistry	4	3	25	75	100	4
17PBC33C	Genetic Engineering	4	3	25	75	100	4
17PBC33D	Hormonal Regulation and Signal Transduction	4	3	25	75	100	4
	Project	4	-	-	-		
17PBC33P	Practical-III: Biochemistry-III	6	6	40	60	100	3
	Elective-III	4	3	25	75	100	4
		30				**600**	**23**
Semester IV							
17PBC43V	Project	20	6	80	120	200	10
17PBC43A	Bioinformatics and Drug Discovery	4	3	25	75	100	4
17PBC43P	Practical-IV Biochemistry-IV	6	6	40	60	100	3
	Total	**30**				**400**	**17**
	Grand Total	**120**				**2250**	**90**

LIST OF ELECTIVES (GROUP OF ELECTIVES)

(Student shall select any one of the groups as Elective)

Course/ Semester	Course Code	Group-A Courses	Course Code	Group-B Courses	Course Code	Group-C Courses
Paper-I Sem-I	17PBC1EA	Cancer: Biology, Diagnosis and Therapy	17PBC1EB	Nutrition through life cycle	17PBC1EC	Basics of Molecular Biology Techniques
Paper-II Sem-II	17PBC2EA	Biochemistry of Toxicology	17PBC2EB	Nutritional Biochemistry	17PBC2EC	Plant Tissue Culture
Paper-III Sem-III	17PBC3EA	Nutrition and Clinical Nutrition	17PBC3EB	Molecular basis of clinical disorders	17PBC3EC	Animal Tissue Culture

Total Credit Distribution

Course	Credits	Total		Credits	Cumulative Total
Core	4	12x 100	1200	48	90
Core	4	2 x 075	150	08	
Core Practical	3	4 x 100	400	12	
Project Work	10	1 x 200	200	10	
Electives	4	3 x 100	300	12	
			2250	**90**	**90**

FOR PROGRMME COMPLETION

Students have to complete the following courses:

- Core papers in I-, II-, III- and IV-Semesters.
- Elective papers in I-, II-, III- and IV-Semesters.
- Project and Viva -Voce in IV-Semester

Earning Extra credits is not mandatory for programme completion

Extra Credits

S.No	Course	Credit	Total credits
1.	Publication with ISSN Journal	1	**1**
2.	Hindi/Other Foreign language	1	**1**
3.	Paper Presented in Sponsored National/ International Seminar/conference/ workshop	1	**1**
4.	Online Courses Prescribed By Department/ Self study paper	1	**1**
5.	Representation– Academic/Sports /Social Activities/ Extra Curricular Activities at University/ District/ State/ National/ International	1	**1**
Total			**5**

Rules:

The students can earn extra credit only if they complete the above during the programme period (I- to III-semester) and based on the following criteria. Proof of completion must be submitted in the beginning of IV-semester. (Earning Extra credits is not mandatory for programme completion).

1. Publication with ISSN Journal by a student and co-authored by staff member will be given one credit extra.
2. Student can opt Hindi/ French/ Other foreign Language approved by certified Institutions to earn one credit. The certificate (Hindi) must be obtained from **Dakshina Bharat Hindi Prachar Sabha** and He/ she has to enroll and complete during their programme period (I- to III-**semester).**

1. Award winners in Paper Presentation in Sponsored International Seminar/conference/Participation in short term workshop (minimum 5 days) will be given one credit extra.
2. Student can earn one credit, if they complete any one online certification courses/ Self study paper prescribed by the concerned department.

Self study paper offered by the Biochemistry Department

S. No.	Semester	Course Code	Course Title
1.	III	17PBCSS1	Inheritance Biology
2.		17PBCSS2	Evolution and Behaviour

List of online courses Prescribed by the Department

1. NPTEL

2. Spoken Tutorial

3. Khan academy

4. Course era.com

5. Udemy

1. Award Winners in Social Activities/ Extra Curricular/ Co-Curricular Activities/ Representation in Sports at University/ District/ State/ National/ International level can earn one credit extra.

PROGRAMME OUTCOMES (PO):

On successful completion of the programme, following are expected outcomes.

PO Number	PO Statement
PO1	Postgraduates are cognizant of progressive principles and concepts in diverse branches of modern biology that govern the integrity of dynamic bio-molecular assembly in varied life forms. Alumni are expressive of mastered wisdom to peers and public to expedite basic understanding of issues of social importance through practice and investigation.
PO2	Postgraduates are comprehensive of complex of biological systems, and they have broadened and perfected competency and skills in principal and contingent areas of modern

	biology. Thereby, alumni as an individual or as a team member can address, investigate, design, develop and demonstrate solutions to important issues facing humanity and preserve natural ecosystems.
PO3	Postgraduates are advantaged to identify and exploit functionally crucial areas in diverse branches of modern biology, and combine it with modern tools to investigate, design, develop, demonstrate and familiarize solutions to both basic and applied research questions in areas of industry, medicine, agriculture, pharmacy, food technology, biotechnology, etc. Alumni are valuable performers as an individual or in a team.
PO4	Postgraduates are competent to enroll in research programs and modeled to receptive of successful career options in diverse branches of modern biology as scholars, managers, counselors, writers, technical experts, field experts, teachers, entrepreneur and a responsible citizen. Alumni have acquired and developed skills to manage projects and finances as individual or as a team member. While discharging duties at varied capacities, postgraduates are inculcated to keep sustainable environment as a goal, and follow ethics of professional stature.
PO5	Postgraduates are infused with metamorphic qualities of education, and inspired to develop scientific temperament and lead a scientific way of life in facing socio-economical challenges that will benefit the society. Alumni are adept at evaluating their learning's to worldwide events. Thereby, they continue their learning lifelong.

17PBC13A	CORE-I: BIOPOLYMERS	SEMESTER-I

PREAMBLE:

- This course offers an overview of structural organization and functional properties of bio-molecules.
- Students can gain an in-depth knowledge and understanding on the structure and functions of biological important macromolecules.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Examine the structure and functions of complex polysaccharides. Assess the importance of carbohydrate containing proteins, homo and heteropolysaccharides.	K_4 & K_5
CO2.	Determine the structure of protein. Explain elaborately the different structural levels of proteins.	K_4 & K_5
CO3.	Value the importance of complex lipids. Infer the functions of saturated and unsaturated fatty acids	K_4 & K_5
CO4.	Give an opinion on the different forms of	K_4 & K_5

	DNA& RNA. Explain various hypotheses.	
CO5.	Justify the structure and functions of important Biological molecules. Explain the role of lipid peroxidation and antioxidant.	K_4 & K_5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**M**	**M**	**M**
CO2	**S**	**S**	**S**	**M**	**M**
CO3	**S**	**S**	**S**	**M**	**M**
CO4	**S**	**S**	**M**	**M**	**M**
CO5	**S**	**S**	**S**	**M**	**S**

L-Low; M-Medium and S-Strong.

17PBC13A	CORE-I: BIOPOLYMERS	SEMESTER-I

TotalCredits: 4
Hours per week: 4

CONTENTS

UNIT–I Biology of Sugars

Homo polysaccharides: Structure and biological functions of starch, cellulose, chitin, fructans, mannans, xylans, and galactans. Hetero polysaccharides: Structure and biological importance of sugar derivatives- glycosaminoglycans, proteoglycans. Glycoprotein – Blood group and bacterial cell wall polysaccharides, O- linked and N- linked oligosaccharides and Lectins.

UNIT-II Biology of Proteins

Primary structure- determination of amino acid sequence of proteins. The peptide bond: Ramachandran plot. Secondary structure- weak interactions involved- alpha helix and beta sheet and beta turns structure. Pauling and Corey model for fibrous proteins. Collagen triple helix. Super secondary structures- helix-loop-helix. Tertiary structure- alpha and beta domains. Quaternary structure- structure of hemoglobin. Solid state synthesis of peptides. Protein folding.

UNIT-III Biology of Lipids

Lipids- classification- saturated and unsaturated fatty acids, phospholipids- classification, structure and functions. Ceramides and sphingomyelins.Eicosanoids, Structure and functions of prostaglandins, thromboxanes, leukotrienes.Types and functions of plasma lipoproteins. Amphipathic lipids- membranes, micelles, emulsions and liposomes.

Steroids- cholesterol structure and biological role- bile acids, bile salts.

UNIT-IV Biology of Nucleic Acids

DNA double helical structure. A, B and Z forms of DNA. Triple and quadruple structures. Chemicals that react with DNA, DNA sequencing procedures- Maxam Gilbert method and Sanger's dideoxy methods. Renaturation and denaturation. DNA bending: The Wedge model and Junction model, Protein induced bending. Crucifrom DNA, Left handed DNA. Types of RNA, Secondary and tertiary structure of RNA.

UNIT-V Biology of Heterocyclic Compounds

Hetero cyclic rings of biologically important compounds. Structure and biological importance of pyridine, pyrole, quinolene, pyrimidine, purine, pteridine, thiazole, imidazole and indole ring containing compounds. Porphyrine - structure and biologically important compounds containing porphyin ring.

TEXT BOOKS:

1. *Nelson, D.L. and Cox, M.M. 2008.* **Lehninger Principles of Biochemistry,** 5th edition. W.H. Freeman and Company, New York.
2. *Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P. and Weil, P.A*. 2015. **Harper's Illustrated Biochemistry**, 30th edition. The McGraw-Hill Inc.
3. *Richard R Sinden,* 1994. **DNA Structure and Function,** Academic Press.

REFERENCE BOOKS:

1. Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L. 2015. Biochemistry, 8th edition, W.H. Freeman and Company, New York.
2. *Geoffrey Zubay,*1993. **Biochemistry,** 3rd Edition.Wm.C.Brown Publishers.
3. *Voet, D. and Voe*t *J.G.* (2011). **Biochemistry,** 4th edition, John Wiley and Sons, New York.
4. *Garrett, R.H. and Grisham, C.M.* (2017). **Biochemistry,** 6th edition, Brooks/Cole Cengage Learning, Boston.

17PBC13B	CORE-II: BIOINSTRUMENTATION	SEMESTER-I

PREAMBLE:

- This course offers an overview of the scientific basis of instruments, the advantages and limitations of conventional and modern bio-analytical techniques.
- Students can gain an in-depth knowledge and understanding of the key analytical techniques used in the areas of Spectroscopy, Centrifugation, Microscopy, Chromatography, Electrophoresis, Biophysics and Radioisotopes.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Distinguish the principles, instrumentation and applications of conventional and recent techniques in the field of spectroscopy. Explain the principle and importance of advanced analytical techniques like ESR, NMR and MS.	K4 & K5
CO2.	Distinguish the preparative and analytical ultracentrifugation techniques. Compare and contrast the principles, instrumentation, and applications of conventional and advanced microscopic methods.	K4 & K5

CO3.	Evaluate the advantages and disadvantages of ancient and recent techniques in chromatography.	K4 & K5
CO4.	Assess and explain the importance of different types of electrophoresis and blotting techniques.	K4
CO5.	Examine the different biophysical techniques like X ray diffraction, ORD and CD. Understand the basics of radioactivity and examine the benefits of using radio-isotopic techniques.	K3, K4 & K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**M**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

L-Low; M-Medium and S-Strong.

17PBC13B	CORE-II: BIOINSTRUMENTATION	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT–I Spectroscopic techniques

Principle, instrumentation and applications of UV-Visible, IR, Fluorescence spectrophotometry, Colorimetry, Turbidimetry, Luminometry and Flame emission spectrometry. Principle and applications of Electron Spin Resonance, Nuclear Magnetic Resonance, Mass and Raman Spectroscopy.

UNIT- II Centrifugation techniques and Microscopy

Principle, technique and applications of preparative ultracentrifugation-differential centrifugation, density gradient centrifugation (caesium chloride and sucrose density gradients) and analytical ultracentrifugation.

Basic principles, instrumentation and applications of Light, Compound microscope, Fluorescence microscopy, Phase contrast microscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Confocal microscopy.

UNIT- III Chromatographic techniques

Principle, technique and applications of paper, TLC, HPTLC, column, affinity, ion-exchange, gel filtration, hydrophobic interaction and adsorption chromatography. Principle, components, limitations and applications of GC, GC-MS, HPLC, RP-HPLC and FPLC.

UNIT- IV Electrophoresis and Blotting techniques

Principle, technique and applications of paper, gels - Agarose, Native and SDS-PAGE, 2D PAGE, Isoelectric focusing, Denaturing gels for RNA, Urea-PAGE, Electrophoresis in DNA sequencing, Peptide mapping, N-terminal sequencing of proteins, Next generation sequencing.
Principle, technique and applications of western, southern and northern blotting. Chemiluminescence and Phosphorimaging.

UNIT- V Biophysical and Radio-isotopic methods

Principles and applications of X-ray diffraction, ORD and circular dichroism. Radioisotopes in Biochemistry, Types of radiation, half-life and units of radioactivity, Detection and measurement of radioactivity– Principle, instrumentation and applications of Liquid scintillation counter and Geiger-Muller counter. Autoradiography and its applications.

TEXT BOOKS:

1. *Boyer R. F,* 2012. **Modern experimental biochemistry,** 3rd edition, Pearson Education Inc and Dorling Kindersley Publishers.
2. *Sheehan D,* 2009. **Physical Biochemistry – Principles and Applications,** 2nd edition, John Wiley and Sons.
3. *Wilson and Walker,* 2010. **Principles and Techniques of Biochemistry and Molecular Biology,** 7th edition, Cambridge University Press.
4. *PelczarJr, Chan and Krieg* 2012. **Microbiology,** 5th edition, Tata McGraw Hill.

REFERENCE BOOKS:

1. *Sawhney and Singh,* 2015. **Introductory Practical Biochemistry**, 11th edition, Narosa Publishing house.
2. *Cooper T. G,* 2011. **The tools of Biochemistry**, John Wiley and Sons**.**
3. *Srivastava S,* 2010. **Molecular Techniques in Biochemistry and Biotechnology**, 1st edition, New Central Book Publishers.

17PBC13C	CORE-III: ENZYMES AND ENZYME TECHNOLOGY	SEMESTER-I

PREAMBLE:

- This course offers an overview on activity and kinetics of enzymes, their mechanism of action and regulation, and prospect of enzymes utilization.
- Students can gain an in-depth knowledge and understanding on methods of enzymes isolation and purification; enzyme kinetics and regulation, and applications of enzymes in fields of industry, agriculture and medicine.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Examine the structural and functional properties of enzymes. Experiment methods of enzymes isolation and purification. Measure the enzyme activity.	K3, K4 & K5
CO2.	Understand and prove the kinetics of enzyme-mediated reactions. Distinguish different types of enzyme inhibition and its kinetics. Solve simple problems related to enzyme kinetics.	K4 & K5

CO3.	Evaluate the enzyme specificity. Determine the mechanism of enzymes action. Understand the regulation of enzyme activity.	K4 & K5
CO4.	Describe elaborately how enzymes can be used in industry. Value the importance of enzymes in clinical diagnostics and therapeutics.	K4 & K5
CO5.	Develop immobilized enzymes using different methods and appraise its applications. Propose a minor project on enzyme isolation, purification and application.	K4, K5 & K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**M**
CO2	**S**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**

L-Low; M-Medium and S-Strong.

17PBC13C	CORE-III: ENZYMES AND ENZYME TECHNOLOGY	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT–I Classification, Purification and Active Site

Nomenclature and classification of enzymes, isolation and purification of enzymes- by different methods, criteria of purity- specific activity. Multi-enzyme complex-occurrence, isolation and properties. Measurement of enzyme activity- two point assay, kinetic assay, using radio-labelled substrates. Active site- determination of active site amino acids- chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations. Structure of active site investigation. Coenzymes and cofactors in enzyme catalyzed reaction.

UNIT-II Enzyme Kinetics and Inhibition

Kinetics of single substrate enzyme- catalysed reactions- Michaelis-Menten equation, importance of V-max, Km, MM equation, and turnover number; Lineweaver- Burk plot, Eadie- Hofstee plot, Hanes- Woolf plot and Eisenthal and Cornish - Bowden plot. Kinetics of Allosteric enzymes-MWC and KNF models Hill' equation coefficient. Sequential and non-sequential bisubstrate and multi-substrate reactions. Enzyme inhibition-types and kinetic differentiation. Simple problems related to enzyme kinetics.

UNIT-III Mechanism of Enzyme Action and Regulation

Enzyme specificity, Mechanism of enzyme action- general acid-base catalysis, covalent catalysis, proximity and orientation effects, role of metal ion in enzyme catalysis, mechanism of serine proteases-

chymotrypsin, lysozyme, and ribonuclease. Metal activated enzymes and metalloenzymes. Role of metal ions in carbonic anydrase, superoxide dismutase, carboxy peptidase. Regulation of enzyme activity-covalently modified regulated enzymes, allosteric enzymes, isozymes.

UNIT-IV Industrial and Clinical Uses of Enzymes

Enzymes applications in food and allied industries- sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese

production. Clinical enzymology- Enzymes as thromblytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Enzymes and isoenzymes in diagnosis- LDH, CK, transaminases, phosphateases, amylase and cholinesterase.

UNIT-V Immobilized Enzymes and Biosensors

Immobilized enzymes-various methods of immobilization, kinetics and applications of immobilized enzyme. Enzymes as diagnostic reagents. Biosensors: Principle, technique and mechanism of Biosensors. Calorimetric biosensors, potentiometric biosensors, Amperometric biosensors, optic biosensors, and immune-sensors. Enzyme engineering: Artificial enzymes. Antioxidant enzymes.

TEXT BOOKS:

1. *Palmar, T. 2004.* **Understanding enzymes,** 1st edition, East West Press Pvt. Ltd., New Delhi.
2. *Bhatt S.M.* 2014. **Enzymology and Enzyme technology**, 15th edition, S. Chand publishing Ltd, New Delhi.
3. *Nelson, D.L. and Cox, M.M. 2008.* **Lehninger Principles of Biochemistry,** 5th edition. W.H. Freeman and Company, New York.
4. *Asokan P.* 2006. **Enzymes**, 1st edition, Chinnaa publications.
5. *Choudhary, N.L. and Singh, A.* 2012. **Fundamentals of Enzymology**, 1st edition, Oxford Book Company.

REFERENCE BOOKS:

1. *Palmer, T. and Bonner, P.L.* 2004. **Enzymes: Biochemistry, Biotechnology, Clinical chemistry**, 1st edition, East West Press Pvt. Ltd., New Delhi.
2. *Price, N.C. and Stevens, L.* 1999. **Fundamentals of Enzymology**, 3rd edition, Oxford University Press.
3. Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L. 2015. **Biochemistry**, 8th edition, W.H. Freeman and Company, New York.
4. *Voet, D. and Voe*t *J.G.* (2011). **Biochemistry,** 4th edition, John Wiley and Sons, New York.

17PBC13D	CORE-IV: CELLULAR BIOCHEMISTRY	SEMESTER-I

PREAMBLE:

- This course offers an overview on cellular organization and function.
- Students can gain an in-depth knowledge and understanding on cellular transport, communication, division, death and cancer.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Distinguish the composition and orientation of macromolecules constituting bio-membranes. Explain methods and models to investigate bio-membranes structure and function.	K4 & K5
CO2.	Distinguish various types of transport system in cells. Compare and contrast different transport process in cells.	K4 & K5
CO3.	Evaluate pathways of energy generation and utilization, cytoskeleton organization in a cell.	K4 & K5
CO4.	Assess and explain molecules of cellular integration and pathways of cellular communication.	K4
CO5.	Examine cell division events and process of cell death. Understand events leading to cellular transformation.	K3, K4 & K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	S	M	M
CO5	S	S	S	M	M

L-Low; M-Medium and S-Strong.

17PBC13D	CORE-IV: CELLULAR BIOCHEMISTRY	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Membrane Biology

Bio-membrane structure- fluid mosaic model; Membrane lipids- fluidity, Asymmetry phase transition, Liposomes, Scott Syndrome. Membrane proteins- Types, Orientation, Mobility- Experiments, flippases, proteins or RBC membrane, Bacteriorhodopsin, Porins-aquaporin. RBC ghosts, solubilisation of proteins, lipid anchored proteins. Carbohydrates- cell surface carbohydrates-Lectins.

UNIT-II Membrane Transport

Membrane transport- Overview, Passive diffusion, Facilitated diffusion in erythrocytes. Carriers and Ion-Channels. Ion cone. Gradients. Uniporter Catalyzed transport. Active transport systems. Transport process driven by ATP-Ion Pumps:Calcium, APT ase; Na^+K^+ATPase; Mechanism, Gastric H^+K^+ATP ase; Mechanism, Gastric H^+K^+ ATP ase, ATP ases that transport peptides and drugs. ABC superfamily- Bacterial PM permeases, Mammalian MDR proteins: Transport process driven by light and ion gradients. Co-transport by Symporters and antiporters. Group translocation Osmosis and Receptor mediated endocytosis.

UNIT-III Cell Energetics and Cytoskeleton

Mitochondria- Reduction potentials, electron transport chain Overview, Complexes, Q-cycle, Cyt-C oxidase complex, Translocation of Protons and the establishment of a proton, motive force Machinery for ATP formation. Chemi-osmotic mechanism, APT Synthase Experiments,

inhibitions of OP. Uncouplers. Microfilaments- Action- Structures, Assembly, Myosin. Microtubules- Organization and dynamics, Kinesin and dynem. Cilia and Flagella- Structure and functions, Intermediary fi1aments. Striated muscle- structure, excitation- contraction.

UNIT- IV Cellular Integration

Cell-Cell and Cell-matrix adhesion: An overview.Cell-Cell, interaction: ECM; Collagen, hyaluronan&proteolycans, laminin, integrins and fibronectins. Cell-Cell adhesion:

Specialised junctions- Desmosomes, Gap junctions, Adhesion molecules-Cadherins-Connexins. Cell-Cel1 signaling- Signaling molecules and their receptors: functions of cell surface receptors, pathways of intracellular signal transduction, second messengers. (G-protein coupled receptors, receptor tyrosine kinases. Ras. MAP kinases.

UNIT-V Protein Transport and degradation

Protein targeting: post-translational modifications in prokaryotes and eukaryotes, role of signal peptide, role of endoplasmic reticulum (protein targeting- signal sequence hypothesis, targeting of proteins to different compartment of mitochondria, ER, plasma membrane, lysosomes, peroxisomes and chloroplast) translocation, heat shock proteins, molecular chaperons, glycosylation, SNAPs and SNAREs, bacterial signal sequences, mitochondrial, chloroplast and nuclear protein transport, endocytosis-viral entry, ubiquitin TAG protein destruction.

TEXT BOOKS:

1. *Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P. and Weil, P.A.* 2015. **Harper's Illustrated Biochemistry**, 30th edition. The McGraw-Hill Inc.
2. *Verma, P.S.* and *Agarwal, V.K.* 2014. **Cell Biology, Genetics, Molecular Biology**, **Evolution and Ecology**, 1st edition, S. Chand and Company Limited, New Delhi.
3. *Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walltre, P.* 2015. **Molecular Biology of the cell**, 6th edition, Taylor and Francis Company.
4. *Kar, G., Iwasa, J. and Marshall, M. 2016*. **Karp's Cell and Molecular Biology: Concepts and Experiments,** 8th edition, John Wiley and Sons, USA.

REFERENCE BOOKS:

1. *Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell*. 2016. **Molecular Cell Biology** 8th edition, WH Freeman and Company, New York.
2. *Cooper*, *G.M. and Hausman, R.E.* 2007. **The Cell: A Molecular Approach,** 4th edition, Sinauer Associates, Inc., USA.

17PBC13E	CORE-V: MOLECULAR BIOLOGY	SEMESTER-I

PREAMBLE:

- This course offers an overview of basic structure and functioning of genetic materials.
- Students can gain an in-depth knowledge and understanding of mechanism of DNA replication, repair, transcription, and protein synthesis and gene regulation at the molecular level.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Compare experimental evidences that proved DNA as the genetic material. Explain evidences that support duplication of DNA in pro- and eukaryotes.	K3, K4 &K5
CO2.	Justify and value the machineries that perform transcriptional and post-transcriptional events in pro-and eukaryotic cells.	K4&K5
CO3.	Explain and judge the importance of genetic code in translational and post-translational processes both in pro- and eukaryotes.	K4& K5
CO4.	Determine protein targeting to different compartments of eukaryotic cells. Propose a research project on heat shock proteins and molecular chaperons. Discuss about gene expression and regulation.	K5 &K6
CO5.	Discuss elaborately on theoretical aspects of mutagenesis. Develop a research project on cancer biology.	K5 &K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	M	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC13E	CORE-V: MOLECULAR BIOLOGY	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Chromosome Structure

Eukaryotic and Prokaryotic chromosomes: structure, banding pattern, c-value, complexity heterochromatin, centromere, nuclear organizer, telomeres, Kinetic complexity of DNA, cot curve, and classes of DNA sequences. Structure of nucleosome, histones, non-histone proteins, and their properties, role of histones in chromatin folding, concept of gene. Evidences for DNA as genetic material: Types of replication, Demonstration of evidence for semi conservative replication- Meselson and Stahl experiment.

UNIT-II Replication and Recombination

Replication in prokaryotes: replications in circular chromosomes- Cairns model, rolling circle model. Inhibitors of replication, replication in RNA virus, plasmid replication, retroviruses, temporal control of replication. Eukaryotic replication. DNA recombination: Homologous, site specific and transposition, Homologous recombination: Holliday Model, Messelsson- Radding Model, Rec BCD pathway. Site-specific recombination: Lambda phage integration, and excision rearrangement, of immunoglobulin genes. Transposition: Prokaryotic transposition, conservative and replicative transposition. Eukaryotic transposable elements, yeast and Drosophila transposons.

UNIT-III Transcription

Transcription- definition, coding strand, template strand, sense strand and antisense strand, promotor, foot-printing experiment, DNA-dependent RNA polymerase, role of Prinbnow box, template binding, prokaryotic transcription, Rho-dependent and independent transcription, posttranscriptional processing in prokaryotes, alternative splicing, RNA editing. Eukaryotic transcription, post-transcriptional modifications of eukaryotic RNAs, RNA splicing, introns and splicing reactions, exons, spacer sequences, enhancers. Transcriptional regulation in eukaryotes-hormonal (steroid hormone receptors), phosphorylation (Stat proteins).

UNIT-IV Translation and gene regulation

Genetic code- definition, deciphering of the genetic code, codon dictionary, salient features of genetic code. Structure of t-RNA, activating enzymes, binding of amino acids to t-RNA, wobble mechanism and its significance, composition of prokaryotic and eukaryotic ribosomes, leader region, Shine-Dalgarno sequence, reading frame-shift, prokaryotic and eukaryotic protein biosynthesis- initiation, elongation, translocation and termination, polysomes. Inhibitors of protein synthesis. Gene expression and regulations, molecular mechanism of regulation, prokaryotes-operon model, lac, trp, arabinose operons, repression and attenuation, eukaryotes- C-value paradox, repetitive DNA, gene dosage and gene amplifications.

UNIT-V DNA Damage and Repair

Mutagenesis and replication fidelity, numerical mutations involving full chromosome set - causes, structural chromosome mutations- balanced and unbalanced- causes, karyotype mixing, misincorporation of

nucleotides during DNA synthesis, transient and spontaneous chemical changes in DNA, frameshift mutagenesis, DNA damage- different types, DNA repair - direct reversal repair, direct repair of nicks, excision repair, nucleotide excision repair, mismatch repair, long and short patch mismatch repair, recombination error, SOS response and mutagenic repair.

TEXT BOOKS:

1. *Verma P.S.* and *Agarwal V.K.* 2014. **Cell Biology, Genetics, Molecular Biology**, **Evolution and Ecology**, S. Chand Publications, New Delhi.
2. *Kar, G., Iwasa, J. and Marshall, M. 2016.* **Karp's Cell and Molecular Biology: Concepts and Experiments,** 8th edition, John Wiley and Sons, USA.
3. *Voet, D. and Voe*t *J.G.* 2011. **Biochemistry,** 4th edition, John Wiley and Sons, New York.

REFERENCE BOOKS:

1. Robert, F. 2005. **Molecular biology**, 3rd edition, McGraw-Hill.
2. Twyman, R.M. 1998. **Advanced molecular biology,** 2nd edition, Viva Books Pvt Ltd., New Delhi.
3. Lewin, B. (2000). **Genes VII**, Oxford University Press, Cell Press, London.
4. *Cooper*, *G.M. and Hausman, R.E.* 2007. **The Cell: A Molecular Approach,** 4th edition, Sinauer Associates, Inc., USA.

17PBC13P	CORE PRACTICAL-I: BIOCHEMISTRY-I	SEMESTER-I

Total Credits: 3
Hours per week: 6

PREAMBLE:

- This course offers an overview of experimental aspects involving biomolecules, cell biology, enzymes and molecular biology.
- Students can gain an in-depth knowledge and understanding on isolation and characterization of biomolecules, proteins, nucleic acids, enzymes and cells in a laboratory environment.

CONTENTS

Biopolymers:

1. Isolation and estimation of starch from potato.
2. Isolation and estimation of cholesterol from egg yolk.
3. Isolation and estimation of casein from milk.
4. Isolation and estimation of DNA and RNA from goat liver (genomic) and Bacteria (plasmid) (Spectrophotometric, DNA by DPA and RNA by orcinol).

REFERENCE:

1. 1. **An introduction to Practical Biochemistry, 3rd Edition, 1988**. By David T. Plummer Tata McGraw-Hill Education.
2. **Lab Manual in Biochemistry, Immunology and Biotechnology, 2008.** By Arti Nigam. Tata McGraw-Hill Education (India).

Cell Biology:

1. Observation of prokaryotic and eukaryotic cells with the help of light microscope.
2. Cell counting and viability (Yeast/Bacteria).
3. Mitosis and cell cycle in Onion root-tip cell.
4. Determination of osmotic fragility of a cell (Goat RBC).

REFERENCE:

1. **The World of the Cell**, **8th Edition, 2012**. By Becker WM, Kleinsmit LJ, Hardin J and Bertoni GP. Pearson/Benjamin-Cummings, Boston, USA.

Molecular Biology:

1. Agarose gel electrophoresis of genomic and plasmid DNA.
2. Restriction digestion of DNA (genomic and plasmid).
3. Denaturation (thermal) of DNA and UV absorption studies (demonstration).
4. PCR Technique (demonstration).
5. Determination of N- and C-terminal amino acids (demonstration).
6. Desalting of proteins by dialysis.
7. Proteins separation or purification by gel filtration using sephadex G-25.

REFERENCE:

1. **Molecular Cloning: a laboratory manual vol-1, 2 & 3, 2001**. By Sambrook J & Russell D.W. CSHL Press.

Enzymes: Cellulase

1. Estimation of enzyme activity.
2. Effect of pH on enzyme activity.
3. Effect of Temperature on enzyme activity.
4. Effect of substrate concentration on enzyme activity.
5. Determination of K_m & V_{max} of an enzyme.
6. Enzyme inhibition studies.

REFERENCE:

1. **Practical Enzymology, 2nd edition, 2012**. By Bisswanger H. John Wiley & Sons.

Suggested Readings:

1. **Methods in Enzymology,** Vol. I and II. By S.P.Colowick and N.O.Kaplan eds.
2. **Basic Biochemical Methods,** 2nd ed. By R.R.Alexander and J.M.Griffith.
3. **Hawk's Physiological Chemistry**. By Bernard L Oser.
4. **An Introduction to Practical Biochemistry.** By David T. Plummer.
5. **Laboratory Manual in Biochemistry.** By S. Jayaraman.
6. **Practical Biochemistry.** By Clarke and Switzer.
7. **Methods in Enzymatic analysis**, Vol I-III. By Bergmeyer H.U.

17PBC1EA	ELECTIVE-I: CANCER- BIOLOGY, DIAGNOSIS AND THERAPY	SEMESTER-I

PREAMBLE:

- This course offers an overview on cancer, mutations causing cancer, repair mechanism and multiples of diagnostic and treatment methods for cancer.
- Students can gain an in-depth knowledge and understanding on the basic principles of cancer development and available therapeutic approaches.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Compare and contrast benign and malignant tumors. Explain morphological characteristics of cancer cells.	K4 & K5
CO2.	Justify molecular basis of the cancer. Distinguish interdisciplinary areas in cancer biology. Elaborate the carcinogenetic process.	K4, K5 & K6
CO3.	Discuss about molecular mechanism of oncogenesis and tumor biology. Compare and explain the role of cell cycle in cancer. Value the importance of nutrition given to cancer patients.	K4, K5 & K6
CO4.	Judge the role of tumor suppressor genes and apoptosis. Elaborate on epigenetics.	K5 & K6
CO5.	Elaborate on the choice of diagnosis and therapy available for cancer patients.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC1EA	ELECTIVE-I: CANCER- BIOLOGY, DIAGNOSIS AND THERAPY	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Introduction

Introduction: Cancer cell-morphology and growth characteristics. Types of growth-hyperplasia, dysplasia, anaplasia and neoplasia. Types and prevalence of cancer. Nomenclature of neoplasms, classification based on origin/organ. Differences between benign and malignant tumors.

UNIT-II Carcinogenesis

Cancerepidemiology. Cancer endocrinology. Cancercausing agents-radiation, viruses, chemicals. Multistep carcinogenesis: Initiation, Promotion, Progression. Para-neoplastic syndromes. Mutation- definition, significance, rates and frequency. Mutagenic agents. Molecular basis of mutagenesis, induced and spontaneous mutations, crossing over and segregation. Various types of mutations- addition, deletion, inversion, reciprocal, translocation, insertional translocation and frame-shift mutations. Chemical carcinogenesis- genetic and epigenetic carcinogens, pro-carcinogens and co-carcinogens, promoters and initiators, testing for carcinogenecity, Ames test. Cancer biology and biochemistry-aberrant metabolism during cancer development.

UNIT-III Tumor Markers and Signal Transduction

Oncogenes- RNA and DNA tumor viruses, retroviruses and viral oncogenes. Src and Ras gene, mechanism and characteristic of cell transformation. Molecular mechanism of oncogenesis- proto oncogenesis, oncogene, oncoproteins, tumour suppressor genes involved in cancer.

Tumormarkers; cellular proto-oncogenes-oncogene activation. Radiation-effect of ionising radiations on DNA, chromosomal aberrations. Genetic basis of cancer, metastasis, use of tumor markers in detection and monitoring of cancer**.** Signal transduction in cancer: cell- cell interactions, cell adhesion-invasion and metastasis - VEGF signaling and angiogenesis; role of transcription factors. Growth factors-EGF, TNF-α and TGF-β and growth factor receptors. Free radicals and antioxidants in cancer. Diet and cancer.

UNIT-IV Cell Cycle, Cell Death and Cancer

Cell Cycle Regulation cancer: control of the cell cycle-cyclins and CDKs, and tumor suppressor genes p53, p21 Rb, BRACA1 and BRACA2. Telomeres, and Immortality; Epigenetics- role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes. Role of DNA-methylation in gene silencing-epigenetic silencing of tumor-suppressor genes; Death-signaling pathways-mitochondrial and death receptor pathways, apoptosis and cancer (Intrinsic and extrinsic pathways). Mechanism of apoptosis. Impact of apoptosis on oncogenesis. Principles and methods of cancer diagnosis-biochemical, genetic, cytotoxic, cell growth and viability tests.

UNIT-V Cancer Diagnosis and Cancer Therapy, Stem Cells and Cancer

Diagnostics of cancer by histo-pathlogy, MRI scan, PET-scan, cytogenetis test, kariotype, FISH. Strategies of anticancer drug therapy–chemotherapy-gene therapy. Immuno-therapy and Radiotherapy. Immune therapy, surgical therapy and biologic therapy. Principles of cancer biomarkers and their applications. Stem Cells and Cancer.

TEXT BOOKS:

1. *McKinnell R. G, Parchment R. E., Perantoni A. O, BarryPierce,Damjanov.I,*.2006. **The Biological Basis of Cancer**, Second Edition, Cambridge University Press, United Kingdom.
2. **The Biology of Cancer**: R. A. Weinberg. Garland Science. 2006.
3. Franks,L.M. and Teich,N.M. 1991. **An introduction to Cellular and Molecular Biology of cancer,** 2nd Edition, Oxford University Press.
4. Vincent,T. *et al*., 2011. **Principles and Practice of Oncology: Primer of the Molecular Biology of Cancer**, 1st Edition, Lippincott Williams and Wilkins.

REFERENCE BOOKS:

1. Weinberg,R.A. 2013. **The Biology of Cancer**, 2nd Edition, Garland Science.
2. Hesketh,R. 2013. **Introduction to Cancer Biology**, Cambridge University Press.
3. Pelengaris,S. and Khan,M. 2002. **The Molecular Biology of Cancer**, 2nd Edition, Wiley Blackwell.

17PBC1EB	ELECTIVE-I: NUTRITION THROUGH LIFE CYCLE	SEMESTER-I

PREAMBLE:

- This course offers an overview on nutrition requirement at various stages of human life span.
- Students can gain an in-depth knowledge and understanding on basics of nutrition and their importance in human growth and development at varied stages.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Compare and contrast nutritional requirement at various stages of human growth and development. Explain recommended daily nutritional allowance.	K4 & K5
CO2.	Distinguish nutritional requirement during pregnancy with other stages of human development. Elaborate management of nutrition at various stages of gestation.	K4, K5 & K6
CO3.	Discuss physiology of lactation. Compare nutritional composition of breast milk. Value breast feeding of newborns.	K4, K5 & K6
CO4.	Judge the requirement of nutrition for school going children. Elaborate on the hormonal influence in adolescents and their role in nutrition.	K5 & K6
CO5.	Elaborate on nutritional requirement during aging and post-menopausal stages.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	S	S	S	S	M
CO3	S	S	S	M	M
CO4	S	S	S	M	M
CO5	S	S	M	M	M

L-Low; M-Medium and S-Strong.

17PBC1EB	ELECTIVE-I: NUTRITION THROUGH LIFE CYCLE	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Introduction

Recommended allowances- RDA for Indians, basis for requirement, computation of allowance based on energy expenditure, components of energy expenditure. General concepts about growth and development through different stages of life.

UNIT-II Nutrition during pregnancy

Nutrition in Pregnancy- Stages of gestation, maternal weight gain-nutritional problems and dietary management, importance of nutrition during and prior to pregnancy.

UNIT-III Nutrition during lactation

Nutrition during Lactation- Physiology of lactation- nutritional composition of breast-milk, nutritional concerns during lactation, special foods during lactation, dietary modification- Nutrition in Infancy-Infant feeding, nutritional needs- Feeding problems.

UNIT-IV Nutrition for children and adolescents

Nutrition in school children- feeding school children and factors to be considered. Planning a menu, feeding problems, packed lunch-Nutrition during Adolescence- changes in growth and development, hormonal influences.

UNIT-V Nutrition during aging

Nutrition and work efficiency, Menopausal and post-menopausal women, hormonal changes, nutritional requirement, planning a menu-Physiological changes in aging- Psycho-social and economical factors affecting eating behavior, social situation, knowledge and belief.

TEXT BOOKS:

1. Martin S.R., 1963. **Robert's Nutrition Work with Children**, The University of Chicago Press, Chicago.

REFERENCE BOOKS:

1. Jellife D.B., 1966. **Assessment of Nutrition Status of the Community**, WHO, Geneva.

17PBC1EC	ELECTIVE-I: BASICS OF MOLECULAR BIOLOGY TECHNIQUES	SEMESTER-I

PREAMBLE:

- This course offers an overview on techniques of basic and molecular biology.
- Students can gain an in-depth knowledge and understanding on different molecular biology techniques that are used to isolate, separate, and probe for specific proteins, nucleic acids, and their interactions.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Compare various DNA sequencing approaches. Explain nucleotides in a DNA after sequencing.	K4 & K5
CO2.	Justify isolation and fractionation methods. Distinguish rapid RNA sequencing with that of DNA. Elaborate on methods that distinguish single and double stranded DNA.	K4, K5 & K6
CO3.	Discuss nucleosome organization. Compare histone and non-histone proteins in a chromatin. Value transcriptional y active chromatin.	K4, K5 & K6
CO4.	Judge the importance of moveable genetic elements. Elaborate on extra-chromosomal DNA.	K5 & K6
CO5.	Elaborate on DNA techniques such as pcr, cloning and hybridization.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	S	M	M
CO5	S	S	S	M	M

L-Low; M-Medium and S-Strong.

17PBC1EC	ELECTIVE-I: BASICS OF MOLECULAR BIOLOGY TECHNIQUES	SEMESTER-I

Total Credits: 4
Hours per week: 4

CONTENTS

NIT-I Introduction

Rapid DNA sequencing techniques and strategies details of a range of methodologies, e.g. plus and minus, dideoxynucleotide, partial ribose substitution, Maxims and Gibert. Use of thin gels, resolution etc. interpretation of DNA sequences. Role of counter ions, deep and narrow grooves, single standard DNA,A,B and Z DNA etc. Chirality of the helix, syn/ anti-parallel complementary strands.

UNIT-II Sequencing Technologies

Physical properties of RNA: Classes of RNA, rRNA, tRNA, mRNA, HnRNA etc. Structure and methods of isolation and fractionation, gel electrophoresis and Dnases, Rnases, Phosphodiesterases. Rapid RNA sequencing techniques: plus and minus. Interpretation of RNA sequence. Methods of distinguishing double and single standard DNA.

UNIT-III Chromatin Biology

Reassociation kinetics: cot values, experimental procedure, qualitative significance, use of Ag + cesium sulphate. Satellite DNA: C-value paradox, possible functions of satellite DNA, mechanical strenth, gene library, suppressor mutation, centromeric DNA, spilt genes. Chromatin: Histone and non-histone proteins, general properties of histones, packing density. Nucleosomes, size variable linker, role of H1. Solenoid structure. Transcriptionally active chromatin.

UNIT-IV Movable genetic elements

Movable genes: Transposons and associated inverted repeats. The cassette model, transforming DNA and plant genes. Retrovirus life cycle. Strategies for cloning in plasmid vectors, features of commonly used vectors, their purification and characterization. Identification of bacterial colonies that contain recombinant plasmids. Bacteriophage □ vectors, growth, purification. Cloning in Bacteriophage λ vectors.

UNIT-V Molecular Techniques

Agarose gel and polyacrylamide gel electrophoresis, detection and extraction of DNA from gels. Construction and analysis of c-DNA: Protocols and strategies for c-DNA cloning. Analysis of genomic DNA by southern hybridization. Amplification of DNA by the Polymerase Chain Reaction. Preparation of radiolabled DNA and RNA probes. Synthetic oligonucleotide probes. Expression of cloned genes in cultured cells. Screening expression with antibodies and oligonucleotides.

TEXT BOOKS:

1. *Sambrook Fritsch J and Maniatis,* 2001. **Molecular Cloning**: Vol-I,II,III, 3rd Edition, Cold Spring Harbor Laboratory Press, New York.
2. *Roger, L.Miesfield,* 1999. **Applied Molecular Genetics**, John Wiley and Sons Inc Publications.
3. *Brown* TA, 2001. **Gene Cloning and DNA Analysis**, 4th edition, Blackwell Scientific Publications, London.

REFERENCE BOOKS:

1. *James D Watson,* 1992. **Recombinant DNA**, 2nd edition, WH freeman Company, New York.
2. *Helan Hruezer,* 2001. **Recombinant DNA and Biotechnology**, , 1st edition, ASM Publishers, Washington.

17PBC23A	CORE-VI: IMMUNOLOGY AND IMMUNO-TECHNIQUES	SEMESTER-II

PREAMBLE:

- This course offers an overview on the ability of our immune system to defend against invading pathogens in a logical fashion and characteristics of antigens, antibodies and the nature of antigen-antibody reactions.
- Students can gain an in-depth knowledge and understanding of immune-pathology, immunotherapy and learn techniques practiced in the immunology field.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Understand the formation of immune cells and its regulation. Illustrate the cells involved in immune response. Compare the membrane molecules of immune cells. Explain development of T-cells and B-cells for immune action. Distinguish types of immune responses. Outline clonal-selection.	K2 &K4
CO2.	Illustrate epitopes of B-cell and T-cell. Differentiate anti-genicity and immunogenicity. Understand the application of haptens and adjuvants. Understand the structure &types of Ab. and TCR. Evaluate the genetic basis of antibody and TCR. Evaluate the antigen recognition by MHC.	K3, K4 &K5

	Demonstrate factors and forces of antigen antibody interaction.	
CO3.	Compare different pathways of complement activation and analyze its consequence. Explain cytokines function. Distinguish various mechanism of cell-mediated cytotoxicity. Predict the diseases caused by immunodeficiencies. Demonstrate the immunological response to infection. Illustrate the treatment and vaccine for AIDS.	K3, K4 &K5
CO4.	Predict allergic responses and types. Understand about immunological tolerance. Evaluate animal models for experiments. Explain breakthroughs in transplantation immunology and cancer immunology for the better understanding. Analyze mechanism of autoimmune disorder.	K4 &K5
CO5.	Distinguish different types of vaccines. Analyze and estimate molecules by several types of immune-techniques. Demonstrate the production of antibodies by immune-technology and its application for immunotherapy.	K4 &K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**M**
CO2	**S**	**M**	**S**	**M**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**M**	**S**	**S**	**S**

L-Low; M-Medium and S-Strong.

17PBC23A	CORE-VI: IMMUNOLOGY AND IMMUNO-TECHNIQUES	SEMESTER-II

Total Credits: 4
Hours per week: 5

CONTENTS

UNIT-I

Cells of Immune System and Immune Responses

Cells of Immune System: Haematopoiesis, haematopoietic growth factors, Regulation of haematopoiesis, Lymphoid cells-T-cells, B-cells-lymphoblast and null cells, granulocytes, monocytes and macrophages, CD antigens and membrane molecules of immune cells. Development, maturation, activation and differentiation of T-cells and B-cells, adhesion molecules. Immune Responses: Humoral and cell-mediated immune responses, primary and secondary immune response, cells and molecules involved in innate and adaptive immune response. Theory of clonal selection.

UNIT-II

Antigens,Antigen Recognition, Immuno-globulins and Antigen antibody interaction

Antigens: B-cell epitopes, T-cell epitopes, antigenicity and immunogenicity, factor influencing immunogenicity, Haptens, adjuants; Immunoglobulins: Structure and functions, Isotype, allotypes, Idiotypes; classes, Immunoglobulins superfamily, Gene rearrangement and antibody diversity. T-cell receptor and its diversity. Antigen Recognition: MHC-Genetic organization and inheritance, Antigen processing and presentation (Cytosolic and Endocytic pathway). Antigen antibody interaction: forces involved in Ag-Ab interaction, Factors governing antigen-antibody interactions: affinity, avidity, valency, cross reactivity.

UNIT-III

Complement, Cytokines, Cytotoxicity, Immune Responses to Infections and AIDS Complement Activation: Complement activation pathways (classical, alternative and Lectin), Biological consequence of complement activation. Cytokines: IL. IFN, TNF, CSF- role in immune regulation, Cytokine receptors, Cytokine antagonists. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity. Immune responses to infections: bacteria (tuberculosis) and parasites (malaria). Primary and secondary immunodeficiency diseases. AIDS: Structure of HIV, destruction of T cells, immunity to HIV virus, AIDS vaccine, gene therapy for treatment.

UNIT-IV

Hypersensitivity, Autoimmunity, Animal Models, Transplantation and Cancer immunology Hypersensitivity reactions: Type I, II, III& IV. Immunological tolerance. Autoimmunity: Autoimmunity: general mechanism, (organ specific, non-organ specific), Autoimmune disease in human-Rheumatoid arthritis, Myasthenia gravis, Systemic lupus erythematosus. Experimental Animal Models: inbred strains, SCID mice, nude, knockout mice. Transplantation immunology: Immunologic Basics of Graft rejection, MHC antigens in Cancer immunology: transplantation and HLA tissue typing, Immunosuppressive Therapy. Tumor antigens, Immune response to tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy.

UNIT-V Vaccines and Immuno-techniques

Vaccines: Active and passive immunization, whole organism vaccines, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccines, multivalent sub-units vaccines. Immunotechniques: Hybridomatechnology-Introduction, Antibody engineering (production of monoclonal antibodies), Immunotherapy with genetically engineered antibodies. Detection of molecules using agglutination, precipitation, immune-diffusion, immune-electrophoresis, ELISA, RIA, western blot, immune-precipitation, flow-cytometry/cell sorting and immune-fluorescence microscopy, immune-histochemistry.

TEXT BOOKS:

1. *Richard A Goldsby, Thomas J.Kindt, Barbara A Osborne and Janis Kuby,* 2003. **Immunology**, 5th Edition, W.H.Freeman and Company.
2. *Ian R.Tizard,* 2004. **Immunology (An Introduction),** 4th Edition, Thomson Publishers.
3. *Ananthanarayanan R and YayaramanPanikar,* 2013. **Text book of microbiology,** 9th Edition, University Press (India) Private Ltd.

REFERENCE BOOKS:

1. *Nandini Shetty,* 2005. **Immunology,** Revised 2nd Edition, New Age International Publishers.
2. *P.J. Delves, S.J. Martin, D.R. Burton and I.M. Roitt* 2006. **Roitt's Essential Immunology**, 11th edition, Wiley-Blackwell, USA.

17PBC23B	CORE-VII: MICROBIAL BIOCHEMISTRY	SEMESTER-II

PREAMBLE:

- This course offers an overview on major metabolic and energy exchange pathways in microbial cell homeostasis.
- Students can gain an in-depth knowledge and understanding on applications and significance of biotechnology in diverse areas of agriculture, medicine and environmental biology.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Examine the importance of microbial nutrition. Determine bacterial growth and its growth kinetics.	K3,K4 & K5
CO2.	Evaluate and explain elaborately the central metabolic pathways existing in microbes.	K5 & K6
CO3.	Compare different types of fermentation technology. Design fomenters for the production of industrially important microbes.	K5 & K6
CO4.	Value the application of microbes in agriculture, mining, and energy production and food industry.	K5
CO5.	Discuss in detail the production of antibiotics, amino acids, vitamins and single cell protein from microbial source.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

L-Low; M-Medium and S-Strong.

17PBC23B	CORE-VII: MICROBIAL BIOCHEMISTRY	SEMESTER-II

Total Credits: 4
Hours per week: 5

CONTENTS

UNIT-I

Microbial Nutrition, Medium, Growth and Measurement

Microbial Nutrition- nutritional requirements and nutrients uptake by microbial cells; nutritional groups of microorganisms (autotrophs, heterotrophs and mixotrophs). Growth media- synthetic, complex, selective, enrichment and differential media. Microbial Growth- different phases of growth in batch cultures, synchronous, continuous and biphasic growth. Factors influencing microbial growth. Methods for measuring microbial growth– Direct microscopy, viable count estimates, turbidometry and biomass. Transport of sugars into bacterial cell– the bacterial phosphotransferase system. Growth cycle of bacterial culture; growth of single cells– cell cycle.

UNIT-II

Microbial Energy and Synthesis Biology

Energy yielding metabolism– carbohydrates– EMP, HMP, TCA– importance in bacteria. Phosphoketolase pathway, ED pathway, characteristics of electron transport in bacteria. Metabolism of one carbon and two carbon compounds. Bacterial Chemotaxis and quorum sensing.

Biosynthesis of cell wall– peptidoglycan, teichoic acid, lipids; biosynthesis of straight and branched chain fatty acids, unsaturated fatty acids and cyclopropane fatty acids. Synthesis of triacylglycerols, phospholipids, glycolipids and polyisoprenoids. Metabolism of purines and pyrimidines.

UNIT-III

Fermentation Technology

Fermentation technology– Principles of fermentation, surface, submerged and solid-state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors continuous stirred tank fermentor (CSTF), air-lift fermentor, Types of reactions in fermentations, Selection and characteristics of industrial microorganisms, Primary and secondary metabolites, Strategies for strain improvement and maintenance of the industrial strains, Raw materials, different types of fermentation media, Recovery of products, steps in downstream processing, Bioreactors.

UNIT-IV

Industrial and Agricultural Fermentation Technology

Genetically modified organisms. Microbial products- production of organic acids: Acetic acid, lactic acid, and citric acid. Bio-fuel production- Ethanol and Butanol, Enzymes- amylase, proteases, streptokinase, Production of biogas from agricultural wastes. Production of bio-insecticides from bacteria and fungi; Microbiology of food-food spoilage, controlling food spoilage, types of food borne diseases, microbiology of fermented food, Applied environmental microbiology- water purification and sanitary analysis. Waste water treatment. Bio-degradation, bioremediation and bio-augumentation.

UNIT-V Bio-Pharmaceuticals

Production of antibiotics – source, production, recovery and uses of penicillin, tetracycline, amoxicillin. Production of bacterial and fungal

polysaccharides; Commercial production of xanthan gum. Single cell protein-production and application. Amino acids- glutamic acid, lysine, threonine, phenylalanine**.** Vitamins - B12, B2, and vitamin-C.

TEXT BOOKS:

1. Alexander V., 2007. **Microbial biotechnology**, 2nd edition, W.H. Freeman Publishers.
2. *Stanbury,* P. 2007. **Principles of fermentation technology,** 2nd edition, Butterworth-Heinemann.
3. Ratledge, C. and Kristiansen, B. 2001, Basic biotechnology, 2nd edition, Cambridge University Press.
4. Gupta, P.K. 2010. **Elements of biotechnology**, 2nd edition, Rastogi Publication.

REFERENCE BOOKS:

1. Shuler, M.L. and Kargi, F. 2009. **Bioprocess engineering–** basic concepts, 2nd edition, Prentice Hall.
2. Balasubramanian, D. 1996. **Concepts in biotechnology**, 1st edition, Universities Press (India) Ltd.

17PBC23C	CORE-VIII: METABOLISM AND METABOLIC REGULATION	SEMESTER-II

PREAMBLE:

- This course offers an overview of energy generation and utilization in a biological system.
- Students can gain an in-depth knowledge and understanding of bioenergetics, and catabolic and anabolic pathways of biologically vital macromolecules.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Apply the bioenergetics principles for energy balance sheet calculation of metabolic pathways.	K3
CO2.	Demonstrate the carbohydrate metabolism and interpret its pattern in various physiological conditions.	K2, K5
CO3.	Illustrate the lipid metabolism and relate it with clinical lab findings.	K2, K4
CO4.	Explain and justify amino acids and nucleic acid metabolic pathways and their regulations.	K5
CO5.	Predict and map clinically the pattern of disease with altered metabolism.	K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	S	S	S	S	M
CO3	S	M	S	S	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC23C	CORE-VIII: METABOLISM AND METABOLIC REGULATION	SEMESTER-II

Total Credits: 4
Hours per week: 5

CONTENTS

UNIT-I Bioenergetics

Free energy and entropy. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain–organization and role in electron capture. Electron transfer reactions inmitochondria. Oxidative phosphorylation- F1/F0 ATPase- structure andmechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and Oxidative phosphorylation–uncouplers, ionophores. Regulation of oxidative phosphorylation. Mitochondrial transport systems- ATP/ADPexchange, malate/glycerophosphate shuttle.

UNIT-II Carbohydrate Metabolism

Glycolysis and gluconeogenesis– pathway, keyenzymes and co-ordinate regulation. Pyruvate dehydrogenase complex and the regulation of this enzyme through reversible covalent modification. The citricacid cycle and regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation. Metabolism of galactose and fructose.The glyoxylate cycle. Cori cycle. Anaplerotic reactions.

UNIT-III Lipid Metabolism

Lipid metabolism: Lipogenesis- control of acetyl CoA carboxylase-Role ofhormones-Effect of diet on fatty acid biosynthesis. Regulation ofbiosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress. α, β and ω, Oxidation of fatty acids– Role of carnitine cycle in the regulation of β -oxidation.

Ketogenesis and its control. Lipoprotein metabolism exogenous and endogenous pathways. Biosynthesis and regulation of Eicosanoids.

UNIT-IV Amino acids and Nucleic acids metabolism

Amino acids metabolism: An overview on Gamma-glutamyl cycle. An overview-Methionine as methyl donor (SAM pathway). An overview & regulation of urea cycle. Regulation of alpha-ketoglutarate family, pyruvate family. 3-Phosphoglycerate family, Aspartate family and Aromatic family of amino acids. Allosteric regulation of glutamine synthase.

Nucleic acid metabolism: Pathways of purines and pyrimidines biosynthesis (both de novo and salvage pathways) and degradation. Regulation of purine biosynthesis: PRPP aminotransferases. Regulation of pyrimidine biosynthesis: Aspartate carbamoyltransferase. Regulation of deoxyribonuclcotides by activators and inhibitors.

UNIT-V Porphyrin and Integrated Metabolism

Porphyrin metabolism: Regulation of biosynthesis and degradation hemoglobin, chlorophyll and cytochrome. Elucidation of metabolic pathways**:** Analysis of single step pathway and Multistep pathway, Mutant study-Complementation for metabolic steps analysis. Integration of metabolism: Metabolic profile of the liver, adipose tissue and brain. Metabolic interrelationships in various nutritional and hormonal states-obesity, aerobic, anaerobic endurance, exercise, pregnancy, lactation, IDDM, NIDDM and starvation.

TEXT BOOKS:

1. 1.*Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P. and Weil, P.A.* 2015. **Harper's Illustrated Biochemistry**, 30th edition. The McGraw-Hill Inc.
2. *Geoffrey Zubay,* 1993. **Biochemistry,** 3rd Edition, Wm.C.Brown Publishers.
3. *Voet, D. and Voe*t *J.G.* (2011). **Biochemistry,** 4th edition, John Wiley and Sons, New York.
4. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2007. **Biochemistry and Molecular Biology of Plants,** 1st edition, , John Wiley & Sons.

REFERENCE BOOKS:

1. Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L. 2015. **Biochemistr**y, 8th edition, W.H. Freeman and Company, New York.
2. *Nelson, D.L. and Cox, M.M. 2008.* **Lehninger Principles of Biochemistry,** 5th edition. W.H. Freeman and Company, New York.
3. *Garrett, R.H. and Grisham, C.M.* (2017). **Biochemistry,** 6th edition, Brooks/Cole Cengage Learning, Boston.

17PBC23D	CORE-IX: PLANT BIOCHEMISTRY	SEMESTER-II

PREAMBLE:

- This course offers an overview of various metabolic pathways and their applications in plant productivity.
- Students can gain an in-depth knowledge and understanding of plant cell physiology and its organelles, metabolism of carbon, nitrogen and sulphur compounds, plant therapeutics and gene transfer technology.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Illustrate the organization of plant genomes and photosynthetic structures, and identify the photosynthetic efficiency of plants.	K2 & K3
CO2.	Analyze and assess the interrelationship between metabolic pathways of various plant species.	K4 & K5
CO3.	Combine and formulate research proposals in areas of seed germination, fruit ripening and stress responses.	K6
CO4.	Demonstrate the roles of plant hormones and secondary metabolites, and to apply the knowledge in designing new strategies for commercial production of plant hormones and secondary metabolites.	K2, K3 & K6
CO5.	Choose the proper genetic engineering tools for developing strategies for crop improvement.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC23D	CORE-IX: PLANT BIOCHEMISTRY	SEMESTER-II

Total Credits: 4
Hours per week: 5

CONTENTS

UNIT-I Structure and Functions of Plant Cell and Sub-cellular Organelles

Structure of plant genes. Organisation of plant chromatin. The nuclear, chloroplast and mitochondrial genomes. Interaction between nuclear and organellar genome. Structure of plant cell membrane and cell wall. Photosynthesis: Structure & function of chloroplast system. Photosynthetic pigments and their functions, Photo system-I & II. Photosynthetic electron transport and photophosphorylation.

UNIT-II Carbon and Nitrogen Metabolism in Plants

Calvin cycle (C3 plants), Hatch slack pathway (C4 plants), Crassulacean acid metabolism. Overview of lipid and protein metabolism in plants; bioluminescence in Gonyaulax**.** Role of photorespiration in plants; biochemical basis of PR pathway– C2 cycle; pathways of glucose oxidation in plants; starch biosynthesis and degradation; metabolic transport between organelles. Nitrogen metabolism: Development and structure of root nodules, Role of nod factors in nodule development. Structure of plant nitrogenase system, Symbiotic nitrogen fixation and its regulation. Formation and assimilation of ammonia. Sulphur chemistry and functions; reductive sulfate assimilation pathway. Synthesis and function of glutathione and its derivatives.

UNIT-III Transport in Plant cells

Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration. Biochemistry of seed development, dormancy, biochemical changes during germination of seeds. Biochemistry of fruit development and ripening, Senescence. Structure and function of phytochrome,cryptochromes and phototropins, hormonal regulation of flowering, photoperiodism, and vernilization. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

UNIT-IV Plant Hormones and Secondary Metabolites

Plant hormones: biosynthesis, structure and biochemical mode of action of auxins, gibberellins, cytokinins, abscisic acid and ethylene. Secondary metabolites: classification, biosynthesis and functions of terpenoids, alkaloids, Phenolics, Flavonoids, Coumarins. Strategies and approaches for the overproduction of plant secondary metabolites. Secondary metabolites in clinical, cosmetic and food industries (each with any two examples).

UNIT-V Plant Molecular Biology and Biotechnology

Plant molecular biology and biotechnology: DNA polymorphism– Importance of RFLP, RAPD and SCAR in plant breeding management. Application of tissue culture for plant improvement, cryopreservation. General principles of gene cloning. Isolation and characterization of plant genes and promoters. Different methods of gene transfer –direct and vector mediated. Gene silencing. Site directed mutagenesis. Molecular analysis of transformants. Potential applications of plant genetic

engineering for crop improvement – Genetic engineering of plant for disease resistance (Bt-cotton & Bt-Brinjal), Cytoplasmic Male Sterility, Edible oil, Biodegradable plastics. Delay of fruits ripening (Tomato).

TEXT BOOKS:

1. Goodwin, T.W. and Mercer, E.I. 1997. **Introduction to Plant Biochemistry**, 2nd edition, Pergamon Press.
2. Slater, A., Scott, N.W. and Fowler, M.R. 2008. **Plant biotechnology**, 2nd Edition, Oxford University Press, New York.
3. *Primrose S.B.* 2001.**Principles of gene manipulation**, 6th edition, Blackwell Scientific Publishers, Oxford.
4. Sinha, R.K. 2013. **Modern Plant Physiology**, 2nd revised edition, Alpha Science International Limited.

REFERENCE BOOKS:

1. *Bob B Buchanan,* 2007. **Biochemistry and molecular biology of plants,** First edition, I.K. International Pvt. Ltd., New Delhi.
2. *P.J. Lea, L.L. Castle and Lea,* 1999. **Plant Biochemistry and Molecular Biology**–2nd Edition, John Wiley & Sons.

17PBC23P	CORE PRACTICAL-II: BIOCHEMISTRY-II	SEMESTER-II

Total Credits: 3
Hours per week: 6

PREAMBLE:

- This course offers an overview on practical aspects of immunology, microbiology, metabolism and plant biochemistry.
- Students can gain an in-depth knowledge and understanding of protein based immune-assays, microbial cell culture and characterization methods, methodologies involving the quantification of metabolites.

CONTENTS

Immunology:

1. Agglutination reactions- active bacterial agglutination- Widal test.
   - passive agglutination- Latex agglutination test.
2. Precipitation reactions on gel-Double Immuno diffusion to check antigen cross reactivity.
3. Immuno-electrophoresis of serum proteins.
4. Preparation of antigen from microbes and isolation by SDS-PAGE.
5. Detection of specific antigens by Indirect ELISA technique
6. Identification of specific antigens by Immuno-blotting technique.
7. Coombs test

REFERENCE:

1. **A Practical Guide to Cellular and Molecular Research Methods in Immunology, 2004, 5th Edition**. By Gordon JR. Sakatchewan.

Microbiology:

1. Introduction to sterilization techniques- sterilization of glass wares, autoclaving, preparation of liquid and solid media.
2. Isolation of Bacteria and fungi from soil samples- serial dilution techniques.
3. Establishment of pure culture by spread, streak and pour plate techniques.
4. Identification of bacteria by morphological, staining (simple & Gram's staining) and biochemical characteristics.
5. Measurement of bacterial population by spectrophotometer (growth curve) and colony counting methods.
6. *In-vitro* antibiotic sensitivity test for selected bacterial cultures.
7. Methods for preserving microbial cultures: slant, glycerol stock and lyophilization.

REFERENCE:

1. **Microbiology A Laboratory Manual**, 6th Edition, 2004. By Cappuccino Sherman.

Metabolism:

1. Estimation of urea by Di-acetyl monoxide method.
2. Estimation of uric acid.
3. Estimation of creatinine in urine.
4. Estimation of pyruvate by DPNH (2,4-dinitrophenylhydrazine) method.

REFERENCE:

1. *Varley, H.* 2005. **Practical, Clinical Biochemistry**, 4th edition, CBS publishers & Distributors Pvt Ltd.

Plant Biochemistry:

1. Isolation of chloroplast and estimation of total chlorophyll, chlorophyll-a and chlorophyll-b pigments from leaves.
2. Quantification of Gibberllins in germinating seeds.
3. Assay of amylase in germinating seeds.
4. Determination of protein quantity under different stress conditions.
5. Separation of plant pigments by chromatographic methods.
6. Estimation of phenols in plant tissues.
7. Estimation of peroxidase in plant tissues

REFERENCE:

1. **Biochemical Methods, 2nd edition, 1996**. By Sadasivam S and Manickam A. New Age International Publishers, New Delhi.

Suggested readings:

1. **Practical Biochemistry**: **An Introductory Course** by Fiona Frais.
2. **Methods in Enzymology,** Vol. I and II. By S.P.Colowick and N.O.Kaplan eds.
3. **Basic Biochemical Methods,** 2nd ed. By R.R.Alexander and J.M.Griffith.
4. **Hawk's Physiological Chemistry**. By Bernard L Oser.
5. **Laboratory Manual in Biochemistry.** By S. Jayaraman.

17PBC2EA	ELECTIVE-II: BIOCHEMISTRY OF TOXICOLOGY	SEMESTER-II

PREAMBLE:

- This course offers an overview of the biochemical basis of toxicology and the effects & metabolism of toxins.
- Students can gain an in-depth knowledge and understanding of general toxicology, methods of toxicity testing, toxins from microbes, carcinogenic & teratogenic toxins, pesticide, metal and chemical toxicology.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Value the importance of toxicology. Explain about factors, which influence toxicity.	K5
CO2.	Distinguish and evaluate the biochemical effects of toxic agents on cellular macromolecules and tissues.	K4 & K5
CO3.	Compare and perceive different genetic methods used for testing toxicity.	K4 & K5
CO4.	Examine the effects and metabolism of various microbial toxins, teratogens and carcinogens.	K4
CO5.	Justify the mode of action of toxic pesticides, heavy metals, chemicals and air pollutants.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

L-Low; M-Medium and S-Strong.

17PBC2EA	ELECTIVE-II: BIOCHEMISTRY OF TOXICOLOGY	SEMESTER-II

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Introduction to Toxicology

Definition and scope of toxicology, Classification of toxic agents. Dose-response relationship: Synergism and Antagonism - Determination of ED_{50} and LD_{50}. Acute and chronic exposures, Factors influencing toxicity - Abiotic and Biotic factors, Chemical interactions - Bioaccumulation and Bio-magnification.

UNIT-II Biochemical basis of Toxicology

Mechanisms of Toxicity, Interaction of toxicant with target molecules - Disturbance of excitable membrane function. Altered calcium homeostasis. Covalent binding to cellular macromolecules. Tissue specificity of toxicity - Metabolism of haloalkanes, haloalkenes and their toxic effects on tissues.

UNIT-III Principles and procedures of testing for acute toxic effects

Toxicity testing- Genetic toxicity testing and mutagenesis assays- *In-vitro* test systems- Bacterial mutation tests: Reversion test and Fluctuation tests. *In-vivo* mammalian mutation tests- Host mediated assay and Dominant lethal test. Use of drosophila in toxicity testing. DNA Repair assays, Chromosome damage test. Toxicity testing in animals.

UNIT-IV Effects and Metabolism of toxins

Fungal toxins, Mycotoxins - Aflatoxins, Bacterial toxins- Exotoxins (types-I, -II and -III) and Endotoxins, Viral toxins, Algal toxins, Teratogens, Carcinogens, Mutagens, Snake venom toxin, Spider, Scorpion and Jellyfish toxins, Antivenom. Xenobiotic metabolism: Phase 1– III reactions, Cytochrome-P450's.

UNIT-V Pesticide toxicology, Metal toxicology, Chemical toxicology, Air and water pollutants

Mechanism and site of action of Chlorinated organics (DDT, BHC), organophosphates and carbamates. Mode of action of toxic heavy metals - arsenic, mercury, cadmium and lead. Biochemical effects of ozone, peroxyacetyl nitrate (PAN), carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide. Common air pollutants, water pollutants and their sources, air pollution due to methyl-isocyanate (MIC) and asbestos. Case studies.

TEXT BOOKS:

1. *Duffus and Worth*, 2006. **Fundamental Toxicology**, Royal Society of Chemistry.
2. *De A.K*, 2017. **Environmental Chemistry,** Eighth edition, Newage International Publishers, NewDelhi.
3. *Manahan and Stanley*, 2003. **Toxicological Chemistry and Biochemistry**, CRC Press.

REFERENCE BOOKS:

1. *Klaassen and Watkins III*, 2015. **Casarett and Doull's Essentials of Toxicology**, Third edition, McGraw Hill.
2. *Cockerham and Shane*, 1993. **Basic Environmental Toxicology**, CRC Press.
3. *Marrsand Turner*, 1999. **General and Applied Toxicology**, Third edition, John Wiley and Sons.

17PBC2EB	ELECTIVE-II: NUTRITIONAL BIOCHEMISTRY	SEMESTER-II

PREAMBLE:

- This course offers an overview on metabolic cycles that are significantly related to human nutrition.
- Students can gain an in-depth knowledge and understanding on how ingested food meets the energy and structural requirement of a human body.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Value enzymes and co-enzymes involved in oxido-reduction reactions in a cell. Explain transfer of energy in the respiratory chain.	K5
CO2.	Distinguish and evaluate synthesis and degradation of carbohydrate molecules in a cell.	K4 & K5
CO3.	Compare and perceive bioenergetics of saturated and unsaturated fatty acids.	K4 & K5
CO4.	Examine disorders associated with amino acid metabolism.	K4
CO5.	Justify biological importance of cAMP.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

L-Low; M-Medium and S-Strong.

17PBC2EB	ELECTIVE-II: NUTRITIONAL BIOCHEMISTRY	SEMESTER-II

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Biological oxidation

Enzymes and co-enzymes involved in oxidation and reduction, respiratory chain, phosphates in biologic oxidation and energy capture, role of respiratory chain and mechanism of phosphorylation.

UNIT-II Carbohydrate Metabolism

Glycolysis, Gluconeogenesis, TCA cycle, HMP shunt, bioenergetics, disorders of carbohydrate metabolism- galactosemia, glycogen storage disease, pentosuria, abnormal level in blood glucose.

UNIT-III Lipids Metabolism

Biosynthesis and oxidation of saturated and unsaturated fatty acids, glycerides, phospholipids and cholesterol, bioenergetics, disorders of lipid metabolism, lipoproteins and their significance.

UNIT-IV Protein Metabolism

Biosynthesis of protein, general catabolism of amino acids, deamination, transamination, urea cycle, disorders of amino acid metabolism- phenyl ketonuria, cystineuria, albinism, alkaptonuria, maple syrup disease.

UNIT-V Nucleic Metabolism

Metabolism of nucleic acids- Biosynthesis of purine and pyrimidine nucleotides, DNA replication and repair, biochemical importance of cyclic AMP. Disorders of urine and pyrimidine metabolism- gout,

aciduria, xanthinuria. Structure and properties of DNA, RNA- mRNA, tRNA, rRNA. Functional tests- Gastric, liver, renal and endocrine.

TEXT BOOKS:

1. *Devlin* D.T. 1997. **Text book of Biochemistry with Clinical Correlations**, John Wiley and Sons, New York.

2. *Plummer* D.T. 1997. **An Introduction to Practical Biochemistry**, Tata Mc Graw Hill Publishing Company, New Delhi.

REFERENCE BOOKS:

1. *Eccles* R. 1993, Electrolytes, Body fluids and Acid Base balance, Edward Arnold - A division of Hodder and Stoughton, London.

17PBC2EC	ELECTIVE-II: PLANT TISSUE CULTURE	SEMESTER-II

PREAMBLE:

- This course offers an overview on techniques in plant cell and tissue culture, in vitro conservation, protoplast culture, micro-propagation and genetic engineering.
- Students can gain an in-depth knowledge and understanding the use of cell cultures in the production of biological products.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Value genomic organization plants. Explain various plant culture methods.	K5
CO2.	Distinguish and evaluate haploidy and diploidy.	K4 & K5
CO3.	Compare and perceive homozygous plant lines.	K4 & K5
CO4.	Examine the application of plant transformation to enhance productivity.	K4
CO5.	Justify use of plant secondary metabolites various industries.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**M**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

L-Low; M-Medium and S-Strong.

17PBC2EC	ELECTIVE-II: PLANT TISSUE CULTURE	SEMESTER-II

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I

Genome organization in plants. Cell and Tissue culture in plants: Tissue culture media (composition and preparation). Apparatus and chemicals used in plant tissue culture. Primary culture: cell line, cell clone, callus and suspension culture, Somoclonal variation, Micropropagation, Organogenesis.

UNIT-II

Embryo culture and Embryo rescue, somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Allopheny, Artificial seeds.

UNIT-III

Anther, Pollen and ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth.

UNIT-IV

Application of Plant Transformation for productivity and performance: Herbicide resistance, Insect resistance, virus resistance, Nematode resistance, and Bt genes.

UNIT-V

DNA banking for germ plasm conservation. Production of plant secondary metabolites by plant tissue culture. Ti plasmids, bacterial transformations, insect resistant plants, Edible vaccines.

TEXT BOOKS:

1. *Robert H Smith*, 2005. **Plant Tissue Culture**, **Techniques and Experiments,** Academic press, New Delhi.
2. *Kalyan kumar* DE, 1992. **Plant tissue culture**, New central book agency pvt Ltd., Calcutta.

REFERENCE BOOKS:

1. *Kumar.U,* 2001. **Methods in plant tissue culture**, *Agrobios (india)*–Jodhipur.
2. *Razdan, M.K.,* 1983. **An Introduction to plant tissue culture**, Oxford and IBH, New Delhi.

17PBC33A	BIOSTATISTICS AND RESEARCH METHODOLOGY	SEMESTER –III

PREAMBLE:

- Provide knowledge and skills sufficient to allow students to understand the role of statistics in research.
- Develop skill in the basic methods of data gathering and analysis.
- Provide sufficient background to be able to interpret statistical results in research papers.
- Develop sufficient knowledge of probability and probability distributions to support further studies in statistics and operations research.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Organize a statistical survey Explain methods of collection, classification, tabulation, analysis and presentation of data. Elaborate the range of research methods available to the researcher for collecting and analyzing qualitative and quantitative data.	**K3, K4 & K5**
CO2.	Explain and interpret data using measures of central tendency, measures of variation, and correlation regression analysis.	**K5 & K6**
CO3.	Discuss the utility of sampling theory, probability theory, and theoretical distributions in conducting research.	**K5**
CO4.	Measure and apply various tests of significance to different areas for the purpose of making estimation and inferences based on available data.	**K5**

CO5.	Discuss the objectives of research and to explain the process of research Explain how to plan and conduct a research project. Explain how to formulate and present research findings and recommendations.	**K5 & K6**

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**M**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

L-Low; M-Medium and S-Strong.

17PBC33A	BIOSTATISTICS AND RESEARCH METHODOLOGY	SEMESTER –III

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT I

Organising a statistical survey - Planning and executing the survey. Source of data – Primary and secondary data, Collection - observation; interview; enquiry forms, questionnaire schedule and check list. Classification and tabulation of data. Diagrammatic & graphic presentation of data.

UNIT II

Measures of central tendency; arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of variation: range, quartile, deviation, mean deviation, standard deviation. Correlation analysis: Scatter diagram, Karl Pearson's coefficient of correlation and Spearman's rank method. Regression analysis. Simple problems.

UNIT III

Probability -- definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability. Theoretical distributions. Binomial - 'Poisonn and normal distribution. Normal-importance, properties, conditions and constants of the distribution (proof not necessary). Simple problems.

UNIT IV

Sampling distribution and test of significance: Testing of hypothesis errors in hypothesis testing, standard error and sampling distribution.

Sampling of variables (large samples and small samples). Student's 't' distribution and its applications. Chi - square test & goodness of fit. Analysis of variance one way and two-way classification, Duncans Multiple Range Test. Design of experiment - completely randomized block design randomized clock design.

UNIT V

Research: General-Introduction, types and classification of research-diagnostic, descriptive, exploratory research ethics. Topology for literature research-scientific methods-components of scientific methods. Formulation of research paper. Research design-types of research design – histological design, descriptive design, formation of hypothesis, synopsis writing**.**

TEXT BOOKS

1. S.P.Gupta (2004) Statistical Methods, 32nd edition, Sultan Chand and Sons publications,New Delhi.
2. R.S.N Pillai and Bagavathi (2012) – Statistical Theory and Practices. 7th edition, S. Chand and company Ltd, New Delhi.

REFERENCE BOOKS

1. Ajai S Gaur and Sanjaya S. Gaur, (2008) Statistical methods for practice and Research, Response Books publications.
2. S.K.S Yadav (2002) Statistics Theory and Practice, 1st edition, Sanjeeva Prakashan publication.

17PBC33B	ADVANCED CLINICAL BIOCHEMISTRY	SEMESTER-III

PREAMBLE:

- This course offers an overview on human metabolism and changes that occur at different physiological and non-physiological states.
- Students can gain an in-depth knowledge and understanding on the relevance of biochemistry to health and disease viz., Biochemical markers of disease and clinical significance of steroid, protein and thyroid hormones.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Explain about the factors that influence disorders associated with hemoglobin. Evaluate the deficiency of coagulation factors in blood coagulation.	K4 & K5
CO2.	Examine and distinguish the different types of body fluids, collection, preservation and analysis.	K4
CO3.	Justify the importance of enzymes in clinical diagnosis.	K5
CO4.	Value the importance and applications of minerals in human biology and disease.	K5
CO5.	Perceive the usefulness of biomarkers and isotopes in clinical diagnosis and treatment.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	S	S	S	S	M
CO3	S	S	S	S	M
CO4	S	S	S	S	M
CO5	S	S	S	S	M

L-Low; M-Medium and S-Strong.

17PBC33B	ADVANCED CLINICAL BIOCHEMISTRY	SEMESTER-III

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT I

Hemoglobin Metabolism: anabolism and catabolism–Porphyrins. Porphyrias: Classification, Intermittent Porphyria; Hemoglobin derivatives, Normal and abnormal hemoglobin, Hemoglobinopathies- Sickle cell anemia, Cooleys anemia, Thalassemia- Major and Minor; Presence of Blood in Urine, Hemolytic diseases of Newborn. Coagulation factors: Deficiency of Coagulation factors, Diseases due to deficiency of Coagulation factor, Prothrombin Time, Partial Thromboplastin time, Fibrinogen and Fibrinogen degradation Products.

UNIT II

Collection of Blood –Preservatives, Collection of 24 hours urine – Preservatives, Test for Urinary Compounds in various diseases and Clinical Significance with reference to Creatinine, Protein, Calcium, Copper, Oxalate, Potassium, Sodium, Phosphorous, Urea,Uric acid, VMA, 5-hydroxy indole aceticacid, 17-ketosteroids, Catecholamines, amylase and Bencejones proteins.

Body fluids-Cerebrospinal fluid (CSF), Asitic fluid (peritoneal), Pleural fluid-Chemical Composition, analysis of fluids in diseases– Transudate, exudates. Sweat analysis- Cystic fibrosis.

UNIT III

Clinical Enzymology: Functional and Nonfunctional enzymes, Definition, assay of nonfunctional enzymes and clinical significance of Transaminases-SGOT , SGPT, Creatinine kinase and its Isoenzymes, LDH and its Isoenzyme, ALP and its isoenzyme, ACP, Isocitrate Dehydrogenase, Glucose-6-Phosphate dehydrogenase, 5-NT, Gamma-GT, amylase, Choline esterase.

UNIT IV

Mineral Metabolism- Sources, Daily requirements, Biochemical functions, Deficiency manifestation of Calcium, Phosphorous, Sodium, Potassium, Chloride and Bicarbonate, Ionic balance in the human body, Trace elements and their biological functions-Iron, Zinc, Copper, Magnesium and Manganese. Heavy Metal Poisoning- Lead, Mercury and Aluminium.Deficiency manifestationof Vitamin D, A, C, B2 and Folic acid.

UNIT V

Oncology – Cancer markers in Oral cancer, Prostate cancer, Colorectal cancer, Breast Cancer and Gastrointestinal tract cancer, Ovarian cancer, Pancreatic cancer. Alpha fetoprotein, Carcino embryonic antigens (colon and rectal), Beta-HCG, ca 125 (breast), ca 15.3 (cervical), ca 19.9 (pancreas) and PSA (prostate).

Free radicals in Diseases – Introduction, Typesof free radicals, free radical induced lipid peroxidation and antioxidants(Enzymic – SOD, Gluta thione peroxidase,Glutathione reductase, Non Enzymic – Ascorbic acid, Tocopherol, Reduced Glutathione). Radio isotopes – Examples of isotopes and applications and uses in Medicine.

TEXT BOOKS:

1. *William J. Marshal, Stephen K. Bangert,* 2014. **Clinical Biochemistry: metabolic and Clinical aspects,** 3rd edition. Churchill Livingstone.
2. *Gerhad Meiserbag & Willian H. Simmons* 2016. **Principles of Medical Biochemistry.** Elsevier Health Sciences.
3. *R.Luxton,* 2008. **Clinical Biochemsitry.** Scion Publishing Limited, Oxfordshire.

REFERENCE BOOK

1. *Mayne PD,* 1994. **Clinical chemistry in diagnosis and treatment,** 6th edition, Hodder Arnold Publications.
2. *Gowenlock AH,* 2006. ***Varley's*** **Practical clinical biochemistry,** 6th edition, CBS Publishers.
3. *Rifai N,* 2017. **Teitz Text book of clinical chemistry and molecular diagnosis,** 6th edition – Elsevier Health Sciences.

17PBC33C	GENETIC ENGINEERING	SEMESTER –III

PREAMBLE:

- This course offers an overview of DNA research and the ability to change Gene Expressions.
- Students can gain an in-depth knowledge and understanding on biotechnological applications of Genetic Engineering, for example, Cloning, Vectors, transgenic animals, treating diseases etc.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Distinguish the transmission and Mendelian genetics. Compare the recessive and dominance in Mendelian inheritance.	K_4 & K_5
CO2.	Explain the role of restriction endonucleases in Restriction mapping. Support of nucleic acid probes in application of genetic engineering techniques.	K_4 & K_5
CO3.	List of different types Vectors and its applications.	K_4 & K_5
CO4.	Explain the cloning techniques. Distinguish Cultured insect cell expression systems; mammalian cell expression systems.	K_4 & K_5
CO5.	Analyze the expression of cloned genes by gene transfer techniques in animal cells. Applications of transgenic animals as models in the prevention of human diseases like cystic fibrosis, muscular dystrophy and anticancer therapy.	K_4 & K_5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	M	M	M
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong

17PBC33C	GENETIC ENGINEERING	SEMESTER –III

Total Credit: 4
Hours per week: 4

CONTENTS

UNIT-I

Introduction to genetics. Transmission genetics. Mendelian genetics. Mendelian analysis of inheritance. Genes, chromosomes, alleles, homozygous, heterozygous and mechanism of Mendelian inheritance. Mendel's laws. Linkage – definition, simple measurement and salient features. Salient features of autosomal dominant, recessive, codominance; X-linked recessive, codominant and dominance; Y-linked characters. Extranuclear inheritance.

UNIT-II

Restriction endonucleases – types and functions; restriction mapping. Nucleic acid probes and their applications – cloned probes, oligonucleotide probes; labeling of nucleic acid probes. Nucleic acid hybridization techniques – liquid and dot blot technique; Southern and Northern hybridization; *in situ* hybridization; whole mount *in situ* hybridization. FISH. Polymerase chain reaction – types and applications. DNA fingerprinting, Chemical synthesis of genes. Principles of DNA sequencing: Sanger's sequencing and Introduction to Illumina or Pyro-sequencing.

UNIT-III

Cloning vectors – salient features. Plasmids as vectors – properties, natural plasmids, pBR 322, pSC 101, pUC, bluescript. Mechanism of cloning in plasmid vectors. Bacteriophage vectors – λ phage, λ -vector –

packing of λ -vector *in vitro*. Cosmid vectors, cosmid cloning. DNA (single stranded) vectors – development of M13 vector, PEMBL vector, viral vectors. SV 40, retrovirus, adenovirus, recombinant vaccinia virus vectors. Baculo virus vector for insects. Transposons as vectors. High capacity cloning vectors – bacterial artificial chromosomes, phage P1, yeast artificial chromosomes and PACs.

UNIT-IV

Cloning strategies – genomic and cDNA cloning. cDNA library. Expression vectors – vectors for maximizing protein synthesis, fusion proteins. Expression vectors – expression of cloned genes in *E. coli*. Cloning and expression of cloned genes in *Bacillus subtilis*. Cloning in yeasts; yeast expression vectors, over expression in yeast. Expression in baculovirus system. Cultured insect cell expression systems; mammalian cell expression systems. Recombination, selection and screening methods and processes.

UNIT-V

Gene transfer methods in animal cells – calcium phosphate copreceipitation, lectroporation, microinjection, using viral vectors. Transfer, cotransfer, selectable markers like TK, PSV, PRSV and reporters genes. Gene targeting in animal cells; transfer and expression of cloned genes in *Drosophila*. Gene knockout. Methods for production of transgenic animals (mice, sheep, goat, fish, pig, cow *etc.*,) – retroviral, DNA microinjection and engineered stem cell methods. Applications of transgenic animals; transgenic animals as models/in the prevention of human diseases like cystic fibrosis, muscular dystrophy and anticancer therapy.

TEXT BOOKS

1. *Primrose S.B and Twyman R.M*, 2012. **Principles of Gene Manipulation and Genomics**, Seventh Edition, Blackwell Publishers.
2. *Gardner, Simmons, Snustad,* 1991.**Principles of Genetics, Eighth Edition**, John Wiley and Sons, Inc, Canada**.**

REFERENCE BOOKS

1. *William S Klug, Michael R Cummings*, 2004. **Concepts of Genetics**, Seventh Edition, Pearson Education Ptd .Ltd, Indian Branch, Delhi.
2. *Ernst L Winnacker.* 2003. From Genes to Clones, **Introduction to Gene Technology**, 2003, Panima Publishing Corporation, New Delhi.

17PBC33D	HORMONAL REGULATION AND SIGNAL TRANSDUCTION	SEMESTER-III

PREAMBLE:

- The goal of this course is to provide students knowledge on the endocrine system, its specific secretions and various disorders related to each hormone due to their hypo and hyper secretion.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Explain the cellular and molecular mechanisms of how hormones are synthesized and secreted, and act by binding to their specific receptors on the target cells	**K2**
CO2.	Explain how hormones regulate various aspects of normal physiology and how impairment of hormone synthesis, secretion and/or actions can result in endocrine disorders	**K2**
CO3.	Develop a differential diagnosis for various endocrine conditions	**K6**
CO4.	Evaluate results of laboratory studies ordered for endocrine conditions and review and critique a journal article in the area of endocrinology	**K5**
CO5.	Provided an case study, able to predict and map the clinical disease pattern with hormone levels	**K6**

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC33D	HORMONAL REGULATION AND SIGNAL TRANSDUCTION	SEMESTER-III

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT I

Introduction: Hormones and homeostasis. Neuroendocrine Integration in homeostasis. Classes of chemical messengers. Hormone secretion. Transport and clearance. Feed back control of secretion.

Signal transduction. Plasma membrane receptors, adenylate kinase, Role of G Proteins, protein kinases, tyrosine kinases, inositol phosphates, calcium and calmodulin. Steroid hormone receptors.

UNIT II

Hypothalamus and Pituitary hormones- Biochemistry and mechanism of action.Regulation of synthesis and secretion. Hypo and hyper activity of pituitary hormones-gigantism, dwarfism, acromegaly, diabetes insipidus, syndrome of inappropriate ADH secretion.

Growth factors: neurotropic growth factors, hematopoietic growth factors, epidermal growth factor.

UNIT III

Thyroid hormones- synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions.Antithyroid agents.Thyroid diseases, thyrotoxicosis, goiter, hypothyroidism, Graves' disease, Hashimoto's disease.Thyroid function tests.

Parathyroid Hormone, Calcitonin and Vitamin D- Biological actions, regulation of calcium and phosphorus metabolism, Pathophysiology

UNIT IV

Pancreatic hormones:- Insulin, glucagons, somatostatin. Pancreatic peptide – chemistry, physiological roles and mechanim of action.

Adrenal hormones- Adrenal cortex- glucocorticoids and mineralocorticoids-synthesis, secretion, transport and mechanism of action.Metabolic fate and biological actions.Adrenal androgens-metabolic effect and functions.Adrenal medulla- catecholamines-synthesis, secretion, transport and mechanism of action.Metabolic fate and biological actions. Abnormal secretion of adrenal hormones-Addison's disease, Cushing's syndrome, Congenital adrenal hyperplasia, phaeochromocytoma.

UNIT V

Gonadal hormones- Androgens and estrogens-synthesis, secretion, transport and mechanism of action.Metabolic fate and biological actions. Ovarian cycle, Pregnancy, Biochemical changes in pregnancy.Human infertility – reasons, therapy and treatment.

Hormones from other organs and tissues.

Synthesis, chemistry functions of Melanocyte stimulating hormones (MSH) Melatonin, Neurohormones and gastrointestinal hormones.

TEXT BOOKS

1. *Mac E Handley*, 1984. **Endocrinology**, 4th edition, Hadley, Prentice Hall.
2. *Guyton,* 2003. **Textbook of medical physiology** 10th edition –Hall, Saunders Publishing Co.

17PBC33P	CORE PRACTICAL-III: BIOCHEMISTRY-III	SEMESTER-III

Total Credits: 3
Hours per week: 6

PREAMBLE:

- This course offers an overview of the experimental aspects involving Advanced Clinical Biochemistry and Genetic Engineering.
- Students can gain an in-depth knowledge and understanding by identifying the various constituents of serum and urine and also from recombinant DNA methods.

CONTENTS

Advanced Clinical Biochemistry:

1. Estimation of blood and urine glucose.
2. Estimation of haemoglobin in blood.
3. Estimation of blood cholesterol.
4. Estimation of serum calcium.
5. Estimation of creatine in serum and urine.
6. Estimation of urine bilirubin.
7. Assay of serum AST (SGOT) and ALT (SGPT).
8. Assay of serum acid and alkaline phosphatase.
9. Assay of serum lactate dehydrogenase.
10. Assay of serum amylase.
11. Estimation of serum total proteins and albumin.

REFERENCE:

1. *Varley, H.* 2005. **Practical Clinical Biochemistry**, 4th edition, CBS publishers.
2. *Burtis and Bruns*, 2014. **Teitz fundamentals of Clinical Chemistry and Molecular Diagnostics,** 7th edition, Saunders.

GENETIC ENGINEERING:

1. Preparation of competent cells
2. Calcium chloride mediated transformation.
3. Culture *of E. coli* cells and isolation of plasmid DNA from *E. coli*.
4. Isolation of genomic DNA from *E. coli*.
5. Estimation of the concentration of DNA obtained from *E. coli* – UV Spectrophometer.
6. Separation of chromosomal and plasmid DNA isolated from *E. coli* by Agarose gel electrophoresis.
7. Restriction mapping of digested chromosomal and plasmid DNA.

REFERENCE:

1. *Green and Sambrook,* 2014. **Gene Cloning Laboratory manual,** 4th edition, CSHL Press.
2. *Carson, Miller and Witherow,* 2012. **Molecular Biology Techniques: A classroom laboratory manual**, Academic Press.

Suggested Reading:

1. *Plummer, D. T*. 2000. **An introduction to Practical Biochemistry,** Tata McGraw Hill Publishing Co.
2. *Jayaraman, J*. 2011. **Laboratory Manual in Biochemistry**, New Age International private limited.
3. *Pattabiraman, T. N.* 2015. **Laboratory Manual and Practical Biochemistry**, 4th edition, All India Publishers.
4. *Sawhney and Singh*, 2014. **Introductory Practical Biochemistry**, 5th edition, Narosa Publishing House.

17PBC3EA	ELECTIVE – III: NUTRITION AND CLINICAL NUTRITION	SEMESTER –III

PREAMBLE:

- This course offers an overview of food science and human nutrition knowledge help in achieving and maintaining good health
- Students can gain an in-depth knowledge and understanding on appropriate nutritional care for prevention/and treatment of the various diseases.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Inspect the composition of fiber and nutritional changes in inborn errors. Asses the nutritional status and Understand the nutritional changes due to preservation of food process.	K_4 & K_5
CO2.	Examine the clinical test for Cardiovascular diseases. Explain the importance of nutritional support during treatment of diseases.	K_4 & K_5
CO3.	Test for liver function. Relationship with food habits during treatment of livers diseases such as Hepatitis, Cirrhosis and Hepatic coma.	K_4 & K_5
CO4.	Examine the clinical test for renal functions. Compare the nutritional care- acid and alkaline ash diet and also diet modification with minerals for treatment of renal calculi.	K_4 & K_5
CO5.	Understand the dietary management during treatment of infectious diseases and cancer.	K_4 & K_5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	M	M	M
CO5	S	S	M	M	M

L-Low; M-Medium and S-Strong

17PBC3EA	ELECTIVE – III: NUTRITION AND CLINICAL NUTRITION	SEMESTER –III

Total Credit: 4
Hours per week: 4

CONTENTS

UNIT I

Dietary fiber

Chemical composition of dietary fiber and its importance - Physiological effects and metabolic adaptation during exercise - Nutritional management of inborn errors of metabolism

Diet and nutrition in India

Assessment of nutritional status - Factors affecting digestion and absorption of food - Effects of irradiation, cooking, refining, sprouting and fermentation on nutritional quality of food

UNIT II

Dietary management of Cardio Vascular Diseases

Clinical diagnostic tests and nutrition management for - Dyslipidemias, Atherosclerosis, Angina Pectoris and Myocardial Infarction (MI) and Congestive Cardiac Failure (CCF), Prevention through life style modifications.

Dietary management of Hypertension

Dietary management - Diet related factors influencing hypertension, DASH diet

UNIT III

Dietary management of Liver disease

Types, Etiology, Symptoms and Complications, Physiology, functions of the liver and liver function tests. Metabolic consequences of alcohol

consumption, Dietary management for - Hepatitis, Cirrhosis and Hepatic coma.

UNIT IV

Dietary management of Kidney Diseases

Kidney function tests; Types of kidney diseases:- Glomerulonephritis, Nephrotic Syndrome, Acute Renal Failure (ARF), Chronic Renal Failure (CRF), End Stage Renal Disease (ESRD)-Dialysis and Kidney Transplant. Nephrolithiasis/Renal Calculi : Etiology, Types of stones and nutritional care- acid and alkaline ash diet. Use of sodium, potassium and phosphorous exchange lists in diet planning of kidney diseases patient.

UNIT V

Dietary management in Febrile condition: Metabolic changes during infection and dietary treatment for - Typhoid, Influenza, Malaria, Tuberculosis and HIV & AIDS

Dietary management of cancer:

Dietary management to cancer patients.

TEXT BOOKS

1. Swaminathan S,(1985): Advanced Textbook on Food & Nutrition Vol. 1 & N (2nd Ed. Revised _ Enlarged) Bapp Co..
2. Mahan L.K., Sylvia Escott-Stump (2000): Krause‟s Food Nutrition and Diet Therapy ,10th Edition, W.B. Saunders Company London.
3. B. Srilakshmi, (2007): Dietetics, published by K.K. Gupta For New age International Pvt. Ltd. New Delhi.
4. Swaminathan, M. 1974. Essentials of food and nutrition Vol. II, Applied aspects, Ganesh Pubishers, Madras

REFERENCE BOOKS

1. James Orten and Otto Neuhaus, 2003. Human biochemistry, 10th edition, CV Mosby Company, London.
2. Antia F.P. And Philip Abraham (2001) Clinical Nutrition and Dietetics, Oxford Publishing Company.
3. Passmore P. And M.A. East Wood: Human Nutrition And Dietetics, Churchill Living Stone.
4. WohlShils and Goodheart: Modern Nutrition In Health And Disease, McLAren And Ubrman, Philadelphia.
5. Robinson Ch., M.B. Lawlea, W.L., Chenoweth, and A.E., Carwick: Normal and Therapeutic Nutrition, Macmillan Publishing Company.

17PBC3EB	ELECTIVE-III: MOLECULAR BASIS OF CLINICAL DISORDERS	SEMESTER-III

PREAMBLE:

- Students understand the selected major human diseases at molecular and cellular level

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Illustrate and analyze about the Membrane Protein Defects, Receptor Defects and Developmental Protein Defects	K3 & K4
CO2.	Demonstrate and Analyse Enzyme Defects, disease of red blood cells inflammation	K3 & K4
CO3.	Explain and evaluate the Structural Gene Defects summarize the Molecular mechanism-asthma, obesity diabetes, cataracts	K3 & K4
CO4.	Compare and analyze the Neurodegenerative Diseases	K3 & K4
CO5.	Break down the Cancer genetics	K3 & K4

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	M	S	S	S	S
CO3	M	S	S	S	S
CO4	M	S	S	S	S
CO5	M	S	S	S	S

L-Low; M-Medium and S-Strong.

17PBC3EB	ELECTIVE-III: MOLECULAR BASIS OF CLINICAL DISORDERS	SEMESTER-III

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT I

Membrane Protein Defects-Familial Hypercholesterolemia – LDLR defect-Niemann Pick disease – lysosomal transporter defect - Sitosterolemia – an ABC transporter defect-Receptor Defects -McKune-Albright syndrome – G protein defect -Night Blindness - Rhodopsin - Acromegaly- Growth hormone Developmental Protein Defects-Synpolydactyly- -Holoproencephaly

UNIT II

Enzyme Defects- Smith-Lemli-Opitz Syndrome- Loss of activity, Tay Sach Disease – accessory protein defect -Anemia- hemolytic-G6PDH deficiency, sickle-cell-thalassemias- Hemophilia-Molecular basis of inflammation -Vascular changes-cellular events-chemical mediators-of inflammation-morphologic patterns in acute and chronic inflammation

UNIT III

Structural Gene Defects- Osteogenesis Imperfecta – Collagen defect - Marfan's Syndrome – Microfibril defect – Molecular and cell biology of asthma -mutation leads to cataracts- Multifactorial diseases-obesity-Molecular Basis of Dyslipidemias- Signal transduction in metabolism and diabetes

UNIT IV

Neurodegenerative Diseases-introduction-amyotrophic lateral sclerosis, Parkinson's Disease-Dementia-Alzheimer's Disease, Huntington's Disease, Motor neurone diseases-Molecular Basis of Cystic Fibrosis

UNIT V

Cell cycle and apoptosis related to cancer-Signal transduction defect in cancer-Histone methyltransferase mutations in human cancers Hereditary Cancers-Breast cancer-Hereditary nonpolyposis colorectal cancer

TEXT BOOK

1. *1.Varley, 1980.* **Practical clinical biochemistry, volume I and II,** 5th edition, CBS Publishers.
2. Kumar, (2014), **Robbins and Cotran Pathologic Basis of Disease**, Elsevier

REFERENCE BOOK

1. *Goodman and Gilman,* 2006. **Pharmacological Basis of therapeutics.**11th edition, McGraw Hill publishers.

17PBC3EC	ELECTIVE-III: ANIMAL TISSUE CULTURE	SEMESTER-III

PREAMBLE:

- This course offers an overview of the requirements for growth of animal cell culture, types of animal cell culture and the characterization of cultured cells.
- Students can gain an in-depth knowledge and understanding of the applications of animal cell culture, embryo culture, stem cells and transgenic animals.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Explain about the factors, which influence the growth of animal cell culture. Evaluate the applications of animal cell culture.	K4, K5
CO2.	Examine and distinguish the different types of animal cell culture.	K4
CO3.	Justify the biology of cultured animal cells.	K5
CO4.	Value the importance and applications of embryo culture and stem cells.	K5
CO5.	Perceive the usefulness of transgenic animals.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	M	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

L-Low; M-Medium and S-Strong.

17PBC3EC	ELECTIVE-III: ANIMAL TISSUE CULTURE	SEMESTER-III

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I Animal cell culture

Simple growth medium and balanced salt solutions. Physical, Chemical and metabolic functions of different constituents of culture medium. Applications of animal cell culture – Monoclonal antibodies, recombinant proteins, and gene therapy.

UNIT-II Types of cell culture

Primary and established culture, organ culture, tissue culture, three dimensional culture and tissue engineering. Immobilization of cells and its applications.

UNIT-III Biology and characterization of cultured cells

Tissue typing, cell-cell interaction, measuring parameters of growth, measurement of cell death, apoptosis and its determination.

UNIT-IV Embryo culture and Stem cells

Collection and preservation of embryo, Culturing of embryos, gametogenesis and fertilization in animals.

Stem cells – isolation, identification, expansion, differentiation and uses.

UNIT-V Transgenic animals

Production and applications of transgenic animals, transgenic animals as models for human diseases, transgenic animals in live stock improvement, Animal pharming. Introduction to alternate animal models (*C. elegans, D. melanogaster*, Zebra fish).

TEXT BOOKS:

1. *Spier and Griffiths*, 2012. **Animal cell biotechnology**, Sixth edition, Academic Press.
2. *Aruni*. A, *Wilson,* 2017. **Animal tissue culture,** First edition, MJP Publishers.
3. *Ian. R, Freshney,* 2011. **Culture of animal Cells: A manual of basic technique and specialized applications**, Sixth edition, Wiley-Blackwell.

REFERENCE BOOKS:

1. *John. R. W, Masters,* 2010. **Animal cell culture: A practical approach**, Third edition, Oxford University Press.
2. *Martin Clynes*, 2012. **Animal cell culture techniques**, Springer Science and Business Media.

17PBC43A	BIOINFORMATICS AND DRUG DISCOVERY	SEMESTER-IV

PREAMBLE:

- This course offers an overview on bioinformatics tools and databases, and fundamentals of drug and drug discovery process.
- Students can gain an in-depth knowledge and understanding of the applications tools of bioinformatics in drug discovery and development.

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO number	CO Statement	Knowledge Level
CO1.	Explain about the various types of bioinformatics databases and search engines and evaluate their applications.	K4, K5
CO2.	Examine and distinguish the different types of sequence alignment, protein folding and protein-protein interaction algorithms.	K4
CO3.	Justify novel drug delivery systems and ADME process.	K5
CO4.	Value the importance and applications of drug target identification, validation, computer aided drug discovery, pre-clinical and clinical drug trails.	K5
CO5.	Perceive the usefulness of bioinformatics in overall drug discovery and development process.	K5

MAPPING WITH PROGRAMME OUTCOMES:

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	S	M	M
CO5	S	S	S	M	M

L-Low; M-Medium and S-Strong.

17PBC43A	BIOINFORMATICS AND DRUG DISCOVERY	SEMESTER-IV

Total Credits: 4
Hours per week: 4

CONTENTS

UNIT-I

Definition, concepts of Bioinformatics: Objectives, History of Bioinformatics, Milestones, Genome sequencing projects, Human Genome Project- Science, applications and ELSI. Introduction to Biological databases: Types of databases, sequence databases-nucleic acid sequence databases, GenBank, protein sequence database, Swiss-Prot, PIR, motif database- PROSITE, structural databases, bibliographic databases and organism specific databases- GMOD- Searching and retrieval of data-Entrez and SRS.

UNIT-II

Introduction to sequence Alignment: Pairwise and multiple sequence alignment, substitution matrices, Similarity searching programs, BLAST, FASTA, Multiple sequence alignment – CLUSTAL, Phylogenetic analysis-PHYLIP theory of phylogeny, tree building methods.

Secondary and tertiary structure prediction of proteins. Introduction to proteomics. Fold recognition. Application of proteomics. Mining proteomes, protein expression profiling, identifying protein- and protein complex. Mapping protein modification. protein interactions

UNIT-III

Classification of drugs. New drug delivery systems:- Stability of proteins, carrier systems, Nano technology, Liposomes, microspheres, RBCs and Viruses. Porous hydrogel system, Osmotic drug delivery systems,

supersonic powder injection system, monoclonal antibody based drug delivery. Site of drug action; methods of location sites of drug action. Drug absorption, distribution and elimination. Consequence of drug-protein interaction. Dose response relationship, LD50, ED50, IC50; drug receptor interactions.

UNIT-IV

Drug discovery: therapeutic targets for drug discovery. Combinational chemistry in drug development-principles-Molecular diversity of proteins. Computer assisted drug design-anti AIDS drug design. Quantitative structure activity relationship (QSAR), structure based drug design, denovo drug design methods. Pharmacogenomics based drug design, Lipinskis rule of 5.

UNIT-V

Introduction about preclinical and clinical trials, Introduction to medical transcription. Adverse reactions to drugs: Side effects. Drug toxicity in humans. Drug intolerance. Idiosyncracy. Allergic Reactions. Treament of acute drug poisoning. Factors modifying the effect of a drug. Drug Tolerance. Tachy phylaxis. Drug Abuse. Assay of drugs: Chemical and Bioassay.

TEXT BOOKS]

1. *Rastogi S.C,* 2009. **Bioinformatics– concepts, skills and applications**, 2nd edition. CBS publishers.
2. *Mani K, Vijayraja N,* 2002. **Bioinformatics for beginners.** 1st edition, Kalaikathir Achagam, Coimbatore.
3. KD Tripathi, 2013, **Essentials of Medical Pharmacology**, 7th Edition, Jaypee Brothers.
4. Sundararajan, S., and Balaji, R., (2003). Introduction to Bioinformatics, Himalaya Publishing House, Mumbai.
5. Kar A, 2007. **Medicinal Chemistry**, 4th Edition, New Age International (P) Ltd., Publishers. New Delhi.

REFERENCE BOOKS

1. Ignacimuthu S, 2013, Basic Bioinformatics, 2nd Edition, Alpha Science Intl Ltd, Chennai.
2. Lemke TL, Zito SW, Roche VF & Williams DA; 2017, "Essentials of Foye's principles of Medicinal Chemistry"' Wolters Kluwer.
3. Rastogi, S.C., Mendiratta, N and Rastogi, P., 2004. Bioinformatics – Concepts, Skills, Applications. CBS Publishers & Distributors, New Delhi.
4. Mount DW, 2013, Bioinformatics: Sequence and Genome Analysis, 2nd Edition. CSHL Press, New York.

17PBC43P	CORE PRACTICAL-IV BIOCHEMISTRY-IV	SEMESTER-IV

Total Credit: 3
Hours per week: 6

PREAMBLE:

- This course provides an overview of experimental aspects involving cancer biology, biochemical toxicology and clinical nutrition.

CONTENTS

BIOINFORMATICS:

1. Retrieval of sequences from online sequence databases (Plant, bacterial & animal databases)
2. Perform pair wise alignment of sequences using BLAST program.
3. Design primers for the given gene sequences.
4. Perform multiple sequence alignment and generate phylogenetic tree.
5. Retrieve and visualize the three dimensional structures of proteins.
6. Retrieve metagenomic sequences and primer designing to develop STS marker.

CANCER BIOLOGY:

1. Study of abnormal human karyotype and pedigrees (dry lab)
2. Isolation of lymphocytes from blood
3. Study of cell viability/ death assay by use of trypan blue and MTT assay
4. Study of apoptosis through analysis of DNA fragmentation patterns.

BIOCHEMICAL TOXICOLOGY:

1. Determination of Kow (octonal-water coefficient) for a xenobiotic
2. Kinetics of activity loss of an enzyme in the presence of trace amounts of metals