

MOTHER TERESA WOMEN'S UNIVERSITY KODAIKANAL – 624 102

M.Sc. BIOCHEMISTRY

Syllabus
(With Effect from 2021)



DEPARTMENT OF BIOTECHNOLOGY

Mother Teresa Women's University, Kodaikanal
Department of Biotechnology
(2021-2022 onwards)
M.Sc. Biochemistry

1. About the Programme

M.Sc., Biochemistry is a 2-year Postgraduate programme that is divided into 4 semesters. The programme offers in-depth knowledge of biological-chemistry with regard to Pharmaceutical Biochemistry, Immunobiology, Clinical biochemistry, Enzyme and Enzyme Technology. The main aim of the program is to make students understand the dynamics and mechanism of the biological activities taking place both in Microbes, Plants and Animals. M.Sc. Biochemistry degrees provides job opportunities for the eligible applicants to work as Research Fellow, Analytical Chemist, Pharma Associate, Clinical Biochemist, Food Safety Analyst, etc.

2. Programme Educational Objectives (PEOs):

PEO1	To inspire the students to pursue a successful career in the chosen field.
PEO2	To equip the students to solve socio-economic challenges in the field of biochemistry
PEO3	To empower the students with analytical and research skills, to nurture entrepreneurial endeavours
PEO4	To develop them with good communicative skills as an individual and as a team member in a professional environment
PEO5	To develop biochemist with professional morals in order to address global and societal issues for sustainable development

3. Eligibility:

- A graduate who possess Degree in any one of the Life Sciences (Biotechnology / Botany / Zoology / Microbiology / Biochemistry / Environmental Science / Food Science and Herbal Sciences) and other relevant Subjects
- Candidate should have secured at least 55% in the above subject from any recognized university.

4. General Guidelines for PG Programme

- Duration:** The programme shall extend through a period of 4 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.
- Medium of Instruction:** English
- Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

Evaluation Pattern	Theory		Practical	
	Min	Max	Min	Max
Internal	13	25	13	25
External	38	75	38	75

- **Internal (Theory):** Test (15) + Assignment (5) + Seminar/Quiz(5) = 25
- **External Theory:** 75

- **Question Paper Pattern for External examination for all course papers.**

Max. Marks: 75**Time: 3 Hrs.**

S.No.	Part	Type	Marks
1	A	10*1 Marks=10 Multiple Choice Questions (MCQs): 2 questions from each Unit	10
2	B	5*4=20 Two questions from each Unit with Internal Choice (either / or)	20
3	C	3*15=45 Open Choice: Any three questions out of 5 : one question from each unit	45
Total Marks			75

*** Minimum credits required to pass: 90**

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 line space.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

5. Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding
80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	Very Good
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

6. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

8. Any Other Information

In addition to the above mentioned regulations, any other common regulations pertaining to the PG Programmes are also applicable for this Programme.

9. Programme Outcomes (POs)

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

PO1	Get enlightened in the advanced concepts and principles of Biochemistry.
PO2	Utilize the knowledge of clinical laboratory techniques to make scientific queries and diagnostic interpretations.
PO3	Establish broad knowledge about molecular pathways, diagnostic tools and techniques and execute diagnostic procedures required in clinical laboratory and pharmaceutical industries
PO4	Gain expertise in different areas and recent trends in advanced biochemistry.
PO5	Apply the principles of biochemistry to comprehend the fundamentals of a living system.
PO6	Relate the theoretical and practical knowledge in securing a successful career and to pursue higher studies.
PO7	Use the scientific skills acquired to develop into a successful women entrepreneur.
PO8	Use the scientific knowledge obtained to contribute to the society and research community.

10. Programme Specific Outcomes (PSOs)

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

PSO1	enrich the knowledge in the advanced concepts and principles of Biochemistry
PSO2	strengthen the theoretical knowledge in biochemistry to secure a successful career
PSO3	utilize the knowledge attained from the programme to work as Biochemists in emerging modern clinical laboratories and scientific government organizations
PSO4	communicate appropriately and effectively with people in the field of Biochemistry and other allied backgrounds
PSO5	develop hands on experience and laboratory experiments perceived will be constructive to pursue research

M.Sc. BIOCHEMISTRY CURRICULUM

Sl. No.	Course Code	Course Title	Credits	Hours		CIA	ESE	Total
				L	P			
Semester - I								
1.	P21BCT11	Core- I - Chemistry of Biopolymers	4	5	-	25	75	100
2.	P21BCT12	Core-II -Enzyme & Enzyme Technology	4	5	-	25	75	100
3.	P21BCT13	Core-III: Cellular Biochemistry	4	5	-	25	75	100
4.	P21BCT14	Core-IV- Bioenergetics and metabolism	4	5	-	25	75	100
5.	P21BCP11	Core-V- Practical - Biochemical Techniques & Biochemical analysis	4	-	6	25	75	100
6.	P21CSS11	Supportive Course I Web Designing and Video Editing	2	-	4	25	75	100
		Total	22	30		-	-	600
Semester II								
7.	P21BCT21	Core VI: Molecular Endocrinology	4	5	-	25	75	100
8.	P21BCT22	Core-VII: Clinical Biochemistry	4	5	-	25	75	100
9.	P21BCT23	Core-VIII - Immunobiology	4	4	-	25	75	100
10.	P21BCT24	Core-IX - Biotechnology	4	4	-	25	75	100
11.	P21BCP22	Core-X: Practical - Immunobiology & Clinical Biochemistry	4	-	6	25	75	100
12.		Non-Major Elective	4	4		25	75	100
13.	P21BCS22	Supportive Course II - Industrial Fermentation Products	2	2		25	75	100
		Total	26	30		-	-	700
Semester III								
14.	P21BCT31	Core – XI: Pharmaceutical Biochemistry	4	5	-	25	75	100
15.	P21BCT32	Core-XII: Molecular Biology	4	5	-	25	75	100
16.	P21BCT33	Core-XIII: Plant Biochemistry	4	4	-	25	75	100
17.	P21BCT34	Core-XIV: Basic Microbiology and Genetics	4	4	-	25	75	100
18.	P21BCT35	Core-XV: Environmental Toxicology	4	4	-	25	75	100

19.	P21BCP33	Core-XVI: Practical - Plant Biochemistry, Microbiology & Molecular Biology	4	-	6	25	75	100
20.	P21WSS33	Supportive Course III Women Empowerment	2	2	-	25	75	100
		Total	26	30				700
Semester IV								
21.	P21BCE411/ P21BCE412	Elective I: Biophysical Methodology / Bioplastics /Any MOOC ^{\$}	4	4	-	25	75	100
22.	P21BCE421/ P21BCE422	Elective II: Research methodology & Biostatistics / Bioethics Biosafety & IPR / Any MOOC ^{\$}	4	4	-	25	75	100
23.	P21BCR41	Project	8	-	22	25	75	100
		Total	16	30				300
		Total	90	120				2300

Additional Credit Courses (Mandatory)

P21BCI21- Internship/Industrial Training -Two Credits- (Second Semester)

P21BCO31 - Online Courses-Two Credits - (Third Semester)

P21BCV11 - Value Added Program I - Characterization techniques of Nano materials (Two Credits) (First Semester)

P21BCV41 - Value Added Program II - Biofertilizer (Two Credits) (Fourth Semester)

Non Major Elective

- Women Health

Outside class hours

- Health, Yoga and Physical Fitness
- Library Information access and utilisation
- Employability Training

* Those who have CGPA as 9, and want to do the project in industry/institution during IV semester, may opt for these two papers in III semester.

^{\$} Students can take one 4 credit course in MOOC as elective or two 2 credit courses in MOOC as elective with the approval of Department committee.

SEMESTER – I

Course Code	P21BCT11	CHEMISTRY OF BIOPOLYMERS	L	T	P	C
CORE I			5	-	-	4
Cognitive Level	K1:Recall K2:Understand K3:Apply					
Learning objective	<ul style="list-style-type: none"> ➤ To gain the knowledge about the chemical structure of biopolymers and their classification. ➤ To know about the classification and functions of carbohydrates and lipids ➤ To understand the primary, secondary, tertiary and quaternary structure of protein, metalloproteins, nucleic acid and their functions. ➤ To learn the structure and composition of nucleic acids and vitamins 					
Unit-I	Carbohydrates					
Classification-Monosaccharides, Disaccharides and Polysaccharides- Reactions of Monosaccharides. Homoglycans: Occurrence, structure, properties and biological functions of glycans. A brief account of chitin, fructans, mannans, xylans, arabinans, galactons and galacturonans. Heteroglycans and complex carbohydrates: Occurrence, structure, properties and biological function of mucopolysaccharides, bacterial cellwall polysaccharides with a xylose backbone, polysaccharides with glucose and Mannose back bone, chemical synthesis of polysaccharides (glycan).						
Unit-II	Lipids					
Classification - saturated and unsaturated fatty acids, phospholipids -classification, structure and functions. Ceramides and sphingomyelins. Eicosanoids, structure and functions of prostaglandins, thromboxane, leukotrienes. Types and functions of plasma lipo proteins. Amphipathic lipid-membranes, micelles, emulsions and liposomes. Steroids-cholesterol. Structure and biological role of bile acids and bile salts.						
Unit-III	Proteins					
Classification- Peptide, poly peptide and protein. Isolation and Purification of Proteins. Functions of protein. Structures- Levels of structure of protein (Primary structure, Determination, Secondary, Tertiary and Quaternary) conformation of proteins structure their analysis and forces. Properties of proteins in aqueous solutions. Isoelectric pH, acid base properties, electrophoretic mobility, influence of ionic concentration on the protein solubility hydrolysis of proteins, denaturation and renaturation of proteins. Metalloprotein - A case study on metal and protein components of metalloprotein. A hierarchy of behavior from metalloprotein. Conformational study on the structure of keratin, collagen and hemoglobin.						
Unit-IV	Nucleic acid					
Structure of nucleic acid, structural transition. Chemical and Enzymatic methods of sequence analysis, properties of DNA in aqueous solution. Sedimentation behavior, viscosity, hyper chromic effect, melting point of DNA and hydrolysis of nucleic acids. Hybridization techniques and chemical synthesis of nucleic acid.						
UnitV	Vitamins					12 hours

Water soluble - thiamine, riboflavin, niacin, pyridoxine, folic acid, ascorbic acid - sources, structure, biochemical functions, deficiency diseases, daily requirements; fat soluble - vitamin A, vitamin D₂, vitamin E and vitamin K - sources, structure, biochemical functions, deficiency diseases, daily requirements. Porphyrins & the porphyrin ring structure, chlorophyll, hemoglobin, myoglobin and cytochrome.

Text Books

1. Seemapavgi Upadhye, Textbook of Biochemistry Dreamtech Press, 2020. Donald
2. Voet & Judith G. Voet, Biochemistry, John Wiley & Sons, 2011.
3. T. Devasena, Biomolecules, MJP Publishers, 2011.
4. Mohan P Arora, Biomolecules, Himalaya publishing House, 1st Edition, 2012.
5. S. Azhagu Madhavan, P. Vinotha, V. Uma, Chemistry of Biomolecules, Notion Press, 2020.

References

1. David Hames & Night Hooper BIOS Instant Notes Biochemistry, Taylor & Francis, 2011.
2. David L. Nelson & Michael. M. Cox, Lehninger Principles of Biochemistry, W. H. Freeman & Co, 2017.
3. Dean R. Appling, Spencer. J. Anthony cohill, Christopher K. Mathews Biochemistry; concepts and connections, Pearson Education, 2017.
4. Seemapavgi Upadhye, Textbook of Biochemistry Dream tech press, 2020.

E- Reference links

1. <https://microbenotes.com/carbohydrates-structure-properties-classification-and-functions/>
2. <https://www.thoughtco.com/protein-function-373550>
3. <https://www.healthline.com/nutrition/micronutrients#definition>
4. <https://courses.lumenlearning.com/boundless-biology/chapter/nucleic-acids/>
5. <https://www.verywellhealth.com/what-is-a-lipid-5084584>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	understand the foundation of life and structure and functions of carbohydrates.	K1,K2
CO2	attain knowledge on the structure, properties, role and classification of lipids and fatty acids.	K1,K2,K3
CO3	illustrate the structure, properties, role and classification of amino acids and proteins.	K1,K2,K3
CO4	understand the types of Nucleic acids, its structure and biological importance.	K1,K2,
CO5	know the basic concept of the various types, functions, requirements and deficiency diseases of Vitamins.	K1,K2,K3

Mapping of Cos with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	M	M	S	S	S	M	S	S	S	M	S	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	M
CO3	S	S	M	M	M	S	S	S	M	M	S	S	S
CO4	S	S	M	M	M	M	M	S	S	M	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M	M	S	S

Strongly Correlating
Weakly Correlating

(S)
(W)

- 3 marks ;
- 1 mark;

Moderately Correlating (M)
No Correlation (N)

- 2 marks
- 0 mark



Course Code	P21BCT12	ENZYMES AND ENZYME TECHNOLOGY			
CORE - II		L	T	P	C
Semester	Semester I	Credits:4		Hours/Week:5	
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To know the classification and properties of enzymes and its application in various field. ➤ To gain knowledge on the enzyme kinetics and mechanisms of enzyme action. ➤ To learn the enzyme activity and immobilization methods and the application of immobilized enzymes ➤ To understand then nomenclature of enzyme, enzyme action, role of enzymes in biosensor and their advantage 				
Unit-I	Enzyme				12 hours
Classification, Nomenclature and IUB system of enzyme classification, Introduction of co-enzymes: Holoenzyme, Apoenzyme, coenzymes and cofactors, free energy, activation energy and transition state theory. Activesite - Fisher and Koshland models. Structure and functions. Thiamine pyrophosphate and flavin nucleotides, NAD/NADP, coenzymeA, Pyridoxal phosphate and Carries of one carbon group: tetrahydrofolate					
Unit-II	Enzyme kinetics				12 hours
Pre Steady state and Steady - State enzyme kinetics, MM equation and linear transformation of MM Equation. Eadie – Hofstee and Hanes - Wolf plots. Factors affecting rate of chemical reaction. Bi-Substrate reactions- Single displacement and double displacement reactions. Enzyme inhibition: Reversible and Irreversible inhibition - Competitive, Non- Competitive and mixed inhibition. Feedback inhibition.					
Unit-III	Enzyme Regulation				12 hours
Allosteric and covalent modification co-operative effective: concentrated model and sequential model, principles of metabolic regulation: Feedback regulation of multi-functional pathway, NAD/NADH ratio, adenylate charge. Lysozymes: A case study – structure, enzymatic activity mechanism of lysozyme action, the ionization states of side chains and denaturation of enzyme.					
Unit-IV	Immobilized Enzymes				12 hours
Principles and techniques of immobilization - Commercial production of enzymes-amylase, protease, cellulase, artificial enzymes, industrial applications, fermentation, enzyme modification, site directed mutagenesis.					
Unit - V	Large scale extraction and purification of enzymes				12 hours
Extraction by chemical and physical method, isolation and purification of enzymes –Measurement and expression of enzyme activity– enzyme assays, enzyme structure-chemical modification, enzyme purification-various chromatographic techniques. Industrial utilization of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.					
Text Books					
1.T.D.H. Bugg, Introduction to Enzymes & Co-Enzyme chemistry, Wiley, 2012.					
2. Irwin. H. Segel, Enzyme Kinetics, Wiley, 2014.					
3.Anil Kumar, Sarika Garg, Enzymes and Enzyme Technology Paperback – Import, Anshan Ltd, 1st Edition, 2015.					
4. N.S. Punekar, Enzymes: Catalysis, kinetics and Mechanisms, Springer 1 st Edition, 2018.					

References

1. Athel Cornish Bowden Fundamental of Enzyme Kinetics , Wiley – Blackwell, 2012.
2. A.C. Bowden, Fundamentals of Enzyme kinetics Medtech, 2017.
3. N.S. Punekar, Enzymes : Catalysis, kinetics and Mechanisms Springer, 2018.
4. T.D.H. Bugg, Introduction to Enzymes & Co-Enzyme chemistry, Wiley, 2012.

E-Reference links

1. <https://medcraveonline.com/ATROA/effectiveness-of-enzyme-inhibitors-in-biomedicine-and-pharmacotherapy.html>
2. <https://www.britannica.com/science/enzyme/Factors-affecting-enzyme-activity>
3. <http://biochem.du.ac.in/web/uploads/43%20Enzyme%20Kinetics.pdf>
4. <https://www.khanacademy.org/science/ap-biology/cellular-energetics/environmental-impacts-on-enzyme-function/a/enzyme-regulation>
5. <https://www.easybiologyclass.com/enzyme-cell-immobilization-techniques/>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	know the classification and properties of enzymes and coenzymes.	K1,K2
CO2	understand the enzyme kinetics and Inhibition.	K1,K2,K3
CO3	attain knowledge the enzyme regulation and lysosome.	K1,K2
CO4	gain knowledge on enzyme immobilization and their uses.	K1,K2
CO5	learn about the commercial production of enzymes and their applications.	K1,K2,K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	M	S	M	S	M	S
CO2	S	S	M	M	M	S	S	M	S	S	S	S	M
CO3	M	S	S	S	S	M	S	S	M	M	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S	M	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating
Weakly Correlating

(S) - 3 marks ;
(W) - 1 mark;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BCT13	CELLULAR BIOCHEMISTRY			
CORE- III		L	T	P	C
Cognitive Level	K1:Recall K2:Understand K3:Apply				
Learning objective	<ul style="list-style-type: none"> ➤ To know the structure and function of membrane ➤ To learn the structure and functions of cell organelles and cell division ➤ To understand the cell communication and cancer cells ➤ To gain the knowledge about cell organelle, cell division, cell communication and mutational changes in gene function. 				
Unit-I	Structural organization and function of intra cellular organelles	12 hours			
Cellwall,nucleus,mitochondria,Golgibodies,lysosomes,endoplasmicreticulum,peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.					
Unit-II	Membrane structure and function	12 hours			
Structure of model membrane, lipid bilayerand membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membrane.					
Unit-III	Cell Communication	12 hours			
Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alternation of host cell behavior by pathogens, Virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.					
Unit-IV	Cell Signaling	12 hours			
ligands and receptors, Endocrine, Paracrine and autocrine signaling. Receptors and signaling pathways – cell surface receptors ionchannels, G-protein coupled receptors, receptor kinases (tyr, ser. thr). Signal transduction through cytoplasmic and nuclear receptors. The Rasraf-map kinase cascade. Second Messengers-cyclic nucleotides, lipids and calcium ions. Cross talking signaling pathways.					
Unit - V	Cell division and cell cycle	12 hours			
Mitosis and Meiosis, their regulation, steps in cell cycle and control of cell cycle. Cancer: Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, cell death-Necrosis, apoptosis.					
Text Books					
1.Aubrey Stimola, Cell biology Rosen Publishing Group, 2011. 2. Lodish. H and Baltimore. D, Cell biology, W.H. Freeman Publishers, 2012. 3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter P. Molecular Biology of the Cell. Garland Science, 6 th Edition, 2014. 4. William D. Stansfield, Jaime S. Colome, Raul J. Cano, Schaum's Outline of Molecular And Cell Biology, McGraw Hill-publisher, 1 st Edition, 2020.					
References					
1.Gerald Karp, Cell and Molecular Biology, John Wiley and Sons, 2013. 2.Bruce Alberts, Essential cell biology, Taylor and Francis Group, 2014. 3.George Plopper, Principle Cell Biology, Jones & Bartlett publishers, 2016.					
E-Reference links					
1. https://microbenotes.com/cell-organelles/ 2. https://www2.le.ac.uk/projects/vgec/highereducation/topics/cellcycle-mitosis-meiosis 3. https://microbenotes.com/cell-organelles/					

4. http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Structure-of-the-cell.pdf
 5. https://mcb.berkeley.edu/courses/mcb110spring/nogales/mcb110_s2008_4signaling.pdf

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the structural organization and function of cell organelles	K1,K2
CO2	know about membrane assembly and membrane transport	K1,K2,K3
CO3	recognize host parasite interaction and induced disease	K1,K2
CO4	employ the knowledge on receptor and signaling pathways	K1,K2,K3
CO5	thoroughly understand the cell division and cell cycle	K1,K2

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	S	S	S	M	S	S

Strongly Correlating
Weakly Correlating

(S) - 3 marks ;
(W) - 1 mark;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BCT14		BIOENERGETICS AND METABOLISM			
CORE IV			L	T	P	C
Cognitive Level	K1:Recall	K2:Understand	K3:Apply			
Learning Objective	<ul style="list-style-type: none"> ➤ To know the biochemical changes and basic thermodynamic Principles. ➤ To gain knowledge on carbohydrate, Lipid and amino acid metabolism. ➤ To learn the integration of metabolic pathways and Hormonal regulation. ➤ To apply the knowledge of metabolic pathways to biotechnological and biochemical research. 					
Unit-I	Bioenergetics				12 hours	
Free energy and entropy. Laws of thermodynamics. Enzymes involved in redox reactions. The electron transport chain-organization and role in electron capture. Oxidative Phosphorylation electron transfer reactions in mitochondria. F1F0AT Pase-structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and oxidative Phosphorylation-uncouplers, ionophores. Regulation of oxidative Phosphorylation. Mitochondrial transport systems ATP/ADP exchange, malate/glycerol phosphate shuttle.						
Unit-II	Carbohydrate metabolism				12 hours	
Glycolysis and gluconeogenesis-pathway, key enzymes and co-ordinate regulation. The citric acid cycle and its regulation. Pentose phosphate pathway. Metabolism of glycogen and regulation. Glucuronic acid pathway.						
Unit-III	Lipid metabolism				12 hours	
Biosynthesis of lipids-Oxidation of fatty acids - β , α and omega oxidation. Metabolism of ketone bodies-formation, utilization, excretion and clinical significance. A brief account of the metabolism of triglycerides, phospholipids and cholesterol. Lipoprotein metabolism.						
Unit-IV	Metabolism of amino acids, purines and pyrimidines				12 hours	
Overview of biosynthesis of non-essential amino acids (Glycine, Serine, tyrosine). Catabolism of amino acid: nitrogen-transamination, deamination, ammonia formation, urea cycle. Catabolism of carbon skeletons of amino acids-overview only. Digestion and absorption of nucleoproteins, Metabolism of purines- denovo and salvage pathways for purine biosynthesis, purine catabolic pathway. Metabolism of pyrimidines – biosynthesis and catabolism.						
Unit - V	Metabolic integration				12 hours	
Interconversion of major food stuffs, metabolic profile of the liver, adipose tissue and brain. General principles of metabolic regulation and enzyme control.						
Text Books						
<ol style="list-style-type: none"> 1. D. Anandhi, Introduction to Biochemistry and Metabolism, Pearson Education India, 2014. 2. K. Ramadevi, Ambika Shanmugam, Fundamentals of Biochemistry for Medical students, Wolters Kluwer India Pvt Ltd, 2016. 3. Sowbhaghya Lakshmi, Textbook of Biochemistry, Paras Medical Publisher, 2015 4. S.P. Singh, Textbook of Biochemistry, Publisher CBS Publishers & Distributors, 2015 						
References						
<ol style="list-style-type: none"> 1. David L. Nelson & Michael. M. Cox, Lehninger Principles of Biochemistry , W.H. Freeman & Co, 2017. 3. Robert. K. Murray, Harper's Illustrated Biochemistry McGraw Hill Education, 2017. 4. Voet, D, Voet, J.G and Pratt, C.W. Principles of Biochemistry., 4th Edition, Publisher Wiley, 2013. 5. Mathews, C.K. & Van Holde, K.E. & Ahern, K G. Biochemistry. 4th Edition, Publisher Addison Wesley. 2012. 						

5.U. Satyanarayana. Biochemistry, Publisher Books and Allied (P) Ltd., Calcutta, 2017.

E- Reference links

1. https://asutoshcollege.in/Study_Material/Semester_4_Introduction_07042020.pdf
2. http://yengage.yenepoya.edu.in/idata/YenepoyaUniversity/ilFile/4/89/file_48903/001/Bioenergetics.pdf
1. <https://nios.ac.in/media/documents/dmlt/Biochemistry/Lesson-03.pdf>
2. <https://courses.lumenlearning.com/boundless-microbiology/chapter/amino-acid-and-nucleotide-biosynthesis/>
3. <https://www.lecturio.com/magazine/nucleotide-metabolism/>
4. https://biolympiads.com/wpcontent/uploads/2018/09/integration_of_metabolism.pdf

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	learn the concepts of thermodynamics and electron transport chain.	K1,K2
CO2	acquire knowledge on carbohydrate metabolism and their regulation.	K1,K2,K3
CO3	know the biosynthesis and metabolism of lipid.	K1,K2
CO4	understand the metabolism of amino acid and nucleic acid.	K1,K2
CO5	acquire deep knowledge on the principles of metabolic regulation	K1,K2,K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	S	S	M	S	S
CO3	S	S	M	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	M	S	M	S	S	M	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCP11	PRACTICAL – BIOCHEMICAL TECHNIQUES AND BIOCHEMICAL ANALYSIS			
CORE V		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand	K3:Apply		
Learning objective	<ul style="list-style-type: none"> ➤ To know the methods for biochemical test and enzyme activity assay. ➤ To learn the chromatography techniques and develop the laboratory skills. ➤ To perform assays to analyze serum enzyme activity 				
Experiments	<p>1. Enzyme kinetics of amylase.</p> <ol style="list-style-type: none"> 1. Preparation of crude enzyme extract <ul style="list-style-type: none"> Effect of pH Temperature Substrate concentration Enzyme concentration Determination of k_m. 2. Assay of serum enzyme activity <ul style="list-style-type: none"> Alkaline phosphatase Acid phosphatase Aspartate transaminase Lactate dehydrogenase Amylase 3. Lipid analysis <ul style="list-style-type: none"> Determination of Saponification number Determination of Acid number Determination of Iodine number 4. Separation of lipids by TLC 5. Separation of Amino acids by Paper chromatography. 				
Text Books	<ol style="list-style-type: none"> 1. Shivaraja Shankara. Y.M. Laboratory Manual for Practical Biochemistry Jaypee Brothers Medical Publishers, 2013. 2. S. Rajan, R. Selvichristy Experimental Procedures in Lifesciences CBS, 2019. 3. Damodaran Geetha K. Practical Biochemistry. Jaypee Brothers Medical Publishers,2016. 4. Gupta Prem Prakash. Essentials Of Practical Biochemistry. Jaypee Brothers Medical Publishers,2017. 5. Evangeline Jones, Manual Of Practical Medical Biochemistry, Jaypee Brothers Medical Publishers,2016 				
References	<ol style="list-style-type: none"> 1. Soundravally Rajendiran, Pooja Dhiman, Biochemistry Practical Manual, Elsevier, 2019. 2. CG. Kaushik, Neha Sharma, Sabira Dabeer, Ruchi Jindal, Practical Manual of Biochemistry, CBS, 2020. 3. Rafi M. D, Manual of Practical Biochemistry, Orient Black swan Pvt. Ltd, , 2020 4. Shivaraja Shankara . Y. M. Laboratory Manual for Practical Biochemistry Jaypee Brothers Medical Publishers, 2nd Edition, 2013. 5. S. Rajan, R. Selviraysca Experimental Procedures in Lifesciences CBS, 2019. 				

E-Reference links	<ol style="list-style-type: none"> 1. http://swe.mit.edu/outreach/virtual_resources/paper_chromatography.pdf 2. http://www.bioquest.org/summer2005/projectfiles/TLC_protocol.pdf 3. https://www.youtube.com/watch?v=hUr3xXxj2a8 4. https://www.youtube.com/watch?v=fQ1hSNGnXYY 5. https://www.youtube.com/watch?v=Dp gmHx-dl1A
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Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	acquire knowledge on preparation of enzyme and their effect various factors.	K1,K2
CO2	demonstrate the serum enzyme activity through assays	K1,K2,K3
CO3	gain knowledge about lipid analysis.	K1,K2,K3
CO4	learn and understand about the separation of lipids	K1,K2
CO5	understand and describe aminoacid separation	K1,K2

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	M	S	S	S	S	M	S	M	M	S
CO2	M	M	M	M	S	M	M	M	M	M	S	M	M
CO3	S	S	M	S	S	S	S	M	S	M	M	M	S
CO4	M	M	S	S	M	S	S	S	S	S	S	S	M
CO5	M	S	S	S	M	S	M	S	S	S	S	S	M

Strongly Correlating
Weakly Correlating

(S) - 3 marks ;
(W) - 1 mark;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

SEMESTER II

Course Code	P21BCT21	MOLECULAR ENDOCRINOLOGY			
CORE VI		5	-	-	4
Cognitive Level	K1:Recall K2:Understand K3:Apply				
Learning objective	<ul style="list-style-type: none"> ➤ To know the hormone classification and biosynthesis. ➤ To learn the synthesis and biological functions of pituitary hormones, growth hormones and thyroid hormones. ➤ To know about functions of pancreas, adrenal hormones, mechanism and role of pathophysiology. ➤ To acquire the knowledge about hormone secretion and function 				
Unit-I	Hormones				12 hours
Definition, classification, biosynthesis & degradation. Mechanism of hormone action, Feedback regulation of hormones, second messengers.					
Unit-II	Pituitary hormones				12 hours
Anatomy of pituitary gland, hormones of the pituitary, pathophysiology. Mechanism of action, Neurohypophysis, neurohypophyseal hormone secretion. Hypothalamic releasing factor, mechanism of action of oxytocin, vasopressin, pathophysiology. Growth hormones: somatotropins and somatomedins, biosynthesis, secretion, transport, regulation and biological effect of growth hormone, FSH, LH, TSH, ACTH and prolactin, acromegaly and dwarfism.					
Unit-III	Thyroid				12 hours
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. Hypo & hyper thyroidism, antithyroid agents, role of parathyroid hormones, calcitonin, calcitriol, calcium and phosphorous homeostasis. Hypo and hyperparathyroidism.					
Unit-IV	Pancreas				12 hours
Endocrine pancreas, islet of Langerhans, cell types, biosynthesis, mechanism of action and biological effect of insulin, glucagon, somatostatin. Pancreatic peptide – chemistry, physiological roles and mechanism of action. Catecholamines - synthesis, chemistry and metabolism. Neurohormones: endorphins - source, chemistry, control of secretion, physiological roles. Mechanism of action and pathophysiology.					
Unit - V	Adrenal hormones				12 hours
Biosynthesis, secretion, transport, mechanism of action and excretion of glucocorticoids and mineralocorticoids, adrenal medullary hormones- epinephrine and nor epinephrine, steroid hormones. Androgens and estrogens - source, synthesis, chemistry and metabolism of androgens, Physiological roles and mechanism of action, pathophysiology. Ovarian steroid hormone synthesis, physiological role.					
Text Books					
1. J.Larry. Jameson, Harrison's Endocrinology Chaukhamba Auriyantaliya, 2017.					
2. David. G. Gardner & Dolores Shoback, Greenspan's Basic & Clinical Endocrinology Overruns, 2017.					

3. Kleine, Bernhard, Rossmannith, Winfried G. Hormones and the Endocrine System, Springer, 2016
4. Dharmalingam, Textbook Of Endocrinology, Jaypee Brothers Medical Publishers, 2010
5. J. Larry Jameson, Endocrinology, Publisher McGraw-Hill Education / Medical, 2016

References

1. C. Donnell Turner, Joseph. T. Bagnara, General Endocrinology Affiliated East – West Press Pvt. Ltd – New Delhi, 2012.
2. Shiomelmed, Kenneth S. Polonsky, P. Reed Larsen, Henry. M. Kronberg, Williams Textbook of Endocrinology Elsevier, 2015.
3. Bernhard Kleine, Winfried. G. Rossmannith Hormones and the Endocrine System – Textbook of Endocrinology Springer Nature, 2016.
4. Shlomo Melmed MBChB, Kenneth S. Polonsky, P. Reed Larsen, Henry M. Kronenberg, Textbook of Endocrinology, Publisher Elsevier, 2015

E-Reference links

1. <https://www.britannica.com/science/hormone/Parathormone-of-the-parathyroid-gland>
2. https://www.emedicinehealth.com/signs_symptoms_hormone_imbalance/article_em.html
3. <https://www.sciencedirect.com/science/article/pii/S016748890700236>
4. <https://www.sciencedirect.com/science/article/pii/S016748891630015>. <http://watcut.uwaterloo.ca/webnotes/Metabolism/Hormones.html> <http://homepage.ufp.pt/pedros/bq/integration.html>

Course Out come

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	know about the hormone biosynthesis and their behavior.	K1, K2, K3
CO2	thoroughly understand the anatomy and biochemical action of pituitary hormones.	K1, K2
CO3	gain knowledge about the regulation of thyroid hormone.	K1, K2, K3
CO4	illustrate the anatomy of pancreas and its hormonal action.	K1, K2, K3
CO5	acquire knowledge on the biosynthesis, secretion and mechanism of action of adrenal hormones.	K1, K2

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	M	M	M	S	S	M	S	M	S	S
CO2	S	M	M	M	M	M	M	S	M	S	M	S	S
CO3	S	S	M	M	M	M	M	S	M	M	M	S	S
CO4	S	M	M	M	M	M	S	S	M	S	M	S	S
CO5	S	S	M	M	M	M	S	S	M	S	M	S	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BCT22	CLINICAL BIOCHEMISTRY			
CORE VII		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To gain knowledge on the disorders caused due to the error in carbohydrate metabolism and regulation of blood glucose level. ➤ To know about the disorders caused due to the defects in lipid, protein and nucleic acid metabolism. ➤ To train the clinical test such as tissue function tests, biochemical tests and renal disorders. ➤ To understand the clinical significance of diagnostic biochemistry. 				
Unit-I	Disorder of carbohydrate and lipid metabolism			12 hours	
Disorders of carbohydrate metabolism – glycogen storage diseases, galactosemia, fructose intolerance and fructosuria. Blood sugar homeostasis: Role of tissues and hormones in the maintenance of blood sugar. Hypoglycemia, hyperglycemia, glycosuria. Diabetes mellitus – classification, metabolic abnormalities, diagnosis and management. Disorders of lipid metabolism – lipoproteinaemias. Lipid storage diseases – Gaucher's, Tay - Sach's, Niemann Pick disease, Fatty liver and Atherosclerosis.					
Unit-II	Disorders of amino acid and nucleic acid metabolism			12 hours	
Disorders of amino acid metabolism – amino aciduria, Phenyl ketonuria, Hartnup disease, alkaptonuria, albinism, cystinuria, cystinosis, homo cystinuria and maple syrup urine disease. Disorders of purine and pyrimidine metabolism: Hyper uricemia and gout, Hypo uricemia, Oroticaciduria. Serology: C - reactive protein test, Rheumatoid arthritis (RA) test.					
Unit-III	Liver function test and gastric function test			12 hours	
Jaundice - Causes, Consequences, biochemical findings, treatment in jaundice, hepatitis and cirrhosis. Liver function test - Tests related to excretory (bile pigments), synthetic (plasma proteins, prothrombin time), detoxifying (hippuric acid, NH ₃ , aminopyrine) and metabolic (galactose) functions, Gallstones. Gastric function tests - Stimulation tests – insulin and pentagastrin. Peptic ulcer, gastritis and Zollinger Ellison syndrome.					
Unit-IV	Renal function test and metabolic disorders			12 hours	
Kidney function - Biochemical findings in glomerulonephritis, renal failure and nephritic syndrome, Nephrolithiasis. Kidney function tests - Glomerular function tests–inulin, urea and creatinine clearance tests, renal plasma flow, plasma micro globulin. Tubular function tests – water load, concentration and acid excretion tests. Abnormal constituents of urine.					
Unit - V	Clinical enzymology			12 hours	
Serum enzymes and enzymes in health and disease. Transaminases (AST, ALT). Alkaline phosphatases, amylase, LDH and CK. Disorders of mineral metabolism: porphyrins, hemoglobin - disorders of erythrocyte metabolism, hemoglobinopathies, thalassemia and anemia, classification of anemia, blood clotting disorders.					
Text Books					
<ol style="list-style-type: none"> 1. Nanda Maheswari, Clinical Biochemistry Jaypee Brothers Medical Publishers, 2016. 2. John. E. Hall, Guyton & Hall Text book of Medical Physiology, Elsevier, Health,2017. 3. Gaw, Clinical Biochemistry, Publisher Elsevier Health, UK,2013 4. Prem Prakash Gupta, Textbook Of Biochemistry With Biomedical Significance, CBS Publishers & Distributors,2013 					

5. Nessar Ahmed, Clinical Biochemistry, Publisher OUP UK,2015

References

1. Rajinder Chawla, Tarek. H. E, Metwally Sucherdasahu, Text book of Medical Biochemistry Wolters Kluwer India, Pvt, Ltd, 2017.
2. Allan Gaw, *et al.*, Clinical chemistry Churchill Living Stone, 2018.
3. Michael Murphy, Rajeer Srivastava, Kevin Deans, Clinical Biochemistry, Elsevier, 2018.
4. Martin Andrew Crook, Clinical Biochemistry and Metabolic Medicine, CRC Press,2012

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1. <https://my.clevelandclinic.org/health/diseases/7104-diabetes-mellitus-an-overview>
2. <https://www.marchofdimes.org/baby/amino-acid-metabolism-disorders.aspx>
3. <https://www.britannica.com/science/metabolic-disease/Disorders-of-amino-acid-metabolism>
4. <https://www.britannica.com/science/lipid-storage-disease>
5. <https://www.sciencedirect.com/topics/medicine-and-dentistry/purine-metabolism-disorder>
6. <https://www.sciencedirect.com/topics/medicine-and-dentistry/orotic-aciduria>
7. <https://www.healthline.com/health/liver-function-tests#types>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	acquire deep knowledge on the disorders of carbohydrate and lipid metabolism.	K, K2, K3
CO2	recognize the disorders of protein and nucleic acid metabolism.	K1, K2, K3
CO3	understand the liver function and gastric function test.	K1, K2
CO4	know about renal function test and adrenal disorder.	K1, K2
CO5	know about the serum enzyme level and mineral metabolism.	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	M	M	S	S	S	M	S	S	S	M	S	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	M
CO3	S	S	M	M	M	S	S	S	M	M	S	S	S
CO4	S	S	M	M	M	M	M	S	S	M	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M	M	S	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

5. BasirF, Textbook of Immunology, Publisher Prentice Hall India Learning Private Limited,2012
Latha P.Madhavee, Textbook of Immunology, Publisher S Chand & Company 2012

References

1. Thao Doan, Immunology Wolters Kluwer India Pvt Ltd, 2012.
2. Abbas, Cellular and Molecular Immunology, Elsevier, 2018.
3. Jenni Punt, Sharon Stanford, Immunology W. H Freeman & Co, 2018
4. Kuby J. Immunology, W.H. Freeman and Company, New York. 2006.
5. Roitt I. Essential Immunology, Blackwell Scientific Publications, 2017
6. Geoffrey Sunshine, Immunology: A Short Course Richard Coico, Wiley-Blackwell,2015.

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1. <https://www.news-medical.net/life-sciences/What-is-an-Antigen.aspx>
2. <https://courses.lumenlearning.com/boundless-biology/chapter/antibodies/>
3. <https://www.nursingtimes.net/clinical-archive/immunology/the-lymphatic-system-2-structure-and-function-of-the-lymphoid-organs-26-10-2020/>
4. <https://www.lecturio.com/magazine/hypersensitivity-and-its-types/>
5. <https://www.narayanahealth.org/organ-transplant/>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	list the types of immunity and their immune response against Antigens.	K1, K2
CO2	know about the importance of immune antigen, antibody reaction and complemen	K1, K2, K3
CO3	Illustrate the interaction of T and B lymphocytes and processing of Antigen.	K1, K2, K3
CO4	know about preparation of vaccines, immune reactions and immune tolerance.	K1, K2
CO5	gain knowledge on transplantation immunology, auto immune di and Immunoglobulin disorder.	K1, K2

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	M	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	M	S
CO3	M	M	S	M	S	M	S	S	S	M	S	S	S
CO4	S	S	M	M	S	S	M	S	S	S	S	M	M
CO5	S	M	S	S	S	S	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BCT24	BIOTECHNOLOGY			
CORE IX		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3: Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To know about the DNA isolation methods, cloning vectors and restriction enzymes. ➤ To learn about southern, northern and western hybridization and gene transfer methods. ➤ To gain knowledge on application of transgenic plants and monoclonal antibodies. ➤ To learn advance bio techniques and its application. 				
Unit-I	Genetic engineering technology				12 hours
rDNA technology, gene cloning, specialized tools and techniques, benefits of gene cloning. Isolation and purification of DNA: Preparation of total cellular DNA, plasmid DNA, bacteriophage DNA, plant cell DNA, isolation of mRNA from mammalian cells.					
Unit-II	Vectors and enzymes in cloning				12 hours
Cloning and Expression vectors, Plasmids - pBR, pUC, phages (M13, λ), yeast vectors, cosmids, phagemids, agrobacterium, PAC, BAC, YAC, MAC, HAC vectors, plant and animal viruses as vector, binary and shuttle vectors, expression vectors for prokaryotes and eukaryotes, expression cassettes. Restriction endonucleases, ligases, S ₁ nuclease, reverse transcriptase, polymerase, alkaline phosphatase, terminal transferase, methods of ligation					
Unit-III	Libraries				12 hours
Construction of genomic and cDNA libraries, selection and screening of recombinants, probes - types, synthesis and uses of probes. Blotting techniques (Southern, Northern and Western), PCR - types and applications. Sequencing - DNA and RNA, site directed mutagenesis. Chromosome walking, jumping, DNA fingerprinting and foot printing.					
Unit-IV	Methods of gene transfer				12 hours
Micro injection, electroporation, particle bombardment gun (biolistic), ultrasonication, and liposome mediated gene transfer. Restriction analysis of DNA, molecular markers - RFLP, RAPD, VNTR, SSR, AFLP, STS, SCAR, SNP, Microarrays. Genomics (human genomic project) and proteomics – types and applications.					
Unit - V	Applications of Genetic Engineering				12 hours
Recombinant insulin, somatotropin, vaccines, role of genetic engineering in diagnosis and cure of diseases, gene therapy, transgenic plants (herbicide resistant, pesticide resistant, and antisense RNA technology and its application). Transgenic animals - IPR, patenting, ethical, legal issues and hazards of genetic engineering.					
Text Books					
<ol style="list-style-type: none"> 1. U. Satyanarayana, U. Chakrapani, Biotechnology Books & Allied Ltd, 2020. 2. R. C. Dubey, A Text book of Biotechnology, S. Chand, 2014. 3. T.A.Brown. An Introduction to Gene cloning & DNA analysis, 7th edition, Wiley balckwell, US. 2016. 4. Desmond S. T. Nicholl, An Introduction to Genetic Engineering, Cambridge University Press,2018. 5. Mariana Ianello Giasseti, Tatjana Brankov, Genetic Engineering Principles And Methods, Scitus Academics,2019 					

References

1. Keya Chaudhuri, Recombinant DNA Technology the Energy and Resources, 2012.
2. H. K. Das Textbook of Biotechnology Wiley, 5th Edition, 2017.
3. Ulhask Patil, Kalyani – Muskan Essentials of Biotechnology, Dreamtech Press, 2020.
4. T.A. Brown, Genomes 4, Publisher Taylor and Francis, New York, 2018.
5. Bernard R. Glick, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition Publisher, 2017.
6. Isil Aksan Kurnaz, Techniques in Genetic Engineering, Publisher CRC Press, 2021.
7. Walter E. Hill, Genetic Engineering A Primer, Publisher CRC Press, 2019.

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1. <https://courses.lumenlearning.com/boundless-biology/chapter/laws-of-inheritance/>
2. <https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod2.pdf>
3. <https://www.ncbi.nlm.nih.gov/books/NBK21578/>
4. <https://plato.stanford.edu/entries/population-genetics/>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	attain the concepts of genetic engineering techniques and isolation of nucleic acid.	K1, K2, K3
CO2	describe about vectors and cloning techniques	K1, K2, K3
CO3	know about construction of genomic libraries and blotting techniques.	K1, K2, K3
CO4	learn about gene transfer techniques and their applications.	K1, K2
CO5	gain knowledge about bioethics, applications of Recombinant technology.	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	S	S	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BCP22	PRACTICAL- IMMUNOBIOLOGY AND CLINICAL BIOCHEMISTRY			
CORE X		L	T	P	C
		-	-	6	4
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To learn the blood grouping and method to estimate hemoglobin level in blood. ➤ To acquire the practical knowledge for the estimation of blood sugar and uric acid level estimation ➤ To learn immuno electrophoresis and immuno diffusion techniques. ➤ To assess the laboratory test to find physiological conditions and diseases 				
Experiments	<p>Immunology</p> <ol style="list-style-type: none"> 1. Identifying blood group and Rh typing 2. Immuno diffusion single radial, double diffusion and Ouchterlony 3. Immuno electrophoresis 4. Rocket immune electrophoresis 5. Agglutination, Precipitation <p>Clinical Biochemistry</p> <p>Blood analysis</p> <ul style="list-style-type: none"> • Blood sugar - Azatoor and king's method • Blood urea - Dam method • Blood cholesterol - Zak's method • Blood uric acid - Caraway's method • Creatinine - Picric acid method • Estimation of protein by Biuret method • Calcium and phosphorous 				
Text Books					
<ol style="list-style-type: none"> 1. Janicespeshock, Immunology Lab Manual, kendall Hunt Publishing, 2019. 2. Beedu Sashidhar Rao, Vijay Deshpande Experimental Biochemistry A Student Companion Dreamtech press, 2020. 					
References					
<ol style="list-style-type: none"> 1. ShivanandaNayak B. Manipal Manual of Clinical Biotechnology Jaypee Brothers, 2013. 2. DrewProvan, Oxford Handbook of Clinical and Laboratory Investigation OUP, Oxford, 2018. 3. S. Rajan, R. Selvi26hristy Experimental Procedures in Life sciences CBS, 2019. 					
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<ol style="list-style-type: none"> 1. https://youtu.be/-atHARq0JbQ 2. https://youtu.be/HfubKxTjvIE 3. https://youtu.be/B88TqQYOENU 4. https://youtu.be/yxokk8VyfII 5. https://youtu.be/PlhbRulwNVo 6. https://youtu.be/CaJ2CjPeCP0 7. https://youtu.be/zUGikX9ZB9U 8. https://youtu.be/kUBHR3TwL9Q 					

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	gain knowledge on different methods for identification of antigens.	K1, K2
CO2	interpret antigen and antibody reaction	K1, K2, K3
CO3	examine blood urea, sugar, uric acid, creatinine.	K1, K2, K3
CO4	learn and understand the urine urea, uric acid and sugar.	K1, K2, K3
CO5	understand the procedure to analyze the urine component.	K1, K2, K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	M	S	M	S	M	S
CO2	S	M	M	S	M	S	M	S	S	M	S	S	S
CO3	M	S	S	M	M	M	M	S	M	S	S	S	M
CO4	M	S	S	M	S	M	S	S	S	S	M	M	S
CO5	S	M	M	S	S	S	S	S	S	S	S	M	M

Strongly Correlating (S)
Weakly Correlating (W)

3 marks ;
- 1 mark ;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BCN211	WOMEN HEALTH			
NME		L	T	P	C
Cognitive Level	K1:Recall K2:Understand K3:Apply				
Learning objective	<ul style="list-style-type: none"> ➤ To understand the life course perspective on women's health and health care interventions, programs and policy. ➤ To understand medical and public health practices directed at women ➤ To analyze a women's health problem relative to its public health implications. ➤ To learn the public health interventions, programs and policies. ➤ To identify trends in major health conditions that affect women. 				
Unit-I	Health				12 hours
WHO, health as a fundamental right, women's health status, causes for women's poor health, discrimination in food and health care, myths - practices, reproductive health.					
Unit-II	Indicators of health				12 hours
IMR (Infant Mortality Rate), MMR (Measles, Mumps and Rubella), TFR (Total Fertility Rate), Institutional health care - family welfare program through PHCs (Primary Health Centre), CHCs (Community Health Centre) & hospitals in urban areas, immunization, hospital delivery – janani suraksha yojana.					
Unit-III	Hygiene and sanitation				12 hours
Importance of personal hygiene, hygiene during menstruation, Safe drinking water and sanitation.					
Unit-IV	Nutrition chart				12 hours
Nutrition status of adolescent girls, pregnant and lactating mothers - malnutrition and its effects on children - anemia in women - causes, measuring methods, nutrition supply programs of Government.					
Unit - V	National Policy				12 hours
National Health Mission, National population policy- 2000, National Health Policy, Occupational health hazards of women.					
Text Books					
<ol style="list-style-type: none"> 1. Shuthargini A. Joshi, Nutrition and Dietetics, McGraw Hill Education, 2017. 2. B. K. Shekbar, National Rural Health Mission in India Book leaf publishers, 2013. 3. Marlene Goldman Rebecca Troisi Kathryn Rexrode, Women and Health, Elsevier, 2012 4. Ellis Quinn Youngkin, Women's Health: A Primary Care Clinical Guide, Publisher Pearson, 2012 					
References					
<ol style="list-style-type: none"> 1. Marlene Goldman, Women & Health, Elsevier, 2012. 2. Sunetra Roday Food Hygiene & Sanitation McGraw Hill Education, 2017. 3. Sunetra Roday, Food Science & Nutrition, Oxford University, 2018 4. Sue Reed, Dino Pisaniello, Geza Benke, Kerrie Burton, Principles of Occupational Health and Hygiene: An introduction, Publisher Routledge, 2013 					
E-Reference links					
<ol style="list-style-type: none"> 1. https://www.slideshare.net/SaratuGarbaAbdullahi/women-and-occupational-health 2. https://www.slideshare.net/drbbharatpaul/indicators-of-health 3. https://medlineplus.gov/ency/article/007458.htm 4. https://nhm.gov.in/images/pdf/guidelines/nrhmguidelines/national_population_policy_2000.pdf 					

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	know about women's health status and reproductive health	K1, K2
CO2	gain knowledge on welfare program and policy	K1, K2, K3
CO3	illustrate the importance of hygiene	K1, K2, K3
CO4	discuss the nutritional status of adolescent, pregnancy and lactation women	K1, K2, K3
CO5	understand and discuss about the occupational health hazards of women	K1, K2, K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	M	S	S	M	S	M	M	M
CO2	S	M	S	M	S	M	S	M	S	S	M	S	M
CO3	M	S	M	M	S	S	S	M	S	M	S	S	S
CO4	M	S	M	S	M	S	M	S	S	M	S	S	S
CO5	S	M	S	S	M	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark ; No Correlation (N) - 0 mark

Course Code	P21BCS22	INDUSTRIAL FERMENTATION PRODUCTS			
SUPPORTIVE COURSE-II		L	T	P	C
Cognitive Level	K1:Recall K2:Understand K3:Apply				
Learning Objective	<ul style="list-style-type: none"> To learn the modern techniques such as fermentation and distillation To acquire knowledge in the production of organic acids, antibiotics, wine and alcohol To gain knowledge on bio-fermenter and its mode of operation To understand the basics in the production of fermented foods and essential oils. 				
Unit I	Fermentation	6 hours			
Definition and importance of fermented products; Organisms used for production of fermented products; Fermented beverages- types, methods of manufacture for vinegar, sauerkraut, tempeh, miso , soya sauce ,beer,wine and traditional Indian foods; Dairy Fermentations – Buttermilk, Yogurt, cheese, Milk- Characteristics, Processing, Starter culture, Growth and Genetics –Properties and beneficial effects of probiotic and prebiotic. Fermented meat and fish products, Indian fermented foods.					
Unit II	Distillation	6 hours			
Types of Distillation – Simple distillation, Fractional distillation, Steam distillation, Vacuum distillation, Air-sensitive vacuum distillation, Short path distillation and Zone distillation. Alcohol distillation: basic principles, equipment, performance relationships, and safety. Mechanism of Distillation. : Hydro diffusion, Hydrolysis, Decomposition by heat, Advantage and Disadvantage of different distillation methods. Application of distillation methods. Heat exchangers.					
Unit III	Practical in fermentation	6 hours			
<ul style="list-style-type: none"> Isolation of industrially important microorganisms Production of Industrially important Enzyme by solid state fermentation Production of Organic acids Production of Antibiotics Wine preparation Production of alcohol by microbes. Production of biofuel by microorganism 					
Unit IV	Practical in food	6 hours			
<ol style="list-style-type: none"> Food Fermentation Technologies. Study of a Bio fermentor – its design and operation, Down Stream Processing and Product recovery. Starter cultures. Production of Baker's Yeast Development of a fermented food/drink utilizing plant products /animal products or by products as substrate 					
Unit V		6 hours			
Extraction methods of natural essential oils- water and steam distillation; and direct steam distillation.					
Text Books					
1. Stanbury P.F., Whitaker A, Hall S.J.Principles of Fermentation					

2. Technology, Butterworth Heinemann, UK, 2016.
3. Shuler M.L and Kargi F. Bioprocess Engineering: Basic concepts Prentice Hall, 2017.
4. Smita S. Patil, Fermentation Technology – II, Success Publications, 2015

References

1. Doran PM, Bioprocess Engineering Principles Elsevier, 2013
2. Cornish-Bowden A. Fundamentals of Enzyme Kinetics, Butterworth group, 2012.
3. Okafor N. Modern Industrial Microbiology and Biotechnology, SP publishers, 2016.
4. Pau Loke Show, Chien Wei Ooi, Tau Chuan Ling, Bioprocess Engineering :Downstream Processing, Published CRC Press, 2021
5. Essentials in Fermentation Technology, Berenjian, Aydin, Publisher Springer, 2019.

E-Reference link

1. <https://nptel.ac.in/>
2. https://www.wakenbtech.co.jp/wp/wpcontent/uploads/2015/11/nbs_fermentation_basics.pdf
3. https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf
4. <https://mbr.asm.org/content/mbr/62/3/646.full.pdf>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	define the concepts in fermentation and learn the production of fermented foods	K1, K2
CO2	list the types of fermentation and explain the advantages and disadvantages of distillation	K1, K2, K3
CO3	learn and experiment the different techniques to produce organic acids, alcohols, wine and antibiotics	K1, K2, K3
CO4	illustrate the design and operation of bio-fermenter	K1, K2, K3
CO5	know about the methods in the production of essential oils.	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	M	M	S	S	M	M	S	S
CO2	S	S	S	M	M	S	M	M	S	M	M	S	S
CO3	M	M	S	M	S	S	M	S	S	S	S	S	M
CO4	M	M	S	S	S	S	S	S	M	S	S	M	M
CO5	S	S	S	S	S	S	S	S	M	S	S	M	S

Strongly Correlating (S) - 3 marks ;
Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

SEMESTER III

Course Code	P21BCT31	PHARMACEUTICAL BIOCHEMISTRY			
CORE-XI		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand	K3:Apply		
Learning objective	<ul style="list-style-type: none"> ➤ To acquire knowledge on mechanism of action of drugs ➤ To know the side effects and toxicity of Drugs ➤ To learn the mechanism of toxic effects ➤ To know the principles of toxicology 				
Unit-I	Biopharmaceutical properties of drugs				12 hours
Mechanism of drug absorption–physio chemical factors versus drug absorption. Drug dissociation versus drug absorption. Isomerism and pharmacological activity. Structural features and pharmacological activity; geometric isomerism, configuration influence on pharmacologic activity. Effect of conformational isomerism on Biological activity of drugs.					
Unit-II	Molecular modeling				12 hours
Principles of computational chemistry, molecular mechanics, chemical methods. Hardware considerations, Software considerations. Receptors and drug action, Affinity – Role of chemical bonding. Dose – Response relationships, Receptor location, Receptor and the biological response. Receptor subtypes. Dynamic nature of receptors. Nonsteroidal anti– inflammatory drugs. Drugs affecting sugar metabolism. Clinical significance of drugs.					
Unit-III	Drug metabolism				12 hours
First pass metabolism – Elimination pathway – Entero –hepatic cycling of drugs. Drug bio transformation pathway – phase I–Hepatic cytochrome P ₄₅₀ enzyme system; Cytochrome P ₄₅₀ cycle– induction and inhibition. Oxidation catalysed by cytochromeP ₄₅₀ isoforms–All types of hydroxylation, Deamination–DE alkylation– DE halogenation. Oxidations: Microsomal & Non–microsomal oxidations. Miscellaneous reductions.					
Unit-IV	Drug conjugation pathways (Phase-II)				12 hours
Hyaluronic acid conjugation– sulfate conjugation – conjugation with amino acids; Acetylation, Glutathione conjugation, cyanide conjugation. Extra hepatic metabolism – Toxicity from oxidative metabolism. Drug interactions–test. Metabolic pathways of common drugs. Lovastatin, Acetaminophen, Ciprofloxacin, Caffeine, Theophylline, Nicotine, Ibuprofen, Tamoxifen. General toxicology: Basic principles of diagnosis mechanism of toxic effect, toxico kinetics. Response of respiratory system, reproductive system, liver, kidney to toxic agents. Toxic effects of metals, Solvents and Environmental pollutants.					
Unit - V	Toxicology				12 hours
Principles of toxicology and treatment of poisoning. Heavy metals and antagonists. Non- metallic environmental toxicants. Methods involved in the development of new drugs. Preclinical toxicological studies. Determination of LD ₅₀ and ED ₅₀ . Acute, sub-acute and chronic toxicity studies. Antidotes in the management of poisoning. Applied analytical toxicology and toxic vigilance.					
Text books					
<ol style="list-style-type: none"> 1. Arthur.J ,Principles of clinical pharmacology,Academic press,2011. 2. Satoskar R.S, Pharmacology and Pharmaco Therapeutics, Popular Prakashan Bombay,2015 3. HarbansLal,Essentials of Pharmaceutical Biochemistry, Publisher CBS,2011 4. S.S Haque S.S Randhawa,Pharmaceutical Biochemistry, Publisher S Vikas and Company (PV),2017 					

References

1. Shargel.L, Applied Biopharmaceutics and pharmacokinetics Mc Gram- Hill Medical,,2015.
2. Eric .J. Nestler, molecular Neuropharmacology, Access Biomedical science,2015.
3. Karen Whalen, Pharmacology, LWW Health Library,2019.
4. Da Poian, Andrea T., Castanho, Miguel ,Integrative Human Biochemistry,Springer,2015

E-Reference links

1. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/ln_toxicology_final.pdf
2. <https://person.hst.aau.dk/gazerani/Introduction%20to%20Toxicology.pdf>
3. <https://nature.berkeley.edu/~dnomura/pdf/Lecture1PrinciplesofToxicology.pdf>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	learn the biopharmaceutical properties of drugs	K1,K2
CO2	discuss the importance of drug designing	K1,K2
CO3	gain knowledge on metabolism of drugs	K1,K2,K3
CO4	understand and explain the conjugation pathways of drugs	K1,K2,K3
CO5	define the key principles of toxicology and treatment of poisoning	K1,K2

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	M	M	S	S	S	S	M	S	S	S	M	M	S
CO3	S	M	S	S	S	M	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	S	S	S	S	M	S

Strongly Correlating(S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BCT32	MOLECULAR BIOLOGY			
CORE - XII		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand	K3:Apply		
Learning objective	<ul style="list-style-type: none"> ➤ To learn about the genetic material, mutation and genetic codon. ➤ To understand the bacterial genetic exchange, genetic maps, linkage and types of DNA replication in prokaryote and eukaryote. ➤ To understand the regulation of gene expression and mutation. ➤ To gain knowledge about recombination in bacteria. 				
Unit-I					12 hours
Structure of chromatin, Histone and Non Histone proteins, nucleosomes. Structure of DNA, evidence for DNA as genetic material, Experimental proof. Bacterial transformation, conjugation and transduction. DNA replication in prokaryotes, modes, steps and enzymes involved in DNA replication. Indicators of replications, Enzymology of DNA replication; Initiation, elongation and termination; Fidelity of Replication, Inhibitors of replication. Protein nucleic acid interaction. DNA damage and repair—all types.					
Unit-II	Transcription and Translation				12 hours
Transcription in prokaryotes, enzymology, inhibitors of RNA synthesis. Reverse transcription, heat shock proteins & Post transcriptional modification. Role of eukaryotic RNA polymerases. RNA splicing and processing of mRNA, tRNA and rRNA. Translation in prokaryotes -Initiation, elongation and termination of protein synthesis; Inhibitors of protein synthesis. Post-Translational modifications of proteins					
Unit-III	Genetic code				12 hours
Wobble hypothesis, Features of genetic code. Composition of Prokaryotic and eukaryotic ribosome. tRNA - structure; activation of amino acids, coding and non - coding strands of DNA. Protein sorting and targeting of mitochondria and chloroplast Proteins. Synthesis and targeting of peroxisome proteins. Overview of secretory pathway. Post translational modification— protein glycosylation in ER and Golgi complex. Receptor Mediated endocytosis.					
Unit-IV	Recombination in bacteria				12 hours
Mechanism forms of recombination, Holiday Model for homologous Recombination, Rec BCD Enzyme, RecAprotein, Messelson model, site specific recombination Regulation of gene expression in prokaryotes operon concept lac operon, trp operon and arabinose operon.					
Unit - V	Gene mutations				12 hours
Types- Nutritional, Lethal, Conditional mutants. Missense mutation and other point mutations. Spontaneous mutations- chemical and radiation – induced mutations – Ames test. Reversion techniques; selection of mutants, Auxotrophs; Replicaplating; Penicillin Cycling. Site directed mutagenesis. Bacterial Transposons: -Insertion sequences; Mechanism of transposition in bacteria.					
Text Books					
<ol style="list-style-type: none"> 1. Singhandphundan, Molecular Genetics ,IBDC publishers,2010 2. Malaciniski, Essentials of molecular Biology, Jones & Bartlelt,2015. 3. Verma P.S.,Agarwal V.K.Molecular Biology,PublisherS Chand,2010 4. James D. Watson,Molecular Biology of the Gene,PublisherPearson Education,2017 					

References

1. James D, Watson, Molecular biology of the gene , Pearson India, 2017.
2. Jocelyn E. Krebs, Gene VIII, Jones & Bartlett learning, 2017.
3. Gakhar S.K, Molecular Biology, Dreamtech press, 2019.
4. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P Walter, Garland
5. Molecular Biology of the Cell, 6th Edition, Publishing (Taylor & Francis Group), New & London, 2014.
6. Harvey Lodish, Molecular Cell Biology. 7th Edition, W.H. Freeman and Company, New York, 2014.

E-Reference links

1. <https://medlineplus.gov/genetics/understanding/basics/chromosome/>
2. <https://biologydictionary.net/transcription/3.https://courses.lumenlearning.com/microbiology/chapter/protein-synthesis-translation/>

Course Outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	know the structure of chromatin, and replication	K1,K2
CO2	gain knowledge on the transcription and translation process	K1,K2,K3
CO3	gain knowledge on genetic code and protein sorting	K1,K2
CO4	understand the recombination mechanisms in bacteria	K1,K2,
CO5	list and explain the types of mutation	K1,K2,K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	M	M	S	S	S	S	M	S	S	S	M	M	S
CO3	S	M	S	S	S	M	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BCT33	PLANT BIOCHEMISTRY			
CORE - XIII		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To understand the photosynthesis process occurs in plants. ➤ To learn the functions of natural and artificial plant growth regulators and hormones. ➤ To gain knowledge about plant nutrition, nitrogen fixation, the function of mineral, sulphur and nitrate metabolism in the plants. ➤ To understand plant physiology and reproduction. 				
Unit-I	Plant cell				12 hours
Structure, composition and functions of plant cell organelles, Including cell wall and cell membranes. Bio synthesis of cell wall. Translocation in xylem and phloem.					
Unit-II	Photosynthesis				12 hours
Photosynthetic apparatus, photosynthetic pigments and role of pigments in plants absorption and properties of light, quantum requirement and quantum yield, Red drop Emerson's enhancement effect. Two photosynthetic pigments, photo system I and II. Electron transport pathway in chloroplast membranes, ATP synthesis in chloroplast cyclic and non cyclic photophosphorylation. Carbon reaction in C3, C4 and CAM plants, Hatch Slack pathway, photorespiration and role of photorespiration in plants, significance of photorespiration, factors affecting photorespiration in plants. Pathway of glucose oxidation in plants, Synthesis and degradation of starch.					
Unit-III	Nitrogen fixation				12 hours
Symbiotic and Non- symbiotic, Symbiotic Nitrogen fixation in legumes, biochemistry and molecular biology of nitrogen fixation-Enzymology of nitrogen fixation, regulation NIF and nod genes of nitrogen fixation. Nitrite assimilation, sulphate activation & reduction, sulphite reduction, secondary metabolites- Alkaloids, glycosides terpenoids, phenols, steroids, phytoalexin.					
Unit-IV	Plant growth regulators				12 hours
Chemistry, biosynthesis, mode of action physiological role of auxin, gibberlin, cytokinin, ethylene and abscisic acid. Plant growth inhibitors. Photomorphogenesis- photoperiodism, phytochrome growth and development. Seed germination & dormancy- physiological biochemical changes factors affecting - water, light, temperature, stress.					
Unit - V	Plant disease				12 hours
Plant disease resistance mechanism and bio chemical changes. Physiology of flowering, biochemistry of fruit ripening, senescence and biochemical changes during senescence.					
Text Books					
<ol style="list-style-type: none"> 1. Jurgenkline – Vehn, Plant hormones, Humana press.2017 2. Srivastava H.S, Plant physiology and Biochemistry,2018 3. Hans-Walter Heldt, Birgit Piechulla, Plant Biochemistry, Publisher Academic Press,2010 4. BobB. Buchanan, Wilhelm Gruissem, RussellL. Jones, Biochemistry and Molecular Biology of Plants, Wiley,2015 					
References					
<ol style="list-style-type: none"> 1. Hans- Walterheldt, Plant Biochemistry, Acedemic press , 2011 2. Dey P.M, Plant Biochemistry, Elsevier science, 2013 3. Mehrotra, Fundamentals plant pathology, MC Graw Hill,2013 					

4. Caroline Bowsher, Alyson Tobin, Plant Biochemistry, Publisher Garland Science, Publisher Garland Science, 2021

E-Reference links

1. <https://forestrypedia.com/floral-terminology-illustrated/>
2. <https://www.biologydiscussion.com/plants/families-of-flowering-plants-and-their-economic-importance/6580>
3. <https://ssec.si.edu/stemvisions-blog/what-photosynthesis>
4. <http://www.omafra.gov.on.ca/english/crops/hort/plantgrowthregulators.htm>
5. <https://ssec.si.edu/stemvisions-blog/what-photosynthesis>
6. <http://www.omafra.gov.on.ca/english/crops/hort/plantgrowthregulators.htm>
7. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry%204.pdf://biologydictionary.net/c3-c4-cam-plants/

Course Outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the structure, composition and functions of plant cell	K1,K2
CO2	gain in-depth knowledge on the process of photosynthesis	K1,K2
CO3	learn nitrogen fixation and role of secondary Metabolites	K1,K2,K3
CO4	illustrate the role of plant growth regulators and photomorphogenesis.	K1,K2,K3
CO5	know about plant disease resistance mechanism and biochemical changes.	K1,K2,K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	M	S	S	S	S	S	S	M	S
CO2	S	S	S	M	S	S	M	S	S	S	M	S	S
CO3	M	M	S	S	S	S	S	M	S	S	S	M	S
CO4	M	S	S	M	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCT34	BASIC MICROBIOLOGY AND GENETICS			L	T	P	C
CORE - XIV					4	-	-	4
Cognitive Level	K1:Recall	K2:Understand	K3:Apply					
Learning Objective	<ul style="list-style-type: none"> ➤ To understand the basic concepts of the biology of microorganisms and its mechanism of action in host cells. ➤ To learn the microbiological techniques used for the classification of microorganisms ➤ To know the concepts of microbial nutrition and metabolism ➤ To understand the mendelian principles 							
Unit I	Introduction to Microbiology						12 hours	
An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM)- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining, spore staining								
Unit II	Microbial Structure and Multiplication						12 hours	
Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells, Multiplication of bacteria, viruses, algae, protozoa, fungi, yeast with appropriate examples, Life history of actinomycetes and bacteriophage								
Unit III	Microbial Nutrition and Metabolism						12 hours	
Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth, Mathematics of growth generation time and growth rate constant, factors affecting growth. Aerobic and Anaerobic respiration, Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway								
Unit IV	Mendelian principles						12 hours	
Segregation and independent assortment. Incomplete dominance. Trihybrid ratio. Epistasis. Pedegree analysis. Chromosome abnormalities, quantitative inheritance, Hardy-Weinberg equilibrium, genetic drift and speciation.								
Unit V	Sex determination and Linkage						12 hours	
(Drosophila, Mammals). Environmental factor and Sex determination, Sex differentiation. Sex linkage in diploids crossing over. Genetic disorders.								
Text Books								
<ol style="list-style-type: none"> 1. Clarke w, Industrial Microbiology, CBS publication,2015 2. Hutkins R W, Microbiology and technology of fermented foods ,John wiley,2019. 3. V.S. Randhawa, Textbook of Microbiology, Peepee Publishers and Distributors,2019 4. R.C.Dubey,A Textbook Of Microbiology, Publisher SChand 2011 5. Peter Snustad, Principles of Genetics, PublisherWiley,2015 								
References								
<ol style="list-style-type: none"> 1. Claudia neuhauser, Microbiology,Pearson,2019 2. AnirbanMukherji, Microbiology,Medtech Publishers, 2019 3. L Edward Alcamo,Microbiology,McGramhill ,2020 4. Jeffrey C. Pommerville,Fundamentals of Microbiology.15th Edition, Publisher Jones and Bartlette. 2018. 5. Madigan Michael T, Martinko John M., Bender Kelly S. 2017.Biology of Microorganisms. 14th Edition, Publisher Pearson Educatio, 2017. 								

E-Reference links

1. <https://www.nature.com/subjects/microbiology#:~:text=Microbiology%20is%20the%20study%20of,host%20response%20to%20these%20agents.>
2. <https://www.moscomm.org/pdf/Ananthanarayan%20microbio.pdf>
3. <https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture1.pdf>
4. https://samples.jblearning.com/076371075X/Wheelis_CH01_001%20copy.pdf
5. http://www.grsmu.by/files/file/university/cafedry/microbiologii-virysologii-immynologii/files/essential_microbiology.pdf

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	list the historical perspective in microbiology and explain the classification of microbes	K1,K2
CO2	know the morphology of microbes	K1,K2,K3
CO3	attain knowledge about the nutritional requirements of microbes and describe their growth pattern	K1,K2
CO4	understand the concepts of Mendelian genetics	K1,K2
CO5	illustrate the concepts of sex determination and linkage	K1,K2,K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	S	M	S	S	S	S	S	S	M	S	M	M
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	M	S	M	M	S	S	M	S	S	M
CO4	S	S	S	S	S	S	M	M	S	S	S	M	S
CO5	M	M	S	S	S	S	S	S	M	M	S	M	S

Strongly Correlating (S) - 3 marks ;
Weakly Correlating (W) - 1 mark;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BCT35	ENVIRONMENTAL TOXICOLOGY			
CORE - XV		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To understand the harmful effect of pesticide and merits of bio pesticides ➤ To know about food toxicology and the related factors. ➤ To learn the protocols in toxicity testing ➤ To obtain basic knowledge about xenobiotic in environmental segments (air, water, soil, biota), its metabolism and effects 				
Unit-I	Scope of toxicology				12 hours
Eco toxicology and its environmental significance. Toxic effects: Basis for general classification & nature. Dose – response relationship: Synergism and antagonism, Determination of ED ₅₀ and LD ₅₀ , LC ₅₀ . Acute and chronic exposures. Factors influencing toxicity. Pharmacogenomics & Chemodynamics.					
Unit-II	Xenobiotic metabolism				12 hours
Absorption & distribution. Organs involved in xenobiotic metabolism. Phase I reactions. Oxidation, reduction, hydrolysis and hydration. Phase II reactions / conjugation: methylation, glutathione and Amino acid conjugations. Detoxification.					
Unit-III	Toxicity testing				12 hours
Test protocol, genetic toxicity testing & mutagenesis assays: In vitro test systems–Bacterial mutation tests: reversion test, Ames test, Fluctuation tests and Eukaryotic mutation tests. In vivo Mammalian mutation tests – Host mediated assay & Dominant lethal test. Use of Drosophila in toxicity in toxicity testing. DNA repair assays. Chromosome damage test. Toxicological evaluation of recombinant DNA– derived proteins.					
Unit-IV	Pesticide toxicity				12 hours
Insecticides: organochlorines, anticholinesterases– organo phosphates and carbamates. Fungicides. Herbicides. Environmental consequences of pesticide toxicity. Biopesticides.					
Unit - V	Food toxicology				12 hours
Role of diet in cardiovascular diseases and cancer. Toxicology of food additives. Metal toxicity: Toxicology of arsenic, mercury, lead, and cadmium. Environmental factors affecting metal toxicity–effect of light, temperature and pH Occupational toxicology & assessment of occupational hazards: Industrial effluent toxicology & environmental health.					
Text Books					
<ol style="list-style-type: none"> 1. Gaoshuang, Environmental Toxicology principles and publication, Harbin institute of Technology press, 2012. 2. Stephen.M, Principles of Toxicology, Wiley –Interscience, 3rd Edition, 2015. 3. Kees van Gestel, VrijeUniversiteit, Amsterdam, Environmental Toxicology,2020 4. Michael H Dong, Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes, Publisher, CRC Press,2017 					
References					
<ol style="list-style-type: none"> 1.ErikHamillon, Enviromental Biochemistry, Larsen and keller Education, 2017. 2.Lanshaw, Principles of Environmental Toxicology,CRC press,2018. 3.Lorris G. cockerhnam, Basic Environmental Toxicology, CRC press,2019. 4.Jiwan P Sarwade, Rawindra V Kshirsagar, Environmental Biology and Toxicology, Success Publication,2015 					

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http://www.organic.lu.se/education/Ekosystemteknik/molecular_cell_biology/5_Metabolism.pdf
<https://www.webpages.uidaho.edu/foodtox/lectures.htm>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	know the concepts of ecotoxicology and its environmental significance	K1,K2
CO2	gain in depth knowledge on Xenobiotic metabolism, Phase I and Phase II reactions	K1,K2,K3
CO3	illustrate the concepts in toxicity testing	K1,K2,K3
CO4	acquire knowledge on pesticide toxicity and Bio pesticides	K1,K2,K3
CO5	understand the concepts of food toxicology occupational toxicology	K1,K2,K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	S	M	S	S	S	S	S
CO2	S	S	M	S	S	S	M	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	M	S	S	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCP33	PRACTICAL PLANT BIOCHEMISTRY, MICROBIOLOGY AND MOLECULAR BIOLOGY			
CORE –XVI		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To gain knowledge in plant biotechnology, microbial and molecular biology techniques ➤ To develop the laboratory skills and to learn the techniques to isolate plasmid DNA and amplification of DNA by PCR. ➤ To learn the estimation procedure of primary and secondary plant metabolites ➤ To get hands on training in microbial plating techniques 				
Experiments	<p>PLANT BIOCHEMISTRY</p> <ol style="list-style-type: none"> 1. Estimation of chlorophyll in leaves 2. Qualitative analysis of Secondary metabolites (Alkaloid, Flavanoid, Terpenoids) 3. Estimation of total alkaloid Content 4. Estimation of Phenol content 5. Estimation of flavonoid content 6. Estimation of Beta Carotene from Carrot 7. Estimation of Ascorbic acid from fruit <p>MICROBIOLOGY AND MOLECULAR BIOLOGY</p> <ol style="list-style-type: none"> 1. Microscope-Components and its Operation 2. Principle of Sterilization 3. Preparation of Culture media 4. Inoculation Techniques- Serial Dilution, Plating and single colony 5. Growth Curve of Bacteria- <i>E.coli</i> 6. Morphological characteristics of bacteria and identification of Microbes- Staining techniques-Simple, Gram's, Capsule and spore 7. Gene transfer in Bacteria–Transformation, Conjugation, Transduction 8. Isolation and Electrophoretic separation of DNA and Plasmid 9. PCR 10. PAGE 				
Text Books	<ol style="list-style-type: none"> 1. Apurba s. Sastry, Essentials of practical Microbiology, Jaypee Publisher, 2021 2. Rakesh. S. Sengar, Advances in Molecular Techniques CRC Press, 2018. 3. DamodaranGeetha K. Practical Biochemistry. Jaypee Brothers Medical Publishers,2016. 4. Apurba S Sastry, Essentials of Practical Microbiology 2nd Edition Publisher Jaypee,2021. 				
References	<ol style="list-style-type: none"> 1. AkhtarInam, A laboratory Manual of plant physiology, Biochemistry and Ecology, Agrobios,, 2012 2. Rathod, Practical manual on Elementary plant Biochemistry and Biotechnology, 2018 3. Ralph Rapley, David White. House Molecular Biology and Biotechnology, 				

	Publisher Royal Society of Chemistry.2021. 4. Advances in Molecular Techniques: Rakesh S.Sengar, Amit Kumar, ReshuChaudhary, Ashu Singh, CRC Press, 1 st Edition, 2018.
E-Reference links	1. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf 2. https://www.youtube.com/watch?v=pnBZeL8nFEo 3. https://www.youtube.com/watch?v=m1z7RrxrjHOc 4. https://www.youtube.com/watch?v=GSHez85LKeo 5. https://www.youtube.com/watch?v=AZS2wb7pMo4

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	gain knowledge on the estimation of alkaloid, phenol, flavonoid, beta carotene and ascorbic acid content	K1,K2
CO2	understand the importance of the sterilization and inoculation techniques	K1,K2,K3
CO3	attain indepth knowledge on gene transfer techniques	K1,K2,K3
CO4	acquire knowledge on isolation and separation of DNA	K1,K2
CO5	know the principles of PCR and electrophoresis	K1,K2,K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	M	S	S	S	S	M	S	M	S
CO2	M	M	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	S	M	S	S	S	M	S	S	M
CO4	S	M	S	S	S	S	M	M	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

SEMESTER IV

Course Code	P21BCE411	CHOICE -I					
ELECTIVE -I		BIOPHYSICAL METHODOLOGY		L	T	P	C
		4	-	-	4		
Cognitive Level	K1:Recall	K2:Understand	K3:Apply				
Learning objective	<ul style="list-style-type: none"> ➤ To learn the properties of electromagnetic radiation. ➤ To learn the principle and applications of UV, NMR, ESR spectroscopy. ➤ To know about radioactive isotopes and its biological applications. ➤ To understand the instrumentation, principle, types and uses of spectroscopy and microscopy, radioactive isotopes, centrifugation, chromatography. 						
Unit-I	Chromatographic techniques					12 hours	
Principle, technique and applications of paper, TLC, ion- exchange, molecular sieve and adsorption chromatography. Principle, components, limitations and applications of GC and HPLC. Electrophoresis techniques: Principle and technique of paper, gels –Agarose gel electrophoresis, SDS-PAGE, Native PAGE, Isoelectric focusing.							
Unit-II	Centrifugation techniques					12 hours	
Principles and types and applications. Types of Rotors, Sedimentation Co-efficient, Sedimentation Velocity, Relationship between rpm and g. Centrifugal field. Relative Centrifugal Force. Ultracentrifugation – types, optical methods used and applications of preparative and analytical ultracentrifuges.							
Unit-III	Microscopy					12 hours	
Basic principles of light microscopy, phase contrast microscopy, fluorescence microscopy. Electron microscopy–Principle, instrumentation and application of SEM and TEM Preparation of Sample. Electron diffraction –principle and application.							
Unit-IV	X – Rays					12 hours	
Properties of X rays. X ray diffraction detection and application. Radio isotopes techniques–nature of radioactivity, measurement of radio activity, applications of radioactive and stable isotopes in biological research. Autoradiography.							
Unit - V	Spectroscopy					12 hours	
Principles of spectroscopy–Regions of electromagnetic radiation, properties of electromagnetic radiations. Molecular and atomic spectra, types and molecular spectra. Absorption spectroscopy – principle, instrumentation and applications of atomic absorption, UV visible spectroscopy, Infrared spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Electron Spin resonance. Mass spectroscopy–principle, instrumentation and application. Raman Spectroscopy; principles, method, application.							
Text Books							
<ol style="list-style-type: none"> 1. L. Veerakumari Bioinstrumentation, MJP Publisher, 2019. 2. M.H. Fulekar & Bhawana Pandey, Bioinstrumentation I.K. International Publishing House Pvt. Ltd, 2014 3. John G. Webster Bioinstrumentation by, Wiley,2018. 4. Terence Allen, Microscopy: A Very Short Introduction, Publisher Oxford University Press,2015 							
References							
1. M. J. Reilly Bioinstrumentation by, CBS Publishers & Distributers, 2016.							

2. Keith Wilson and John Wilson. . Practical Biochemistry. Cambridge University Press, 2018
3. Donald L. Pavia, Introduction to Spectroscopy, Publisher Cengage Learning India Private Limited,2015
4. Hans-Joachim Hübschmann, Handbook of GC-MS: Fundamentals and Applications, Wiley,2015.

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1. <https://www.nature.com/scitable/topicpage/protein-structure-14122136/>
2. <https://www.hindawi.com/journals/ijpro/2014/147648/>
3. <https://world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-medicine.aspx>

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	know the principle and techniques of chromatography.	K1, K2
CO2	comprehend about types and applications of centrifuges.	K1, K2, K3
CO3	list the types and application of microscopy.	K1, K2, K3
CO4	learn about importance of radioactive isotopes.	K1, K2
CO5	gain the knowledge on types, principle, instrumentation and applications of spectroscopy.	K1, K2

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	M	M	M	M	S	S	S	M	M
CO3	M	S	S	S	M	S	S	S	M	S	M	S	S
CO4	M	S	M	M	S	S	M	M	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCE412	CHOICE - II	L	T	P	C
ELECTIVE- I		BIOPLASTICS	4	-	-	4
Cognitive Level	K1:Recall K2:Understand K3:Apply					
Learning objective	<ul style="list-style-type: none"> ➤ To learn the properties of Bioplastics and Biodegradation. ➤ To know about a medical and dental devices ➤ To gain knowledge on types of Biomaterials 					
Unit-I	Biopolymers					12 hours
Types of Bioplastics (starch based, cellulose based plastics, Aliphatic Polyesters – (PLA, PHB), Polyamides, bio based composites from soyabean oil and chicken feathers, bioderived polyethylene and genetically modified bioplastics. Environmental impact such as Bioplastics and biodegradation.						
Unit-II	Bioplastics and Biocomposites processing and their applications					12 hours
Bioplastics and Biocomposites. Processing of Bioplastics and Biocomposites. Applications of Bioplastics and Biocomposites-Civil Engineering, Biomedical and Auto motive application. Measuring of Biodegradation of polymer- Enzyme assays, Platetest, Respiratory test, Natural environment and Field trial, Gasevolution test (CO ₂ and CH ₄). Host tissue reaction.						
Unit-III	Biomaterials in Medical and Dental devices					12 hours
Biomaterials-Material choice implication based on device design. General Biomaterial evolution procedures. Replacement of skeletal hard tissues. Poly Mercedes cosmetic implants, controlled drug delivery system artificial heart valves, bone replacement, artificial organs, dental applications.						
Unit-IV	Surface modification of Biomaterials for Improved Functionality					12 hours
Enhancement of biocompatibility by the use of corona discharge and plasma processes, surface coating silver/ silver oxide silicone, hydro gels, UV curable system, PC coatings heparin loaded systems.						
Unit – V	Characterization and testing of biomaterials					12 hours
Bulk analysis methods applied to the study of biomaterials (XRD, FTIR, DSC,TGA) surface analysis methods applied to the study of biomaterials (SEM, AFM) Mechanical test - Wear, Friction, Flexibility, Fatigue. Application and manufacture of Bioplastics. Use of Biomaterials for manufacture of plastic films, various types of films and application, Usage of Biological friendly plastics in Homes, Industry.						
Text Books						
<ol style="list-style-type: none"> 1. Srikanthpilla, Hand Book of Bioplastics and Bio composition Engineering Applications, Scrivener Publishing LLC, 2011. 2. Syed Ali Ashter, Introduction to Bioplastics Engineering,Publisher Elsevier, 2016. 3. Publisher: Wiley-Scrivener 4. SrikanthPilla, Handbook of Bioplastics & Biocomposites, Engineering Applications, Publisher Wiley-Scrivener, 2011 						
References						
<ol style="list-style-type: none"> 1. Michael Thielen, Bioplastics: Basics and Applications, Polymedia Publisher GmbH, 2012. 2. Stephan Kabasei, Bio-based plastics: Materials and applications, Publisher Wiley,2013. 						

3. Robert Murray-Smith. Bioplastics: A Home Inventors Handbook, Publisher: Robert Murray-Smith, 2014.
4. SrikanthPilla, Handbook of Bioplastics and Biocomposites Engineering Applications, John Wiley & Sons, 2011

E-References link

1. <https://www.vedantu.com/chemistry/biopolymers>
2. <https://www.activesustainability.com/environment/what-are-bioplastics/>
3. <https://matmatch.com/learn/material/biopolymers>
4. https://www.researchgate.net/publication/332538701_BiopolymersDefinition_Classification_and_Applications
5. <https://ijpsr.com/bft-article/new-advancements-of-bioplastics-in-medical-applications/?view=fulltext>
6. <https://royalsocietypublishing.org/doi/10.1098/rsfs.2012.0003>
7. <https://www.sciencedirect.com/topics/materials-science/biomaterials-characterization>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	understand the types of bioplastics and their Impacts on environment	K1, K2
CO2	illustrate the applications of bioplastics, biocomposites	K1, K2, K3
CO3	attain knowledge about Biomaterials in Medical and Dental applications.	K1, K2
CO4	understand about Surface modification of biomaterials for enhancement of biocompatibility	K1, K2
CO5	know about the characterization method of biomaterials	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	M	S	S	M	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

2. Balaji.K, Biostatistics : Wiley publishers, 2014
 3.Kulkarni AP, Basics of Biostatistics, CBS publishers, 2020.

E-Reference links

1. <https://www.easybiologyclass.com/statistical-data-variables-types-and-classification-biostatistics-short-notes/>
2. <https://www.toppr.com/guides/business-economics-cs/descriptive-statistics/diagrammatic-presentation-of-data/>
3. <https://www.kluniversity.in/arp/uploads/2096.pdf>
4. <https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/anova/>
5. <https://www.investopedia.com/terms/s/standarddeviation.asp>
6. <https://www.graphpad.com/support/faq/what-is-the-difference-between-correlation-and-linear-regression/>
7. <https://data36.com/statistical-averages-mean-median-mode/>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	gain in depth knowledge on the research objectives, methods and significance.	K1, K2
CO2	illustrate scientific writing and its characteristics	K1, K2, K3
CO3	know the concepts in measures of central tendency and distribution	K1, K2, K3
CO4	illustrate the measures of symmetry.	K1, K2, K3
CO5	acquire knowledge on tests of statistical significance.	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	M	M	S	S	S	S	M	S
CO2	S	M	S	S	S	M	S	S	S	S	S	M	S
CO3	S	S	S	M	M	S	M	S	S	S	S	S	S
CO4	S	M	S	M	S	S	S	M	S	S	S	M	M
CO5	S	M	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCE422	CHOICE -II			
ELECTIVE - II		L	T	P	C
		4	-	-	4
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To understand the concept of biosafety and its importance. ➤ To know the biosafety guidelines and regulations and the function of institutional biosafety committee. ➤ To learn the application of GMOs in various field and methods to release GMO's in the environment ➤ To acquire the knowledge of IPR and patenting process 				
Unit-I	Introduction to bioethics	12 hours			
concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and environment benefits and risks, GM crops, Release of GMO to the environment. Risk of genetic engineering, Ecocide-Eco terrorism.					
Unit-II	Ethics	12 hours			
Animal rights, ethics of human cloning, Reproductive cloning, Ethical legal and Socio economic aspects of Gene therapy, Somatic, Embryonic and Adult stem cell research, ELSI of human genome project. Transgenic plants and animals.					
Unit-III	Biohazards and Biosafety	12 hours			
Primary containments for biohazards, Biosafety levels, recommended biosafety levels for specific microorganism, infectious agents and Infected animals. Biosafety guidelines by Govt. of India, Role of Intuitional biosafety committee, GEAC, RCGM, Cartagena protocol. CPCSEA Guidelines.					
Unit-IV	IPR	12 hours			
Introduction to IPR– types; copy rights, patents, trademarks, trade secret design rights, geographical indication-patentable and non-patentable – PCT, importance of IPR, Types of Patent applications, PCT cost, procedure and requirements for international patenting- patent in fringement – scope, litigation, meaning, case studies & examples. Biopiracy.					
Unit - V	Patent	12 hours			
Introduction to WTO, GATT, WIPO, TRIPS, Patenting in India, Indian patent act, WIPO treaties, Budapest treaty, publication of patents-Gazette of India, Patenting by research students, lectures and scientist University/ Organizational rules in India and aboard.					
Text Books					
<ol style="list-style-type: none"> 1. V.K. Ahuja, Intellectual property rights in India By - Lexisnexis publishers,2015 2. M.K.Satheesh Bioethics and Biosafety. Wiley Publishers, 2020 3. Princy Louis Palatty ,Ashish Kumar U , Russell Souza..A Textbook of Bioethics for Healthcare Professionals. Jaypee Brothers Medical Publishers (P) Ltd. 2017. 4. S.V. Damodar Reddy. Intellectual Property Rights -- Law and Practice, Publisher Asia Law House,2019. 					
References					
<ol style="list-style-type: none"> 1. DeepaGoel ,IPR, Biosaftey and Bioethics Pearson publishers, 2013 2. Rae Scott B- Willam B, Bioethics , Eerdmans publishing house, 2013 					

3. Ramesh Shahabdkar, S SaiSatyanarayanaReddy, Intellectual Property Rights, Publisher Notion Press, 2019.

E-Reference links

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2. <https://microbenotes.com/biosafety-cabinets/>
3. <https://consteril.com/biosafety-levels-difference/>
4. <https://genesandnutrition.biomedcentral.com/articles/10.1007/s12263-012-0316-4>
5. <https://www.dubaicustoms.gov.ae/en/IPR/Pages/WhatIsIPR.aspx>
6. <https://cleartax.in/s/patent-regsitration>
7. <https://www.mondaq.com/india/patent/783950/international-patent-filing-via-patent-co-operation-treaty-pct>

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	discuss the concepts, benefits and Issues in recombinant DNA technology.	K1, K2
CO2	gain knowledge on bioethics, transgenic plants and animals.	K1, K2, K3
CO3	understand the biosafety levels and guidelines.	K1, K2, K3
CO4	list the IPR types and applications.	K1, K2, K3
CO5	know the importance of patenting	K1, K2, K3

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	S	S	S	S	S	S	M
CO2	S	S	M	S	M	S	M	S	M	S	M	S	S
CO3	S	S	M	M	S	S	S	S	S	S	S	S	M
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

VALUE ADDED PROGRAMME

Course Code	P21BCV11	CHARACTERIZATION TECHNIQUES OF NANOMATERIALS	Total Hours	C
SEMESTER - I			30	2
Cognitive Level	K1:Recall	K2:Understand	K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To understand the Classifications and types of nano material ➤ To learn about the Spectroscopy, X – ray techniques ➤ To understand the Electron Spectroscopy and its applications ➤ To understand the techniques of used to measure the nano materials 			
Unit-I	Classifications and types of nano material		6 hours	
1D 2D 3D nanomaterials. Concept of bulk versus nanomaterials and dependence of properties on size. Introduction to ‘Top down’ vs. ‘Bottom up’ approach of synthesis with suitable examples.				
Unit-II	Spectroscopy		6 hours	
Basic principles and applications of UV-Vis-NIR, FTIR, FT-Raman, Photoluminescence, NMR, ESR and Light Scattering methods.				
Unit-III	X – ray techniques		6 hours	
X-ray powder diffraction –Quantitative determination of phases; Structure analysis, single crystal diffraction techniques - Determination of accurate lattice parameters - structure analysis-profile analysis - particle size analysis using Scherer formula- Particle SizeAnalyzer- Ellipsometry- thickness measurements				
Unit-IV	Electron Spectroscopy		6 hours	
X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, X-Ray Characterization of Nanomaterials – EDAX and WDA analysis – EPMA - Applications to nanomaterials characterization				
Unit - V	Mechanical, Magnetic and electrical properties measurement		6 hours	
Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions- models for interpretation of Nanoindentation load-displacement curves- Nanoindentation data analysis methods-Hardness testing of thin films and coatings- MD simulation of nanoindentation. Vibration Sample Magnetometer, Impedance Spectroscopy- PPMS, - Measurement of Magnetic and electrical properties of nanomaterials.				
Text Books				
1. Thomas Varghese &K.M.Balakrishna, Nanotechnology: An Introduction to synthesis, properties and Applications of Nanotechnology, Atlandic Edition, 2016.				
2. Manasi Karkare, Nanotechnology, Fundamentals and Applications, Wiley India pvt.Ltd, 2020				
References				
1. Maria Benelmekki, Nanomaterials, Morgan & Claypool Publishers, 2019				
2. Deborah M. Kanea, Adam Micolich, , Peter Roger, Nano materials Science and Applications, Jenny Stanford Publishing, 2016				
3. Kan Yao, Yongmin Liu, Plasmonic Metamaterials, arXiv Publishers, 2013				
4. Nicoleta Lupu, Nanowires Science and Technology, InTech Publishers, 2010				
5. Malsch, Ineke, Emond, Claude , Nanotechnology and Human Health, Boca Raton Publications, 2014				
E-Reference links				
1. https://www.safenano.org/knowledgebase/resources/faqs/what-is-a-nanomaterial/				

2. http://www.nanotech-now.com/news.cgi?story_id=20860

3. <https://www.azonano.com/article.aspx?ArticleID=1872>

Course Outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	understand the classifications of Nano materials	K1, K2
CO2	know the techniques of spectroscopy	K1, K2, K3
CO3	comprehend the techniques and equipment on X ray techniques	K1, K2, K3
CO4	understand the types and applications of Electron spectroscopy	K1, K2, K3
CO5	knowledge on properties, models and mechanisms of nano materials and its techniques	K1, K2, K3

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	P21BCV41	BIOFERTILIZER			
SEMESTER - IV		L	T	P	C
Cognitive Level	K1:Recall	K2:Understand		K3:Apply	
Learning objective	<ul style="list-style-type: none"> ➤ To know the production of biofertilizer using algal and fungal strains which are alternative for the chemical fertilizer. ➤ To learn the preparation methods of manures and bio pesticides using plant based sources and green manuring to increase the soil fertility. ➤ To learn the application and production of organic compost and vermicomposting through eco-friendly route. ➤ To gain knowledge on importance and need of eco-friendly biofertilizer for improving crop yield also can become entrepreneur. 				
Unit-I	Introduction				6 hours
History, importance and present status of different types of fertilizers and their application to crop plants. Need of ecofriendly fertilizers. Effect of chemical fertilizers on environment. Energy consuming pattern for chemical fertilizers.					
Unit-II	Biofertilizers				6 hours
Algal and fungal (mycorrhizae) biofertilizers- Bacterial biofertilizersRhizobial, free living N ₂ fixers and phosphate solubilizing bacteria, their significance and practice. Nitrogen fixing mechanisms.					
Unit-III	Manures				6 hours
A general account of manures such as leaf moulds, composts form Yard Manure and a study of the following oilseed cakes: castor and neem as Biopesticide. Green Manuring Role of serbaniaserban for improving soil fertility.					
Unit-IV	Application of biofertilizers and manures				6 hours
A combination of biofertilizer and manure application. Organic farming- compost and vermin compost.					
Unit - V	Mass production				6 hours
Mass production of Cyanobacterial Biofertilizers- Nostoc, Anabaena Azolla. Blue green algae. Bacterial Biofertilizers -Azotobacter, Azospirillum, Rhizobium, Pseudomonas					
Text Books					
1. N. S. Subba Rao, Soil microorganisms and plant growth. Science publishers, 2011					
2. N. S. Subba Rao, Biofertilizer, CBS Publishers, 2020					
3. Amitava Rakshit, Vijay Meena, Manoj Parihar, H.B.Singh, A.K.Singh. Biofertilizers, Volume 1: Advances in Bio-inoculant, Publisher Elsevier,2021.					
4.N.S. Subba Rao. Biofertilizers in Agriculture and Forestry, 3 rd Edition, CBS Publishers,2020.					
References					
1. Ronald M. Atlas & Richard Bertha, Microbial Ecology, Fundamentals & application, Addition Wesley, 2011					
2.Surjit Sen, Krisnenduacharya, Munjula Rai, Bio fertilisers and Biopesticides Techno world publishers, 2019					
3.Bikas R. Pati, Santi M.Mandal. Recent Trends in Biofertilizers. I K International Publishing House,2016					
4.Keshav Singh. Vermicompost: Vermiwash and Biopesticides, Publisher Biotech Books,2014.					
E- Reference links					

1. <https://www.onlinebiologynotes.com/biofertilizer-advantages-types-methods-of-application-and-disadvantages/>
2. https://www.kstate.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf

Course outcome

Upon completion of this course, the students will be able to		
CO	Course Outcomes	Knowledge Level
CO1	attain knowledge on different types of fertilizers	K1,K2
CO2	know the preparation of algal, fungal and bacterial biofertilizers	K1,K2,K3
CO3	gain knowledge about manures and green manuring	K1,K2
CO4	know about applications of biofertilizer	K1,K2,K3
CO5	understand the techniques in mass production of biofertilizers	K1,K2

Mapping of COs with POs& PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	M	S	S	S	M	S
CO2	M	S	M	S	M	S	M	S	M	S	S	M	M
CO3	S	S	M	M	S	S	S	M	S	M	S	S	S
CO4	S	S	S	S	S	M	M	S	S	M	M	S	S
CO5	S	M	M	M	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark
