M. Sc. Biochemistry

Syllabus

AFFILIATED COLLEGES

Program Code: 32H

2020 – 2021 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking : Times - 801-1000, Shanghai - 901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Program Educational Objectives (PEOs)	
The **M. Sc. BIOCHEMISTRY** program describe accomplishments that graduates are expected to attain within five to seven years after graduation	
PEO1	To apply the fundamentals of life sciences with all the interdisciplinary fields
PEO2	To educate the basics of Biochemistry with the need for further innovations in Pharma associated companies
PEO3	To demonstrate and expertise the ethical perspectives in all the areas related to Clinical Biochemistry and Food industry
PEO4	To have critical thinking, analysis and predicting solutions for the upliftment of mankind by involving in different researches.
PEO5	To equip the domain knowledge for successful career in academics, industry research and other health care associated concerns
PEO6	To promote life- long learning so as to face any unexpected hazards to mankind
PEO7	To face any sort of global competitions and be the creators of employment opportunities to others

Program Specific Outcomes (PSOs)	
After the successful completion of M.Sc.,Biochemistry program, the students are expected to	
PSO1	To acquire the in depth theoretical and practical knowledge of Biochemistry and the ability to apply the acquired knowledge to provide cost efficient solutions in Biochemistry
PSO2	To integrate and apply the techniques of Analytical biochemistry, Clinical Biochemisatry, Micro and Molecular biology and Basics of bioinformatics
PSO3	To learn the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind
PSO4	To compare and contrast all the interdisciplinary areas like molecular genetics, microbiology, biotechnology, genetic engineering immunochemistry, enzymology, bioinformatics etc
PSO5	To practice an individual to work independently or in groups to carry out research investigations in an efficient manner
PSO6	To understand the Biochemical basis of human diseases, protein structure and conformation, regulatory metabolic pathways, drug development, diagnostic and therapeutic mechanisms

Program Outcomes (POs)	
On successful completion of the M. Sc. Physics program	
PO1	To demonstrate a core knowledge base in the theory and practice of ethical and modern Biochemistry
PO2	To understand that communication comprises attention, listening, responding, and collecting information through different formats
PO3	To develop innovative strategies for the challenges faced by healthcare industries and the biochemical approaches to solve them
PO4	To learn and accomplish tasks with proficient skills in group, to lead the academic integrity and intellect independence
PO5	To master the applications of current tools for the best health care and development of Bio markets
PO6	To have the application of contemporary research methods, skills and techniques to conduct independent research works in all possible fields of Biosciences
PO7	To recognize and appreciate the ideas of others, promote interdependence with different fields, dissolve disagreements, harness cognitive ability , and resolve the conclusions in group settings
PO8	To have the ability of understanding the issues of environmental contexts and sustainable developments
PO9	To promote the self responsibility towards the society with social concern, sincerity, involved professionalism, dedication and volunteering in civic participation
PO10	To motivate the ability of engaging in independence and lifelong learning to update the current scenario

BHARATHIAR UNIVERSITY: COIMBATORE 641 046

M. Sc. BIOCHEMISTRY (Affiliated colleges)

(For the students admitted during the academic year 2020 – 21 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
13A	Paper-I Biomolecular Chemistry	4	5	-	25	75	100
13B	Paper-II Analytical Biochemistry and Bioinformatics	4	5	-	25	75	100
13C	Paper III Enzymes andEnzyme Technology	4	4	-	25	75	100
13D	Paper-IV Cellular Biochemistry	4	4	-	25	75	100
13E	Paper-V Plant Biochemistry and Biotechnology	4	4	-	25	75	100
	Practical-I Core Biochemistry Practical-I	-	-	5	-	-	-
	Elective – Paper I	4	3	-	25	75	100
Total		24	25	5			
SECOND SEMESTER							
23A	Paper-VI Microbial Biochemistry	4	5	-	25	75	100
23B	Paper-VII Immunology	4	5	-	25	75	100
23C	Paper-VIII Advanced Clinical Biochemistry	4	5	-	25	75	100
23D	Paper-IX Molecular Biology	4	5	-	25	75	100
23P	Practical-I Core Biochemistry Practical I	4	-	5	40	60	100
	Elective-Paper II	4	5	-	25	75	100
	Swatch Bharat Summer internship*						
Total		24	25	5			
THIRD SEMESTER							
33A	Paper-X Biostatistics and Research Methodology	4	5		25	75	100

33B	Paper-XI Metabolism and Metabolic Regulation	4	4	-	25	75	100
33C	Paper-XII Genetic Engineering	4	5	-	25	75	100
33D	Paper-XIII Endocrinology	4	4	-	25	75	100
33E	Paper-XIV Pharmaceutical Chemistry and Neurochemistry	4	5	-	25	75	100
	Practical-II Core Biochemistry Practical-II	-	-	4	-	-	100
	Elective-Paper III	4	3	-	25	75	100
	Summer Training and Industrial visit@	2	-	-	50	-	50
Total		26	26	4			
FOURTH SEMESTER							
43P	Practical-II Core Biochemistry Practical-II	4	-	5	40	60	100
43V	Project Work	8	20	-	50	150	200 *
	Elective-Practical/Project	4	-	5	40	60	100 *
	Industrial Visit						
Total		16	20	10			2250
Grand Total		90	96	24			2250
ONLINE COURSES							

* For Project report - 80%; Viva-voce - 20% [Assessment of Internal marks should be based on Monthly assessment and report by the concerned guide and HOD]
* Includes 25 / 40% continuous internal assessment marks for theory and practical papers respectively.
@ No University Examinations. Only Continuous Internal Assessment (CIA)
*Swatch Bharat Summer internship- extra 2 credits would be given. It is mandatory
*Value added course(30-40hours)-extra 2 credits would be given(course is optional)

First Semester

Course code	13A	SEMESTER – I PAPER I BIOMOLECULAR CHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basic knowledge in structure of biomolecules	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are:

1. This course provides an overview of the macromolecules that are key to all living system. Topics covered include structure, properties and functions of polysaccharides, proteins, lipids and nucleic acids.
2. This course is to develop sufficient knowledge about higher order structures i.e. Polysaccharides, proteins, lipids and nucleic acids.
3. At the end of this course students will be able to obtain a keen knowledge on the characterization of biological macromolecules.

Expected Course Outcomes:

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

1	Knowledge on the conformational properties of biological proteins.	K2, K1
2	An in depth understanding on the basic principles, mechanisms and significances of bio polysaccharides.	K2, K3
3	Information about all lipids and their biological significance.	K1 K3
4	Clear idea on the types, structure and biological functions of nucleic acids	K4, K5
5	Clear understanding on the characterization and nucleic acid recognition by proteins and their related techniques.	K5, K4

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

Unit:1	Polysaccharides	15 hours

Polysaccharides – occurrence, structure and biological functions of cellulose, chitin, starch and glycogen. A brief account on chitin, fructans, arabinans and galactans.
Occurrence, structure, isolation, purification, properties and biological functions of mucopolysaccharides, bacterial cell wall polysaccharides and blood group antigens. Glycosaminoglycans – structure and biological role of hyaluronic acid, chondroitin sulfate and heparin. Sialic acid – structure and significane, proteoglycans. A brief account on glycoproteins and their biological importance.

Unit:2	Proteins	14 hours

Orders of protein structure. Primary structure – determination of amino acid sequence of proteins. The peptide bond. Secondary structures – α-helix, β-sheet and β-turns. The Ramachandran plot, Pauling and Corey model for fibrous proteins. Reverse turns and super secondary structures. Collagen triple helix Tertiary structure – α and β domains. Conformational properties of silk fibroin. Quaternary structure of proteins. The structure of haemoglobin. Models for haemoglobin allostery.

Unit:3	Lipids	14 hours

Lipids – Introduction, fate of dietary lipids, simple lipid, compound lipids and derived lipids – structure and functions.
Fatty acids – saturated, unsaturated and hydroxy fatty acids. Phospholipids and glycolipids – structure and functions.
Plant and animal sterols – structure and functions of cholesterol.
Lipid peroxidation and antioxidants. Lipoproteins – classification and composition.

Unit:4	Nucleic acids	15 hours

Nucleic acids DNA double helical structure – Watson and Crick model. A, B and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number.
Properties of DNA – buoyant density, viscosity, denaturation and renaturation – The cot curve – Chemical synthesis of DNA. DNA binding motifs in proteins – the basic helix loop helix (bHLH) motif, zinc finger, the leucine zipper and helix-loop helix.
Major classes of RNA – mRNA, rRNA, tRNA, sn RNA, hn RNA – structure and biological functions. RNA binding motifs in proteins. Molecular aspects of protein-nucleic acid binding – direct interactions. Techniques characterizing nucleic acid-protein complex – gel retardation assay, DNase I footprinting.

Unit:5	Structural Biology	15 hours

Protein sequences, Basic polypeptide stereochemistry, Protein structure determination by X-ray crystallography. Principles of protein purification, crystallization,
RNA secondary structure prediction and covariation analysis; RNA secondary structure determination methods, RNA structure determination and dynamics by X-ray and NMR, RNA dynamics studies by other biophysical methods.
Structure and organisation of genomes; genome sequencing, assembly, annotation and functional genomics; gene expression and its regulation.
Artificial intelligence-Introduction.AI in structural prediction and protein folding analysis.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars– webinars

	Total Lecture hours	75 hours

Text Book(s)

1	Lehninger Principles of Biochemistry (7th edition). David L. Nelson; Michael M. Cox, WH Freeman Publishers, 2017.
2	Biochemistry (4th edition). Donald Voet, Judith G. Voet, John Wiley & Sons, 2011
3	Biochemistry (9th Edition). J. M. Berg, J. L. Tymoczko and L. Stryer, W.H. Freeman Publishers, 2019
4	P.Kaliraj,T.Devi,Higher Education for Industry4.0 and Transformation to Education5.0,2020

Reference Books

1	Textbook of Structural Biology (2nd edition). Anders Liljas. World Scientific, 2019.
2	Nucleic acid structure and recognition. Neidle, Oxford University Press, 2002.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/102/105/102105034/
2	https://www.mooc-list.com/course/biochemistry-biomolecules-methods-and-mechanisms-edx

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

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

Course code	13B	SEMESTER – I PAPER-II ANALYTICAL BIOCHEMISTRY AND BIOINFORMATICS	L	T	P	C
Core/Elective/Supportive		Core	3	1		4
Pre-requisite		Basic knowledge in instrumentation	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. At the end of this course students will be able to have a basic understanding of the theoretical principles involved in Bioinstrumentation
2. To have the practical skills and techniques required in biochemical analysis
3. To become competent in the basic experimental techniques of biochemistry
4. To gain knowledge in using software techniques and internet resources to handle and compare sequence and structure information, search databases and Interpret protein structure.

Expected Course Outcomes:

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

1	Detailed information on the principles and applications of spectroscopic techniques and centrifugation methods.	K1, K2
2	Keen knowledge on separation of bioactive components by chromatographic and electrophoretic techniques.	K4, K5
3	Overview on characterization of biomolecules by diffraction and radio chemical methods.	K2, K3
4	Thorough knowledge on various applications and scopes of Bioinformatics.	K4, K3
5	In depth understanding of the concepts of biological databases and their applications.	K3, K6

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

Unit:1	Spectroscopic Techniques	15 hours

Basic principles, instrumentation and applications of UV, visible and IR spectrophotometers. Electron spin resonance, Nuclear Magnetic Resonance, Mass Spectrometry, Flame Photometry – principles and applications. Centrifugation techniques: Principle and technique of preparative and analytical centrifugation, differential centrifugation, density gradient centrifugation, ultracentrifuge and its application.

Unit:2	Chromatographic Techniques	20 hours

Principle, technique and applications of paper, TLC, ion-exchange, molecular sieve and adsorption chromatography. Principle, components, limitations and applications of GLC and HPLC. Electrophoresis techniques: Principle and technique of paper, gels – SDS-PAGE. High voltage and discontinuous electrophoresis. Isoelectric focusing.

Unit:3	Radio and Immunochemical Techniques	15 hours

X-rays, X-ray diffraction, crystals and detectors – quantitative analysis and applications. ORD and circular dichroism – principles and applications.

Nature and units of radioactivity. Radiochemical methods: basic concepts, counting methods and applications, autoradiography.
Immunochemical techniques and its applications: RIA, ELISA, MIT, FISH.

Unit:4	**Basics of Bioinformatics**	**15 hours**

Introduction: Objectives, Scope and Challenges of Bioinformatics. Connecting to Internet and WWW. Search Engines. Perl/Bioperl and their applications in Bioinformatics. NCBI and DNA Sequence database (GenBank). Alignments: Pairwise (FASTA,BLAST) and multiple alignments (CLUSTALW/X). Phylogenetic analysis (PHYLIP and tree building tools).
Artificial intelligence and Machine learning-Introduction,Tools,Challenges and application in Biological sciences and future aspects.

Unit:5	**Genome and Protein Database**	**13 hours**

Genome Databases. Protein Sequence (Swissprot/UniprotKB) and Structure (PDB) databases. Structure prediction (Secondary and Tertiary). Protein Structure visualization tools (Rasmol/Pymol). Genomics, Proteomics and transcriptomics. Protein expression profiling.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**75 hours**

Text Book(s)

1	Principles and techniques of biochemistry and molecular biology (8th Edition) Wilson and Walkers Cambridge University Press, 2018.
2	Bioinformatics – concepts, skills and applications 1st edition. S.C. Rastogi et al., CBS publishers, 2003
3	Introduction to bioinformatics 1st edition – S. Sundararajan, R. Balaji, Himalya publishing house, 1st edition, 2002
4	P.Kaliraj,T.Devi,Higher Education for Industry4.0 and Transformation to Education5.0,2020

Reference Books

1	Analytical biochemistry – D.J. Homie and H. Peck. Longman group – Rastogic CBS publishers, 1st edition, 2003.
2	Discovering genomics, proteomics and bioinformatics – Campbell, Heyer, Cold Spring Harbor Laboratory Press, 2002

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

1	https://nptel.ac.in/courses/102/103/102103044/
2	https://swayam.gov.in/nd1_noc20_bt10/preview
3	http://www.dypatil.edu/schools/biotech-and-bioinformatics/swayam-nptel-local-chapter/
4	http://www.ncbi.nlm.nih.gov/genbank

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

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

Course code	13C	SEMESTER – I PAPER-III ENZYMES AND ENZYME TECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basic knowledge in Enzymology	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Demonstrate an understanding of the kinetics of enzyme-catalysed reactions
2. Describe how enzymes can be used in the laboratory and industrially.
3. Demonstrate an understanding of the mechanism of enzyme action.
4. Demonstrate a critical appreciation of the preparation and use of immobilised enzymes

Expected Course Outcomes:

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

1	Knowledge on the basic concept and recent advances in Enzyme studies.	K1
2	In depth understanding of current issues in enzyme catalysis, antioxidants etc.	K2, K3
3	Comprehensive understanding on enzyme kinetics and inhibition.	K2, K3
4	Knowledge on applications of enzymes in various industries	K4, K3
5	Clear idea on techniques of immobilization and biosensors.	K5, K5

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

Unit:1	Outline of Enzymes	10 hours

Enzymes- Introduction, Classification of enzymes, Factors affecting enzyme activity. Active site- Definition: investigations of active site structure, Trapping ES complex, use of substrate analogues. Modification by sing chemicals procedures, enzyme modification by treatment with proteases, enzyme modification by site directed mutagenesis. Isoenzymes, Multi-enzyme complex.

Unit:2	Enzyme Catalysis	10 hours

Acid base catalysis, covalent catalysis, Mechanisms of reaction catalyzed by enzyme lysozyme, chymotrypsim. Metal activated, enzymes & metalo Enzyme. Role of metal ions in mechanism - carbonic anhydrase, superoxide dismutase, carboxy peptidase, Coenzymes and cofactors in enzyme catalysed reaction.

Unit:3	Enzyme Kinetics	10 hours

MM Kinetics, LB plot, Eadie - Hofstee plot and Hanes plot. Allosteric enzymes – Co-operativity, Hill plot, K & V series of Enzyme. R & T states. Bi substrate reaction. Concerted, Sequential Enzyme & enzyme inhibition - Types & kinetic differentiation. Of competitive, uncompetitive, non-competitive inhibitions. Allosteric inhibition and regulation.

Unit:4	Enzymes and its Application	15 hours

Application of enzymes in industry; Industrial scale enzyme extraction, purification and stabilization. Industrial application of carbohydrases, proteolytic enzyme, lignocellulose degrading enzyme, pectin and pectic enzyme. Enzyme in animal nutrition.
Non - catalytic industrial proteins, Animal & microbial proteins. Sweet and taste modifying proteins. Application of enzymes in food Industry. Ribozyme, abzyme.

Unit:5	**Immobilised Enzymes**	**13 hours**

Immobilised enzymes- Techniques of immobilization and applications of immobilized enzyme. Enzymes as diagnostic reagents.
Biosensors: calorimetric biosensors: potentiometric biosensors: Amperometric biosensors: immunosensors.
Applications of Monoclonal antibodies.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**60 hours**

Text Book(s)

1	Molecular Enzymology (Tertiary Level Biology) by Christopher W. Wharton; Springer 2013
2	Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Palmer T. and Bonner P. Horwood Publishing Ltd., United Kingdom 2007.
3	Hand book of Enzyme technology 3rd edition – Weisman, Printice Hall.

Reference Books

1	Fundamentals and Application of New Bioproduction Systems (Advances in Biochemical Engineering/Biotechnology). An-Ping Zeng; Publisher: Springer 2016.
2	Enzyme kinetics. A modern approach – Marangoni, John Wiley, 2002

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

1	https://nptel.ac.in/courses/102/102/102102033/
2	https://swayam.gov.in/nd2_cec20_bt20/preview
3	https://www.ebi.ac.uk/training/online/course/enzymes-uniprot

Mapping with Programme Outcomes

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

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

Course code	13D	SEMESTER – I PAPER-IV CELLULAR BIOCHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Knowledge about Cell organelles and their functions	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Demonstrate an understanding of the membrane models and membrane transport.
2. Demonstrate an understanding of the major types of living organisms and the characteristics of and fundamental differences in their body plans/organisation and functions
3. Demonstrate an understanding of the various types of microfilaments and microtubules.
4. Demonstrate an understanding of the structures and functions of the major cell and tissue types of higher animals, particularly humans.
5. Demonstrate an understanding of the cell cycle, its control through apoptosis, and explosion of cancer and its mechanism.

Expected Course Outcomes:

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

1	Disseminate knowledge about the chemistry and functions of cell membrane.	K1, K2
2	Understand about the transport in cell membrane.	K2
3	Knowledge on the power house of the cells.	K2, K3
4	Gain knowledge on cell to cell signalling and interactions.	K3, K4
5	Brain storming about the programmed cell death and cancer cell properties.	K4, K5

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

Unit:1	Membrane Bilayers	10 hours

Membrane bilayer - Models, Membrane lipids - fluidity, Asymmetry phase transition, Liposomes. 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:2	Membrane Transports	15 hours

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 ATP ase; Na+K+ATPase; 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:3	Details View of Mitochondrial System	10 hours

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. ATP Synthase Experiments, Inhibitors

and Uncouplers of oxidative phosphorylation. Microfilaments - Actin – Structures, Assembly, Myosin. Microtubules - Organisation and dynamics, Kinesin and dynein. Striated muscle - structure, excitation - contraction.

Unit:4	**Cell Matrix and Signaling**	**13 hours**

Cell - matrix adhesion, metallo proteinase types and its importance. Cell-Cell, interaction:- ECM; Collagen, hyaluronan&proteolycans, laminin, integrins, adeponectin and fibronectins.
Cell-Cell adjunction: Specialised junctions -- Desmosomes, Gap junctions, - Cadherins - Connexins. Cell-Cell 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, PEP-CK.

Unit:5	**Subcellular Organelles and Cell Cycle**	**10 hours**

Subcellular organelles – structure and biochemical functions of ER, Lysosomes, Chloroplast and Golgi apparatus
Cell Cycle: Overview and its phases. Regulation of cell cycle and regulatory proteins (Cyclins and CDKCs). Studies of frog oocyte maturation and the discovery of Cyclins. Cell cycle control and check points in yest and mamalian cells.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**60 hours**

Text Book(s)

1	Molecular cell biology 8th edition- Lodish, Berk et al., Freeman and Co., 2016
2	Molecular Biology of the Gene, 7th edition, James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael and Losick Richard, Pearson Education. 2017
3	Molecular Biology of the Cell, 6th edition, Bruce Alberts, Alexander D. Johnson, Julian Lewis, W. W. Norton & Company., 2014

Reference Books

1	Biology, 8th edition, Campbell, N.A. and Reece J.B., Pearson Benjamin Cummings, San Francisco 2008.
2	Raven Biology, 12th edition, Raven, P.H., Johnson, G.B., Mason, K.A., Losos, J., Singer, S. McGraw Hill Education, St. Louis. 2018.

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

1	https://nptel.ac.in/courses/102/103/102103012/
2	https://swayam.gov.in/nd2_cec19_bt12/preview
3	https://www.edx.org/learn/cellular-biology

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

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

Course code	13E	SEMESTER – I PAPER-V PLANT BIOCHEMISTRY AND BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basic facts about the biochemistry of plants	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To obtain knowledge on production of transgenic plants.
2. To understand the functions and regulations of major biosynthetic pathways of plants.
3. To become familiar with the exciting topics in plant biology research.

Expected Course Outcomes:

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

1	Understand about the photosystem of plants and chemical synthesis of photophosphorylation.	K1, K2
2	Analysis cognizant of different types of plants based on their carbon absorption.	K4, K3
3	Gain basic knowledge about nitrogen and sulphur metabolism.	K2, K6
4	Overview of Structural organization of plant genome.	K2
5	Clear idea about the plant organelle development.	K2, K5

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

Unit:1	Photo System	10 hours

Photosynthesis – photosynthetic apparatus; organisation of thylakoid; role of chlorphylls, carotenoids and other photosynthetic pigments; light absorption and energy conservation. Light – properties of both particle and wave; light absorbed by pigment molecules; the reaction centre complex. The photo systems I and II. Electron transport pathways in chloroplast membranes. ATP synthesis in chloroplasts; cyclic and noncyclic photophosphorylation.

Unit:2	Plant Metabolism	10 hours

Carbon reactions in C3, C4 and CAM plants - Calvin cycle; Hatch-Slack pathway. Photorespiration: 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; Overview of lipid and protein metabolism in plants; bioluminescence in *Gonyaulax*

Unit:3	Plants and Nitrogen Cycle	10 hours

Nitrogen fixation – symbiotic and non-symbiotic. Symbiotic nitrogen fixation in legumes by Rhizobia – biochemistry and molecular biology of nitrogen fixation – enzymology of nitrogen fixation; Nitrogen metabolism - Nitrate and ammonium assimilation, regulation of nif and nod genes of nitrogen fixation. Interaction between nitrate assimilation and carbon metabolism. Sulphur chemistry and functions; reductive sulfate assimilation pathway. Synthesis and function of glutathione and its derivatives.

Unit:4	Plant Genomics	15 hours
Structure of plant genes. Organisation of plant chromatin. The nuclear, chloroplast and mitochondrial genomes. Interaction between nuclear and organellar genome. Biosynthesis of organelles – development of chloroplast and plastids. Gene transfer to plants; Agrobacterium mediated transformation – Ti plasmids. Ri plasmids. Direct DNA transfer to plants – protoplast transformation. Plant viruses as vectors – CaMV, Gemini viruses, RNA viruses (TMV, potato virus X) as vectors. Advantages and uses of transgenic plants.		
Unit:5	**Plant Cell and Tissue Culture**	**13 hours**
Plant cell and tissue cultute. Tissue culture media – composition and preparation. Micropropagation; somoclonal variation. Callus. Protoplast culture - isolation and purification of protoplasts. Protoplast fusion; genetic modification of protoplasts. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Uses of haploids in plant breeding. Selection of hybrid cells and regeneration of hybrid plants, cybrids. Uses of plant tissue culture.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**60 hours**

Text Book(s)	
1	Plant Physiology and Development – Taiz, L., Zeiger, E., Moller, I.M., Murphy, A., Sinclair Associates. 2015.
2	Plant Biotechnology. The Genetic Manipulation of Plants- Slater, A., Scott, N.W., Fowler, M.R. Oxford University Press. 2016.
3	Lehninger Principles of Biochemistry (7th edition). David L. Nelson; Michael M. Cox, WH Freeman Publishers, 2017.
Reference Books	
1	Plant Biochemistry and Molecular Biology, Lea, P.J. and Leagood, R.C. John Wiley and Sons Ltd., New Jersey, 1999.
2	Plants, genes and crop biotechnology 2nd edition – Chrispeels et al., Jones and Bartlett, 2002
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/102/103/102103016/
2	https://swayam.gov.in/nd2_cec20_bt01/preview

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

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

Second Semester

Course code	23A	SEMESTER – II PAPER VI MICROBIAL BIOCHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Fundamentals of microbial techniques	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Understand the basic principles of metabolic processes within the cell.
2. Gain theoretical knowledge about the fermentation techniques and the synthesis of intermediary components.
3. Acquire theoretical knowledge on bio process technology.
4. Gain insight on microbial production of fermented products.
5. Obtain knowledge on the in vitro cultivation of cells.

Expected Course Outcomes:

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

1	Understand the basic principles of metabolic processes within the cell	K1. K2
2	Theoretical knowledge about the fermentation techniques and the synthesis of intermediary components.	K2, K3
3	Knowledge on bio process technology.	K4, K5
4	Insight on microbial production of fermented products.	K5, K6
5	Knowledge on the in vitro cultivation of cells.	K3, K5

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

Unit:1	Microbial Growth And Metabolism	15 hours

Transport of sugars into bacterial cell – the bacterial phosphotransferase system. Growth – balanced and unbalanced; measurement of growth; continuous culture, fed batch culture; growth and environment; growth cycle of bacterial culture; growth of single cells – cell cycle. Energy yielding metabolism – carbohydrates – EMP, HMP, TCA – importance in bacteria. Phosphoketolase pathway, ED pathway, characteristics of electron transport in bacteria

Unit:2	Fermentations	15 hours

Fermentations: alcoholic fermentation, propionic acid, formic acid, butyric acid and lactic acid fermentation; oxidation of aliphatic and aromatic hydrocarbons; metabolism of one carbon and two carbon compounds. Amino acid biosynthesis; 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:3	Bioprocess technology	13 hours

Bioprocess technology – screening for industrially important microbes, strain improvement for better yield; design of fermenter- parts of the fermenter and their functions; types of fermentation processes. Analysis of batch and continuous bioreactions; stability of microbial reactors; Tower fermenter; air lift fermenter; specialized bioreactors; solid substrate fermentation and media formulation. Inocula prepation; Recovery and purification of products; monitoring of downstream processing.

Unit:4	Microbial products	15 hours

Microbial products – production of organic acids – source, production of microbial process, recovery and applications. Production of organic acids – source, recovery and uses of citric acid and lactic acid. Production of antibiotics – source, production, recovery and uses of penicillin, tetracycline, amoxicillin. Production of bioinsecticides from bacteria and fungi; production of bacterial and fungal polysaccharides; commercial production of xanthan gum.

Unit:5	Infectious microbes	15 hours

Pathophysiology of Infectious microbes (Biochemical and Molecular trigerring). Bacteria- TB, UTI. Virus- Swine flu, Ebola. Fungus- Candidiasis, Aflatoxicosis. Parasite- Malaria, Dengu. Modifications of host metabolism by viral and bacterial pathogens. Endocrine and metabolic aspects of the COVID-19 pandemic.

	Contemporary Issues	
Expert lectures, online seminars – webinars		2 hours
	Total Lecture hours	**75 hours**

Text Book(s)

1	Microbial biotechnology – Alexander *et al.*, -W.H. Freeman Publishers, 1995
2	Biology of microorgansisms – Madigan *et al.*, - Printice Hall, 2002
3	Biochemistry of bacterial growth – Mandelstram, Blackwell Scientific Publishers
4	Principles of fermentation technology 2nd edition – Stanbury *et al.*, Pergamon Publishers, 1995
5	Concepts in biotechnology – Balasubramanian *et al.*, Universities Press (India) Ltd., 2004

Reference Books

1	Basic biotechnology 2nd edition – Ratledge, Kristiansen Cambridge University Press, 2001
2	Elements of biotechnology – Gupta, Rastogi Publication, 1998
3	Bioprocess engineering – basic concepts 2nd editon – Schuler, Karg, Printice Hall, 2001

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

1	https://onlinecourses.swayam2.ac.in/cec20_ag09/preview
2	https|://onlinecourses.swayam2.ac.in/cec20_bt14/preview

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**
CO1	S	M	M	S	S	S	M	S	S	S
CO2	S	M	M	S	S	S	M	S	M	S
CO3	S	M	S	S	S	S	M	S	M	S
CO4	S	M	S	S	S	S	M	S	M	S
CO5	S	M	S	S	S	S	M	S	M	S

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

Course code	23B	SEMESTER – II PAPER – VII IMMUNOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Fundamentals of Immune system	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are
1. Key knowledge about the lymphoid organs and their products.
2. Improve the development of antibodies and their detection.
3. Understanding about the immune cell receptors.
4. Significant knowledge development in over expression of immune system.
5. Detailed study on the immunological disorders of life threatening diseases.

Expected Course Outcomes:

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

1	Gain thorough knowledge on the immune cells.	K2, K1
2	Understand about Ag and Abs interactions and their expression.	K2 K3
3	Pathway of immunological reactions using complement system was understood.	K2 K4
4	Develop knowledge on the cytotoxic assay and vaccine production.	K2 K5
5	Attain knowledge on investigation of life threatening diseases.	K5, K6

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

Unit:1	Experimental Animal Models	10 hours

Experimental Animal Models: inbred strains, SCID mice, nude, knockout mice. hemolytic plaque assay. Cells of the immune system: haematopoiesis. haematopoietic growth factors. Regulation of haematorpoiesis, clinical uses of stem cells. Primary and Secondary lymphoid organs and cells. Leucopoiesis

Unit:2	Immunoglobulins	15 hours

Antigens : Factor influencing immunogencity B cell epitopes, T cell epitopes, Haptens : Mitogens, adjuvant technology; Immunoglobulins: domains classes and biologically active antigenic determinants on lmmunoglobulins. Immunoglobulins superfamily, Monoclonal Antibodies Immunoglobulin genes - Multigene family, antibody diversity, expression of immunoglobulin genes. MHC: Organization, MHC molecules and genes, Cellular distribution, regulation of MHC and immune responsiveness. MHC and disease. Antigen processing and presentation.

Unit:3	**Complement Activation**	**15 hours**
Complement Activation: Pathways, regulation of complement system, Biological consequence of complement activation, complement deficiencies. Cytokines: IL, IFN, TNF, CSF, Cytokine, receptors, Cytokine antagonists, Cytokines related diseases. B&T cell maturation, activation, proliferation & differentiation. Nutritional influences on Immunogenicity.		
Unit:4	**Hypersensitivity reactions**	**16 hours**
Hypersensitivity reactions - Type I, II, III & IV. Hypersensitivity disease. Cell mediated immunity: CTL mediated cytotoxicity, NK cell mediated toxicity. Delayed type hypersensitivity. Immunological tolerance. Vaccines: Active and passive immunization, whole organism vaccines, recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines, multivalent sub-units vaccines. Immunodeficiency diseases.		
Unit:5	**Autoimmunity**	**17 hours**
Autoimmunity: Autoimmune disease in human, animal models, mechanism for induction of autoimmunity, Therapy. Transplantation immunology: clinical manifestation, therapy and bone-marrow transplants. organ-transplants. Cancer immunology: Tumor antigens, immune response to tumors, tumor evasion, Cancer immuno therapy. AIDS: Structure of HIV, destruction of T cells, immunological symptoms of AIDS. AIDS vaccine, gene therapy for treatment.		
	Contemporary Issues	
Expert lectures, online seminars – webinars		2 hours
	Total Lecture hours	**75 hours**

Text Book(s)

1	Kuby immunology 4th edition – Goldsby *et al.*, Freeman and Co. 2013
2	Immunology V-The immune system in health and disease. Janeway Jr.Paul Travels and Co., 2001
3	Immunology 3rd edition – Roitt *et al.*, Mosby publishers 2001
4	Immunology 4th edition - Zubay, W.M.C. Brown publishers, 1992
5	Textbook of Immunology-A Paul 2018

Reference Books

1	Cellular and molecular immunology 2nd edition Abbas *et al.*, W.B.Saunders 2000
2	Cellular and Molecular Immunology 7th Edition,Abul K,2011
3	Introduction to Medical immunology 4th edition, Virella, Marcel Dekker Ltd., 1999

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

1	https://onlinecourses.nptel.ac.in/noc20_bt43/preview

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**
CO1	S	S	M	M	M	S	M	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S
CO3	S	S	M	M	M	S	M	M	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

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

Course code	23C	SEMESTER – II PAPER – VIII ADVANCED CLINICAL BIOCHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Fundamentals of Clinical Biochemistry	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1.Understand the physiological and clinical importance of Hb and its disorders. .

2. Gain detailed knowledge on the biological sample collection and its interpretation.

3. Understand the importance of enzymes in diagnosis of diseases.

4. Obtain clinical Knowledge on physiological organs and its related disordes.

5. Have an depth idea on oncologic aspects and anti- oxidants.

Expected Course Outcomes:

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

1	Understand the physiological and clinical importance of Hb and its disorders	K2
2	Gain detailed knowledge on the biological sample collection and its interpretation.	K2
3	Understand the importance of enzymes in diagnosis of diseases	K2
4	Acquire clinical knowledge on physiological organs and its related disorders.	K3
5	Obtain in depth idea on oncologic aspects and anti oxidants.	K1

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

Unit:1	Specimen collection and processing	15 hours

Specimen collection and processing:- Collection of blood vein puncture, collection with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants. Collection of urine:- Timed urine specimens, urine preservatives. Test for urinary compounds. Clinical significance of urinary components with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. CSF:- Composition and collection ,chemical examination and infections, spinal cord infections. Amniotic fluid:- Origin, collection, composition and analysis of amniotic fluid.
Artificial intelligence and Machine learning in maintaining electronic health record data.

Unit:2	Serology and hematology	13 hours

Serology and hematology :- C- reactive protein test, immunological test for pregnancy. Rheumatoid arthritis (RA) test. ESR., Coagulation test, Prothrombin test. Hemoglobin: Normal and abnormal Hb, Separation of hemoglobin. Thalasemia, Hemoglobinopathies. Erythrocyte metabolic pathways, Disorders of erythrocyte metabolic pathways,. Porphyrins and porphyrias.

Unit:3	Clinical Enzymology And Endocrinology	15 hours

Clinical enzymology and endocrinology:- Principles of diagnostic enzymology - Factors affecting enzyme levels in blood. Principle, assay, and clinical significance of transaminases, creatine kinase,

lactate, Dehydrogenase, phosphatases, isocitrate dehydrogenase, 5'nucleotidase, gamma –glutamyl transferase, amylase, lipase, trypsin, chymotrypsin, choline esterase, glutamate dehydrogenase, glucose -6-phosphate dehydrogenase and ceruloplasmin. Enzyme pattern in diseases:- Myocardial infarction, hepatobiliary diseases. Overview of clinical significance of steroid, protein and thyroid hormones. (Experimental details not required).

Unit:4	**Liver Function Test And Related Disorders**	**12 hours**

Liver function test and related disorders:-Jaundice ,cirrhosis, hepatitis, fatty liver and gall stones. Renal function test and related disorder:- Acute renal failure.glomerular disease,tubular diseases, analysis of urinary calculi. Gastric and pancreatic function test. Hyper and hypo lipoproteinemias and diagnostic test for lipoprotein disorders.

Unit:5	**Oncology**	**17 hours**

Oncology: Definition and types of Cancer (Carcinoma, sarcoma, melanoma etc..). Prevalent cancers: Colorectal, Lung, Breast and Blood cancers. Properties of cancer cells. Genetic basis of cancer: Oncogenes, Antioncogens and Tumor suppressor genes. Viral oncogenes. Carcinogens and teratogens. Molecular diagnosis of Cancer: PCR and RFLP based methods. Tumor Markers such as CA125, CEA, AFP, HCG, Triple (ER/PR/HER2) negative breast cancer markers, BRAC genes. Stem Cell Banking.

Free radicals in diseases:- Introduction , Types of free radicals. Free radical induced lipid peroxidation and antioxidants (Enzymic – SOD, Glutathione peroxidase, Glutathione reductase; Non Enzymic-Ascorbic acid, Tocopherol, Reduced Glutathione .

	Contemporary Issues	
Expert lectures, online seminars – webinars		2 hours

	Total Lecture hours	**75 hours**

Text Book(s)

1	Fundamentals of Clinical Chemistry – Teitz, W.B.Saunders company, 2014
2	Clinical chemistry in diagnosis and treatment 6th edition – Mayne, ELBS Publications, 1994
3	Practical clinical biochemistry, volume I and II, 5th edition – Varley *et.al.*, CBS Publishers, 1980
4	Teitz text book of clinical biochemistry 3rd edition – Burtis *et al.*, William Heinmann medical books, Ltd., 1999

Reference Books

1	Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd.1995
2	Clinical chemistry 5th edition – Mosby, Marshall, 2004
3	Harrison's Principles of internal medicine Vol. I and II. 14th edition, McGraw Hill 2012
4	Clinical Biochemistry-Allan GAW Michael J,an illustrated Colour Text,5th Edition,2013

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

1	https://onlinecourses.swayam2.ac.in/cec20_ago1/preview
2	https://onlinecourses.swayam2.ac.in/sc01_ago1/preview

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

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

Course code	23D	SEMESTER – II PAPER-IX MOLECULAR BIOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basics of Molecular Biology	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:
1. Gain knowledge on structural organization of eukaryotic chromosomes.
2. Understand the molecular mechanism of replication of recombination.
3. Have knowledge about the eukaryotic and prokaryotic transcription process.
4. Obtain knowledge regarding RNA processing and regulation.
5. Understand about the transcriptional processing units

Expected Course Outcomes:

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

1	Obtain knowledge on structural organization of eukaryotic chromosomes.	K2, K1
2	Understand the molecular mechanism of replication and recombination	K2 K4
3	Gain knowledge about the eukaryotic and prokaryotic transcription process.	K2, K4
4	Obtain knowledge regarding RNA processing and regulation.	K2, K4
5	Undersand about the transcriptional processing units	K1, K2

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

Unit:1	Molecular Structure Of Genes And Chromosomes	15 hours

Molecular structure of genes and chromosomes; molecular definition of gene – pro and eukaryotic transcription units. Chromosomal organization of genes and non-coding DNA – protein coding genes. Tandemly repeated genes, single sequence DNA. Mobile DNA – mobile elements. Bacterial insertion sequence, bacterial transposons, viral retrotransposons, non-viral retrotransposons. Structural organization of eukaryotic chromosomes – histone proteins, chromatin. Functional elements of eukaryotic chromosomes. Mutations – types.

Unit:2	DNA replication	14 hours

DNA replication, repair and recombination. General features of chromosomal replication. DNA replication machinery – eukaryotes and prokaryotes. Role of topoisomerases in DNA replication. DNA damage and repair – all types. Recombination – Holliday model, Rec BCD enzyme, Rec A protein, Messelson model, site specific recombination

Unit:3	Prokaryotic transcription	18 hours

Prokaryotic transcription – initiation, elongation and termination (rho dependent and rho independent). Lac operon and trp operon. Transcriptional control of gene expression. Overview of eukaryotic gene control and RNA polymerases. Regulatory sequences in protein coding genes – TATA box, initiators, proximal elements, distant enhancer sites. Transcription initiation by RNA polymerase II, I and III. Regulation of transcription – factor control, Antisense RNA. Mitochondrial and chloroplast DNA – transcription by organelle specific RNA polymerases

Unit:4	**Post RNA transcriptional gene control**	**13 hours**

Post RNA transcriptional gene control. Processing of eukaryotic pre mRNA, hnRNA proteins, Si RNA, RNA binding motifs, splicing, snRNA, spliceosome. RNA editing, macromolecular transport across the nuclear envelope. Nuclear pore complex, cytoplasmic polyadenylation, degradation of mRNA, regulation of processing of rRNA and tRNA

Unit:5	**Genetic code**	**13 hours**

Genetic code – wobble hypothesis. Protein sorting and targeting of mitochondria and chloroplast proteins. Synthesis and targeting of peroxisomal proteins. Overview of secretory pathway. Translocation of secretory products across ER membrane. Insertion of proteins into ER membrane. Posttranslational modification – protein glycosylation in ER and Golgi complex. Receptor mediated endocytosis.

	Contemporary Issues	
Expert lectures, online seminars – webinars		2 hours

	Total Lecture hours	**75 hours**

Text Book(s)

1	Advanced molecular biology – Twyman, Viva publication, 1998
2	Genes VIII – Lewin, Printice Hall, 2004
3	Molecular biology of the cell 4th edition – Alberts *et al.*, Garland Science Publications, 2002
4	Molecular biology of the gene 5th edition – Watson, Pearson Education, 2004
5	The Cell-A Molecular Approach Geoffrey Cooper,Robert E Harsman,3rd edition ASM Press 2004

Reference Books

1	Molecular cell biology 5th edition – Freeman Publishers, 2003
2	Molecular Cell Biology Eighth Edition Harvey Lodish Baltimore et.al.,2010

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

1	https://onlinecourse,swayam2.ac.in/cec20_ma13/preview
2	https:onlinecourse.nptel.ac.in/noc20_bt32/preview

Mapping with Programme Outcomes

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

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

Course code	23P	SEMESTER I AND II CORE BIOCHEMISTRY PRACTICALS - I	L	T	P	C

Core/Elective/Supportive	**Core**	**-**	**-**	**4**	**4**
Pre-requisite	**Basic analytical skills**	**Syllabus Version**		**20-21**	

Course Objectives:

The main objectives of this course are to:
1.Knowledge on structural organization of eukaryotic chromosomes.
2. Understand the molecular mechanism of replication of recombination.
3. Knowledge about the eukaryotic and prokaryotic transcription process.
4. Obtain knowledge regarding RNA processing and regulation.
5. Understand about the transcriptional processing of its involving sub cellular organelle

Expected Course Outcomes:

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

1	Obtained knowledge on structural organization of eukaryotic chromosomes.	K2
2	Understood the molecular mechanism of replication of recombination	K2
3	Knowledge about the eukaryotic and prokaryotic transcription process.	K2
4	Obtained knowledge regarding RNA processing and regulation.	K3
5	Understood about the transcriptional processing of its involving sub cellular organelles.	K1

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

Unit:1	**Clinical Biochemistry**	**30 Hours**

1. Assay of the activity of the following serum enzymes:
a) LDH b) Acid phosphatase c) Alkaline phosphatase d) Aspartate amino transferase e) Alanine amino transferase f) Creatine kinase g) Superoxide dismutase h) glutathione peroxidase
2.Determination of the following from Urine/Serum a) Chloride b) Calcium c) Magnesium
3. Estimation of albumin
4. Estimation of thiobarbituric acid reactive substances (TBARS) in serum
5. Estimation of glucose, protein and chloride in serum

Unit:2	**Genetic Engineering And Molecular Biology** (Demonstration)	**8 Hours**

6. Agarose gel electrophoresis of DNA
7. Preparation of competent *E. coli* – Transformation
8. Plasmid DNA isolation from *E. coli* degradation of mRNA

Unit:3	**Immunology**	**7 Hours**

9. Immunodiffusion – single radial and double diffusion
10. Immunoelectrophoresis
11. Rocket immunoelectrophoresis
12. Agglutination antibodies
13. Identifying blood group and Rh typing

Unit:4	**Separation techniques**	**15 hours**

14. Separation of amino acids by paper chromatography – circular, ascending and descending 15. Separation of amino acids/lipids/sugars by TLC 16. Separation of plant pigments by column chromatography		
Unit:5	**Bioinformatics**	**13 hours**
17. Sequence and Structural Database 18. BLAST and Clustal W 19. Gene Prediction using GenMark and GenScan		
	Contemporary Issues	**2hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 Hours**

Text Book(s)	
1	Experimental Prosedures in Life Sciences S.Rajan R.Selvi Christy CBS Publishers&Distributors Ltd.
2	Laboratory manual in biochemistry by J.Jayaraman,Wiley Eastern Publishers
3	Laboratory manual in Biochemistry by Pattabiraman
Reference Books	
1	David T.Plummer,An introduction to practical biochemistry.3rd Edition.McGraw Hill Publishing Company Ltd
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/106/105/106105166/

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

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

Third Semester

Course code	33A	SEMESTER - III PAPER –X BIOSTATISTICS AND RESEARCH METHODOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Fundamentals of Basic Mathematics	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To provide knowledge and skills for understanding the role of statistics in research.
2. To develop skills in the basic methods of data gathering and analysis.
3. To provide sufficient background to interpret the statistical results in research
4. To develop a sound knowledge of probability and probability distributions to support further studies in statistics and operations research.

Expected Course Outcomes:

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

1	To provide knowledge on conducting survey and data interpretation and to develop skill in identification of research problem, thesis writing and publication in journal	K1, K3
2	To have basic knowledge on measures of central tendency and variation	K1, K2
3	To gain sufficient knowledge on theoretical and normal distribution	K1, K2
4	To grasp knowledge on tests of significance	K4, K5
5	To have better understanding on analysis of variance.	K4, K6

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

Unit:1	Research Methodology	15 -- hours

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.

Thesis writing, Publication in a scientific journal, Preparation of Abstract and manuscript. Research problem, research design, preparation for a research and funding agencies. Bioethics& Biosafety, IPR & Patenting.

Unit:2	Measures Of Central Tendency	15 -- hours

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

Unit:3	**Probability**	**15 -- hours**

Probability -- definition, concepts, Addition and Multiplication theorems (proof of the theorems not necessary) and calculations of probability.
Theoretical, distributions.
Binomial ,Poisson, Fit a Poisson distribution.
Normal distribution -importance, properties, conditions and constants of the distribution (proof not necessary).Simple problems.

Unit:4	**Hypothesis Testing**	**15 -- hours**

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.

Unit:5	**Anova And Designing Of Experiment**	**13 -- hours**

Analysis of variance one way and two-way classification. SPSS Packages and its correlations, Duncans Multiple Range Test. Design of experiment - completely randomized block design and randomized block design. Clinical trials and machine learning algorithms to find association across biological data.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**75 -- hours**

Text Book(s)

1	Statistical methods S.P.Gupta 43rd edition
2	Biostatistics – A foundation for analysis in health science Danien 11th edition
3	Biostatistical analysis - Jerrold H.Zar. Pearson Education, 5th Edition
4	IPR, Biosafety and Bioethics – Deepa Goal and Shomini Parashar, PearsonPublications 1st edition
5	Biostatistics and research Methodology by S.Karthikeyan,R.M.Chaturvedi,R.M.Bhosale 1st edition
6	P.Kaliraj,T.Devi,Higher Education for Industry 4.0 and Transformation to Education 5.0,2020

Reference Books

1	Research Methodology: Methods and techniques by C.R.Kothari, New age International Publishers4th edition
2	.Methods in Biostatistics for Medical Students & Research Workers by Bratati Banerjee, 9th Ed

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

1	https://www.mooc-list.com/tags/biostatistics

2	https://www.mooc-list.com/tags/researchmethodology

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

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

Course code	33B	SEMESTER – III PAPER-XI METABOLISM AND METABOLIC REGULATION	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basic knowledge on Metabolic pathways	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are

1.To understand anabolic and catabolic pathways of carbohydrate, lipids, amino acids and porphyrin metabolism.

2.To learn the role of plant hormones & biosynthesis of secondary metabolites & its application.

3.To have an idea about the regulatory pathways in metabolism

4.To develop and analyse the clinical correlations with the disorders of metabolism

Expected Course Outcomes:

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

1	To understand carbohydrate metabolism and its regulation with energetics	K1, K2
2	To have an overview on lipid metabolism and its regulation	K2, K3
3	To analyse amino acid metabolism and its regulation.	K4, K5
4	To get detailed overview on porphyrin metabolism and its regulation with its enzymes	K2, K3
5	To have knowledge on plant metabolism and its regulation.	K2, K3

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

Unit:1	Carbohydrate Metabolism	12 -- hours

An overview & energetics of glycolysis and gluconeogensis - Regulation of glycolysis and gluconeogenesis - phosphofructokinase, hexokinase and pyruvate kinase as regulatory enzymes in glycolysis; hormone regulation. Anaphlerotic reactions 'filling up reactions

Gluconeogensis: Regulation by allosteric and substrate level control mechanisms.

TCA - cycle - steps: Regulation at branch points :-Pyruvate dehydrogenase. alpha - keto glutarate dehydrogenase, and citrate synthase. Glycogen metabolism - Regulation of glycogen phosphorylase; glycogen synthase by effectors, covalent modification and hormones.

Unit:2	Lipid Metabolism	12 -- hours

An overview of fatty acid anabolism and catabolism - Regulation of fatty acid synthesis - Control of acetyl CoA carboxylase line on fatty acid synthetase complex: Role of hormones; effect of diet on fatty acid synthesis. Regulation of biosynthesis of triacylglycerols, cholesterol, phosphotidyl choline, phosphotidyl ethanolamine and sphingomyelin. Biosynthesis and regulation of prostaglandins, Eicosanoids, Thromboxanes leukotrienes.

Unit:3	Aminoacid Metabolism	12 -- hours

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

Unit:4	**Porphyrin Metabolism**	**12 -- hours**

An overview on porphyrin metabolism-Regulation of biosynthesis & degradation hemoglobin, chlorophyll & cytochrome. Nucleic acid metabolism. Pathways of purine and pyrimidine biosynthesis (both de novo and salvage pathways) & degradation. Regulation of purine biosynthesis. PRPP aminotransferases. Regulation of pyrimidine biosynthesis: Aspartate carbamoyl transferase. Regulation of deoxyribonucleotides by activators and inhibitors.

Unit:5	**Plant Metabolism**	**10 -- hours**

Elucidation of metabolic pathways-Analysis of single step pathway and Multistep pathway , Mutant study-Complementation for metabolic steps analysis.

Plant metabolism - Hormones: Biosynthesis of – Indole acetic acid, Gibberellins, cytokinins, Ethylene, salicylic acid. Pathways of synthesis of secondary metabolites and its application. Alkaloids, Flavanoids and Terpenoids.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**60 -- hours**

Text Book(s)

1	Biochemistry 3rd edition - Zubay, John Wiley,2002
2	Regulation in metabolism - E.A.Newsholme and C.Start, JohnWiley&Sons 4th edition
3	Lehninger's Principles of biochemistry, 4thEd. – Nelson, Cox, McMillan Worth 7th edition
4	Biochemistry 4th edition – Campbell, Farrell, Brooks PublishingCo., Metabolism and metabolic regulation
5	Biochemistry 9th edition – Stryer, Freeman2002
6	Biochemistry and Molecular biology of plants by Bob B.Buchanan,W.Gruissem and R.Jones(2nd edition)
7	Principles or Biochemistry with a human focus – Garrette, Grisham. Brookes Colel997 1st edition

Reference Books

1	Intermediary metabolism by Braeckman, 2018, (NCBI bookshelf)
2	Metabolic Regulation by Henry J Vogel, 3rd Ed. (Vol.5)

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

1	https://www.mooc-list.com/course/biochemical-principle of energy metabolism

Mapping with Programme Outcomes

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

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

Course code	33C	SEMESTER – III PAPER-XII GENETIC ENGINEERING	L	T	P	C

Core/Elective/Supportive	Core	**3**	**1**	**-**	**4**
Pre-requisite	**Basic principles of Genetics**	**Syllabus Version**		**20-21**	

Course Objectives:

1.To learn the advent of DNA research and the ability to change gene expressions,
2. To learn and change human capacities, whether they be physical, cognitive, or emotional.
3.To understand about the potentially momentous biotechnological applications
4.To apply the recent advances of Genetic engineering techniques in various fields

Expected Course Outcomes:

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

1	To have basic understanding of Mendelian genetics	K1, K2
2	To equip on the techniques of gene manipulation	K3, K6
3	Clear understanding of cloning vector, development and their application	K3, K6
4	Knowledge of cloning strategies and expression vectors	K2, K3
5	Adequate knowledge on gene transfer methods and selectable markers and their applications	K4, K3

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

Unit:1	**Genetics**	**13 -- hours**

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, codominance and dominance; Y-linked characters. Extra nuclear inheritance.

Unit:2	**Genetic Techniques**	**15 -- hours**

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. Chemical synthesis of genes, DNA fingerprinting, DNA sequencing.
DNA Foot printing and Sequence generation, Next generation sequencing. DNase Foot Printing Assay.
Artificial Intelligence in Phylogeny and AI in next sequence generation sequencing

Unit:3	**Vectors**	**15 -- hours**

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, X-vector – packing of X-vector *in vitro*. Cosmid vectors, cosmid cloning.
DNA (single stranded) vectors – development of M13 vector, PEMBL vector, λ 2AP 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 aritificial chromosomes and PACs.

Unit:4	**Cloning Strategies And Expression Vectors**	**15 -- hours**

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.
Recombination, selection and screening methods and processes.

Unit:5	**Gene Transfer Methods In Animal Cells**	**15 -- hours**

Gene transfer methods in animal cells – calcium phosphate copreceipitation, electroporation, 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, DNAmicroinjectionandengineeredstemcellmethods.Applications of transgenic animals; transgenic animals as models/in the prevention of human diseases like cystic fibrosis, muscular dystrophy and anticancertherapy.

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

Expert lectures, online seminars – webinars

	Total Lecture hours	**75 -- hours**

Text Book(s)

1	Genomes – Brown, John Wiley, 1999
2	Principles of gene manipulation 6th edition – Primrose et al., Blackwell Scientific Publishers, 2001
3	Genetics 4th edition – Elrod, Stansfield, 2002
4	Molecular cell biology 5th edition – Lodish et al., Freeman Publishers, 2004
5	Molecular biotechnology 3rd edition – Glick, Paternak, Panima Publishers, 2003
6	Genetic engineering – Nicholls, Cambridge University Press, 2002

7	Molcular biology of the gene 5th edition – Watson, Pearson Education
Reference Books	
1	.S. B. Primrose and R. M. Twyman , Principles of Gene Manipulation, Blackwell Science, 2006.
2	.B. Lewin, Genes IX, International Edition, Pearson education, 2008
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.mooc-list.com/tags/genetics
2	https://www.mooc-list.com/tags/genetically-modified-organisms

Mapping with Programme Outcomes

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

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

Course code	33D	SEMESTER III PAPER-XIII ENDOCRINOLOGY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Basics of Physiology and Endocrine system	Syllabus Version		20-21	

Course Objectives:

1. To have a clear knowledge on the chemistry, synthesis, biological functions, mechanism of action and pathophysiology of all the hormones
2. To learn about the various receptors of the hormones with their mechanism of action
3. To learn the biochemical changes occurring in pregnancy, parturition and lactation.
4. To have an idea over Human infertility-reason and therapy

Expected Course Outcomes:

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

1	To gain basic knowledge of hormones and their receptors	K1.K2
2	To provide information on pituitary, thyroid, parathyroid hormone	K2,K4
3	To provide information on melanocyte hormones and pineal gland	K2,K4
4	To gain knowledge on pancreatic hormones and their pathophysiology	K3,K5
5	To gain information on reproductive hormones and their pathophysiology	K3,K6

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

Unit:1	Hormones	12 -- hours

Hormones- Introduction, chemical structure. Hormones and homeostasis.Neuroendocrine integration in homeostasis. Classes of chemical messengers. Hormone secretion. Transport and clearance. Hormones and behavior. Feed back control of secretion .Mechanisim of hormone action –receptors .second messengers. Cytosolic hormone receptors: Eicosonoids and hormone action. calmodulin.

Unit:2	Pituitary Gland	12 -- hours

Pituitary hormones- Anatomy of pituitary gland, hormones of the pituitary, pathophysiology. Endocrine hypothalamus- structure, hypophysiotropic hormones, control of hypothalamic hormone secretion. Feed back mechanisms. Mechanism of action.

Neurohypophysis: Synthesis and chemistry of N.H. hormone, control of neurohypophyseal hormone secretion. Role and mechanism of action of oxytocin and vasopressin. Pathophysiology .

Growth hormones: somatotropins and somatomedins, pathophysiology.

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

Unit:3	Thyroid, Parathyroid And Pineal Gland	12 -- hours

Thyroid gland:- Synthesis and chemistry of hormones, control of thyroid hormone secretion, circulation and metabolism, physiological roles, mechanism of action. Pathophysiology. Parathyroid gland: synthesis, chemistry and metabolism of parathyroid gland hormones ,control of secretion. Physiological role and vitamin D. Mechanism of action of calcium homeostasis,pathophysiology. Melanotropic hormones- chemistry, role of MSH and mechanism of action.Pathophysiology. Pineal gland - melatonin hypothesis, melatonin secretion and circulation, proposed role of pineal, mechanism of action.		
Unit:4	**Pancreas And Adrenal Gland**	**12 -- hours**
Pancreas:- Endocrine pancreas, insulin, glucagons, somatostatin. Pancreatic peptide – chemistry, physiological roles and mechanim of action. Catecholamines :- synthesis, chemistry andmetabolism. Neurohormones:- endorphins-source, chemistry, control of secretion; physiological roles. Mechanism of action and pathophysiology.		
Unit:5	**Reproductive Endocrinology**	**10 -- hours**
Male reproductive system:- source, synthesis, chemistry and metabolism of androgens, Physiological roles and mechanism of action. Pathophysiology. Female reproductive system:- Ovarian steroid hormone synthesis, physiological role, Mechanism of action, Neuroendocrine control of ovarian function. Pathophysiology. Endocrinology of pregnancy, parturition and lactation. Sex differentiation and development, Puberty and hormone control. Human infertility – reasons, therapy and treatment.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**60 -- hours**

Text Book(s)	
1	Endocrinology 6th edition – Hadley & Levine, PrenticeHall
2	Text book of medical physiology 10th edition – Guyton, Hall, Saunders PublishingCo.,
3	Principles of biochemistry 7th edition – Smith *et al.*, McGraw Hill,1983
4	William's Textbook of endocrinology 8th edition – Wilson,Foster.
Reference Books	
1	Lary Jameson J, 2017 Harrisons Endocrinology, McGraw Hill Publishers 20th Edition 2017.
2	Norman Levin, 2019 Manual of Endocrinology and Metabolism 5th Edition, Wolters Kluwer Publishers 2019.
3	Hormones and the Endocrine System: A text Book of Endocrinology by Bernhard K, Winfried B, Springer Nature Publishers 2016
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.mooc-list.com/tags/anatomy-xseries
2	https://swayam.gov.in/endocrinology

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

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

Course code	33E	SEMESTER –III PAPER-XIV PHARMACEUTICAL CHEMISTRY AND NEUROCHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite		Fundamentals of Drug Biochemistry	Syllabus Version		20-21	

Course Objectives:

The main objectives of the course are
1.To understand the various aspects of Pharmacology
2.To have an idea about the various assays used in Pharmacology
3.To know about the genetically modified drugs with their clinical correlations
4.To gain knowledge about the therapeutic measures of various drugs

Expected Course Outcomes:

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

1	To have deeper understanding on various routes of drug administration, its distribution , and excretion.	K1,K2
2	To enable students to learn about principles of basic pharmacokinetics	K2,K3
3	To gain knowledge on drug delivery system	K3,K4
4	To have understanding on genetically engineered products	K5,K6
5	To gain knowledge on neurotransmitters and neuro degenerative disorders	K3,K4

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

Unit:1	Chemistry of Drugs	13 -- hours

Drugs – sources, classification, dosage forms and routes of administration. Drugs – structural features and pharmacological activity, prodrug concept. Absorption, factors modifying drug absorption. distribution, metabolism and excretion of drugs – phase I, II reactions, action of cytochrome P450.

Drug receptors – localization, types and subtypes, models and theories. G-protein coupled receptor and ion-channel linked receptors. Examples of drug-receptor interactions. Agonists and antagonists.

Unit:2	Pharmocokinetics	15 -- hours

Drug tolerance and drug dependence. Principles of basic pharmacokinetics, ADME properties of drugs. Adverse response to drugs, drug intolerance, pharmacogenetics, drug allergy, tachyphylaxis, drug abuse, vaccination against infection, factors modifying drug action and effect. Assay of drug potency: chemical, bioassay and immunoassay.

Unit:3	Genetically Engineered Drugs	15 -- hours

Genetically engineered protein and peptide agents. Drug delivery systems : Non-conventional routes of administration, anti-AIDS drug development, oncogenes as targets for drugs, multidrug resistance, production of secondary metabolites by plant culture.

Patenting of Drug, Marketing, Computer aided drug design.

Biotechnology and Pharmacy-Manufacturing practices, Quality control, Drug management, discovery and regulations.		
Unit:4	**Therapeutical Applications**	**15 -- hours**
Mechanism of action of drugs used in therapy of A). Respiratory system – cough, bronchial, asthma, pulmonary tuberculosis. B). Antimicrobial drugs – sulfonamides, trimethoprim, penicillins, aminoglycosides and bacterial resistance. C). Cancer chemotherapy D). Thyroid and anti-thyroid drugs, insulin and oral anti-diabetic drugs, anti-fertility and ovulation inducing drugs.		
Unit:5	**Neurodrugs**	**15 -- hours**
Neurotransmitters :- Cholinergic transmission and receptors; adrenergic transmission and receptors; muscarinic receptors. Non-steroidal and anti-inflammatory drugs; adrenergic blocking drugs; cholinergic blocking drugs; muscarinic blocking drugs; Parkinson's disease; Alzhemier's disease.Neurodegenerativedisorders–amylotropic,lateralsclerosis,seniledementia, Schizophrenia, Huntington's disease, meningitis.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 -- hours**

Text Book(s)	
1	The pharmacology, Volumes I and II – Goodman,Gilman 13th edition
2	Basic and Clinical Pharmacology– Katzung, Printice Hall, NewDelhi 7th edition
3	Pharmacology– Rang,Tale 3rd edition
4	Pharmacology and Pharmacotherapeutics – Satoskar *et al.*, 25edition Popular Prakashar, Mumbai
5	Principles of Medicinal Chemistry – Foye, Waverks Pvt. Ltd. NewDelhi 8th edition
6	Burger's medicinal chemistry and drug discovery: principles and practice – Wolf, JohnWiley 5th edition
7	Molecular basis of inherited diseases – Davies, Read, IRLPress 4th edition
8	Molecular biotechnology– Glick, Pasternak, Panima Publishers,2002 2nd edition
Reference Books	
1	The Organic Chemistry of Drug Design and Drug Action, Richard B. Silverman, Second Edition
2	An Introduction to Medicinal Chemistry, Graham L. Patrick; Second Edition
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.mooc-list.com/tags/pharmaceutical
2	https://www.mooc-list.com/tags/medicinal-chemistry

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

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

Fourth Semester

Course code	43P	CORE BIOCHEMISTRY PRACTICALS – II	L	T	P	C
Core/Elective/Supportive		Core	-	-	4	4
Pre-requisite		Basic knowledge on Biochemical isolations	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:
1.Learn the isolation of biochemicals from different samples
2.Know about the enzyme assays
3.Correlate the clinical interpretations of the analysis
4.Expertise in staining techniques
5.Be equipped with all the biochemical isolations

Expected Course Outcomes:

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

1	Carryout the isolation of biochemicals from different samples	K4 K3
2	Perform the enzyme assays	K4 K5
3	Correlate the clinical interpretations for diagnosis	K5 K6
4	Perform the staining and microbiological tests	K2 K3
5	Expertise and be equipped with all the biochemical test	K5 K6

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

Unit:1	Colorimetric Experiments	15 hours

1.Isolation and estimation of starch from potato
2.Isolation and estimation of glycogen from liver
3.Isolation and estimation of ascorbic acid from fruit
4.Estimation of β-carotene from carrot
5.Estimation of lactose from milk

Unit:2	Colorimetric Experiments	15 hours

6.Estimation of RNA – UV and visible methods
7.Isolation and estimation of DNA from spleen/liver – UV and visible methods
8.Estimation of fructose in fruits
9.Antioxidant assay- DPPH, FRAP and H_2O_2 scavenging assay

Unit:3	Enzyme Studies	10 hours

10 . Isolation , purification (precipitation methods, dialysis and chromatography), properties, kinetics and inhibitor studies of any one of the following enzymes:

a) peroxidase b) amylase c) cellulase d) protease		
Unit:4	**Clinical Microbiology**	**18 hours**
11.Isolation of pure culture – serial dilution, pour plate, spread plate, streak plate methods, and slab culture techniques for long term storage 12.Colony morphology – colony counting 13.Staining techniques – simple, differential, negative, acid fast, spore, capsule and fungal staining		
Unit:5	**Clinical Microbiology**	**15 hours**
14.Antibiotic sensitivity disc – phenol coefficient method 15.Estimation of bacteria – growth curve of bacteria and generation time 16.Biochemical test – IMVIC , Starch test and Catalase test		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	Practical Clinical Biochemistry Methods and Interpretations 5th Edition 2020 by Ranjna Chawla
2	Manual of Practical and Clinical Biochemistry 1st Edition 2020 By Ashish Sharma&Anita Sharma
3	Experimental Procedures in Life Sciences S.Rajan,R.Selvi Christy
Reference Books	
1	Varley's Practical Clinical Biochemistry Sixth edition Alan H Gowenlock
2	David T.Plummer,An introduction to practical Biochemistry
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses.swayam2.ac.in/nce20_ag01/preview

Mapping with Programme Outcomes

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

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

Course code	1EA	ELECTIVE-A PAPER-I PLANT TISSUE CULTURE	L	T	P	C
Core/Elective/Supportive		Elective	3	1	-	4
Pre-requisite		Fundamentals of tissue culture	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To understand the knowledge about genome organization in plants
2. To have an idea on embryo culture and artificial seed production
3. To understand the basic concepts of cryopreservation and germplasm
4. To knew about the basic concepts of plant transformation
5. To have a brief idea on secondary metabolitess

Expected Course Outcomes:

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

1	Remember the genome organization of plants	K1, K2
2	Application of Artificial seed production	K3, K6
3	Analysis of cryopreservation and germplasm	K3, K4
4	Analysis of basic concepts of plant transformation	K4
5	Evaluation and production of secondary metabolites	K5, K6

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

Unit:1	Tissue Culture In Plants	10 hours

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

Unit:2	Embryo Rescue	8 hours

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

Unit:3	Haploid Plants	8 hours

Anther, Pollen and ovary culture for production of haploid plants and homozygous lines.Cryopreservation, slow growth and DNA banking for germ plasm conservation

Unit:4	Application of Plant Transformation	8 hours

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

Unit:5	Secondary Metabolites	9 hours

Plant secondary metabolites, Edible vaccines, and Biodegradable plastics. Phytochemistry –

Extraction methods and purification of alkaloids, flavonoids and terpenoids. Therapeutic importance of medicinal plants.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Molecular activities of plant cell-An introduction to Plant Biochemistry. John.W.
2	Anderson and John Brardall,Black well Scientific Publications,1994
3	Concepts in Biotechnology D.Balasubramanian University Press
Reference Books	
1	Plant Physiology – Devlin N.Robert and Francis H.Witham,CBS Publications.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.toppr.com/guides/biology/plant-growth-and-development/plant-growth-regulators/

Mapping with Programme Outcomes

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

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

Course code	2EA	ELECTIVE-A PAPER-II ANIMAL TISSUE CULTURE	L	T	P	C
Core/Elective/Supportive		Elective	3	1	-	4
Pre-requisite		Fundamentals of tissue culture	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

4. To understand the preparation of different cultures with its composition
5. To know about the types of cell culture
6. To have an in depth knowledge of characterization of cultured cells
7. To analyse and apply the stem culturing methods
8. To understand the production of Transgenic animals and its applications

Expected Course Outcomes:

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

1	Have a complete understanding of different types of preparation of cultures	K2, K3
2	Analyse and apply the apt type of cell cutures for experiments	K3. K4
3	Characterization of the cultured cells	K4, K6
4	Application of stem culturing methods	K6, K4
5	Production of transgenic animals	K4, K6

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

Unit:1	Animal Tissue Culture	18 hours

Animal cells; Culture media: Balanced salt solution and simple growth medium, Physical, Chemical and metabolic functions of different constituents of culture medium.

Unit:2	Types Of Culture	15 hours

Types of cell culture: primary and established culture, organ culture, tissue culture, three dimensional culture and tissue engineering.

Unit:3	Biology And Characterization Of Cultured Cells	15 hours

Biology and characterization of cultured cells : tissue typing, cell-cell interaction, measuring parameters of growth, measurement of cell death, apoptosis and its determination, Cytotoxicity assay

Unit:4	Embryology	15 hours

Embryology: collection and preservation of embryo, culturing of embryos, gametogenesis and fertilization in animals. Stem cell – isolation, identification, expantion, differentiation and uses.

Unit:5	Transgenic Animals	10 hours

Transgenic animal production and application, transgenic animals as models for human diseases, transgenic animals in live stock improvement, transgenesis in industry.

Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 hours**
Text Book(s)		
1	Principles of Animal Cell Culture Students Compendium by Basant Kumar Sinha and Rinesh Kumar	
2	Cell culture technology: Recent advances and future prospects (Euroscicon Meeting Reports Book by Bruserud, Øystein and Astrid Englezou	
Reference Books		
1	Culture of Animal Cells by R.Freshney	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://onlinecoursesnptel,ac,in/noc20_bt32/preview	

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

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

Elective Course

Course code	3EA	ELECTIVE PAPER-A PAPER III METHODS IN MOLECULAR BIOLOGY	L	T	P	C
Core/Elective/Supportive		Elective	3	1	-	4
Pre-requisite		Basic knowledge on Molecular principles	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To know about the structural organization of eukaryotic chromosomes
2. Understand the nucleic acids with their properties
3. Know about the functions and techniques of chromosomes
4. Understand about phages and vectors
5. Practice the cloning strategies

Expected Course Outcomes:

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

1	Know about the structural organization of eukaryotic chromosomes	K1, K2
2	Understand the nucleic acids with their properties	K2, K4
3	Know about the functions and techniques of chromosomes	K3, K4
4	Understand about phages and vectors	K2, K5
5	Practice the cloning strategies	K3, K6

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

Unit:1	DNA Sequencing Techniques	10 hours

Rapid DNA sequencing techniques and strategies details of a range of methodologies, e.g. plus and minus, di- deoxynucleotide, partial ribose substitution, Maxims and Gilbert. Use of thin gels, resolution etc. interpretation of DNA sequences Role of counter ions , Deep and narrow grooves ,single stranded DNA,A,B and Z DNA etc. Chirality of the helix, syn / antiparallel complementary strands.

Unit:2	RNA Sequencing Techniques	10 hours

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 stranded DNA

Unit:3		8 hours

Re-association kinetics: cot values, experimental procedure, qualitative significance, use of Ag + cesium sulfate. Satellite DNA : C-value paradox, possible functions of satellite DNA, mechanical strength, 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:4		**8 hours**
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 vectors.		
Unit:5		**7 hours**
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 radiolabelled DNA and RNA probes. Synthetic oligonucleotide probes. Expression of cloned genes in cultured cells. Screening expression with antibodies and oligonucleotides		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 hours**

Text Book(s)	
1	BRS Biochemistry,Molecular Biology and Genetics 7th Edition 2019 by Liberman
2	Techniques in Molecular Biology by Agrawal,Suraksha Ibdc Publishers
3	Molecular Biology and Genetic Engineering Saras Publications
Reference Books	
1	Molecular Biology Techniques A classroom laboratory manual Susan Carson
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses.swayam2.ac.in/cec20_bt17/preview

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

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

Course code	4EP	ELECTIVE-A PRACTICALS CELL CULTURE AND MOLECULAR TECHNIQUES	L	T	P	C
Core/Elective/Supportive		Elective	-	-	4	4
Pre-requisite		Basic analytical skills	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:
1.Learn about the techniques of Plant Tissue Culture
2.Learn about the techniques of Plant Tissue Culture
3.Expertise in molecular techniques

Expected Course Outcomes:

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

1	Understand the techniques of plant tissue culture	K1, K2
2	Apply the techniques of plant tissue culture	K3, K4
3	Understand the techniques of animal tissue culture	K2, K4
4	Apply the techniques of plant tissue culture	K4, K5
5	Expertise in molecular techniques	K5, K6

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

Unit:1	PLANT TISSUE CULTURE	15 hours

1.PTC laboratory organization
2.Sterilization procedures
3.Preparation of PTC medium
4.Callus induction

Unit:2	PLANT TISSUE CULTURE	15 hours

5.Micro propagation
6.Artificial seed production
7.Mitotic Preparation –Onion root tip

Unit:3	ANIMAL TISSUE CULTURE	15 hours

1.Preparation of ATC medium and membrane filtration
2.Preparation of primary culture from chick embryo

Unit:4	ANIMAL TISSUE CULTURE	15 hours

3.Isolation of DNA from animal cell
Quantification of DNA- Spectrophotometric method

Unit:5	**METHODS IN MOLECULAR BIOLOGY**	**13 hours**
1.Isolation of genomic DNA and RNA 2.Isolation of plasmid DNA and estimations by DNP method 3.Polymerase chain reaction		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	Molecular Cloning : a laboratory Manual, J. Sambrook, Fritschand Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2	Applied Molecular Genetics, Roger, L.Miesfield, John Wiley and Sons Inc Publications, 1999.
3	Recombinant DNA Principles and Methodologies, James .J. greene, Vengalla B.Rao, Marcel Dekker Publications, 1998
Reference Books	
1	DNA Cloning, a pratical approach, D.M. Glover and B.D. Hames, IPL press, Oxford, 1995
2	Molecular and Cellular methods in Biology and Medicine, P.B. Kaufman, W.Wu, D.Kim and L.J.Cseke, CEC press, Florida, 1995.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https:onlinecourses.swayam2.ac.in/cec20_bt17/preview

Mapping with Programme Outcomes

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

Course code	IEB	ELECTIVE GROUP- B PAPER-I **COMPUTATIONAL MOLECULAR BIOLOGY**	L	T	P	C
Core/Elective/Supportive		Elective	**3**	**1**	**-**	**4**
Pre-requisite		**Basics of Computer in Biology**	**Syllabus Version**		**20-21**	

Course Objectives:

The main objectives of this course are
1.Have an in depth knowledge about all genome databases
2.To obtain an overview of the sequence alignment
3.To gain knowledge about the evolutionary bioinformatics
4.To get Knowledge about the functional transcriptional regulatory signals
5.To get knowledge about the profile pattern

Expected Course Outcomes:

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

1	Gain knowledge about all genome databases	K1,K2
2	Understand the overview of the sequence alignment	K2,K4
3	Gain knowledge about the evolutionary bioinformatics	K1,K5
4	Gain knowledge about the functional transcriptional regulatory signals	K1,K3
5	Gain knowledge about the profile pattern	K1,K6

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

Unit:1	**Computational Molecular Biology**	**7 hours**

Computational Molecular Biology: Bioinformatics - Literature database: PubMED. Bibliographic and Full Text Journal Access- Genome Databases - Molecular Biology Databases on the Web - DNA and protein forensics analysis - Probability and statistics - Prior probability - Linkage analysis.

Unit:2	**Pattern Matching with Consensus Sequences**	**8 hours**

Pattern Matching with Consensus Sequences - Quantitative & Probabilistic Pattern Matching - Sequence Alignment - Rapid Sequence Similarity Search - Near-Optimal Sequence Alignments - Multiple Sequence Alignment.

Unit:3	**Distance Based Phylogenies**	**7 hours**

Distance Based Phylogenies - Sequence Blocks & Profiles - Protein Sequence Motifs Protein Structural motif.

Unit:4	**Clustering and Functional Analysis**	**13 hours**
Clustering and Functional Analysis of Coordinately Regulated Genes - Discovering Transcriptional Regulatory Signals - Ultra conservation in the Human Genome - Pathway Bioinformatics.		
Unit:5	**Machine Learning Algortihms And Artificial Intelligence**	**8 hours**
Introduction to GCG SeqWeb and EMBOSS Web interface software suites and their tools: Best Fit, GAP, WATER, NEEDLE, TRANSEQ, BACKTRANSEQ, PEPINFO, CpG PLOT, DOTMATCHER. PRETTYPLOT. Machine learning algorithms and Artificial Intelligence for biomedical big data. Data analytics.		
	Contemporary Issues	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 Hours**

Text Book(s)	
1	Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley- Dream Tech India Pvt.Ltd.
2	Bioinformatics by David.W.Mount, CBS publishers and distributers.
3	Instant notes in bioinformatics by D.R. Westhead, J.H.Parish andR.M.Twyman.
4	Introduction to bioinformatics by T.K. Attwood and D.J. Parry –smith, Pearson EducationAsia.
Reference Books	
1	Biostatistical analysis.Zar.J.H
2	Peuzner, P.A., Computational molecular Biology, An algorithmic approach.
3	Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reillypublications
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://www.dypatil.edu/schools/biotech-and-bioinformatics/swayam-nptel-local-chapter/
2	http://www.ncbi.nlm.nih.gov/genbank

Mapping with Programme Outcomes

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

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

Course code	2EB	ELECTIVE GROUP- B PAPER-II	L	T	P	C

		GENOMICS				
Core/Elective/Supportive		Elective	**3**	**1**	**-**	**4**
Pre-requisite		**Basics in Genetics**	**Syllabus Version**		**20-21**	

Course Objectives:

The main objectives of this course are to have
1. Basic uses of structures of genomes
2. Thorough knowledge of mapping and sequencing of genome
3. The knowledge about the gene evolution and human genome project
4. Gain the knowledge about the DNA sequencing and modelling

Expected Course Outcomes:

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

1	Gain basic uses of structures of genomes	K1,K2
2	Gain thorough knowledge of mapping and sequencing of genome	K3,K4
3	Gain knowledge about the gene evolution and human genome project	K2,K6
4	Gain knowledge about the DNA sequencing and modelling	K2,K3
5	Understand concepts of comparative genomics of prokaryotes and eukaryotes	K2,K5

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

Unit:1	**Genome Structure**	**10 hours**

Genome structure: Genome sizes and the C-value paradox, introns and exons, microbial and organelle genomes - Centromeres and telomeres, tandem repeats- dispersed repeats (transposons), gene density, intergenic DNA.

Unit:2	**Genome Sequencing**	**15 hours**

Genome physical mapping and sequencing: Fragmenting the genome, the need for markers - marker sequences (RFLPs, AFLPs, SNPs, etc) - hybridization mapping -mapping without cloning - Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – resequencing.

Unit:3	**Genome Project And Bioinformatics**	**13 hours**

Genome project and bioinformatics - www databases for genomes - DNA dynamics - Recombination – Evolution - Gene diversity - Consensus and pattern recognition - Sequence diversity – Polymorphism.

Unit:4	**Phylogenetic Genome mapping**	**10 hours**

Phylogenetic Genome mapping - DNA sequence database analysis - Random-shearing GenBank - Web-based ORF finding, sequence alignment and 3-D matrix tools – Genotator - DNA modeling.		
Unit:5	**Orthologues and paralogues**	**10 hours**
Orthologues and paralogues, RNA transactions, comparative genomics of viruses, bacteria, organelles and eukaryotes, lateral gene transfer.		
	Contemporary Issues	
Expert lectures, online seminars – webinars		**2 hours**
	Total Lecture hours	**60 hours**

Text Book(s)	
1	The Human Genome Project; Deciphering the blueprint of heredity ; Edited by Necia Grant Cooper; University Science books, CA, USA, 1994. 2. Bioinformatics
2	Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley-Dream Tech India Pvt. Ltd.
Reference Books	
1	Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reilly publications.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses,nptel,ac,in/noc20_bt19/preview
2	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
Course Designed By:	

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

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

Course code	3EB	**ELECTIVE GROUP- B PAPER-III**	**L**	**T**	**P**	**C**

		PROTEOMICS				
Core/Elective/Supportive		**Elective**	**3**	**1**	**-**	**4**
Pre-requisite		**Knowledge on Protein Chemistry**	**Syllabus Version**		**20-21**	

Course Objectives:

The main objectives of this course are to
1. To know about electrophoresis, chromatography techniques.
2. Clearly understand analysis of proteins.
3. Have thorough knowledge on structural proteomics.
4. Gain knowledge on developing new drugs.
5. Have clear idea on computational protein – protein interactions.

Expected Course Outcomes:

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

1	Know about electrophoresis, chromatography techniques.	K1,K2
2	Clearly understand analysis of proteins.	K2,K3
3	Gain thorough knowledge on structural proteonomics	K2,K4
4	Gained knowledge on developing new drugs.	K2,K6
5	Get clear idea got on computational protein – protein interactions	K2,K5

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

Unit:1	**Chromatography Techniques**	**8 hours**

Introduction to 2D gel electrophoresis, multidimensional chromatography, mass spectrometry, and analytical protein chips. Identifying proteins in complex mixtures. Protein profiling, quantitative 2DGE, quantitative mass spectrometry.

Unit:2	**Protein interaction**	**7 hours**

The analysis of phosphoproteins and glycoproteins. Protein interaction analysis, Y2H, mass spec complex analysis, functional protein chips, protein localization, high throughput functional annotation.

Unit:3	**Proteomics**	**8 hours**

Protein domains and folds, using sequences and structures to predict gene function, high throughout structural analysis of protein, structural proteomics and what it can achieve.

Unit:4	**Phamacogenomics**	**7 hours**

Phamacogenomics and new drug design. Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors.		
Unit:5	**Bioinformatics**	**13 hours**
Significance of metabolomics, methodologies, technical problems, data handling, data Interpretation. Computational protein-protein interactions RasMol – Swiss PDB viewer		
	Contemporary Issues	
Expert lectures, online seminars – webinars		**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Branden, C and J.Troze, 1999. Introduction to protein structure. Second edition.
2	Baxevanis, A.D and Ouellette, B.F.F (Eds), 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley interscience. New York.
Reference Books	
1	Higgins, D and Taylor, W (Eds), 2000. Bioinformatics: Sequence, structure and databnks.Oxford University Press, Oxford.
2	Misener, S and Krawetz, S.A (Eds), 2001.Bioinformatics: methods and protocols. Replica press private limited, New Delhi.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses,nptel.ac.in/noc20_bt19/preview
2	https://onlinecourses.nptel.ac.in/noc20_bt20/preview

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

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

Course code	4EP	ELECTIVE -COMPUTATIONAL BIOLOGY PRACTICALS	L	T	P	C
Core/Elective/Supportive		Elective	-	-	4	4
Pre-requisite		Basic Computer skills	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to
1.Gain hands on experience on molecular databases
2.Gain knowledge about the classification of sequence and structure

Expected Course Outcomes:

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

1	Gain basic uses of molecular databases	K1, K3
2	Gain thorough knowledge on Bioinformatic tools	K2, K3
3	Gain knowledge about the retrieval, integration and interpretation	K3, K6

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

Unit:1	Expasy –Proteomic Tools.	40 hours

A. Peptide cutter
B. Peptide Mass
C. Reverse Translate
D. Interproscan
E. 2Zip
F. Coils
G. EPestfind
H. Protparam
I. Radar
J. Compute pI/Mw

Unit:2	Small Molecules, Fatty Acids	20 hours

Other data bases Small molecules, Fatty acids etc.,
A. Drawing small molecules using chemsketch.

B. Retrieving fatty acids and drawing using chemsketch.		
Unit:3	**Multiple Sequence Alignment**	**13 hours**
Multiple sequence alignment (Clustal).		
	Contemporary Issues	
Expert lectures, online seminars – webinars		2 **hours**
	Total Lecture hours	**75 hours**
Text Book(s)		
1	K. Mani, N. Vijayaraj, Bioinformatics for beginners. 1 st edition, Kalaikathir Achagam, Coimbatore, 2002.	
Reference Books		
1	Mani. K and Vijayraja, Bioinformatics – A practical approach, Aparna publications, Coimbatore 2005.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://onlinecourses.nptel.ac.in/noc20_bt23/preview	

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

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

Course code	1EC	ELECTIVE GROUP- C PAPER- I: FUNDAMENTALS OF NANOSCIENCE	L	T	P	C
Core/Elective/Supportive		Elective	3	1	-	4
Pre-requisite		Basics of Nanoparticles	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to
1.Understand the history of Nanotechnology, Nanomaterials and interaction of Nanoparticles,
2.Have a keen knowledge on forces between atoms and molecules
3.Get knowledge on Nano carbon tubes and their applications
4.Understand about High vaccum technology

Expected Course Outcomes:

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

1	To understand the history of nano techniques at their atomic level	K2.K3
2	Gain knowledge about the interactions of nanoparticles	K1,K3
3	Have knowledge about nanostructures and their properties	K4,K5
4	Get Idea about various forms of carbon	K1,K5
5	Have In depth knowledge on high vacuum technology	K3,K5

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

Unit:1	Basics of Nanotechnology	09 hours

Background to Nanotechnology – Scientific revolutions – types of Nanotechnology and Nanomachines – Atomic structure molecules & phases – molecular and atomic size – surfaces and dimensional space –Nanomaterials- top down and bottom up approach

Unit:2	Forces Between Atoms And Molecules	09 hours

Strong intermolecular forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Van der Waals forces – repulsive forces; special interactions such as hydrogen – bonding, hydrophobic and hydrophilic interactions.

Unit:3	Nanostructures and their properties	08 hours

Definition of Nano systems – Dimensionality and size dependent phenomena in Quantum dots, and Quantum wires – size dependent variation in magnetic, electronic transport properties		
Unit:4	**Nanocarbon Tubes and their properties**	**09 hours**
Types of nanotubes – formation of nanotubes – methods and reactants – arcing in the presence of cobalt – laser methods – ball milling – chemical vapour deposition methods – properties of nano tubes – plasma arcing – electro deposition – pyrolytic synthesis – Zeolites and templated powders layered silicates.		
Unit:5	**High Vacuum Technology**	**08 hours**
Evaporation theory – different sources for evaporation – working principles of rotary and diffusion pumps – Cryogenic pumps – Cryo sorption and Getter pumps – Vacuum materials.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 hours**

Text Book(s)

1	Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press(2005)
2	Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,)(2000)
3	Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley-Interscience (2003)
4	Nanotechnology: A Gentle Introduction to the Next Big Idea, Mark A. Ratner, Daniel Ratner, Mark Ratne, Prentice Hall PTR; 1st edition(2002)
5	Fundamentals of Surface and Thin Film Analysis, Leonard C.FeldmanandJames W. Mayer
6	Hand book of thin film technology, L.I. Maissel and R. Glang (McGraw – Hill Book Company)

Reference Books	
1	Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press(2005).
2	Understanding Nanotechnology, Scientific American, editors at Scientific American, Warner Books(2002).
3	Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley-Interscience (2003).
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.my-mooc.com/tags/nanotechnology
2	https://www.coursera.org/courses/nanotechnology
3	https://www.classcentral.com/tag/nanotechnology
4	https://swayam.gov.in/endocrinology

Mapping with Programme Outcomes

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

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

Course code	2EC	ELECTIVE GROUP- C PAPER-II: NANOMATERIALS SYNTHESIS	L	T	P	C
Core/Elective/Supportive		Elective	3	1	-	4
Pre-requisite		Basics of Nanoparticles	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to
1.Know about the gel processing techniques
2.Synthesise the nanocomposites
3.Understand the film deposition methods
4.Apply different synthetic methods
5.Synthesise the nanostructures

Expected Course Outcomes:

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

1	Gain knowledge about fundamentals of sol gel processing techniques of nanoparticles	K1, K2
2	Understand the in-depth detail of synthesis of Nanocomposites	K2 K3
3	Know about synthesis by Film deposition techniques	K1, K3
4	Know and apply various methods for the synthesis of Nanomaterials	K3, K6
5	To know and apply advanced methods used in the synthesis of Nanostructures	K3, K5

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

Unit:1	Sol-Gel Processing Method	20 hours

Fundamentals of sol-gel process – sol-gel synthetic methods for oxides – The Pecheni method – Silica gel – Zirconia and Yttrium gel – Aluminosilicate gel methods.

Unit:2	Synthesis of Nanocomposites	10 hours

Synthesis of other Inorganic materials- Synthesis of Nanocomposites – Synthesis of Polymer Nanocomposites.

Unit:3	**Film deposition methods**	**15 hours**
Introduction – Fundamentals of film deposition – Thermal Evaporation – Molecular Beam Epitaxy – Pulsed laser deposition – Sputter deposition – Chemical Vapour Deposition (CVD) – layer by layer growth and ultra thin films – chemical solution deposition – Langmuir Blodgelt films.		
Unit:4	**Other Synthesis Methods**	**08 hours**
Molecular Beam Epitaxy – Pulsed laser deposition – Sputter deposition – Chemical Vapour Deposition (CVD). Surface Chemistry and its role to prepare Quantum dots – Polymer as Quantum dot size stabilizer.		
Unit:5	**Synthesis of Nanostructures**	**20 hours**
One-dimensional (1D) structure synthesis by Spontaneous Growth – One-dimensional (1D) structure synthesis by VLS and SLS Growth – Template Assisted Growth method – Electrochemical growth of one-dimensional (1D) structures.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 -- hours**

Text Book(s)

1	Nanoelectronics and Information technology: Advanced electronic materials and novel devices (2nd edition), Rainer Waser (Ed.), Wiley – VCH Verlag, Weiheim(2005)
2	Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley – VCH Verag, Weiheim(2003)
3	Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,)(2000)
4	Quantum Heterostructures: Microelectronics and Optoelectronics, Vladimir Mitin
5	Theory of Modern electronic semiconductor devices, K.F.Brennanand A.S. Brown

6	Semiconductor Nanostructures for Optoelectronic applications, Todd D.Steiner
7	Smart Electronic Materials (Fundamentals and applications), JaspritSingh
8	The Physics of Low dimensional semiconductors, John H.Davies.
Reference Books	
1	Nanostructures and Nanomaterials (Synthesis, Properties and Applications), GuozhongCao.
2	Nanoelectronics and Information technology Edited by RainerWaser.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.my-mooc.com/tags/nanotechnology
2	https://www.classcentral.com/tag/nanotechnology
3	https://swayam.gov.in/structuralanalysisof nanomaterials

Mapping with Programme Outcomes

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

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

Course code	3EC	ELECTIVE GROUP- C PAPER-III: CHARACTERIZATION OF NANOMATERIALS	L	T	P	C
Core/Elective/Supportive		Elective	3	1		4
Pre-requisite		Basics of Nanoparticles	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to
1.Understand the analytical tools and applications of different techniques
2.Gain knowledge on quantum dot materials
3. Apply the nanomaterials in different fields.

Expected Course Outcomes:

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

1	Gain knowledge about fundamentals of XRD and NMR techniques	K1, K2
2	In-depth detail of AFM and EDX techniques	K2, K3
3	Have knowledge about characterization of Nanoparticels by SEM and TEM	K1, K5
4	To know and apply the synthetic techniques of Quantum dots	K3, K5
5	To know the advanced applications of Nanomaterials	K3, K6

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

Unit:1	XRD and NMR	08 hours

X-Ray diffraction technique- Basics and its application to size analysis of Nanomaterials.
NMR Technique- Basics and application tosize analysis ofNanomaterials.

Unit:2	AFM and EDX	09 hours

Working of Atomic Force Microscopy (AFM) – Mode of operations (qualitative) and its application.
EDX spectra- Basics and its application to size analysis of Nanomaterials.

Unit:3	SEM and TEM	09 hours

Scanning Electron Microscope (SEM)-Theory, Instrumental setup and its applications – Low KV SEM and its application – Low temperature SEM and its application.
Transmission Electron Microscope (TEM)-Theory, Instrumental setup and its applications

Unit:4	Quantum dot Materials	08 hours

Quantum dot IR photo detectors- Quantum dot lasers –working of electron probe micro analysis and its application in elemental analysis – SK growth of germanium dots on silicon and its application.		
Unit:5	**Applications of Nanomaterials**	**09 hours**
Synthesis of Zinc oxide nanomaterials and its application – Synthesis of Silver Nanomaterials and its application-Synthesis of Copper Nanomaterials and its application-Synthesis of Group-III Nitride Nanostructures and their applications.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Theory of Modern electronic semiconductor devices, K.F.Brennanand A.S. Brown
2	Semiconductor Nanostructures for Optoelectronic applications, Todd D.Steiner
3	Smart Electronic Materials (Fundamentals and applications), JaspritSingh
4	The Physics of Low dimensional semiconductors, John H.Davies
5	Nanoscale calibration and Standards and Methods Edited by C.Wilkening andKoenders
6	Nanostructures and Nanomaterials (Synthesis, Properties and Applications), GuozhongCao
7	Nanoelectronics and Information technology Edited by RainerWaser
Reference Books	
1	Scanning Electron Microscopy for Nanotechnology Edited by W.Zhou and Z. LinWang Nanosystem characterizationtools in the life sciences Edited by ChallaKumar
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.my-mooc.com/tags/nanotechnology
2	https://www.classcentral.com/tag/nanotechnology
3	https://swayam.gov.in/structuralanalysisof nanomaterials

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

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

Course code	4EP	ELECTIVE – NANOTECHNOLOGY PRACTICALS	L	T	P	C
Core/Elective/Supportive		Elective	-	-	4	4
Pre-requisite		Basic analytical skills	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Update the students with latest nano techniques
2. Train the students with all synthetic process
3. Enrich the students skill in nanoscience so as to undertake their project works

Expected Course Outcomes:

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

1	Understand the different synthesis methods of nanoparticles	K2
2	Apply the synthesis with different samples	K3
3	Characterize the structural components of a sample	K4
4	Elucidate different activities of the organisms	K5
5	Apply the knowledge in synthesizing naomaterials	K6

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

Unit:1	NANOPARTICLES SYNTHESIS	15 hours

1.Green synthesis of silver Nanoparticles

Unit:2	NANOPARTICLES SYNTHESIS	25 hours

2.Zinc oxide Nanoparticles Synthesis
3.Zinc oxide Titanium Nanoparticles synthesis by chemical method

Unit:3	NANOPARTICLES SYNTHESIS	15 hours

4. Mic Assay of Nanoparticles
5.Green synthesis of copper Nanoparticles

Unit:4	NANOPARTICLES CHARACTERIZATION (Demonstration only)	13 hours

1). Characterization of Nanoparticles by - UV, Visible and FTIR
2). Demonstration of XRD, SEM and TEM
3). Applications of Nanoparticles

Unit:5	NANOPARTICLES CHARACTERIZATION (Demonstration only)	15 hours

a). Determination of Antibacterial activity

b). Determination of Anti-fungal activity c). Determination of Anti-cancer activity		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars – webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	Nanotechnology:Fundamentals and applications Manasi Karkare
2	Nanostructures and Nanomaterials (Synthesis, Properties and Applications), GuozhongCao
Reference Books	
1	Nanoelectronics and Information technology: Advanced electronic materials and novel devices (2nd edition), Rainer Waser (Ed.), Wiley – VCH Verlag, Weiheim(2005)
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Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

Annexure

BHARATHIAR UNIVERSITY: COIMBATORE 641046

DEPARTMENT OF BIOCHEMISTRY

MISSION

1.To bring out proficient graduates with a broad based knowledge in the concepts, principles and applications of Biochemistry

2.To identify the local and global issues that need intervention for the development of intelligent strategies and biochemical approaches in problem solving methods

3.To spread an atmosphere to acquire skills in identifying the link between the biological and human resources

4.To provide research based projects activities in the emerging areas of Biochemical sciences with critical thinking

5.To have the ability of being employed with self dedication and professional ethics

List of Group Elective papers (Colleges can choose any one of the Group papers as electives)

Paper / Sem	GROUP A Elective - Cell Culture and Molecular Techniques	GROUP B Elective - Computational Molecular Biology	GROUP C Elective – Nanoscience
I	Plant Tissue Culture	Computational Molecular Biology	Fundamentals of Nanoscale Science
II	Animal Tissue Culture	Genomics	Nanomaterials Synthesis
III	Methods in Molecular Biology	Proteomics	Characterization and Application of Nano Materials
IV	Elective Practical	Elective Practical	Elective Practical