



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
					30	21

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
					30	22

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
					30	24

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
					30	23
	Total Credits	90+2*				

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*.

SECOND YEAR THIRD SEMESTER
CORE 8–GENETIC ENGINEERING

Course Code	Course name	Category	L	T	P	S	Credit	Hours	Marks		
									CIA	External	Total
24PBTC31	GENETIC ENGINEERING	CC - 8	3	1	2	0	5	6	25	75	100
Learning Objectives											
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
I	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
II	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
III	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
IV	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
V	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

Course Outcomes	
The students will be able to	
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.
Textbooks	
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 th 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 th Edition . Pearson Publisher.
Reference Book	
1	Dr.R. C. Dubey. A textbook of Biotechnology. S Chand Publisher
2	H.K. Das. Textbook of Biotechnology. 5 th 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	SBB2102.pdf
2	https://www.mlsu.ac.in/econtents/119_Cloning%20vectors.pdf
3	https://pubmed.ncbi.nlm.nih.gov/3034735/

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	3	3	2
Total	15	13	15	15	15	10	14	15	15	15	11
Average	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
Learning Objectives											
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

Course Outcomes	
The student will be able to	
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
Textbooks	
1	Andreas D. Baxevans, B.F. Francis Ouellette, Bioinformatics- A practical guide to the analysis of genes and protein, 3 rd Edition, Wiley Publications, 2005, 540 pages
2	S.C. Rastogi, N. Mendiratta P. Rastogi, Bioinformatics- Methods and Application-Genomics, Proteomics and Drug Designing, 4 th 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
Reference Books	
1	Zhumur Ghosh , Bibekanand Mallick, Bioinformatics: Principles And Applications, OUP India Publishers, 2008, 560 pages
2	Jonathan pevsner , bioinformatics and functional genomics, 3rd edition , John Wiley, 2022 2020 pages
3	Jin xiong , Essential Bioinformatics, Cambridge University Press; First Edition , 2007, 352 pages.

Web Resources

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

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

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

Course Outcomes	
The student will be able to	
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
Textbooks	
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.
Reference Books	
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 th Edition. Saunders College Publishing.
4	David Male, jonathan Brostoff, David B Roth, Ivan Roitt, 2006. Immunooogy 7 th 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	www.library.csusm.edu/course guides/biology
2	www.immunologylink.com
3	http://www.wiley.com/college/bio/karp12791/weblinks.html

Mapping with Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	1	1	1	3	1	1	3	3	1	1
CO2	3	1	1	1	3	1	1	3	3	1	1
CO3	3	2	3	3	3	2	2	3	3	2	2
CO4	3	1	2	1	3	1	2	3	3	1	1
CO5	3	2	3	3	3	3	2	3	3	3	3
Total	15	7	10	9	15	8	8	15	15	8	8
Average	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
24PBTC34 P	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	<u>Genetic Engineering - Practical</u> 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

Course Outcomes	
The student will be able to	
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

Textbooks	
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)
Reference Books	
1	Janusz M. Bujnicki, Practical Bioinformatics, 2008, Springer Berlin Heidelberg , 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	https://nu.edu.sd/file/last%20manual.pdf
2	https://link.springer.com/book/10.1007/978-3-030-64686-8

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	3	2	3	2	3	3	3	3	2
CO2	3	3	3	2	3	2	3	3	3	3	2
CO3	2	3	3	2	3	2	3	3	3	3	2
CO4	3	3	3	2	3	2	3	3	3	3	2
CO5	3	3	3	2	3	2	3	3	3	3	2
Total	13	15	15	10	15	10	15	15	15	15	10
Average	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
Learning Objectives											
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										
Unit											
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

Course Outcomes	
The student will be able to	
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
Textbooks	
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, Springer Nature Singapore , Page count: 478
3	Saurabh Bhatia , Saif Hameed , Zeeshan Fatima , Introduction to Pharmaceutical Biotechnology, Basic Techniques and Concepts, 2024, IOP Publishing Limited , Pages 488
Reference Books	
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	https://www.nebiolab.com/drug-discovery-and-development-process/
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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
CO1	3	3	2	1	3	3	3	2	3	1	1
CO2	3	2	2	1	3	2	2	2	2	2	2
CO3	3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	2	1	2	2	2	2	2	2	2
CO5	3	3	3	3	3	3	3	2	2	2	2
Total	15	14	11	8	14	13	13	11	11	9	9
Average	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
Learning Objectives											
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.										
Unit											
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

Course Outcomes	
The students will be able to	
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.
Textbooks	
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
Reference Books	
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	1519041212M4SequenceorganizationofgenomeQuad1.pdf
2	https://en.wikipedia.org/wiki/Human_genome
3	https://www.slideshare.net/slideshow/protein-structure-prediction-primary-structure-analysispptx/256797713

Mapping with Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	2	2	1	2	3	3	1	1
CO2	3	2	3	1	3	1	2	3	3	1	1
CO3	3	2	3	3	3	2	2	3	3	2	2
CO4	3	1	2	1	3	1	2	3	3	1	1
CO5	3	2	3	3	3	3	2	3	3	3	3
Total	15	10	12	10	14	7	10	15	15	8	8
Average	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

Course Outcomes	
The students will be able to	
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
Textbooks	
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.
Web Reference	
1	www.nuigalway.ie/anatomy/tissue_engineering.htm
2	Full article: Tissue engineering; strategies, tissues, and biomaterials

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	3	3	3	3	2
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	1	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3
Total	15	15	15	15	15	10	15	15	15	15	13
Average	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
24PBTC41	Research Methodology	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
	Total	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	https://tripurauniv.ac.in/site/images/pdf/StudyMaterialsDetail/POLS-902C-Research%20Methodology.pdf
2	https://southcampus.uok.edu.in/Files/Link/DownloadLink/RM%20U1%20P1.pdf
3	https://www.drnishikantjha.com/papersCollection/Research%20Methodology%20.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3
Total	15	15	15	15	15	15	15	15	15	15	15
Average	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	Externa I	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	Environment: 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	Biofilm Technology: 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	Waste water management: 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	Toxicity: Types and Test for evaluating Toxicity. Biosensors and Bio chips, Biomonitoring of toxic materials. Biomagnification, Biomining and Biofuels	16
V	Bioremediation; <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
	Total	90

Course Outcomes	
The students will be able to	
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
Textbooks	
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.
Reference Book	
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	https://egyankosh.ac.in/bitstream/123456789/95583/1/Unit-1.pdf
2	https://prepp.in/news/e-492-bioremediation-environment-notes

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	3	3	2
Total	15	13	15	15	15	10	14	15	15	15	11
Average	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	CRYOBIOLOGY	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 _g , 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

	Total	90
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Course Outcomes	
The students will be able to	
CO1	Analyze the limitations and challenges of cryopreservation, including biological, technical, and ethical considerations.
CO2	Describe the concept of cryostasis and its applications, with emphasis on neuropreservation and its potential impact on medicine and biotechnology.
CO3	Describe the nature of crystals 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.
Textbooks	
1	Fundamentals of Cryobiology: Physical Phenomena and Mathematical Models – Alexander I. Zhmakin
2	Cryobiology: Concepts and Applications – Marianne Wilde
3	Cryobiology: An Introduction – Michael Cedric
4	Colby Gunn, A comprehensive introduction to Cryobiology, 2017 library press publishing, New York.
5	Cryopreservation: Concepts and Applications – Marianne Wilde
Reference Book	
1	Cryobiology: Fertility Cryopreservation – Cambridge University Press

Web Resources:

1	http://ndl.iitkgp.ac.in/document/
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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
CO1	3	3	3	2	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	3	3	2

Total	15	13	15	15	15	10	14	15	15	15	11
Average	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	BIOSAFETY, BIOETHICS& IPR	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
	Total	90

Course Outcomes	
The students will be able to	
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
Textbooks	
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
Reference Book	
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 https://nptel.ac.in/courses/110/105/110105139/
2	Bioethics – NPTEL https://nptel.ac.in/courses/109/106/109106092/

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	3	3	2
Total	15	13	15	15	15	10	14	15	15	15	11
Average	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	Bio-Entrepreneurship	PEC – 1	1	1	0		2	2	25	75	100
Learning Objectives											
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	Innovation and Bioentrepreneurship: 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	Major start-ups in Biotechnology: 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	Knowledge centers - 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	Biotech enterprises: 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	Financial analysis: Ratio analysis, Investment process, Break even										5

	analysis, Profitability analysis, Budget and planning process.	
	Total	30

Course Outcomes	
The student will be able to	
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
Textbooks	
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
Reference Books	
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 Prasanna
4	Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008

Web Resources

1	Entrepreneurship – SWAYAM https://onlinecourses.swayam2.ac.in/cec19_mg39/preview
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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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CO1	3	3	2	2	3	3	3	3	3	2	2
CO2	3	2	2	2	3	2	3	3	3	3	2
CO3	3	2	2	2	3	2	3	3	3	3	2
CO4	3	3	2	2	3	1	3	3	3	2	2
CO5	3	3	2	2	3	1	3	3	3	3	2
Total	15	13	10	10	15	9	15	15	15	13	10
Average	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	Review Article Writing	SLC - 1	-	-	1	3	2	4	25	75	100
Learning Objectives											
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										
Unit											
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
	Total										60
Course Outcomes											
The student will be able to											
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
Textbooks	
1	Diana Ridley, The Literature Review A Step-by-Step Guide for Students, SAGE Publications, 2012
Reference Books	
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
Web resources	
1	https://onlinelibrary.wiley.com/doi/10.1155/2024/7822269
2	https://pmc.ncbi.nlm.nih.gov/articles/PMC4548566/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

3 – Strong, 2- Medium, 1- Low