



**Marudhar Kesari Jain College for Women (Autonomous)**

**Vaniyambadi – 635 751**

**PG & Research Department of Biotechnology**

**For**

**Postgraduate Programme  
Master of Science in Biotechnology**

**From the Academic Year 2024-25**

Semester – I						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PBTC11	CC – 1 – Molecular Cell Biology	4	2	0	0	5
24PBTC12	CC – 2 - Biochemistry	4	2	0	0	3
24PBTC13P	CC - 3 Practical - Cell & Molecular Biology and Biochemistry	0	0	4	0	3
24PBTE11	EC - 1 – Cancer Biology/Enzymology	4	1	0	0	3
24PBTE12	EC – 2 – Bioinstrumentation/ Biostatistics	4	1	0	0	3
24PBTA11P	AECC – 1- MS- Office Fundamentals Practical	1	1	0	0	2
24PCHR11	VE - 1 Human Rights	1	1	0	0	2
					<b>30</b>	<b>21</b>

Semester - II						
Code	Course Title	Hours Distribution				C
		L	T	P	S	
24PBTC21	CC – 4- Plant & Animal Biotechnology	3	1	2	0	4
24PBTC22	CC – 5 - Microbiology	3	1	2	0	4
24PBTC23	CC - 6 Practical - Plant & Animal Biotechnology and Microbiology	0	0	4	0	3
24PBTC24	CC – 7 – Bioprocess Technology	2	1	1	0	3
24PBTE21	EC – 3 – Stem Cell Biology/ Regulatory Affairs and Industrial standards	2	1	1	0	3
24PBTE22	EC – 4 – Aquaculture Biotechnology/ Nanotechnology	2	1	1	0	3
24PNDS21	SEC - 1 (NME) – a) Organic Farming b) Entrepreneurship c) Pollution Control	1	1	0	0	2
					<b>30</b>	<b>22</b>

Semester – III						
24PBTC31	CC – 8 – Genetic Engineering	3	1	2	0	5
24PBTC32	CC – 9 – Bioinformatics	2	1	2	0	4
24PBTC33	CC - 10 - Immunology	3	1	1	0	4
24PBTC34P	CC – 11 – Practical – Genetic Engineering, Bioinformatics & Immunology	0	0	5	0	4
24PBTE31	EC – 5 – Pharmaceutical Biotechnology/ Genomics and Proteomics	2	1	1	0	3
24PBTS31	SEC – 2 – Tissue Engineering	1	1	0	0	2
24PBTIN31	Internship	0	0	3	0	2
					<b>30</b>	<b>24</b>

Semester - IV						
24PBTC41	CC – 12 – Research Methodology	3	1	2	0	5
24PBTC42	CC – 13 – Environmental Biotechnology	3	1	2	0	5
24PBTC43P	CC - 14 Project	0	0	6	0	5
24PBTE41/ 24PBTE42	EC – 6 – Biofertilizer Technology/ Biosafety and Bioethics	4	1	1	0	4
24PBTP41	PEC – 1 – NET/SET Preparation Course	1	1	0	0	2
24PBTL41	SLC – 1 – Case Study / Writing Review Article	0	0	1	3	2
					<b>30</b>	<b>23</b>
	<b>Total Credits</b>	<b>90+2*</b>				

Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, or Nanmulalvan within the fifth semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2\*.

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC11	<b>Molecular Cell Biology</b>	CC-1	4	2	0	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the basics of cell organization										
LO2	To understand the cell cycle and cell signalling										
LO3	To learn the nucleus structure and organization										
LO4	To understand the process of transcription										
LO5	To know the mechanism on protein synthesis and transport										
Unit	Content										Hours
1	Cells: Basic properties of cells-Cellular dimension-Size of cells and their composition. Cell origin and Evolution –Theory. Prokaryotic cells – Structural organization, Functions. Eukaryotic cells – Structural organization, Functions. Structural Organization: Cell membranes – Nucleus- organization of Chromatin– Golgi apparatus and vesicular transport – Lysosome – Endocytosis – Ectocytosis – mitochondria – peroxisomes- actin cytoskeleton and cell movement - Microtubules and intermediary filaments –Active and Passive transport across membranes										18
2	Molecular basis of eukaryotic cell – Cell cycle – regulation – check points. Cell to cell Adhesion, Cell Junctions - Extracellular matrix, Programmed cell death. Cell to cell signalling – Signalling molecules –Types of signalling – Signal transduction pathways-overview										18
3	Chromosome-structure, Nucleic Acids: Structure and Properties of DNA. Types of DNA, Functions of DNA. Structure and Properties of RNA – Types of RNA – Functions of RNA.DNA and RNA as Genetic Material, Non-coding RNA. Central Dogma of the Cell –Basic concepts of Gene. Regulatory regions-UTR, Promoter, Operator										18
4	Transcription – mechanism in Prokaryotes and Eukaryotes. Post transcriptional modifications- Regulation of Transcription Initiation, Elongation. Reverse transcription. Non coding regions of DNA & RNA. Operon-Lac, Trp										18
5	Genetic code - Mechanism of translation- post translational modification in RER – synthesis , sorting and trafficking of proteins- site of synthesis of membrane and organelle protein – transport of membrane protein across ER. Transport of protein to Mitochondria, nucleus, chloroplast, and peroxisomes Protein Glycosylation – mechanism and regulation of vesicular transport. Golgi and post golgi sorting and processing – Receptor mediated endocytosis										18

<b>CO</b>	<b>Course Outcomes</b>
CO1	To understand the structure and functional organization of cell and its components
CO2	To understand the different types of cell cell communications and process that drive cellular mechanism
CO3	The students will be able to understand the importance of DNA and its function in cell
CO4	The students will be able to understand the process of transcription and importance of RNA in cell functioning
CO5	The students will be able to understand the process of protein synthesis and its functional modifications
<b>Textbooks:</b>	
1	Paul A, 2001, Text Book Of Cell And Molecular Biology 2edition
2	T.Fleming. 2002. Cell interactions: A practical approach Second edition
3	Prakash S. Lohar , 2009. Cell and Molecular Biology
4	David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
5	Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic Histology Text and Atlas. McGraw-Hill Professional
<b>Reference Books:</b>	
1	Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley Sons, New York.
2	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007., Molecular Biology of the Cell, Fifth edition. Garland Science
3	Geoffrey. M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates
4	Alberts B, Molecular Cell Biology.
5	Pollard et al., Cell Biology. Saunders
<b>Web resources:</b>	
1	<a href="https://libguides.pcom.edu/cmbm/tools">https://libguides.pcom.edu/cmbm/tools</a>
2	<a href="https://frazer.uq.edu.au/files/3522/MolBiolWS08Immunofluorescence.pdf">https://frazer.uq.edu.au/files/3522/MolBiolWS08Immunofluorescence.pdf</a>
3	<a href="https://www.uou.ac.in/sites/default/files/slm/BSCZO-102.pdf">https://www.uou.ac.in/sites/default/files/slm/BSCZO-102.pdf</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO2</b>	3	3	3	2	3	2	3	3	3	3	2
<b>CO3</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO4</b>	3	3	2	2	3	2	3	3	3	3	2
<b>CO5</b>	3	3	3	2	3	2	3	3	3	3	2
<b>Total</b>	15	13	12	10	15	10	15	15	15	15	10
<b>Average</b>	<b>3</b>	<b>2.6</b>	<b>2.4</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC12	<b>Biochemistry</b>	CC-2	4	2	0	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the basics of Biochemistry										
LO2	To understand the concepts of energy flow										
LO3	To understand the concepts of energy flow										
LO4	To understand the functioning of nuclei acids and amino acids										
LO5	To understand the transport system of a cell										
Unit	Content										Hours
1	Introduction and scope of Biochemistry; classification of Biomolecules, Structure and significance of water in biochemistry; acid-base concept, buffers, pH and pK; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; Classification and structure of Carbohydrate, Metabolism- Gluconeogenesis, Glycogenesis, Glycogenolysis, - Biochemistry of hyper and hypoglycaemia										18
2	Bioenergetics process, Thermodynamics principles of biological process, Oxidation and reduction reactions; Redox potentials; High energy compounds; Concept of free energy, conservation and utilization of energy in cell, Chemiosmosis; Cellular Respiration Glycolysis, Pyruvate decarboxylation, TCA cycle, Ketogenesis, ,Oxidative phosphorylation, Pentose Phosphate Pathway; Photosynthesis; Electron Transport Chain, ATP synthesis, Urea cycle										18
3	Lipids: Structure and classification, Chemical and physical propertied of fatty acids, Metabolism and biosynthesis of fatty acids, Triglycerides, phospholipids, glycolipids. Cholesterol biosynthesis, Bile acids and salt formation, Oxidation of fatty acids and ketone bodies. Biochemistry of lipid disorder; hypercholesterolemia;										18
4	Structure, Classification and properties of Nucleic acids, synthesis of purines and pyrimidines, catabolism of nucleic acids, Structure, Classification and properties of aminoacids, Biosynthesis of aminoacids. Metabolic diseases and disorders: Clinical significance of variations in blood glucose Enzyme kinetic (negative and positive cooperativity); Ordered and ping pong mechanism; Regulation of enzymatic activity; Active sites; Enzymes and coenzymes: Coenzymes interactions, activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes.										18
5	Principles of membrane transport; Membrane Structure and Function; Transport proteins and methods; Membrane fluidity; Membrane and cytosolic receptors; Ion channels- gated, ligand activated, Aquaporins; Role of pumps in transport; Membrane potential-transmission of nerve impulse, synapse, neurotransmitters										18

CO	Course Outcomes
CO1	The students will be able to understand the importance and functions of all the types of biomolecules
CO2	The students will be able to understand the different cellular process that drive cellular functions of an organism
CO3	The students will be able to understand how molecules are being transported across different cellular machinerys
CO4	The students will be able to understand the importance of molecular homeostasis and problems related to its imbalance
CO5	The students will gain understanding on the practical concepts in analyzing biomolecules
<b>Textbooks:</b>	
1	Cambell, M.K. and Farrell, S.O. (2018) Biochemistry, Ninth Edition, Cengage Learning
2	Voet, D., Voet, J.G. and Pratt, C.W. (2018) Principles of Biochemistry, John Wiley & Sons. Inc, New York.
3	Instrumental Methods of Analysis - Chatwal and Himalayan Publication
4	Principles And Techniques of Practical Biochemistry - Bryan L, Williams and Keith Wilson, Cambridge Univ, Press.
5	Medical Biochemistry (2005) 2nd ed., Baynes, J.W. And Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN: 0-7234-3341-0
<b>Reference Books:</b>	
1	Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641- 0962-1.
2	Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
3	Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2
4	Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman Company (New York), ISBN: 13:978-1-4641-0981-2.
5	Principles And Techniques of Practical Biochemistry- Keith Wilson And John Walker, Cambridge Press.
<b>Web resources:</b>	
1	<a href="https://pmc.ncbi.nlm.nih.gov/articles/PMC7182109/">https://pmc.ncbi.nlm.nih.gov/articles/PMC7182109/</a>
2	<a href="https://www.britannica.com/science/lipid">https://www.britannica.com/science/lipid</a>
3	<a href="https://www.geeksforgeeks.org/nucleic-acids-definition-structure-properties-types/">https://www.geeksforgeeks.org/nucleic-acids-definition-structure-properties-types/</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	2	2	2	2	2	3	3	3	2
<b>CO2</b>	3	3	2	2	2	2	2	3	3	3	2
<b>CO3</b>	3	2	3	3	2	2	2	3	3	3	2
<b>CO4</b>	3	3	3	3	3	2	2	3	3	3	2
<b>CO5</b>	3	3	3	3	3	2	3	3	3	3	2
<b>Total</b>	14	14	13	13	12	10	11	15	15	15	10
<b>Average</b>	<b>2.8</b>	<b>2.8</b>	<b>2.6</b>	<b>2.6</b>	<b>2.4</b>	<b>2</b>	<b>2.2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTP13	<b>Cell &amp; Molecular Biology and Biochemistry Practicals</b>	CC-3	0	0	4	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To separate and identify cell organelles using separation techniques										
LO2	To study stages of cell cycle										
LO3	To quantify biomolecules using different methods										
LO4	To separate biomolecules using chromatographic techniques										
LO5	Use electrophoretic techniques to separate DNA and proteins										
Unit	Content										Hours
1	Identification of cell organelles ,Histochemical staining to localize proteins/ carbohydrate/ lipids										12
2	Study of divisional stages in Mitosis, Mitotic index calculation ,Study of divisional stages in Meiosis. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v) Preparation of biochemical solution with different concentrations										12
3	Estimation of RNA by orcinol method, Estimation of DNA by diphenylamine method Estimation of protein by Lowry's Method										12
4	Estimation of Carbohydrate by Anthrone method, Separation of amino acids by Paper Chromatograph, Separation of Sugar by Paper Chromatograph										12
5	Separation of /proteins by SDS PAGE,Separation of sugars by thin layer Chromatograph,Isolation of DNA from Plant/ Bacteria/ Animal cells and visualization of bands with Agarose Gel Electrophoresis										12

CO	Course Outcomes
CO1	To practically observe and analyse cell structure and organization
CO2	To observe the stages of cell division in somatic and germ cells
CO3	To understand and apply the principle of biochemical calculations
CO4	To extract, quantify and analyse functional biomolecules of a cell
CO5	Handle and experiment various methods in isolation of different biomolecules
<b>Textbooks:</b>	
1	Experimental Procedures in Lifescience - Dr.S.Rajan Mrs. R. Selvi Christy, Anjana Book House
2	Analytical Techniques in Biochemistry and Molecular Biology; Rajan Katoch; 2011; ISBN:9781441997852
3	Cell and Molecular Biology Lab Manual. 14 June 2011 by Cristina C Thompson
4	Practical Guide Of Cell Biology Molecular Genetics 6 February 2023by Dr. Kanak Saxena
5	A Cell Biology Lab Manual Spiral-bound –2022 by Joseph Francis
<b>Reference Books:</b>	
1	Cell and Molecular Biology: A Lab Manual.30 October 2013 by K. V. Chaitanya
2	Practical Handbook of Biochemistry: Lab Manual. 17 April 2020 by Deepak Shrivastava (Author)
3	Lab Manual of Biochemistry. 12 April 2020 by Deepika Bairagee (Author)
4	Cell and Molecular Biology Lab Manual. 14 June 2011. by Cristina C Thompson David
5	Lab in Cell Biology, Microbiology and Bioinstrumentation: Laboratory Manual Kindle Edition by Geethalakshmi Sundararaman ,Anitha Arumugam ; 2017
<b>Web resources:</b>	
1	<a href="https://www.researchgate.net/publication/343636082">https://www.researchgate.net/publication/343636082</a> Practical manual on Techniques in Molecular Biology
2	<a href="https://www.uou.ac.in/sites/default/files/slm/ZO(N)-102.pdf">https://www.uou.ac.in/sites/default/files/slm/ZO(N)-102.pdf</a>
3	<a href="https://www.deanza.edu/faculty/heyerbruce/b6b_pdf/Bio6B-Manual_W19.pdf">https://www.deanza.edu/faculty/heyerbruce/b6b_pdf/Bio6B-Manual_W19.pdf</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	3	2	3	2	3	3	3	3	2
<b>CO2</b>	3	3	3	2	3	2	3	3	3	3	2
<b>CO3</b>	2	3	3	2	3	2	3	3	3	3	2
<b>CO4</b>	3	3	3	2	3	2	3	3	3	3	2
<b>CO5</b>	3	3	3	2	3	2	3	3	3	3	2
<b>Total</b>	13	15	15	10	15	10	15	15	15	15	10
<b>Average</b>	<b>2.6</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTE11	<b>Cancer Biology</b>	EC-1	4	1	0	0	3	5	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the molecular basis of cancer										
LO2	To understand the signalling pathways associated with cancer										
LO3	To understand the causes of cancer										
LO4	To understand the different biomarkers in cancer diagnostics										
LO5	To understand the novel approaches in cancer therapeutics										
Unit	Content										Hours
1	Introduction to cancer biology-History and research; Stages in cancer progression; Cell cycle and regulation; Cell senescence, Autophagy and Necrosis, Hypoxia and Angiogenesis, Metastasis and Invasion; Cancer epigenetics; Oncogene and tumor suppressor genes, proto oncogenes Genomic instability in cancer; Somatic and germ cell mutations-Mutagen and infectious agents										15
2	Growth factors; Signal transduction pathways- RTK, Ras-MAPK, Wnt signalling, Notch signalling, TGF beta signalling, JAK-STAT pathway, PIK3/AKT pathway										15
3	MicroRNAs and Cancer; Bacteria and cancer; Viral Mechanisms in Carcinogenesis; Fungi and cancer; Hereditary cancer; Immune system and cancer-NK cells, B-cells, T-cells, APCs, Cancer cell receptors, Stem cells										15
4	Introduction to biomarkers; Types of biomarkers; Cancer biomarkers- DNA markers, RNA biomarkers, Protein biomarkers, Challenges in cancer biomarkers, Cancer detection and diagnosis, Biopsy, Imaging techniques; Molecular techniques- Cytogenetic analysis, Immunophenotyping										15
5	Cancer therapeutics- Surgical treatment in cancer, Chemotherapy in cancer, Mechanism of chemotherapeutic drugs, Immunotherapy, Personalized medicines, Targeted therapy, Stem cell therapy, Hormone therapy, Novel therapeutics in cancer, Current research trends in cancer; Cancer prevention- Gene therapy-CRISPR										15

<b>CO</b>	<b>Course Outcomes</b>
CO1	Understand the molecular basis of cancer biology
CO2	Understand different signalling events in cancer progression
CO3	Comprehend the different causes of cancer carcinogenesis
CO4	Understand the various biomarkers in cancer diagnostics
CO5	Understand the various methods of cancer treatments and research trends in cancer therapeutics
<b>Textbooks:</b>	
1	Cancer Biology, 3rd Edition, Roger J B King and Mike W Robins, 2006
2	Textbook of Cancer Biology, Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019
3	Cell Signalling, By John Hancock · 2010; ISBN: 9780199232109
4	Treatment of Cancer;2020; Karol Sikora, ISBN:9780429649004
5	Cancer Biomarkers: Clinical Aspects and Laboratory Determination; 2022; Lakshmi V. Ramanathan, Martin Fleisher, Michael J. Duffy; ISBN:9780128243039
<b>Reference Books:</b>	
1	Principles of Cancer Biology; Lewis J. Kleinsmith, Pearson Benjamin Cummings, 2006
2	Understanding Cancer An Introduction to the Biology, Medicine, and Societal Implications of this Disease- By J. Richard McIntosh
3	Molecular and Cell Biology of Cancer- Rita Fior, Rita Zilhao
4	Cancer Biology, Raymond W. Ruddon, Oxford University Press, USA, 2007
5	The Biology of Cancer by Robert A Weinberg, ISBN: 978-0-393-88764-8
<b>Web resources:</b>	
1	<a href="https://pmc.ncbi.nlm.nih.gov/articles/PMC8002322">https://pmc.ncbi.nlm.nih.gov/articles/PMC8002322</a>
2	<a href="https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/regulation-of-cell-cycle/a/cancer">https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/regulation-of-cell-cycle/a/cancer</a>
3	<a href="https://www.pnas.org/doi/10.1073/pnas.1219651110">https://www.pnas.org/doi/10.1073/pnas.1219651110</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	2	2	3	2	3	2	3	3	2
<b>CO2</b>	3	3	2	2	3	2	3	2	3	3	2
<b>CO3</b>	3	3	3	3	3	2	3	2	3	3	2
<b>CO4</b>	3	3	3	3	3	2	3	2	3	3	2
<b>CO5</b>	3	3	3	3	3	2	3	3	3	3	2
<b>Total</b>	15	15	13	13	15	10	15	11	15	15	10
<b>Average</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>2.6</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2.2</b>	<b>3</b>	<b>3</b>	<b>2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTE12	<b>Bioinstrumentation</b>	EC-2	4	1	0	0	3	5	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the concepts of Chromatography and electrophoresis										
LO2	To understand the principles of GC-MS										
LO3	To understand the concepts and working principles of Microscopy										
LO4	To understand the working mechanism Spectroscopy										
LO5	To understand the basic principle of radio isotopic techniques										
Unit	Content										Hours
1	Chromatography-types, HPLC – History, Scope, Overview, Principle and Application, Parts and mechanism of HPLC – Mobile Phase, Solvent Delivery Pump, Injector, Column, Detector and Data System with LC-MS, HPTLC, Electrophoresis-AGE, PAGE, SDS-PAGE, 2D-PAGE, capillary										15
2	GCMS – History, Scope, Overview, Principle and Application, Parts and mechanism of GCMS – Carrier Gas, Pneumatic Controller, Injector, Oven, Column, Interface, Ion Source, Mass Analyzer, Detector, Vacuum System and Control Electronics; MALDI TOF										15
3	Microscopic techniques, Principles and applications, compound, light, stereo, phase contrast, fluorescent, atomic force microscopy, confocal, flow cytometry, SEM –, Scope, Overview, Principle and Application, Parts and mechanism of SEM; TEM – Scope, Overview, Principle and Application, Parts and Mechanism of TEM										15
4	Spectroscopic techniques-theory and application. Part and mechanism of UV- visible spectroscopy, fluorescence spectroscopy, Mass spectroscopy, IR, NMR, AAS, X-ray spectroscopy, Raman spectroscopy										15
5	Radio-isotopic techniques, Introduction of radio isotopes, Biological applications, Radioactive decay-types, Autoradiography, Health effects of radiations										15

<b>CO</b>	<b>Course Outcomes</b>
CO1	To understand the principle and working mechanism of HPLC
CO2	To understand the principle and working mechanism of GCMS
CO3	To understand the principle and working mechanism of SEM
CO4	To understand the principle and working mechanism of TEM
CO5	To understand the principle and working mechanism of NMR
<b>Textbooks:</b>	
1	Gas Chromatography and Mass Spectrometry: A Practical Guide; O. David Sparkman, Zelda Penton, Fulton G. Kitson; ISBN:9780080920153
2	HPLC: A Practical Guide; 2007; Toshihiko T Hanai, ISBN:9781847551078
3	A Beginners' Guide to Scanning Electron Microscopy; 2018; Anwar Ul-Hamid; ISBN:9783319984827
4	A Practical Guide to Transmission Electron Microscopy: Fundamentals; Zhiping Luo; 2016; ISBN-13: 978-1-60650-703-2
5	Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods; Joseph B. Lambert , Eugene P. Mazzola , Clark D. Ridge ; 2018; SBN:9781119295280
<b>Reference Books:</b>	
1	Bioinstrumentation; L. VEERAKUMARI; 2019; MJP Publisher
2	Bioinstrumentation; 2016; M. J. Reilly; ISBN:9788123929132
3	Principles of Bioinstrumentation; Richard Normann ; 1988; ISBN:9780471605140
4	Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Applications; Clifford D. Ferris ; 1979; ISBN:9780896030039
5	Analytical Techniques in Biosciences From Basics to Applications; Azhar Rasul, Jonathan C. Ifemeje, Kingsley C. Patrick-Iwuanyanwu, Muhammad Ajmal Shah; 2021; ISBN:9780128227992
<b>Web resources:</b>	
1	<a href="https://cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/ZOO/PK%20(4).pdf">https://cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/ZOO/PK%20(4).pdf</a>
2	<a href="https://microbenotes.com/instruments-used-in-microbiology-lab/">https://microbenotes.com/instruments-used-in-microbiology-lab/</a>
3	<a href="https://www.scribd.com/doc/6846793/Bioinstrumentation">https://www.scribd.com/doc/6846793/Bioinstrumentation</a>
4	<a href="https://www.nature.com/articles/s41598-019-48815-9">https://www.nature.com/articles/s41598-019-48815-9</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	3	2	3	3	2	3	3	3	3
<b>CO2</b>	2	3	3	2	3	3	2	3	3	3	3
<b>CO3</b>	2	3	3	2	3	3	2	3	3	3	3
<b>CO4</b>	2	3	3	2	3	3	2	3	3	3	3
<b>CO5</b>	2	3	3	2	3	3	2	3	3	3	3
<b>Total</b>	10	15	15	10	15	15	10	15	15	15	15
<b>Average</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: FIRST SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTA11	<b>MS- Office Fundamentals</b>	AEC C-1	1	1	0	0	2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the basics of MS-Word										
LO2	To understand basic functions of MS-Word										
LO3	To understand the basic functions of MS-PowerPoint										
LO4	To comprehend basic functionalities of MS-PowerPoint										
LO5	To understand and work with MS-Excel										
<b>Unit</b>	<b>Content</b>										<b>Hours</b>
1	Introduction to MS-Word; Typing and editing text; Formatting Text: Font Size, Style; Color, Use the Bold, Italic, and Underline; Shading text and paragraph; Tabs and Indents; Spacing; Insert Shapes, Clipart and Picture, Word Art, Page Number; Insert Shapes, Clipart and Picture, Inserting Text boxes; Inserting symbols.										06
2	Inserting custom Header and Footer; Bullets and Numbering; Page formatting, Alignment; Creating and formatting tables; Shortcut keys; Grammar and Spell check										06
3	Introduction to MS PowerPoint; Typing the text, Alignment of text; Formatting text- Font style, Font color; Cut, Copy, Paste, Select All, Clear text; Find & Replace; Choosing slide formats; Inserting shapes, charts and symbols										06
4	Animations- custom animations; slide transition; Insert tables; formatting tables; Insert; Slide layouts; Slide formatting; Slide show settings; Side themes; Preparing professional presentation										06
5	Introduction to MS-Excel; Working with excel workbook and sheets; Data entry and editing; Cell properties; Inserting formula; Data analysis- Types of charts, Statistical analysis of data, AI in MS-Office										06

<b>CO</b>	<b>Course Outcomes</b>
CO1	To become practically skilled in working with MS-WORD
CO2	To become familiarized with functionalities of MS-WORD for thesis and manuscript preparation
CO3	To become practically skilled in working with MS-POWERPOINT
CO4	To become familiarized with functionalities in MS-POWERPOINT for oral and poster presentation
CO5	To become practically skilled in working with MS-EXCEL for research data analysis
<b>Textbooks:</b>	
1	Microsoft Office 2003: The Complete Reference by <u>Jennifer Kettell</u>
2	Office 2010 Visual Quick Tips (Paperback) by Sherry Willard Kinkoph Gunter
3	Microsoft Office PowerPoint 2007 Quick Steps (Paperback) by Carole Boggs Matthews
4	Microsoft Excel 2010 In Depth (Paperback) by <u>Bill Jelen</u>
5	Learn Microsoft Office for Windows 95: Comprehensive Tutorials for Word 7.0, Excel 7.0, Access 7.0, Power point 7.0, Schedule 7.0, Shortcut Bar, Binder, and Much More... (Paperback) by <u>Russell A. Stultz</u>
<b>Reference Books:</b>	
1	Microsoft Office 365 All-In-One for Beginners & Power Users: The Concise Microsoft Office 365 A-Z Mastery Guide for All Users (Word, Excel, PowerPoint, ... (Office 365 Mastery Guide 2022 Book 1) Kindle Edition by Tech Demystified
2	MS-Office, <u>Dr. S.S. Srivastava</u>
3	Microsoft Office Reference Guide by Tom Bunzel
4	Computer MS Office Book by Prof. Satish Jain, M.Geetha, Kratika
5	MS Office 2013 (Revised Edition), VISHNU P. SINGH, ISBN: 978-81-7317-705-7
<b>Web resources:</b>	
1	<a href="https://learn.microsoft.com/en-us/microsoft-365/enterprise/urls-and-ip-address-ranges?view=o365-worldwide">https://learn.microsoft.com/en-us/microsoft-365/enterprise/urls-and-ip-address-ranges?view=o365-worldwide</a>
2	<a href="https://www.geeksforgeeks.org/how-to-add-a-hyperlink-in-ms-word/">https://www.geeksforgeeks.org/how-to-add-a-hyperlink-in-ms-word/</a>
3	<a href="https://be10x.in/blog/top-5-ai-features-in-ms-office-and-how-they-can-benefit-you/">https://be10x.in/blog/top-5-ai-features-in-ms-office-and-how-they-can-benefit-you/</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	3	2	3	3	3	3	2	2	3
<b>CO2</b>	2	3	3	2	3	3	3	3	2	2	3
<b>CO3</b>	2	3	3	2	3	3	3	3	2	2	3
<b>CO4</b>	2	3	3	2	3	3	3	3	2	2	3
<b>CO5</b>	2	3	3	2	3	3	3	3	2	2	3
<b>Total</b>	10	15	15	10	15	15	15	15	10	10	15
<b>Average</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC21	<b>PLANT AND ANIMAL BIOTECHNOLOGY</b>	CC-1	3	1	2	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To Develop a strong theoretical foundation in plant biotechnology techniques, including tissue culture, plant genetic transformation, and their industrial applications.										
LO2	To Understand the significance of secondary metabolites and their production in plants.										
LO3	To Build a clear understanding of the concepts, principles, and processes involved in animal biotechnology.										
LO4	To Explore the fundamentals of animal cell culture, including different types of cultures and cell lines.										
LO5	To Apply molecular biology techniques to genetically engineer animals, enhancing their sustainability, productivity, and suitability for pharmaceutical and industrial applications.										
Unit	Content										Hours
1	Definition, scope, and applications of plant tissue culture, Media preparation: MS medium, nutrient requirements, and hormone regulation. Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants – Classification– Alkaloids, Terpenoids (Isoprenoids), Phenolics - Flavonoids, Glycosides, Saponins, Volatile Oils (Essential Oils), therapeutic applications.										18
2	Transgenic plants: rDNA Technology; Gene transfer methods – Microinjection, electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, Molecular Marker aided breeding: RFLP maps, Linkage analysis. Applications of Transgenic Plants. Biosafety and Ethical Issues in Transgenic Plants.										18
3	Animal cell culture: Types (primary, secondary, continuous), Culture media: Essential nutrients, serum-free media, and growth factors. Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Oral vaccines, DNA Vaccines in animal disease.										18
4	Disaggregation of tissue and primary culture; cell separation, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation . Somatic cell cloning. Karyotyping; measuring parameters for cell growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays										18
5	Application of animal cell culture: in vitro testing of drugs, production of human and animal viral vaccines and pharmaceutical proteins. Transgenic animals: Production and application. Bioartificial organs: Skin substitutes, bioartificial pancreas, liver, and heart valves. Stem Cells- Properties, Types, Therapy, Prospects, and Ethics in stem cell research										18

CO	Course Outcomes
CO1	Students will gain knowledge about the concepts, scope, and applications of plant tissue culture.
CO2	Students will explore Agrobacterium Ti plasmid vectors for genetically modified plants
CO3	Students will be trained in scaling up cell cultures and performing cell culture techniques
CO4	Students will learn critical processes like tissue disaggregation, cell synchronization, and cryopreservation.
CO5	Students will be able to describe the production and use of transgenic animals for pharmaceutical and research purposes
<b>Textbooks:</b>	
1	Razdan. M. K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.
2	Chawla. H. S., 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New delhi.
3	Ian Freshney, 2010. Culture of animal cells. 6th edition, Wiley-Blackwell publishers.
4	Slater, 2008. Plant Biotechnology: The Genetic manipulation of plants, Second Edition, Oxford University Press, USA.
5	J.D.Watson, Gillman, J.Witkowski and M.Zoller, 2006. Recombinant DNA. 3rd ed.
<b>Reference Books:</b>	
1	W.H.Freeman. 26 K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
2	H.Kreuzer A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
3	M.Sudhir. 2000. Applied Biotechnology Plant Genetics. Dominant publishers Distributors.
4	Genetic Engineering of Animals by (Ed) A.Puhler, VCH Publishers, Weinheim, FRG, 1993. Animal Cell culture Practical approach. Ed. John R.W.Masters, Oxford.2004
5	Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996
<b>Web resources:</b>	
1	<a href="https://www.isaaa.org/resources/publications/pocketk/14/default.asp">https://www.isaaa.org/resources/publications/pocketk/14/default.asp</a>
2	<a href="https://agritech.tnau.ac.in/bio-tech/biotech_tc_notes.html">https://agritech.tnau.ac.in/bio-tech/biotech_tc_notes.html</a>
3	<a href="https://www.corning.com/catalog/cls/documents/application-notes/CLS-AN-042.pdf">https://www.corning.com/catalog/cls/documents/application-notes/CLS-AN-042.pdf</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	3	3	3	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO3</b>	3	2	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	2	2	3	3	3	3	3	3	3
<b>CO5</b>	3	2	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	12	12	14	15	15	15	15	15	15	15
<b>Average</b>	<b>3</b>	<b>2.4</b>	<b>2.4</b>	<b>2.8</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC22	<b>MICROBIOLOGY</b>	Core 5	3	1	2	0	4	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.										
LO2	To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques										
LO3	To enlighten the students on host microbe interaction and Epidemiology of microbial disease										
LO4	To update the knowledge on epidemic and pandemic diseases										
LO5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches										
Unit	Content										Hours
1	History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Carl Woese. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Role of Bacteria in Ecosystems. Applications of Microbial Diversity. Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs.										18
2	Microbial culture, identification, and control: Growth media and types – culturing techniques: Streaking method, Pure culture techniques: Serial dilution and plating methods. Identification of bacteria – Biochemical – IMViC. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes. Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Osmotic Pressure, Radiation; Chemical Methods.										18
3	Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases.										18
4	Microbial Diseases: General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Leprosy, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, filariasis, Candidiasis, superficial mycosis.										18
5	Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremophiles-Thermophiles, Acidophiles, Halophiles and alkalophiles.										18

CO	Course Outcomes
CO1	students familiarize with the major historical discoveries in microbiology by pioneers like Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, and Carl Woese, and to provide knowledge of microbial taxonomy, including bacteria, viruses, fungi, algae, and protozoa.
CO2	Students can impart practical knowledge on culturing microorganisms, media preparation, and identification methods such as biochemical tests (e.g., IMViC) and microscopy, along with the physical and chemical control of microbial growth.
CO3	Students learn to provide insights into the human microbiome, microbial symbiosis, and the epidemiology of infectious diseases, focusing on their causes, transmission, and patterns of outbreaks (epidemic, endemic, and pandemic).
CO4	Students able to understand the characteristics, pathogenesis, diagnosis, and control of major microbial diseases, with a focus on pandemic and epidemic diseases like COVID-19, AIDS, dengue, and Ebola.
CO5	Students can understand the microbial roles in nitrogen fixation, biofertilizers, rhizosphere interactions, biogeochemical cycles, and extremophiles, emphasizing their importance in agriculture and environmental sustainability.
<b>Textbooks:</b>	
1	Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594.
2	Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
3	Ananthanarayan and Paniker's (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251.
4	Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill.
<b>Reference Books:</b>	
1	Agriculture Microbiology 2016. E-Course Developed By TNAU (ICAR)
2	Prescott's Microbiology by Joanne Willey, Kathleen Sandman, and Dorothy Wood
3	Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller
4	Textbook of Diagnostic Microbiology by Connie R. Mahon, Donald C. Lehman, and George Manuselis
5	Environmental Microbiology by Ian L. Pepper, Charles P. Gerba, and Terry J.Gentry
<b>Web resources:</b>	
1	<a href="https://www.britannica.com/science/microbiology">https://www.britannica.com/science/microbiology</a>
2	<a href="https://www.ncbi.nlm.nih.gov/books/NBK560448/">https://www.ncbi.nlm.nih.gov/books/NBK560448/</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	3	-	3	3	3	3	-
<b>CO2</b>	3	-	3	3	3	-	3	3	3	3	-
<b>CO3</b>	3	-	3	3	3	-	3	3	3	3	-
<b>CO4</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	-	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	3	15	15	15	6	15	15	15	15	6
<b>Average</b>	<b>3</b>	<b>0.6</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1.2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1.2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER CC-6**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC23P	Plant and Animal Biotechnology, Microbiology Practical	CC-6	0	0	4	0	3	4	25	75	100
Learning Objectives											
LO1	To Isolate organism from Different Environment										
LO2	To develop proficiency in microbial identification and characterization										
LO3	To gain hands-on expertise in plant tissue culture techniques										
LO4	To Develop skills in isolating plant protoplasts, assessing their viability, and accurately localizing the nucleus using appropriate staining techniques for cellular analysis.										
LO5	To acquire practical skills in animal cell culture techniques										
Unit	Content										Hours
1	Isolation and Enumeration of bacteria from soil, Isolation and Enumeration of bacteria from water, Isolation and Enumeration of bacteria from air, Isolation and Enumeration of bacteria from plant surface, Isolation of bacteria from root nodules, Isolation of pure culture of <i>Aspergillus niger</i> , Isolation of pure culture of <i>Streptomyces</i> .										12
2	Gram staining and morphological characterization of microbes, Determination of growth curve of bacteria – <i>E.coli</i> , Biochemical characterization - catalase, oxidase, urease, coagulase, Starch Hydrolysis test, Lipid Hydrolysis test, Test for H <sub>2</sub> S production or TSI agar test, Antibiotic sensitivity test										12
3	Preparation of MS medium stock solution –Macro salt, Micro salt, Vitamin, growth regulator, Surface sterilization of various explants – leaf, shoot, root, seed, Generation of Callus from any two explants (leaf, root, bud and shoot apex), Maintenance of callus culture, Anther culture, Pollen culture, Embryo culture.										12
4	Isolation of plant protoplast 8. Protoplast viability test, Localization of nucleus using nuclear stain.										12
5	Introduction to Animal Cell culture: Procedure for handling cells and medium, Cleaning and sterilization of glassware and plastic tissue culture flasks, Preparation of tissue culture media, Trypsinization of established cell culture, Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue).										12

CO	Course Outcomes
CO1	Demonstrate the ability to isolate and enumerate various microorganisms from different environmental sources, including soil, water, air, and plant surfaces, using appropriate microbiological techniques.
CO2	Perform biochemical characterization and morphological identification of bacteria, including the Gram staining technique and tests for enzymatic activity, to assess microbial diversity.
CO3	Conduct plant tissue culture techniques, including the preparation of MS medium, surface sterilization of explants, and generation of callus, to understand plant propagation methods.
CO4	Apply animal cell culture practices, including media preparation, sterilization, trypsinization, and viability testing using Trypan blue, to study cell behavior and growth dynamics.
CO5	Execute advanced techniques such as 16S rRNA sequencing and protoplast isolation, enhancing understanding of genetic identification and plant cellular biology.
<b>Textbooks:</b>	
1	Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie R. Sherman
2	Bergeys Manual of Determinative Bacteriology by John G. Holt
3	Microbiology Laboratory Theory and Application by Michael J. Leboffe and Burton E. Pierce
4	Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith
5	Animal Cell Culture: A Practical Approach by J. M. Davis
<b>Reference Books:</b>	
1	Laboratory Manual in General Microbiology by J. W. D. and E. T. K.
2	Plant Cell and Tissue Culture by A. M. M. P. G.
3	Animal Cell Culture and Technology by John C. D.
4	Handbook of Plant Cell Culture by R. A. Dixon
<b>Web resources:</b>	
1	<a href="https://jru.edu.in/studentcorner/lab-manual/agriculture/Lab%20Manual%20PPB.pdf">https://jru.edu.in/studentcorner/lab-manual/agriculture/Lab%20Manual%20PPB.pdf</a>
2	<a href="https://microbiologysociety.org/static/uploaded/23cbf9c5-f8c8-4f91-b092a4ad819e6357.pdf">https://microbiologysociety.org/static/uploaded/23cbf9c5-f8c8-4f91-b092a4ad819e6357.pdf</a>
3	<a href="https://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf">https://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	3	-	3	2	3	3	3	3	2
<b>CO2</b>	3	3	3	-	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	-	3	2	3	3	3	3	2
<b>CO4</b>	3	2	3	-	3	2	3	3	3	3	2
<b>CO5</b>	3	2	3	-	3	2	3	3	3	3	2
<b>Total</b>	15	12	15	-	15	10	15	15	15	15	10
<b>Average</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	-	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTC24	<b>Bioprocess Technology</b>	CC-7	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	Explain the concept of fermentation and its importance										
LO2	Learn about bioreactors and its types										
LO3	Obtain a strong knowledge on product production and recovery										
LO4	Perceive knowledge on separation techniques of bioproducts										
LO5	Understand the commercial importance of microbes in fermentation and bioprocessing										
Unit	Content										Hours
1	Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes.										12
2	Bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters. Production of citric acid, penicillin and insulin.										12
3	Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction.										12
4	Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, and its types										12
5	Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites.										12

CO	Course Outcomes
CO1	Students learn to Identify the major types, such as embryonic, adult, mesenchymal, and adipose-derived stem cells, and their unique properties.
CO2	Students learn to Compare the roles of embryonic and adult niches in maintaining stem cell populations, with examples like Drosophila germline stem cells.
CO3	Students can Understand the criteria used to validate stem cell properties, such as surface markers and molecular assays.
CO4	Students learn to Analyze key signaling pathways (e.g., JAK-STAT, PI3K, Ras/Raf) that regulate the cell cycle, self-renewal, and differentiation.
CO5	Students can able to Develop an awareness of the ethical considerations involved in human stem cell research, along with recent innovations in the field.
<b>Textbooks:</b>	
1	Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
2	Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
3	Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.
4	Progress in gene therapy, Volume 2, Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers
5	Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003
<b>Reference Books:</b>	
1	Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan
2	“Stem cell basics and application” Ed. By K. D. Deb and S. M. Totey, Tata McGraw Hill Pvt. Ltd, 2011.
3	“Hand book of Stem Cells” Edited by RoberLanza, Elsevier, Academic Press, 2011.
4	“Stem Cells Handbook”, Edited by Stewart Sell, Human Press, 2010.
5	“Stem cell therapy for organ failures”, Edited by S. Indumathi, Springer Verlag, 2015
<b>Web resources:</b>	
1	<a href="https://ipeccgroup.com/wp-content/uploads/formidable/6/bioprocess-technology-lecture-notes.pdf">https://ipeccgroup.com/wp-content/uploads/formidable/6/bioprocess-technology-lecture-notes.pdf</a>
2	<a href="https://www.sciencedirect.com/journal/biotechnology-notes">https://www.sciencedirect.com/journal/biotechnology-notes</a>
3	<a href="https://bnmv.ac.in/images/uploads/2020%20Dr.%20Ruma%20Dutta%20Advances%20in%20Bioprocess%20Engineering%20and%20Technology2.pdf">https://bnmv.ac.in/images/uploads/2020%20Dr.%20Ruma%20Dutta%20Advances%20in%20Bioprocess%20Engineering%20and%20Technology2.pdf</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	-	3	2	3	3	3	3	3	3	3
<b>CO2</b>	3	-	3	2	3	3	3	3	3	3	3
<b>CO3</b>	3	3	3	2	3	3	3	3	3	3	3
<b>CO4</b>	3	2	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	2	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	7	15	12	15	15	15	15	15	15	15
<b>Average</b>	<b>3</b>	<b>1.4</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTE23	<b>Aquaculture</b> <b>Biotechnology</b>	EC-4	3	1	0	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the application of biotechnology in different aspects of aquaculture										
LO2	To study about Feed Biotechnology										
LO3	To understand environmental management										
LO4	To study applications of Biotechnological tools										
LO5	To study Molecular technique sin Aquaculture										
Unit	Content										Hours
1	Introduction - Scope of biotechnology in fisheries and aquaculture research. Transgenics – Principles of transgenic technology and its application in fisheries, Synthetic hormones for induced breeding										12
2	Feed biotechnology: Probiotics, single cell proteins, nutraceuticals. Commercial Recombinant protein - enzymes, hormones, bioactive compounds, therapeutic proteins. Antimicrobial peptides and their applications. Marine toxins.										12
3	Biotechnological approaches in environmental management: Bioremediation, biosensors, biofouling, treatment of waste water. Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines										12
4	Applications of biotechnological tools - Recombinant DNA, Monoclonal antibodies, Cell lines, Stem cell culture, DNA markers and MAS. Application of tissue culture in sea weed and pearl production										12
5	Molecular diagnostic technology in aquaculture: PCR protocol for white spot syndrome virus WSSV, Infectious hypodermal and hematopoietic necrosis virus IHNV, Yellowhead disease YHD, Taura syndrome virus TSV. Electron microscopy in advanced fisheries research. Cryomicroscopy in aquaculture research.										12

CO	Course Outcomes
CO1	Students will recall and describe the scope of aquatic biotechnology as an emerging field
CO2	Students will explain and apply the concepts of feed biotechnology, single-cell proteins (SCP), active compounds, and proteins in aquatic contexts
CO3	Students will utilize and assess various technologies in environmental management related to aquatic ecosystems
CO4	Students will interpret and analyze the applications of biotechnology in aquatic environments
CO5	Students will demonstrate the use of molecular diagnostic technologies in aquatic biotechnology to solve relevant problems
<b>Textbooks:</b>	
1	Ramesh RC. (Ed.). 2007. Microbial Biotechnology in Agriculture and Aquaculture. Vol.II. Science Publ.
2	Nagabhushanam R, Diwan AD, Zahurnec BJ ,Sarojini R. 2004.Biotechnology of Aquatic Animals. Science Publ
3	Felix S 2007. Molecular diagnostic technology in aquaculture, Narendra Publishing House, Delhi, India
4	Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
5	Reddy PVGK, Ayyappan S, Thampy DM , Gopalakrishna. 2005. Text Book of Fish Genetics and Biotechnology. ICAR.
<b>Reference Books:</b>	
1	Pandian TJ, Strüssmann CA Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ. Primrose SB. 1989. Modern Biotechnology. Blackwell
2	Applications of Recombinant DNA Technology. ASM Press.
3	Fingerman M, Nagabhushanam R Thompson MF. 1997. Recent Advances in Marine Biotechnology. Vols. I-III. Oxford & IBH.
4	Zhanjiang JL. 2007. Aquaculture Genome Technologies. Blackwell
5	Singh B. 2006. Marine Biotechnology and Aquaculture Development. Daya Publ. House
<b>Web resources:</b>	
1	<a href="https://www.researchgate.net/publication/336982982_BIOTECHNOLOGY_AND_ITS_APPLICATIONS_IN_AQUACULTURE_AND_FISHERIES">https://www.researchgate.net/publication/336982982_BIOTECHNOLOGY_AND_ITS_APPLICATIONS_IN_AQUACULTURE_AND_FISHERIES</a>
2	<a href="https://extension.psu.edu/introduction-to-aquaculture">https://extension.psu.edu/introduction-to-aquaculture</a>
3	<a href="https://www.sciencedirect.com/science/article/abs/pii/S004484860100864X">https://www.sciencedirect.com/science/article/abs/pii/S004484860100864X</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO2</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO3</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	-	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	-	15	15	15	15	15	15	15	15	15
<b>Average</b>	<b>3</b>	-	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

**1<sup>st</sup> YEAR: SECOND SEMESTER**

Course Code	Course Name	Category	L	T	P	S	Credits	Hours	Marks		
									CIA	External	Total
24PBTE21	<b>STEM CELL BIOLOGY</b>	EC 3	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the major discoveries of stem cell biology										
LO2	To provide basic knowledge about stem cell niche and functions										
LO3	To enlighten the students on Stem cell isolation and culture techniques										
LO4	To update the knowledge on Stem cell cycle										
LO5	To assess and appraise Applications of Embryonic stem cells.										
Unit	Content										Hours
1	Stem cells - Definition, Characterization, Totipotent, pluripotent, multipotent and unipotent cells. Self-renewal and differentiation. Types of stem cells- Embryonic stem cells, Adult stem cells and mesenchymal stem Cells, Adipose stem cells										12
2	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells. Embryonic niche vs. adult niche.										12
3	Stem cell isolation and culture techniques. Characterization of stem cells. Culture of Stem Cells.										12
4	Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control										12
5	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research. Stem Cells in Bioartificial Organs and Tissue Engineering. Recent Advances in Stem Cell Research.										12

CO	Course Outcomes
CO1	Students learn to Identify the major types, such as embryonic, adult, mesenchymal, and adipose-derived stem cells, and their unique properties.
CO2	Students learn to Compare the roles of embryonic and adult niches in maintaining stem cell populations, with examples like Drosophila germline stem cells.
CO3	Students can Understand the criteria used to validate stem cell properties, such as surface markers and molecular assays.
CO4	Students learn to Analyze key signaling pathways (e.g., JAK-STAT, PI3K, Ras/Raf) that regulate the cell cycle, self-renewal, and differentiation.
CO5	Students can able to Develop an awareness of the ethical considerations involved in human stem cell research, along with recent innovations in the field.
<b>Textbooks:</b>	
1	Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
2	Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
3	Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.
4	Progress in gene therapy, Volume 2, Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers
5	Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003
<b>Reference Books:</b>	
1	Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan
2	“Stem cell basics and application” Ed. By K. D. Deb and S. M. Totey, Tata McGraw Hill Pvt. Ltd, 2011.
3	“Hand book of Stem Cells” Edited by RoberLanza, Elsevier, Academic Press, 2011.
4	“Stem Cells Handbook”, Edited by Stewart Sell, Human Press, 2010.
5	“Stem cell therapy for organ failures”, Edited by S. Indumathi, Springer Verlag, 2015
<b>Web resources:</b>	
1	<a href="https://www.medicalnewstoday.com/articles/323343">https://www.medicalnewstoday.com/articles/323343</a>
2	<a href="https://www.jto.org/article/S1556-0864(15)31506-9/fulltext">https://www.jto.org/article/S1556-0864(15)31506-9/fulltext</a>
3	<a href="https://www.dvcstem.com/post/benefits-of-stem-cells">https://www.dvcstem.com/post/benefits-of-stem-cells</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO3</b>	3	-	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	2	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	7	15	15	15	15	15	15	15	15	15
<b>Average</b>	<b>3</b>	<b>1.4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**3 – Strong, 2- Medium, 1- Low**

SECOND YEAR THIRD SEMESTER  
**CORE 8–GENETIC ENGINEERING**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
<b>24PBTC31</b>	<b>GENETIC ENGINEERING</b>	CC - 8	3	1	2	0	5	6	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the fundamental techniques of gene cloning and genetic engineering.										
LO2	To study E. coli cloning vectors like pBR322 and its derivatives, as well as vectors for gram-negative bacteria, including (ColE1, p15A, R1, IncPa, and pSC101).										
LO3	To understand cloning in <i>Saccharomyces cerevisiae</i> , including its life cycle and various eukaryotic vectors like SV40, specialized cDNA vectors, and in vitro RNA synthesis.										
LO4	To learn nucleic acid hybridization techniques, molecular probes, and probe labeling methods like nick translation, end labeling, and random primer labeling.										
LO5	To understand advanced molecular techniques like site-directed mutagenesis, DNA microarrays, chromosome walking, and jumping, along with their applications in prenatal diagnosis and gene therapy.										
Unit	Contents										Hour
<b>I</b>	Gene cloning-Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries										15
<b>II</b>	E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria ( <i>Bacillus subtilis</i> )										15
<b>III</b>	Cloning in yeast <i>Saccharomyces cerevisiae</i> . Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number										20
<b>IV</b>	Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing).Second generation sequencing methods										20
<b>V</b>	Site directed mutagenesis; DNA microarray; chromosome walking and jumping.Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavrsavr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis										20

<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Describe gene cloning techniques, genetic engineering tools, and nucleic acid manipulating enzymes used in recombinant DNA technology.
CO2	Explain Cloning Vectors for Gram Negative bacteria including ColE1, p15A, R1, IncPa, and pSC101
CO3	Illustrate cloning in <i>Saccharomyces cerevisiae</i> , its life cycle, and various eukaryotic vectors, including SV40 and specialized cDNA vectors.
CO4	Analyze various nucleic acid hybridization techniques, molecular probes, and probe labeling methods such as nick translation, end labeling, and random primer labeling
CO5	Evaluate various advanced genetic engineering techniques such as site-directed mutagenesis, DNA microarrays, chromosome walking, and jumping.
<b>Textbooks</b>	
1	T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
2	Sandy B Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
3	Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
4	William SKlug, Michael RCummings.2005. Concepts of Genetics, 7 <sup>th</sup> edition. Pearson Publisher.
5	James D. Watson, Tania ABaker, Stephen P.Bell, Alexander Gann, Michael Levine, Richard Losick.2004.Molecular Biology of the Gene 5 <sup>th</sup> Edition . Pearson Publisher.
<b>Reference Book</b>	
1	Dr.R. C. Dubey. A textbook of Biotechnology. S Chand Publisher
2	H.K. Das. Textbook of Biotechnology. 5 <sup>th</sup> Edition. Wiley Publisher
3	Ernst- L. Winnacker. Introduction to Gene Technology. Panima Publisher
4	Benjamin Lewin. Genes IX. Jones and Bartlett Publishers
5	Maxine Singer and Paul Berg. Genes and Genomes. University Science Books
6	Kumaresan. Biotechnology. Saras publication

#### **Web Resources:**

1	<a href="#">SBB2102.pdf</a>
2	<a href="https://www.mlsu.ac.in/econtents/119_Cloning%20vectors.pdf">https://www.mlsu.ac.in/econtents/119_Cloning%20vectors.pdf</a>
3	<a href="https://pubmed.ncbi.nlm.nih.gov/3034735/">https://pubmed.ncbi.nlm.nih.gov/3034735/</a>

**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	2	3	2	2	3	3	3	3
<b>CO2</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO4</b>	3	2	3	3	3	2	3	3	3	3	2
<b>CO5</b>	3	2	3	3	3	2	3	3	3	3	2
<b>Total</b>	15	13	15	15	15	10	14	15	15	15	11
<b>Average</b>	3	2.6	3	3	3	2	2.8	3	3	3	2.2

**3 – Strong, 2- Medium, 1- Low**

**SECOND YEAR THIRD SEMESTER**

**BIOINFORMATICS**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTC32	Bioinformatics	CC - 9	2	1	2		4	5	25	75	100
<b>Learning Objectives</b>											
LO1	To Understand the scope and importance of Bioinformatics										
LO2	To Understand comparison of sequences using sequence alignment										
LO3	To Understand the concepts in genome decoding										
LO4	To Understand structural organization and functional annotation of proteins										
LO5	To Understand principles and concepts in drug designing										
Unit	Contents										No. of Hours
I	Introduction to Bioinformatics – Importance and Scope, Omics of Bioinformatics and its application -Genomics, Transcriptomics, Proteomics, Metabolomics and Systemics. Types of biomolecules and data types and formats. Biological database- Types and Classification. Literature databases- Pubmed, Pubmed Central, OMIM. Sequence databases- Nucleotide and Protein-NCBI-Genbank, GenPept, EMBL-EBI, Uniprot.										15
II	Sequence analysis- Methods and Application, Sequence alignment types- Global and Local; Pairwise and Multiple sequence alignment. Pairwise Sequence alignment algorithm- Needleman-Wunsch and Smith-Waterman Algorithm. BLAST, FASTA, Multiple sequence alignment- algorithm and applications. Phylogenetic tree, CLUSTALW.										15
III	Genomics- Genome sequencing, Genome databases, Specialized genome- Plant, Animal, Microbial databases. Prokaryotic and Eukaryotic genome structure and organization. Functional annotation of genomes- Intron, Exon, ORF, Splice sites, Promoter, Terminator, CpG islands, Satellite regions. Gene prediction tools- Genscan, GenMark, Spliceview, ORF Finder, CpG islands. Gene mutation database-HGMD.										15
IV	Proteomics- Structural Hierarchy of proteins. Motifs and Domains. Primary Structure, Sequence analysis-ProtScale, ProtParam, FindMod, Peptide Cutter, TMpred. Secondary Structure of proteins-Jpred, PROTEUS, Methods for protein structure prediction- X-ray, NMR, Homology modeling of proteins. Structure Visualization- RASMOL, SwissPDBviewer. Comparison of Protein sequences and Database searching.										15
V	History of Drug Discovery, Computational Drug Designing, Steps in Drug design, Pharmacokinetics, Pharmacodynamics, Molecular docking- Methods, Active site prediction, Intermolecular interactions -Types, Ligand libraries, Virtual screening, Cheminformatics.										15

<b>Course Outcomes</b>	
<b>The student will be able to</b>	
CO1	understand the Scope and application of Bioinformatics in various fields
CO2	understand the Importance sequence alignment algorithm in comparative studies
CO3	understand the Significance of bioinformatics tools in genome decoding
CO4	Analyse the Computational methods of protein structure prediction and validation
CO5	understand the Principles and computational support in drug designing
<b>Textbooks</b>	
1	Andreas D. Baxevans, B.F. Francis Ouellette, Bioinformatics- A practical guide to the analysis of genes and protein, 3 <sup>rd</sup> Edition, Wiley Publications, 2005, 540 pages
2	S.C. Rastogi, N. Mendiratta P. Rastogi, Bioinformatics- Methods and Application-Genomics, Proteomics and Drug Designing, 4 <sup>th</sup> Edition, PHI Publishers, 2015, 628 pages
3	T.K. Attwood, D.J Parry Smith, Samiron Phukan, Introduction to Bioinformatics, Pearson Publishers, 2014
4	Author M. Lesk, Introduction to Bioinformatics, Oxford Press, 2003, Pages 283
<b>Reference Books</b>	
1	Zhumur Ghosh , Bibekanand Mallick, Bioinformatics: Principles And Applications, OUP India Publishers, 2008, 560 pages
2	<a href="#">Jonathan pevsner</a> , bioinformatics and functional genomics, 3rd edition , John Wiley, 2022 2020 pages
3	<a href="#">Jin xiong</a> , Essential Bioinformatics, Cambridge University Press; First Edition , 2007, 352 pages.

### Web Resources

1	<a href="https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001209/M014177/ET/1526979793P14_M1_ET.pdf">https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001209/M014177/ET/1526979793P14_M1_ET.pdf</a>
2	<a href="https://library.fiveable.me/bioinformatics/unit-3/pairwise-sequence-alignment/study-guide/X75d1KtnnunHWZyJ">https://library.fiveable.me/bioinformatics/unit-3/pairwise-sequence-alignment/study-guide/X75d1KtnnunHWZyJ</a>
3	<a href="https://booksite.elsevier.com/9780123749796/Chapter_13.pdf">https://booksite.elsevier.com/9780123749796/Chapter_13.pdf</a>
4	<a href="https://pmc.ncbi.nlm.nih.gov/articles/PMC10819513/">https://pmc.ncbi.nlm.nih.gov/articles/PMC10819513/</a>
5	<a href="https://www.e3s-conferences.org/articles/e3sconf/pdf/2023/36/e3sconf_iconnect2023_04042.pdf">https://www.e3s-conferences.org/articles/e3sconf/pdf/2023/36/e3sconf_iconnect2023_04042.pdf</a>

### Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	2	2	3	3	3	3	3	2	2
<b>CO2</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO3</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO4</b>	3	3	2	2	3	1	3	3	3	2	2
<b>CO5</b>	3	3	2	2	3	1	3	3	3	3	2
<b>Total</b>	15	13	10	10	15	9	15	15	15	13	10
<b>Average</b>	3	2.6	2	2	3	1.8	3	3	3	2.6	2

**3 – Strong, 2- Medium, 1- Low**

**SECOND YEAR – THIRD SEMESTER  
CC- 10 IMMUNOLOGY**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTC33	IMMUNOLOGY	CC-10	3	1	1	0	4	5	25	75	100
Learning Objectives											
LO1	To illustrate the overview of Immune system										
LO2	To describe cells of Immune system										
LO3	To learn the concepts of cellular and molecular processes that represents the human immune system.										
LO4	To elucidate the role of immunological regulation and tolerance at a cellular and molecular level										
LO5	To Comprehend the concepts on immunological principles and diagnosis										
Unit	Contents										No. of Hours
I	History and overview of the immune system: Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes										15
II	Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvants. Immunoglobulins-structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity.										15
III	Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology- immunological basis of graft rejection, cinical transplantation and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours										15
IV	Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins										15
V	Immunotechniques- Principle and Applications: Immuno diffusion,Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test.Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.										15

<b>Course Outcomes</b>	
<b>The student will be able to</b>	
CO1	Explain the History and overview of Immune system.
CO2	Describe key events and cellular players of Immune system.
CO3	Demonstrate the concepts of cellular and molecular processes that represents the human immune system.
CO4	Elucidate the role of immunological regulation and tolerance at a cellular and molecular level
CO5	Illustrate concepts on immunological principles and diagnosis
<b>Textbooks</b>	
1	Junith A. Owen, Jenny Punt, Sharon A. Stanford, Patrica P. Jones 2013. Kuby Immunology. 7th edition, W. H . Freeman and Company.
2	Dulsy Fathima, N Arumugam, 2006. Immunology. Saras Publication.
3	Ashim K. Chakravarty, 2015. Immunology and Immunotechnology. Oxford University Press
4	Kannan. I., 2010. Immunology. MJP Publishers, Chennai
5	Bharat Singh, 2006. Immunology, Pointer Publishers.
<b>Reference Books</b>	
1	Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and Molecular Immunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
2	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 13th edition, Wiley- Blackwell. USA.
3	Ian R. Tizard, 2004. Immunology an Introduction, 4 <sup>th</sup> Edition. Saunders College Publishing.
4	David Male, jonathan Brostoff, David B Roth, Ivan Roitt, 2006. Immunooogy 7 <sup>th</sup> Edition. Elsevier.
5	Charles A. Janeway, Paul Travers, Mark Walport, Mark J Shlomchik. (2005). Immunobiology- the immune system in health and disease. Garland Science Publishing. 6rd Edition.

**Web Resources:**

1	<a href="http://www.library.csusm.edu/course_guides/biology">www.library.csusm.edu/course guides/biology</a>
2	<a href="http://www.immunologylink.com">www.immunologylink.com</a>
3	<a href="http://www.wiley.com/college/bio/karp12791/weblinks.html">http://www.wiley.com/college/bio/karp12791/weblinks.html</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	1	1	1	3	1	1	3	3	1	1
<b>CO2</b>	3	1	1	1	3	1	1	3	3	1	1
<b>CO3</b>	3	2	3	3	3	2	2	3	3	2	2
<b>CO4</b>	3	1	2	1	3	1	2	3	3	1	1
<b>CO5</b>	3	2	3	3	3	3	2	3	3	3	3
<b>Total</b>	15	7	10	9	15	8	8	15	15	8	8
<b>Average</b>	3	1.4	2	1.8	3	1.6	1.6	3	3	1.6	1.6

**3 – Strong, 2- Medium, 1- Low**

**SECOND YEAR – THIRD SEMESTER**  
**CC-11- GENETIC ENGINEERING, BIOINFORMATICS & IMMUNOLOGY**  
**PRACTICALS**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
<b>24PBTC34</b> <b>P</b>	Genetic Engineering, Bioinformatics & Immunology Practicals	CC - 11	0	0	5	0	4	5	25	75	100
Learning Objectives											
LO1	To understand and perform plasmid DNA extraction, electrophoretic separation, staining, and DNA recovery from agarose gels.										
LO2	To develop proficiency in DNA manipulation techniques, including restriction digestion, ligation, RAPD, and RFLP analysis.										
LO3	To understand and perform DNA amplification by PCR, molecular weight determination, and RT-PCR demonstration for COVID-19 detection.										
LO4	To understand computational methods in biological sequence analysis										
LO5	To learn the technique of immunodiagnostics										
Unit											
Unit	Contents										No. of Hours
I	<b><u>Genetic Engineering - Practical</u></b> Preparation of plasmid DNA by alkaline lysis method. Agarose gel electrophoresis Silver staining of gels/ Methylene blue DNA staining Elution of DNA from agarose gel.										15
II	Restriction enzyme digestion. Ligation. RAPD/ RFLP										15
III	Amplification of DNA – PCR Determination of molecular weight of DNA RT-PCR (Demonstration)										15
IV	Literature survey databases-PubMed, OMIM Retrieval of Nucleotide and protein sequence from GenBank and Uniprot Genome analysis- ORF Finder, Genscan, Glimmer, Promoter, Spliceview Sequence Similarity Search using BLASTN and BLASTP Multiple Sequence Alignment – ClustalW Phylogenetic tree-Phylip										15

	Primary and Secondary Structure analysis- Expassy 3Dimensional structure of protein- PDB Visualization of protein structures- RASMOL Protein structure prediction-SwissPDBviewer Protein structure evaluation- Ramachandran Plot, SAVES	
V	a) Lymphocyte separation and identification b) Preparation of serum and plasma/ Isolation of IgG molecule from serum c) Immunodiagnosics: CRP/ Widal/ RA/ Blood grouping and typing/ HCG/ ELISA d) Radial Immunodiffusion/ Ouchterlony Immunodiffusion	15

<b>Course Outcomes</b>	
<b>The student will be able to</b>	
CO1	Acquire practical skills in plasmid DNA isolation, electrophoresis, DNA staining, and gel elution techniques.
CO2	Perform hands-on experience in DNA restriction digestion, ligation, and genetic analysis using RAPD and RFLP techniques.
CO3	Develop expertise in DNA amplification by PCR, molecular weight determination, and understanding RT-PCR applications for COVID-19 detection.
CO4	Computationally analyse protien and DNA sequences
CO5	Perform various Immunodiagnostic techniques

<b>Textbooks</b>	
1	Life Science Manual
2	Fundamentals Of Practical Genetics & Biotechnology by Roy Brototi by Platium Publisher
3	Advanced Genetics Manual for Genetic Engineering (Hb 2023) by Jose Callahan. American Academic Publisher (Exclusive)
<b>Reference Books</b>	
1	Janusz M. Bujnicki, Practical Bioinformatics, 2008, <a href="#">Springer Berlin Heidelberg</a> , ebook, Pages 265
2	Practical manual on fundamentals of Genetics (Paperback, Dr. Mamata Behera Dr. Rinny Swain Dr. Aditya Pratap Singh). Bigfoot Publications
2	Frank C. Hay, Olwyn M. R. Westwood. (2008).Practical Immunology, 4th Edition, Wiley-Blackwell.

Web Resources:

1	<a href="https://nu.edu.sd/file/last%20manual.pdf">https://nu.edu.sd/file/last%20manual.pdf</a>
2	<a href="https://link.springer.com/book/10.1007/978-3-030-64686-8">https://link.springer.com/book/10.1007/978-3-030-64686-8</a>

**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	3	2	3	2	3	3	3	3	2
<b>CO2</b>	3	3	3	2	3	2	3	3	3	3	2
<b>CO3</b>	2	3	3	2	3	2	3	3	3	3	2
<b>CO4</b>	3	3	3	2	3	2	3	3	3	3	2
<b>CO5</b>	3	3	3	2	3	2	3	3	3	3	2
<b>Total</b>	13	15	15	10	15	10	15	15	15	15	10
<b>Average</b>	2.6	3	3	2	3	2	3	3	3	3	2

**3 – Strong, 2- Medium, 1- Low**

**SECOND YEAR THIRD SEMESTER**

**EC – 5 PHARMACEUTICAL BIOTECHNOLOGY**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTE31	Pharmaceutical biotechnology	EC - 5	3	1	0	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To Understand the basic concepts in pharmacology										
LO2	To Understand the importance of biotechnological techniques in pharmaceuticals										
LO3	To Understand the stages in drug development process										
LO4	To Understand clinical aspects of drug action										
LO5	To Understand types and criteria in drug formulation										
<b>Unit</b>											
Unit	Contents										No. of Hours
I	Introduction to pharmacology, Application of Biotechnology in pharmacology, Pharmacology and Ethnopharmacology: Scope, Applications and Importance; Sources and classification of drugs, Pharmacokinetics- Absorption, Distribution, Metabolism and Excretion (ADME), Pharmacodynamics- Mechanism of drug action										10
II	Biotechnology in pharmaceuticals- Vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Hybridoma technology - Production, Purification and Applications; Application of rDNA technology and genetic engineering in the production of vaccines, hormones and antibiotics; Brief introduction to Protein Engineering, Synthetic DNA, therapeutic ribozymes, Downstream processing										12
III	Drug development and process- Genomics and proteomics in drug discovery, Pharmacogenetics and pharmacogenomics, Gene expression, Drug targets, Synthetic drugs, Plant Chemicals in modern pharmacology, Drug improvement by structure modification and bio-transformation, Preclinical studies, Criteria for pharmacological evaluation of drugs; Toxicity studies- mutagenicity, carcinogenicity, computational drug design.										14
IV	Clinical Pharmacology- Drug therapy, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug administration, factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and causes of ADR; principle										14

	clinical manifestations and treatment of ADR, General principles of management of drug poisoning; antidotes.	
V	Formulation of drugs- Drug dosage forms- Classification of Dosage Forms, Manufacturing dosage forms, Solid forms- Tablet, Capsule, Powder, Granules; Tablet design and formulation, size and shape, Organoleptic properties, Liquid dosage forms- Emulsion, Suspension; Semi solid forms- Ointment, Gels, Creams, Pastes Aerosols- Inhalers; Controlled release, Sustained release, Drug Factors Affecting Dosage Form Design	10

<b>Course Outcomes</b>	
<b>The student will be able to</b>	
CO1	Perceive the fundamentals in pharmacology
CO2	Gain insights into biotechnological applications in pharmaceutical industries
CO3	Acquire knowledge on the critical aspects in drug designing
CO4	Comprehend clinical factors employed in designing novel drugs
CO5	Obtain theoretical knowledge in formulating different dosage forms of drugs
<b>Textbooks</b>	
1	Gray Walsh, Pharmaceutical Biotechnology-Concepts and Applications, 2007, Wiley Publications, Pages 465
2	Amritesh C. Shukla, Gitishree Das, Jayanta Kumar Patra, Advances in Pharmaceutical Biotechnology Recent Progress and Future Applications, 2021, <a href="#">Springer Nature Singapore</a> , Page count: 478
3	<a href="#">Saurabh Bhatia</a> , <a href="#">Saif Hameed</a> , <a href="#">Zeeshan Fatima</a> , Introduction to Pharmaceutical Biotechnology, Basic Techniques and Concepts, 2024, <a href="#">IOP Publishing Limited</a> , Pages 488
<b>Reference Books</b>	
1	Ana Catarina Silva, Hugo Almeida, José Manuel Sousa Lobo, João Nuno Moreira, Current Applications of Pharmaceutical Biotechnology, Springer International Publishing, 2020, Pages – 400
2	Daan J. A. Crommelin, Robert D. Sindelar, Pharmaceutical Biotechnology Fundamentals and Applications, Second Edition, Taylor & Francis Publication, 2002, Pages- 425

## Web Resources

1	<a href="https://www.nebiolab.com/drug-discovery-and-development-process/">https://www.nebiolab.com/drug-discovery-and-development-process/</a>
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## Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	2	1	3	3	3	2	3	1	1
<b>CO2</b>	3	2	2	1	3	2	2	2	2	2	2
<b>CO3</b>	3	3	2	2	3	3	3	3	2	2	2
<b>CO4</b>	3	3	2	1	2	2	2	2	2	2	2
<b>CO5</b>	3	3	3	3	3	3	3	2	2	2	2
<b>Total</b>	15	14	11	8	14	13	13	11	11	9	9
<b>Average</b>	3	2.8	2.2	1.6	2.8	2.6	2.6	2.2	2.2	1.8	1.8

**3 – Strong, 2- Medium, 1- Low**

**SECOND YEAR – THIRD SEMESTER**  
**EC- 5 GENOMICS AND PROTEOMICS**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTE31	Genomics and Proteomics	EC - 5	2	1	1	0	3	4	25	75	100
<b>Learning Objectives</b>											
LO1	To Practice, experiment with and apply the basic instruments in the laboratory.										
LO2	To Predict the functionality of Beer – Lambert’s law in identifying and quantifying a biomolecule.										
LO3	To Employ the separation techniques for separating bio-molecules based on chromatography and electrophoretic techniques.										
LO4	To Understand the clinical important isotopes and detection of isotopes										
LO5	To Employ the separation techniques for separating bio-molecules based on centrifugal force by centrifugation.										
<b>Unit</b>											
Unit	Contents										No. of Hours
I	Introduction to Genomics: Introduction – Organization and structure of genomes, Sequence complexity in Genome, Introns and Exons, SNPs, Microsatellite, tandem repeats or VNTR, DMRs, Contigs and Scaffolds. Genomic DNA isolation methods, Sequencing Methods, Genomic and Gene sequence databases.										12
II	Gene Expression and Identification: Genome annotation, traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, gene ontology, overview of comparative genomics, southern Blotting, cDNA Library, and DNA Micro-Array.										12
III	Introduction to Proteomics – The Proteome, mining proteomes, Bridging Genomics and Proteomics, Post Translational modifications of Protein. Protein Isolation, SDS-PAGE, Western Blotting, Protein Chip, Structural Biology: Primary, Secondary, Super Secondary, Tertiary and Quart nary structure, domain, receptor, PDB, SCOP and CATH										12
IV	Protein Structure Analysis and Identification: Primary Structure Analysis, Secondary Structure Analysis, 3d-Structure prediction, Homology Modeling, NMR, Mass Spectrometer and X-ray Crystallography.										12
V	Analysis of RNA expression, RNA types, siRNA, types of siRNA and its therapeutic applications. Northern Blotting and its application. Applications of genomics and Proteomics.										12

<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Explain genome organization, sequencing methods, genetic variations, and genomic databases.
CO2	Describe gene identification, annotation, functional analysis, and comparative genomics techniques.
CO3	Explain proteome analysis, protein structure, modifications, and key proteomic techniques.
CO4	Understand protein structure analysis, prediction methods, and identification techniques.
CO5	Describe RNA expression analysis, siRNA applications, and the role of genomics and proteomics in research.
<b>Textbooks</b>	
1	Campbell and Heyer. Discovering Genomics, Proteomics and Bioinformatics. Cold Spring Harbor Laboratory. Press & Benjamin Cummings, 2002.
2	Krane et al. Fundamental concepts of bioinformatics. Benjamin Cummings, 2002
3	Lesk, A.M. Introduction to Bioinformatics. Oxford, 2002.
4	Higgins, D and Taylor, W (Eds), 2000. Bioinformatics: Sequence, structure and databanks. Oxford University Press, Oxford
5	Misener, S and Krawetz, SA (Eds), 2001. Bioinformatics: methods and protocols. Replica press private limited, New Delhi
<b>Reference Books</b>	
1	Higgins, D and Taylor, W (Eds), 2000. Bioinformatics: Sequence, structure and databanks Oxford University Press, Oxford
2	Misener, S and Krawetz, SA (Eds), 2001. Bioinformatics: methods and protocols. Replica press private limited, New Delhi

**Web Resources:**

1	<a href="#">1519041212M4SequenceorganizationofgenomeQuad1.pdf</a>
2	<a href="https://en.wikipedia.org/wiki/Human_genome">https://en.wikipedia.org/wiki/Human_genome</a>
3	<a href="https://www.slideshare.net/slideshow/protein-structure-prediction-primary-structure-analysispptx/256797713">https://www.slideshare.net/slideshow/protein-structure-prediction-primary-structure-analysispptx/256797713</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	1	2	2	1	2	3	3	1	1
<b>CO2</b>	3	2	3	1	3	1	2	3	3	1	1
<b>CO3</b>	3	2	3	3	3	2	2	3	3	2	2
<b>CO4</b>	3	1	2	1	3	1	2	3	3	1	1
<b>CO5</b>	3	2	3	3	3	3	2	3	3	3	3
<b>Total</b>	15	10	12	10	14	7	10	15	15	8	8
<b>Average</b>	3	2	2.4	2	2.8	1.4	2	3	3	1.6	1.6

**3 – Strong, 2- Medium, 1- Low**

## SEC - 2: TISSUE ENGINEERING

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTS31	TISSUE ENGINEERING	SEC - 2	1	1	0	0	2	2	25	75	100
Learning Objectives											
LO1	To learn the fundamental concepts of cell growth, differentiation and morphogenesis in tissue Engineering										
LO2	To understand the role of growth factors, bioreactors, and 3D cell culture in invitro tissue development.										
LO3	To learn about biomaterials such as scaffolds, extracellular matrix, polymers, and nanocomposites in tissue engineering.										
LO4	To study the development and applications of bioartificial organs, including the bioartificial pancreas, Hepatassist liver support system, and artificial womb.										
LO5	To comprehend the principles of structural tissue engineering for bone, skin, and neural regeneration.										
Unit Contents											
Unit	Contents										Hours
I	Basic biology of tissue engineering: The basis of growth and differentiation-morphogenesis and tissue engineering										6
II	In vitro control of tissue development-Growth factors-Tissue engineering bioreactors- In vitro synthesis of Tissue and organs- Organotypic and histotypic engineered tissues. 3D cell culture-Tissue assembly in microgravity										6
III	Biomaterials in tissue engineering-Scaffolds, extracellular matrix, polymers and nanocomposites. Approaches to transplanting engineered cells										6
IV	Bioartificial pancreas, Hepatassist liver support system, Artificial Womb, Heamatopoietic system: Red blood cell substitutes, Renal replacement devices										6
V	Structural tissue engineering-Bone regeneration through cellular engineering, Skin tissue engineering, Brain implants-Neural stem cells, Periodontal applications										6

<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Explain the basics of Tissue Engineering
CO2	Apply the knowledge to create tissue culture methods
CO3	Demonstrate in the use of Various types of biomaterial in medical application
CO4	Evaluate the application of bioartificial organs
CO5	Analyze the importance of applications of Structural tissue engineering with respect to bone, Skin and regeneration
<b>Textbooks</b>	
1	Sylvia, S. Mader, 2011, Human Biology, Twelfth edition, Mc Graw Hill, USA.
2	Robert P. Lanaza, Robert Langer and Joseph Vacanti, 2007. Principles of Tissue Engineering. Third edition Academic Press.
3	Mickle.H.S., Loutit John.F., 2004, Tissue grafting and radiation, Academic Press, New York.
4	Penso.G., Balducci.D., 2004.Tissue cultures in biological research,Elsevier, Amsterdam
5	Cecie Starr, 1996, Biology, Third edition , Wordsworth, America.
<b>Web Reference</b>	
1	<a href="http://www.nuigalway.ie/anatomy/tissue_engineering.htm">www.nuigalway.ie/anatomy/tissue_engineering.htm</a>
2	<a href="#">Full article: Tissue engineering; strategies, tissues, and biomaterials</a>

**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO2</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	1	3	3	3	3	3
<b>CO5</b>	3	3	3	3	3	2	3	3	3	3	3
<b>Total</b>	15	15	15	15	15	10	15	15	15	15	13
<b>Average</b>	3	3	3	3	3	2	3	3	3	3	2.6

**3 – Strong, 2- Medium, 1- Low**

SECOND YEAR FOURTH SEMESTER

**Research Methodology**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
<b>24PBTC41</b>	<b>Research Methodology</b>	CC - 12	3	1	2		5	6	25	75	100
Learning Objectives											
LO1	To understand the concepts of research principles, its types and importance										
LO2	To comprehend the art of designing research concept										
LO3	To understand the statistical approaches in research										
LO4	To develop practical skills in representing research output										
LO5	To perceive the practical implication of internet support in research										
Unit	Contents										No. of Hours
I	Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Review of literature, Writing the Research Report (Thesis and Research Articles), Components of research report, types of research reports, Importance of research										15
II	Defining the Research Problem; Research Design; Formulation of the research objectives. Sampling Design, Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals; Hypothesis- Null and Alternative hypothesis; Hypothesis testing- one tail, two tail, errors; Variables and types										20
III	Statistics- Mean, mode, median, standard deviation, standard errors, T test. Chi square test, correlation and regression, Probability distributions- Normal, Binomial and Poisson distribution; Z-test; F-test; Analysis of Variance components (ANOVA) - oneway and two way; Degrees of freedom, Confidence interval; Parametric and non-parametric statistics.										25
IV	Data Analysis and representation- Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features										20

	for Statistical data analysis, Generating charts/ graph and other features. Data interpretation-Univariate, Bivariate, Results vs Discussion	
V	Search Engines: Pubmed, Science direct, Scopus etc, and Using advanced search techniques, Research paper formatting-Latex, Bibliography, Reference management software- Mendeley/Zotero, Ethical issues in publishing, Software to detect Plagiarism, AI tools in Statistics	10
	<b>Total</b>	60

### Course Outcomes

#### The student will be able to

CO1	Understand the meaning and importance of research
CO2	Obtain knowledge on the designing research hypothesis and protocol
CO3	Acquire knowledge on the statistical principles involved in research
CO4	Gain practical knowledge in presenting research output
CO5	Use the web resources to retrieve information from research articles

### Reference Books

1	Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
2	Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
3	Mousami V. Munot, Vinayak Bairagi, Research Methodology:A Practical and Scientific Approach, 2019, CRC Press, 320 pages

### Textbooks

1	Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
2	Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjana M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).
3	The complete reference Office Xp – Stephan L. Nelson, Gajula Kelly (TMH).

### Web resources

1	<a href="https://tripurauniv.ac.in/site/images/pdf/StudyMaterialsDetail/POLS-902C-Research%20Methodology.pdf">https://tripurauniv.ac.in/site/images/pdf/StudyMaterialsDetail/POLS-902C-Research%20Methodology.pdf</a>
2	<a href="https://southcampus.uok.edu.in/Files/Link/DownloadLink/RM%20U1%20P1.pdf">https://southcampus.uok.edu.in/Files/Link/DownloadLink/RM%20U1%20P1.pdf</a>
3	<a href="https://www.drnishikantjha.com/papersCollection/Research%20Methodology%20.pdf">https://www.drnishikantjha.com/papersCollection/Research%20Methodology%20.pdf</a>

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	3	3	3	3	3	3	3	3	3	3
<b>Total</b>	15	15	15	15	15	15	15	15	15	15	15
<b>Average</b>	3	3	3	3	3	3	3	3	3	3	3

**Overall Average= 3**

**3-Strong, 2-Medium, 1-Low**

SECOND YEAR FOURTH SEMESTER  
CORE 13 – ENVIRONMENTAL BIOTECHNOLOGY

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTC42	ENVIRONMENTAL BIOTECHNOLOGY	CC - 13	3	1	2	0	5	6	25	75	100

Learning Objectives		
LO1	To understand the fundamentals of Environment & Pollution	
LO2	To study the Biofilm Kinetics.	
LO3	To learn Waste Water Management	
LO4	To understand the types and tests for Evaluating Toxicity	
LO5	To understand Bioremediation	
Unit	Contents	Hour
I	<b>Environment:</b> Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of pollution & its management strategies - Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution	17
II	<b>Biofilm Technology:</b> Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Pollution Monitoring, detection and assessment	17
III	<b>Waste water management:</b> source of waste water, Waste water treatment- physical, chemical and biological treatment. Use of aquatic plants in waste water treatment. Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal.	20
IV	<b>Toxicity:</b> Types and Test for evaluating Toxicity. Biosensors and Bio chips, Biomonitoring of toxic materials. Biomagnification, Biomining and Biofuels	16
V	<b>Bioremediation;</b> <i>In-situ and Ex-situ</i> Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production.	20
	<b>Total</b>	90

<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Describe the basic concepts of Environment and Pollution.
CO2	Explain Biofilm Kinetics and various types of reactor
CO3	Illustrate various process of waste water management
CO4	Analyse various tests for evaluating Toxicity
CO5	Describe the Bioremediation of contaminated soil and waste land
<b>Textbooks</b>	
1	Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.
2	Bruce E. Rittmann and Perry L. McCarty. 2001. Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork.
3	Ronald M Atlas, Richard Bartha. Microbial Ecology – Fundamentals and Applications.
<b>Reference Book</b>	
1	Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
2	M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
3	M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India
4	Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press. Environmental chemistry 5th edition by A.K.De. 1997
5	Bruce E. Rittmann and Perry L. McCarty. 2001. Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork

**Web Resources:**

1	<a href="https://egyankosh.ac.in/bitstream/123456789/95583/1/Unit-1.pdf">https://egyankosh.ac.in/bitstream/123456789/95583/1/Unit-1.pdf</a>
2	<a href="https://prepp.in/news/e-492-bioremediation-environment-notes">https://prepp.in/news/e-492-bioremediation-environment-notes</a>

**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	2	3	2	2	3	3	3	3
<b>CO2</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO4</b>	3	2	3	3	3	2	3	3	3	3	2
<b>CO5</b>	3	2	3	3	3	2	3	3	3	3	2
<b>Total</b>	15	13	15	15	15	10	14	15	15	15	11
<b>Average</b>	3	2.6	3	3	3	2	2.8	3	3	3	2.2

**3 – Strong, 2- Medium, 1- Low**

SECOND YEAR FOURTH SEMESTER  
EC- 6 CRYOBIOLOGY

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTE41	<b>CRYOBIOLOGY</b>	EC - 6	4	1	1	0	4	6	25	75	100

Learning Objectives		
LO1	To understand the essential of equipment and materials required for cryopreservation procedures.	
LO2	The students will know challenges, limitations, and ethical issues in cryostasis and neuro preservation.	
LO3	The students will know about the importance of Ethical Clearance.	
LO4	The students will get knowledge about concept of target temperature management in medical and biological contexts.	
LO5	The students will know about Explain the physiological basis of hibernation and heterothermy.	
Unit	Contents	Hour
I	Introduction to Cryobiology, cryopreservation - natural cryopreservation , temperature, risks, slow, permeable freezing, vitrification, uses freezable tissues, equipment, limitations.	15
II	Liquid nitrogen – uses, safety, production; glass transition- introduction, transition temperature T <sub>g</sub> , kausmann’s paradox, the glass transition, specific materials, silica, polymers, mechanism of vitrification, electronic structures; ex-situ conservation; cryoprotectants; cryostasis; neuropreservation.	15
III	Methods of Cryopreservation – antifreeze protein, antifreeze, psychrophile, insect winter ecology, cryogenic treatment, cryogenic seal, cryogenic fuel, energy storage, crystal, cryotank, absolute zero, target temperature management.	20
IV	Hibernation , heterothermy, hibernaculum, hypothermia, chilblains, frost bite, trench feet, thermoregulation.	20
V	Application of Cryobiology - cloning, molecular cloning, organ transplantation, sperm bank, semen extender, in-vitro fertilization, embryo transfer, cryosurgery, cryoablation.	20

	<b>Total</b>	90
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<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Analyze the <b>limitations</b> and challenges of cryopreservation, including biological, technical, and ethical considerations.
CO2	Describe the concept of <b>cryostasis</b> and its applications, with emphasis on <b>neuropreservation</b> and its potential impact on medicine and biotechnology.
CO3	Describe the nature of <b>crystals</b> in cryopreservation and their impact on biological materials, including crystal formation control.
CO4	Evaluate adaptations in animals and humans that enable survival in extreme cold through behavioural, physiological, and biochemical strategies.
CO5	Evaluate the broad applications of cryobiology in medicine, agriculture, biotechnology, and conservation, considering both benefits and limitations.
<b>Textbooks</b>	
1	<b>Fundamentals of Cryobiology: Physical Phenomena and Mathematical Models</b> – Alexander I. Zhmakin
2	<b>Cryobiology: Concepts and Applications</b> – Marianne Wilde
3	<b>Cryobiology: An Introduction</b> – Michael Cedric
4	Colby Gunn, A comprehensive introduction to Cryobiology, 2017 library press publishing, New York.
5	<b>Cryopreservation: Concepts and Applications</b> – Marianne Wilde
<b>Reference Book</b>	
1	<b>Cryobiology: Fertility Cryopreservation</b> – Cambridge University Press

**Web Resources:**

1	<a href="http://ndl.iitkgp.ac.in/document/">http://ndl.iitkgp.ac.in/document/</a>
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**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	3	2	3	2	2	3	3	3	3
<b>CO2</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO4</b>	3	2	3	3	3	2	3	3	3	3	2
<b>CO5</b>	3	2	3	3	3	2	3	3	3	3	2

<b>Total</b>	15	13	15	15	15	10	14	15	15	15	11
<b>Average</b>	3	2.6	3	3	3	2	2.8	3	3	3	2.2

**3 – Strong, 2- Medium, 1- Low**

**EC- 6 BIOSAFETY, BIOETHICS & IPR**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTE42	<b>BIOSAFETY, BIOETHICS&amp; IPR</b>	EC – 6	4	1	1	0	4	6	25	75	100

Learning Objectives		
LO1	The students will understand the concepts of Bioethics.	
LO2	The students will realize the impact of Gene cloning in societal problems and also understand the need of the Bioethics.	
LO3	The students will know about the importance of Biosafety in biotechnology	
LO4	The students will get knowledge about intellectual property rights	
LO5	The students will know about Patents Rights in the field of Research.	
Unit	Contents	Hour
I	Introduction to biosafety – biosafety issues in biotechnology – risk assessment and risk Management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment	15
II	Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project	15
III	Introduction to ethics/bioethics – framework for ethical decision making; biotechnology and ethics – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare	20
IV	Introduction to intellectual property and intellectual property rights – types: patents, copy rights, Trade marks, design rights, geographical indications – importance of IPR - world intellectual Property rights organization (WIPO)	20
V	What can and what cannot be patented? – Patenting life – legal protection of biotechnological Inventions – Patenting in India: Indian patent act.	20
	<b>Total</b>	90

<b>Course Outcomes</b>	
<b>The students will be able to</b>	
CO1	Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life
CO2	Recognize importance of biosafety practices and guidelines in research
CO3	Follow good laboratory procedures and practices
CO4	Comprehend benefits of GM technology and related issues
CO5	Understand the social and ethical issues related to plant, animal and modern biotechnology
<b>Textbooks</b>	
1	Ignacimuthu, S (2009), <i>Bioethics</i> , Narosa Publication house, ISBN: 978-81-7319-966-0
2	V. Sree Krishna . V (2007), <i>Bioethics and Biosafety in Biotechnology</i> , (1st ed.), New Age International Private Limited.
3	Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press, 2002
<b>Reference Book</b>	
1	Trayer, P.C, Fredrick.R., and Koch, M. (2002), <i>Biosafety</i> . Michigan State University
2	Biosafety, Traylor, Fredric & Koch, 2002. Michigan state University pub., USA.
3	Contemporary issues in Bioethics, Beauchamp & Leroy, 1999. Wardsworth Pub. Co. Belmont, California.
4	Biotechnology and safety assessment, John.A.Thomas, 2004. pp.333

**Web Resources:**

1	Intellectual Property Rights and Competition Law – NPTEL <a href="https://nptel.ac.in/courses/110/105/110105139/">https://nptel.ac.in/courses/110/105/110105139/</a>
2	Bioethics – NPTEL <a href="https://nptel.ac.in/courses/109/106/109106092/">https://nptel.ac.in/courses/109/106/109106092/</a>

**Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	3	2	3	2	2	3	3	3	3
<b>CO2</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO3</b>	3	3	3	3	3	2	3	3	3	3	2
<b>CO4</b>	3	2	3	3	3	2	3	3	3	3	2
<b>CO5</b>	3	2	3	3	3	2	3	3	3	3	2
<b>Total</b>	15	13	15	15	15	10	14	15	15	15	11
<b>Average</b>	3	2.6	3	3	3	2	2.8	3	3	3	2.2

**SECOND YEAR FOURTH SEMESTER  
BIO-ENTREPRENEURSHIP**

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTP41	<b>Bio-Entrepreneurship</b>	PEC – 1	1	1	0		2	2	25	75	100
<b>Learning Objectives</b>											
LO1	To enable the students to understand the sources of innovation opportunities in Biotechnology										
LO2	To Understand Business development										
LO3	To know the various fundings of Biotech Business.										
LO4	To develop personal skills set for creativity, innovation and entrepreneurship										
LO5	To Understand the financial aspects of Bioentrepreneurs										
Unit	Contents										No. of Hours
I	<b>Innovation and Bioentrepreneurship:</b> Biotechnology in a global scale, Scope in Bioentrepreneurship, Importance of entrepreneurship. Innovation as strategy in Biotech Companies – Biotechnology based products and services – license and protection – IPR issues in bioentrepreneurships										7
II	<b>Major start-ups in Biotechnology:</b> Prototype, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited, MSME, DBT, BIRAC, Startup and Make in India)										7
III	<b>Knowledge centers</b> - Universities, innovation centre, research institutions and business incubators. Funding of biotech business in India - Bioentrepreneurship efforts in India, organizations supporting biotech growth, biotech policy initiatives										6
IV	<b>Biotech enterprises:</b> Desirables in start-up, Quality control in Biotech industries, steps for starting a small industry, incentives and subsidies, exploring export possibilities. Types of bioindustries – Pharma, Agri and Industry.										5
V	<b>Financial analysis:</b> Ratio analysis, Investment process, Break even										5

	analysis, Profitability analysis, Budget and planning process.	
	<b>Total</b>	30

<b>Course Outcomes</b>	
<b>The student will be able to</b>	
CO1	Identify the Biotech based companies, products, services and IPR
CO2	Understand the Business proposal for starting a company
CO3	Know the funding of biotech business
CO4	Aspire to set up Biotech enterprises
CO5	Analyse the Financial requirement for bioentrepreneurship
<b>Textbooks</b>	
1	The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991
2	Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
3	Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John
<b>Reference Books</b>	
1	Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005
2	Entrepreneurship Development” S S Khanka , S Chand & Co
3	Projects Planning Analysis, Selection, Implementation & Review by Prasannan
4	Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008

#### Web Resources

1	Entrepreneurship – SWAYAM <a href="https://onlinecourses.swayam2.ac.in/cec19_mg39/preview">https://onlinecourses.swayam2.ac.in/cec19_mg39/preview</a>
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#### Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
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<b>CO1</b>	3	3	2	2	3	3	3	3	3	2	2
<b>CO2</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO3</b>	3	2	2	2	3	2	3	3	3	3	2
<b>CO4</b>	3	3	2	2	3	1	3	3	3	2	2
<b>CO5</b>	3	3	2	2	3	1	3	3	3	3	2
<b>Total</b>	15	13	10	10	15	9	15	15	15	13	10
<b>Average</b>	3	2.6	2	2	3	1.8	3	3	3	2.6	2

**3 – Strong, 2- Medium, 1- Low**

## SELF LEARNING COURSE- REVIEW ARTICLE WRITING

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTL41	<b>Review Article Writing</b>	SLC - 1	-	-	1	3	2	4	25	75	100
<b>Learning Objectives</b>											
LO1	To understand the importance of literature review										
LO2	To obtain knowledge on data collection of review article										
LO3	To gain deeper insights into different components of review article										
LO4	To comprehend the use right usage of grammar in writing reviews										
LO5	To perceive knowledge on the path to publication process										
<b>Unit</b>											
Unit	Contents										No. of Hours
I	Literature review: Importance and scope, Types of literature review, Steps in writing a review article										5
II	Sources of literature review, Article formats, Citations in review articles										15
III	Structure of review article- Abstract, Introduction, Body, Conclusion, References, Graphical abstracts, Keywords										20
IV	Grammar components in review article, standard writing, Collating information										5
V	Selection of journals, Formatting article, Ethics in review paper writing- conflict of interest, plagiarism										15
	<b>Total</b>										60
<b>Course Outcomes</b>											
<b>The student will be able to</b>											
CO1	Understand the importance of writing review article										
CO2	Refer and collect information from various literature resources										
CO3	Distinguish the difference in the context of review components										

CO4	Skillfully write and provide a comprehensive report on the study topic
CO5	Analyze the metrics in publishing the literature review
<b>Textbooks</b>	
1	Diana Ridley, The Literature Review A Step-by-Step Guide for Students, SAGE Publications, 2012
<b>Reference Books</b>	
1	Sara Efrat Efron, Ruth Ravid, Writing the Literature Review, A Practical Guide, Guilford Publications, 2018, 298
2	Paula Dawidowicz, Literature Reviews Made Easy A Quick Guide to Success, Information Age Pub., 2010, 177 pages
<b>Web resources</b>	
1	<a href="https://onlinelibrary.wiley.com/doi/10.1155/2024/7822269">https://onlinelibrary.wiley.com/doi/10.1155/2024/7822269</a>
2	<a href="https://pmc.ncbi.nlm.nih.gov/articles/PMC4548566/">https://pmc.ncbi.nlm.nih.gov/articles/PMC4548566/</a>

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**3 – Strong, 2- Medium, 1- Low**