

MASTER OF SCIENCE (BIOTECHNOLOGY)

VISION

- To nurture the young minds with a potential to innovate, invent and disseminate knowledge for the benefit of the society and environment.

MISSION

- To motivate the learners to take up challenging task in biotechnology and to prepare for a career of self-employment through environmental friendly biotechnology enterprises.
- To innovate and explore novel solution for the existing problems in the fields of environment, agriculture, animal biotechnology and health sector.

Programme Educational Objectives (PEO)

Graduate of the programme will

PEO1: Succeed in obtaining employment appropriate to their interest, education and will become productive and valued professional in Biotechnology domain.

PEO2: Continues to develop professionally through lifelong learning, higher education in their area of interest.

PEO3: Cater to the needs of the industry, society so as to contribute for the development of the country.

Programme Outcomes (PO)

After the completion of the programme, the graduates will be able to

PO1: Graduates will use the basic knowledge towards applied Plant/ Animal/ Environmental Biotechnology.

PO2: Graduates will be able to design processes/products for Biotechnology industries.

PO3: Graduates will be able to gain hands on experience to design, analyze and interpret data for investigating research problems in biotechnology and other fields.

PO4: Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological practices

PO5: Graduates will gain hands on experience to take up independent/team research in a multidisciplinary environment.

PO 6: The outcome of the course will make the student ready for lifelong learning of Biotechnology.

Programme Specific Outcomes (PSO)

PSO 1: Apply the knowledge of Biotechnology in the domain of environmental, agriculture, healthcare, molecular mechanics in Bioindustry.

PSO2: Solve the complex problem in the field with a understanding of societal, legal and cultural impact of the solution.

PSO3: Apply the contextual knowledge of Biotechnology to function effectively as an individual or leader in multidisciplinary domain of Biotechnology.

PSO 4: Predict, formulate, demonstrate, analyze and interpret data for integrating research problem in life science domain.

PSO5:Synthesis,compare,evaluate,classify,integrateandeffectivelyapplythebasic laws, principles, phenomena, process and mechanism involved in the domain of Biotechnology.

ELIGIBILITY

A Bachelor's degree in Science, with Biotechnology/ Botany/ Zoology/ Biology/ Microbiology/ Microbial Gene technology/ Bioinstrumentation/ Bioinformatics/ Biochemistry/Chemistry/Agriculture/Marine Biology/Home Science/Farm Science/Nutrition and Dietetics/Integrated Biology/Plant

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

Science/Animal Science/Fisheries Science/Agriculture/Mathematics with Physics, Chemistry as Ancillary/Medical Lab Technology MBBS/BDS, B.Pharm and BSMS of a recognized Indian or Foreign University.

DURATION OF THE PROGRAMME:

The duration of the course is TWO academic years divided into four semesters under Choice Based Credit System with OBE pattern.

MAXIMUM DURATION FOR THE COMPLETION OF THE PGPROGRAMME:

The maximum duration for completion of the PG Programme shall not exceed 8 semesters

OBJECTIVES OF THE PROGRAMME

- ☐ The two-year M.Sc., programme is designed to help the student to become pioneering and resourceful personalities in the field of life science.
- ☐ The ultimate aim is to enable the students to develop an interdepartmental approach for understanding the life science problems at the molecular level. In addition, the present curriculum gives scope for vertical and horizontal mobility in the education system so that the students can enter different modules to update their knowledge depending upon the employment opportunities in each area.
- ☐ Various MDC and practical courses have been designed not only to enable the students to appreciate scientific basis of various life processes but also to train them for self-employment. The practical training will develop their reasoning ability to critically evaluate the results obtained from the projects.
- ☐ The present curriculum aimed to cater the global demand for skilled and trained man power in various areas like Research and Development, Quality

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control labs, Industries, Biopharmaceutical companies and in field of teaching.

- ☐ The curriculum also has its module to explore the students entrepreneurial skill and help them to become a successful entrepreneur.

PG SCHEME OF EXAMINATION

Subject Code	Subject	Hours of Instruction	Exam Duration (Hours)	Maximum Marks			Credit Points
				CA	CE	Total	
FIRST SEMESTER							
Part-A							
24PBTM101	DSC I: Cell Biology and Cell Communication	5	3	25	75	100	4
24PBTM102	DSC II: Genetics	5	3	25	75	100	4
24PBTM103	DSC III: Microbiology	4	3	25	75	100	4
24PBTM104	DSC IV: Biochemistry	5	3	25	75	100	4
24PBTM105	DSC V: Molecular Biology	5	3	25	75	100	4
24PBTMP101	DSC Practical I:	6	6	40	60	100	3
	Total	30				600	23
SECOND SEMESTER							
Part-A							
24PBTM201	DSC VI: Immunology	5	3	25	75	100	5
24PBTM202	DSC VII: Bioprocess Technology	4	3	25	75	100	4
24PBTM203	DSC VIII: Genetic engineering	5	3	25	75	100	5
24PBTEL201	DSE I: Biophysics and Bioinstrumentation	3	3	25	75	100	3
24PBTEL202	DSE I: Artificial Intelligence and Bioinformatics						
24PBTMP201	DSC Practical II:	4	6	40	60	100	2
Optional Subjects							
24PBCBTI201	MDC I: Diagnostic Biochemistry	3	3	25	75	100	2
24PBCBTIP201	MDC Practical I: Diagnostic	3	3	40	60	100	2

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24PMBBTI201	MDC I: Clinical Microbiology	3	3	25	75	100	2
24PMBBTIP201	MDC Practical I: Clinical Microbiology	3	3	40	60	100	2
Part-B							
24PVE201	Value Added Course: Human Rights	2	3	25	75	100	2
24PLS201	AEC: CCS-I	1	-	100	-	100	1
Total		30				900	26
THIRD SEMESTER							
Part-A							
24PBTM301	DSC IX: Plant Tissue and Animal Cell Culture Technology	4	3	25	75	100	5
24PBTM302	DSC X: Research Methodology, Bioethics and IPR	4	3	25	75	100	3
24PBTM303	DSC XI: Biostatistics	4	3	25	75	100	3
24PBTEL301	DSE II: Developmental Biology	3	3	25	75	100	3
24PBTEL302	DSE II: Evolution and Biodiversity						
24PBTMP301	DSC Practical III:	6	6	40	60	100	3
24PBTMP302	DSC Practical IV: Statistical software (SPSS)	2	3	40	60	100	2
24PBTI301	Summer Internship (100 % Internal Evaluation)	-	-	100	-	100	2
Optional Subjects							
24PBCBTI301	MDC II: Pharmaceutical Biochemistry	3	3	25	75	100	2

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24PBCBTIP301	MDC Practical II: Pharmaceutical Biochemistry	3	3	40	60	100	2
24PMBBTI301	MDC II: Industrial Microbiology	3	3	25	75	100	2
24PMBBTIP301	MDC Practical II: Industrial Microbiology	3	3	40	60	100	2
Part - B							
24PLS301	AEC: CCS-II	1	-	100	-	100	1
	Total	30				1000	26
FOURTH SEMESTER							
Part-A							
24PBTM401	DSC XII: Food and Pharmaceutical Biotechnology	5	3	25	75	100	6
24PBTM402	DSC XIII: Environmental Biotechnology	5	3	25	75	100	5
24PBTPR401	Project & Viva-Voce	6	-	40	60	100	6
	ACC-MOOC Courses offered in SWAYAM/ NPTEL/ CEC etc.,						
	Total	16				300	17
Grand Total						2800	92

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE):

The department offers the following four subjects as Elective courses for second and third semesters.

S.No	Subject Code	Semester	Subject
1.	24PBTEL201	II	DSE I:Biophysicsand Bioinstrumentation
2.	24PBTEL202		DSE I:Artificial Intelligence and Bioinformatics
3.	24PBTEL301	III	DSE II: Developmental Biology
4.	24PBTEL302		DSE II: Evolution and Biodiversity

ADDITIONAL CREDIT COURSE (ACC):

Students may choose any course as ACC from MOOC course offered in SWAYAM/NPTEL/CEC, etc. Additional 4 credit as per course will be given on completion with certificate.

MDC offered to Microbiology and Biochemistry students

S.NO	SUBJECT CODE	SUBJECT	SEMESTER	CREDITS
1	24PBTMBI201/ 24PBTBCI201	MDC I: Plant Tissue Culture Technology	II	2
2	24PBTMBIP201/ 24PBTBCIP201	MDC Practical I: Plant Tissue Culture Technology	II	2
3	24PBTMBI301/ 24PBTBCI301	MDC II: Animal Cell Culture Technology	III	2
4	24PBTMBIP301/ 24PBTBCIP301	MDC Practical II: Animal Cell Culture Technology	III	2

FOR COURSE COMPLETION

Students should complete

- Two DSE subjects in II and III semester.
- Two MDC in II and III semester.
- Human Rights as value education in II semester.
- Internship in III semester.
- Project at the end of IV semester.

ABBREVIATION

- DSC: Discipline Specific Course
- DSE: Discipline Specific Elective Course
- MDC: Multi-Disciplinary Course
- VAC: Value Added Course
- AEC: Ability Enhancement Course
- ACC: Additional Credit Course

TOTALCREDITDISTRIBUTION

S.no	Part	Components	No of Course× Marks	Maximum marks	Total marks	Credit points
1	PART-A	DSC Subjects	13× 100	100	1300	55
		DSC Practical	4×100	100	400	11
		MDC Paper	2×100	100	200	04
		MDC Practical	2×100	100	200	04
		DSE	2×100	100	200	06
		Internship	1×100	100	100	02
		Project & Viva voce	1×100	100	100	06
2	PART-B	Value Education	1×100	100	100	02
		AEC:CCS-I	2×100	100	200	02
Total					2800	92

24PBTM101	DSC I: CELLBIOLOGY AND CELL COMMUNICATION	SEMESTER-I	
Course Objective:			
The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation. The student will get to understand the core concepts of Molecules and cell biology.			
Credits:4		Total Hours:50	
UNIT	CONTENT	Hrs	CO
I	Structure and function of prokaryotic and eukaryotic cell; Structure and organization of cell membrane –membranes model. Membrane dynamics-Active and passive transport; Cytoskeleton. Biogenesis of mitochondria and chloroplast, Structure and functions of cytoskeletal elements: Microtubules, microfilaments and intermediate filaments.	10	CO1
II	Structure and function of cell organelle: Mitochondria and Chloroplast – Molecular events of electron transport chain, ATP synthesis. Endoplasmicreticulum, nucleus, Golgi complex, lysosomes, peroxisomes.	10	CO2
III	Cell shape and motility: Actin -binding proteins and their significance. Nucleus – Chromosomal DNA and packaging, Chromatin structure, genome evolution. Intracellular compartments-protein transport into mitochondria, chloroplast, peroxisome and endoplasmic reticulum.	10	CO3
IV	Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	10	CO4
V	Cellular communication: Regulation of hematopoiesis, general Principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extra cellular matrix, integrins, neurotransmission and its regulation.	10	CO5
Text Book			
1	<i>Gupta,P.K,andJangirM.L.,2003.Cell Biology: Fundamentals and Application. Student Edition, India.</i>		
Reference Books			
<ul style="list-style-type: none"> • Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York. • David E.Sadva.,2009.Cell biology organelles structure and function, CBS 			

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Publishers and distributors, New Delhi.

- Prakash S.Lohar, 2009. Cell and Molecular Biology.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007. Molecular Biology of the Cell, Fifth edition. Garland Science.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J.2007. Molecular Cell Biology. Media Connected, sixth edition. W.H.Freeman and Company
- Geoffrey.M.Cooper, Robert.E.Hausman. 2007. The Cell - A Molecular Approach, Fourth edition. Sinauer Associates.
- Luiz Carlos Uchoa, Janqueira, Jose, Carneiro.2005. Basic Histology Text and Atlas. Mc Graw-Hill Professional.
- PaulA,2001,TextBookOfCellandMolecular Biology 2 edition Niyogi Books
- T.Fleming.2002.Cell interactions: A practical approach Second edition.

Course outcomes:

CO-1	To understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.
CO-2	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism
CO-3	Demonstrate knowledge and understanding of the principles and basic knowledge of cell shape and motility.
CO-4	Understand the metabolic pathways and the process of transmission of Extracellular signals
CO-5	Understand the Cellular communications

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	H	M	H	H	M
CO2	M	M	M	M	M	H	M	H	H	M
CO3	M	M	M	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	H	H	M
CO5	M	M	M	M	M	H	M	H	M	M

H-High; M-Medium; L-Low

Prepared By

(Course Coordinator)

Approved By

(BoS Chairman)

24PBTM102	DSC II: GENETICS	SEMESTER-I	
Course Objective: The paper focuses on the basic principles of genetics by presenting the important Concepts of classical, microbial and population genetics.			
Credits: 4		Total Hours:50	
UNIT	CONTENT	Hrs	CO
I	Mendelian Principles: Dominance, segregation, independent assortment: Allele, multiple alleles, pseudoallele, complementation tests. Supplementation test Extensions of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy.	10	CO1
II	Linkage and crossing over, sex linkage, sex limited and sex influenced characters Linkage maps, tetrad analysis. Extra chromosomal inheritance in Paramecium Inheritance of Mitochondria and chloroplast, maternal inheritance.	10	CO2
III	Microbial genetics: Natural Plasmids and its types, Methods of genetic transfers - transformation, conjugation, lytic and lysogenic cycle of Lambda bacteriophage, transduction - Generalized and Specialized. Recombination mapping genes by interrupted mating, fine structure of genes.	10	CO3
IV	Population genetics: Hardy - Weinberg equilibrium, estimating allele frequencies, factors affecting, in breeding and out breeding.	08	CO4
V	Human Genetics: Human karyotype, banding techniques, genetic traits and inborn errors in man.lod score for linkage testing, Variations in chromosome number - Genetics of human behavioural traits. Twin studies - Pedigree analysis - symbols - sex linked and autosomal pedigree. Eugenics, Euthenics and Genetic counselling.	12	CO5
Text Books			
1	<i>Snustad DP and Simmons MJ (2010).Principles of Genetics, Fifth edn, John Wiley & Sons, Inc, New York.</i>		
2	<i>Genetics - Kavitha B.Ahluwalia, New Age International Pvt Ltd and Publishers, New Delhi, 2010.</i>		
3	<i>Genetics-P.S Vermaand A.K Agarwal</i>		
Reference Books			
<ul style="list-style-type: none"> • Brooker RJ (2005) Genetics - Analysis and Principles, Second edn, McGraw-Hill Book Company, Boston, USA. • Hartl DL and Jones WJ (2005). Genetics-Analysis of Genes & Genomes, Sixth edn, 			

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Jones & Barlett Publishers, Massachusetts.

- Hexter W and Yost HT (1977).The Science of Genetics, Prentice Hall of India Private Ltd., New Delhi.
- Levine L (1969).Biology of the Gene. The CV Mos by Company, St.Louis, USA
- Roth Well NV (1977). Understanding Genetics, Second edn, Oxford University Press, London.

Course outcomes:

CO-1	Identify Mendelian principles and theories of heredity.
CO-2	Explain the mechanisms and importance of linkage and crossing over.
CO-3	Analyze the mechanisms of microbial genetics.
CO-4	Discuss the importance of Hardy -Weinberg equilibrium and factors affecting it.
CO-5	Apply the concepts related to human genetics.

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	M	M	H	M	H	H	M
CO2	H	M	M	M	M	H	M	H	H	M
CO3	H	M	M	M	M	H	M	H	M	M
CO4	H	M	M	M	M	M	M	H	H	M
CO5	H	M	M	M	M	H	M	H	M	M

H-High; M-Medium; L-Low

Prepared By

(Course Coordinator)

Approved By

(BoS Chairman)

24PBTM103	DSC III: MICROBIOLOGY	SEMESTER-I	
<p>Course Objective: To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment.</p>			
Credits:4		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	<p>History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs</p>	10	CO1
II	<p>Microbial culture, identification and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria - Biochemical - IMViC, 16s rRNA sequencing. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods - Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods.</p>	10	CO2
III	<p>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.</p>	10	CO3
IV	<p>Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria, filariasis, Candidiasis, Superficialmycosis.</p>	10	CO4

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V	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; Biotechnological application of extremophiles.	10	CO5
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Text Book			
1	<i>Willey JM, Sherwood LM and Woolverton CJ (2016) Prescott's Microbiology, Tenth edn, McGraw Hill International publication, New York.</i>		
2	<i>Kapil A and Bhaskaran CS (2013) Ananthanarayan and Paniker's Textbook of Microbiology, Ninth edn, University Press.</i>		
3	<i>Pelczar MJJR, Chan ECS and Krieg NR (1993) Microbiology, Fifth edn, Tata McGraw-Hill, New Delhi.</i>		
Reference Books			
	<ul style="list-style-type: none"> • Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Prescott's Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594. • Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India. • Ananthanarayan and Paniker's (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251. • Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill. • Managing epidemics - Key facts about major deadly diseases, World Health Organization (WHO) 2018. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11. • Agriculture Microbiology, 2016. E-Course Developed By TNAU (ICAR). 		

Course outcomes:

CO-1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.
CO-2	To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques
CO-3	To enlighten the students on host microbe interaction and Epidemiology of microbial disease
CO-4	To update the knowledge on epidemic and pandemic diseases.
CO-5	To assess and appraise the role of novel microbes in environment and integrate the min specific innovative approaches.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	M	M	H	H	H	H	M
CO2	H	H	M	M	M	H	H	H	H	M
CO3	H	H	M	M	M	H	H	H	M	M
CO4	H	H	M	M	M	M	H	H	H	M
CO5	H	H	M	M	M	H	H	H	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM104	DSCIV:BIOCHEMISTRY	SEMESTER-I	
Course Objective: To learn the physical and chemical concepts in biology and fundamentals of Biomolecules and its function in living system.			
Credits: 4		Total Hours:50	
UNIT	CONTENT	Hrs	CO
I	Biomolecule interaction - van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction and covalent bond. pH, Acid, base. Buffers- Henderson- Haselbach equation, Biological buffer system -Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Bioenergetics - Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP as a universal unit of free energy in Biological systems.	10	CO1
II	Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, Cori's cycle, glyoxalate pathway, Photosynthesis.	10	CO2
III	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phosphor lipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones. Oxidation of fatty acids- mitochondrial and peroxisomal β -oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies.	10	CO3
IV	Aminoacids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of aminoacids. Over all in born error metabolisms.	10	CO4
V	Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. De novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases.	10	CO5

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Text Book			
1	Voet JG, Pratt CW and Voet D (2016) Fundamentals of Biochemistry: Life at the molecular level, Fifth edn, John Wiley & Sons, New York		
2			
3	Sathyanarayana.UandU.Chakrapani.,2011. Biochemistry. Books and Allied private limited, Kolkata. Murray RK, Granner DK and Rodwell VW (2006) Harper's Illustrated Biochemistry, Twenty Seventh edn, McGraw Hill Companies, Inc.		
Reference Books			
	<ul style="list-style-type: none">• Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011.Schaum.s Outline of Biochemistry, Third Edition (Schaum.s Outline Series), McGraw-Hill.• Nelson DL and Cox MM (2013) Lehninger Principles of Biochemistry, Sixth edn, W.H.Freeman, New York.• Jeremy M. Berg, John L.Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W.H.Freeman.• Albert Lehninger, David L. Nelson Voet Donald, Judith G.Voet and Charlotte W.Pratt.,2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.• Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman publishers.		

Course outcomes:

CO-1	Explain the basic concepts of biochemistry such as chemical bonds, pH, buffer and kinetic properties of biological reactions.
CO-2	To enlighten the students on Carbohydrates and Biological oxidation pathways.
CO-3	To provide basic knowledge about lipid metabolism and related significance.
CO-4	To update the knowledge on Amino acids and Protein.
CO-5	To assess and appraise the role of Nucleic acids.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	H	H	M	M	M	H	H
CO2	M	H	M	H	H	M	H	M	H	H
CO3	M	H	M	H	H	M	H	M	H	H
CO4	M	H	M	H	H	M	M	M	H	H
CO5	M	H	M	H	H	M	H	M	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM105	DSC V:MOLECULARBIOLOGY	SEMESTER-I	
Course Objective: To learn the physical and chemical concepts in biology and fundamentals of Biomolecules and its function in living system.			
Credits:4		-	Total Hours:50
UNIT	CONTENT	Hrs	CO
I	Chemical structure of nucleic acids- Nucleotides and Nucleosides, central dogma of molecular biology. Replication of DNA in Prokaryotes and Eukaryotes -DNA polymerase, Initiation, elongation and termination of DNA replication.	10	CO1
II	Mutation - Mutagens, Types, Transposition, Transposons - types, DNA repair mechanism - Excision repair, recombination repair, mismatch repair and SOS repair. Recombination - Models for Homologous recombination and Holliday model, site-specific recombination.	10	CO2
III	Transcription -in prokaryotes and Eukaryotes - RNA polymerase and promoters. Mechanism of Transcription- initiation, elongation and termination. RNA splicing - spliceosome machinery, Alternative splicing, Exon shuffling, RNA editing, mRNA transport. Post transcriptional modifications - capping, polyadenylation.	10	CO3
IV	The Genetic code, Wobble hypothesis. Translation - structure And function of Transfer RNA, Ribosome, Process of translation - Initiation, elongation and termination of translation. Post translational modification , Molecular chaperones.	10	CO4
V	Concept of gene , Gene regulation - Eukaryotes - Inducible and repressible systems - Prokaryotes - The operon concept : lac operon, Lac positive and negative control mechanisms - trp operon - DNA binding proteins - galactose metabolism in Yeast- DNA looping and homeo box - Gene Silencing.	10	CO5
Text Book			
1	<i>Watson JD, Baker TA, Bell SP, Alexander G and Levine M (2013) Molecular Biology of the Gene, Seventh edn, Benjamin - Cummings Pub Co., San Francisco, USA.</i>		
2	<i>Friefelder D(1987) Molecular Biology, Narosa Publishing House, NewDelhi.</i>		
3	<i>Murray RK, Granner DK and Rodwell VW (2006).Harper's Illustrated Biochemistry, Twenty Seventh edn, McGraw Hill Companies, Inc.</i>		

Reference Books	
<ul style="list-style-type: none">• Peter Snustad, D. and Michael J. Simmon, 2000. Principles of Genetics. [Second Edition]. John Wiley and Sons Publication.• Peter,J.Russell, 1997. Genetics. [Fifth Edition].Benjamin – Cummings Publishing Company.• Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, 2007.Molecular Cell Biology. [Fifth Edition]. W.H. Freeman and Company. New York.• Robert F.Weaver, 1999. Molecular Biology.[First Edition]. McGraw Hill Publication Company, USA.• Williams. S. Klug and Michael. R. Cummings, 2004. Concepts of Genetics. [Seventh Edition]. Pearson Sons Education (Singapore) Pvt. Ltd., Indian Branch, Delhi.	

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Become familiar with the concepts of central dogma of molecular concepts and structures of the genetic materials
CO2	Understand the mechanism behind the mutations and repair methods in cell
CO3	Get back ground of the transfer of genetic information from parent to daughter and their modification systems.
CO4	Get back ground of protein formations and modifications it taking for actions in cellular levels.
CO5	Develop knowledge about the genetic level changes for protein and enzyme functioning.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	H	M	H	M	H
CO2	M	M	M	M	M	H	M	H	M	H
CO3	M	M	H	M	M	H	M	H	M	H
CO4	M	M	M	M	M	H	M	H	M	H
CO5	M	M	M	M	M	H	M	H	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PBTMP101	DSC PRACTICAL - I	SEMESTER-I	
Credits:3	Experiments	Total Hours: 60	
1.	Micrometry-Measurement of Cell Size (Yeast, Bacteria)	03	CO1
2.	Mitosis & Meiosis	03	
3.	Antimicrobial Susceptibility testing - Kirby-Bauer Diffusion Method	03	
4.	Isolation and Enumeration of bacteria from soil sample.	06	CO2
5.	Determination of Growth Curve by turbidity method (temperature optimization)	06	
6.	Biochemical test for identification of bacteria IMViC test Oxidase test Catalase test Triple Sugar Iron test	12	
7.	Extraction of Genomic DNA from bacteria	06	CO3
8.	Estimation of protein (Lowry's method)	03	
9.	Estimation of DNA (Diphenylamine method)	06	
10.	Separation of protein by SDS-PAGE.	06	CO4
11.	Extraction and estimation of starch from potato	03	
12.	Separation of aminoacids by Thin-layer Chromatography method	03	CO5
13.	Preparation of Buffer and calibration of pH meter	03	

REFERENCE BOOKS:

1. *Joseph Sambrook and David W. Russell,2001. Molecular cloning - A laboratory manual Volume 1 to 3. [Third Edition]. Cold Spring Harbor Laboratory Press, New York.*
2. *Aneja, K.R. 2003. Experiments in Microbiology, Plant pathology and Biotechnology. [Fourth Edition]. New age international.*
3. *Cappucino,J.G and Sherman,N.2012. Microbiology -A laboratory manual. [Seventh Edition]. Pearson Education Inc.*
4. *Andreas D Baxevanis and B F Francis. 2002. Bioinformatics- A Practical Guide to Analysis of Genes & Proteins. John Wiley Publications.*
5. *David W Mount.2004.Bioinformatics: Sequence and Genome Analysis. CSHL*
6. *Harold Varley. 1988. Practical Biochemistry, Volume I & II. [Fourth Edition]. CBS Publishers, New Delhi.*
7. *Janarthanan, S. and Vincent,S.2009. Practical Biotechnology: Methods and Protocols. [Second Edition].Universities press,(India) Pvt Ltd, Hyderabad.*

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1	1. Observe the microscope and to calculate the size and number of the Bacteria / Yeast.
CO2	1. Determine the growth rate of the bacteria by plotting a bacterial growth curve using turbidity method 2. Prepare media and characterize different types of microorganisms
CO3	1. Prepare a broth culture and genomic DNA isolate using AGE 2. Estimate the amount of protein in unknown sample 3. Estimate the concentration of DNA from unknown sample using standards
CO4	1. Separate protein by polymerizing gel using PAGE 2. Extract a starch from the potato and estimate carbohydrate level
CO5	1. Prepare a silica gel plate and identifying, separating aminoacids 2. Separate protein in paper using electrophoresis 3. Calibrate and operate the pH meter by preparing a Na/K phosphate buffer.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	H	M	M	M	M	H	M
CO2	M	H	M	H	M	M	H	M	H	H
CO3	M	H	M	H	M	M	M	H	M	M
CO4	M	H	M	H	M	M	M	M	H	H
CO5	M	H	M	H	M	M	H	M	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM201	DSC VI: IMMUNOLOGY	SEMESTER-II	
Course Objective:			
The paper imparts a thorough knowledge on the basics of immunology. The student will get to understand the core concepts of immune systems and their non-specific and specific mechanisms, vaccine, etc.			
Credits:5		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	Elements of immune system. Immunity and its types, Haematopoiesis. Cells & Organs of immune system. Antigens – Antigenicity & Immunogenicity, Haptens, Adjuvants, Epitope.	08	CO1
II	Immunoglobulins: Basic structure, classes and biological activities. Antigenic determinants on immunoglobulin. Organization and expression of immunoglobulin genes – variable gene rearrangements, mechanism of rearrangements. Generation of Antibody diversity. MHC organization and structure, Antigen Processing and presentation; Cytosolic and Endocytic pathway.	12	CO2
III	Complement proteins and pathways. Cell mediated immune response – T cell maturation, activation and differentiation, Cytokines; properties, types. Humoral immune response–B cell generation, activation & differentiation. Primary and Secondary humoral immune response.	12	CO3
IV	Hyper sensitivity reactions, Immuno deficiency – Primary and Secondary immune deficiency. Autoimmunity- Organ specific and Systemic autoimmunity. Transplantation- Immunological aspects of graft rejection. Vaccines, types and vaccination schedule.	10	CO4
V	Antigen-antibody interaction; Agglutination, Precipitation, Immuno electrophoresis, ELISA, Western blot, Immunofluorescence. Hybridism Hybridoma technology, FACs, HLA typing.	08	CO5
Text Book			
1	Nandini Shetty,1996, Immunology: introductory text book - I. New Age International, New Delhi.		
2	Kannan.I.,2010. Immunology. MJP Publishers, Chennai.		
3	Murray RK, Granner DK and Rodwell VW (2006) Harper's Illustrated Biochemistry, Twenty Seventh edn, McGraw Hill Companies, Inc.		

Reference Books

1. *Kuby Richard.A.Goldsby, Thomas.J.Kint and Barbara.A.Osborne.2000. Immunology [Fourth Edition].W.H.Freeman and Company, New York.*
2. *Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt. 2006. Roitt's Essential Immunology. [Eleventh Edition]. Blackwell Publication.*
3. *Tristram G. Parslow, Daniel P. Stites, Abba I.Terr and John B. Imboden. 2001. Medical Immunology.[Tenth Edition].Tata McGraw Hill Publication.*
4. *IanTizard,K.1995. Immunology: An Introduction.[Fourth Edition] Saunders College Publication.*
5. *Kalus D.Elbert, 2009. Immunology - Understanding the Immune System. [Second Edition]. Wiley-Blackwell Publication.*
6. *Kenneth Murphy, Paul Travers and Mark Walport, 2008. Janeway's Immunobiology. [Seventh Edition]. Garland Science Taylor and Francis Group, New York.*

COURSE OUTCOMES

At the end of the course, the students will be able to

CO1	Describe the features of cells and tissues of the immune system, differentiate immunogens, antigens, haptens and adjuvants with respect to immunological functions.
CO2	Understand the developmental behaviors of B cells and study antigen And antibody interaction.
CO3	Able to draw the structure of immunoglobulin and apply the mechanism of biology of antigen processing and presentation.
CO4	Describe the injury and inflammation and the broad education necessary to understand AIDS. And understand the mechanism of immune responses with respect to transplantation and graft rejection.
CO5	Identify modern techniques to analyze tumor antigens and study autoimmune diseases. And to develop the monoclonal antibodies through hybridoma technology for humoral immunity.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	H	H	M	M	M	M	H
CO2	M	H	H	H	H	M	M	H	M	H
CO3	M	H	H	H	H	M	M	H	M	H
CO4	M	H	H	H	H	H	M	M	M	H
CO5	M	H	H	H	H	H	M	M	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM202	DSC VII: BIOPROCESS TECHNOLOGY	SEMESTER-II	
Course Objective:			
To learn about the various bioprocess and engineering technology and to implement in Industries			
Credits:4		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	Isolation of industrially important microbes. Primary and secondary screening and assay of fermentation products. Improvement of the strain. Preservation of important strains. An overview of aerobic and anaerobic fermentation process. Fermentation: Submerged and solid-state fermentation. Immobilization.	10	CO1
II	Medium for Industrial Fermentations: Medium formulation, Optimization, Inoculum development Growth kinetics. Sterilization of Air. Batch, Fed batch and continuous fermentation system. Bioreactor design- Parts of Fermentor. Types of bioreactor- Stirred tank, Air lift, Bubble column, Packed beds, Photo Bioreactor.	10	CO2
III	Microbial production of fermented products: Organic acid – Citric acid and Lactic acids. Antibiotic – Penicillin, Streptomycin. Vaccines – BCG. Vitamin – Vitamin B12. Enzyme – Amylase, Protease.	10	CO3
IV	Bioprocess control and monitoring: Methods of measuring process variables such as Temperature, Agitation, Pressure, DO, pH and foam. Online measurement, Control system: Manual and automatic control, On/Off controls and PID Control. Computer application in Fermentation technology.	10	CO4
V	Separation of microbial cells and suspended solids. Intracellular products recovery: Cell disruption – Physical and chemical method, Ultra filtration, Centrifugation, Chromatography, Electrophoresis, Solvent extraction, Distillation, Crystallization, Evaporation and Drying.	10	CO5
Reference Books			
1. Stanbury.P.R and Whitaker,2002. Principles of Fermentation Technology. Elsevier Science Ltd.			
2. PaulineM.Doran.1995. Bioprocess Engineering Principles. Academic Press.			
3. Shuler M.L. and Kargi, F.2004. Bioprocess Engineering: Basic Concepts. [Second Edition] Prentice Hall. Pvt.Ltd., New Delhi.			

4. *Crueger,W.,Crueger,A.2002. A Text Book of Industrial Microbiology. [Second Edition].Science Tech Publishers, USA.*
5. *Patel,A.H.2005. Industrial Microbiology. [Fifth Edition].MacMillan India Ltd., New Delhi.*

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Apply the basic knowledge of fermentation process.
CO2	Overview of the medium for Industrial fermentation & growth kinetics.
CO3	Demonstrate the different phases of mass transfer.
CO4	Illustrate the bioprocess control & monitoring.
CO5	Explain the separation of microbial cells from various techniques.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	H	H	M	M	M	M	H
CO2	M	H	H	H	H	M	M	H	M	H
CO3	M	H	H	H	H	M	M	H	M	H
CO4	M	H	H	H	H	H	M	M	M	H
CO5	M	H	H	H	H	H	M	M	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM203	DSC VIII: GENETIC ENGINEERING	SEMESTER-II	
Course Objective: To know about the advances in rDNA technology and its importance in various fields.			
Credits:5		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	Enzymes in Genetic engineering – DNA modifying enzymes – i) Restriction enzymes, ii) DNA polymerase – Klenow, DNA polymerase I, T4 DNAPolymerase, iii) Reverse transcriptase, iv)Terminal transferase, v) T4 polynucleotide kinases, vi) Alkaline phosphatase, vii) DNA ligase, viii)Nucleases: S1 nucleases, DNase I, Ribonucleases, EXO III, RNAPolymerase, Thermostable enzymes.	10	CO1
II	Bacterial vectors - pBR322 and pUC vectors. Phage vectors – Lambda, M13, Cosmid and Phagemid, Artificial chromosomes – YAC, BAC, PAC and HAC, Expression vectors - pMAL, GST, pET based vector and Shuttle vectors. Host cell types and transformation.	10	CO2
III	Cloning strategies – Gene library construction – Genomic and cDNA libraries. DNA cloning – Homopolymer tailing and use of adapters and linkers. Screening and analysis of recombinants – radio labeled and non – radiolabeled probes. Blotting techniques –Southern / Northern / Western. Immunological screening of expressed genes.	10	CO3
IV	Expression strategies - Gene Expression in <i>E. coli</i> , <i>Saccharomyces cerevisiae</i> , <i>Schizo saccharomyces</i> , CHO cell line. Expression in insect cells, higher eukaryotic system –Tet On / Off systems, Phage display and Metagenomics.	10	CO4
V	DNA sequencing –Chemical, enzymatic and automated DNA sequencing. Next Generation Sequencing Microarrays – Principles and applications. PCR – Principle, types and applications, PCR in Molecular diagnostics. Gene silencing techniques, introduction to siRNA technology, Micro RNA. Site directed mutagenesis and Protein engineering. Gene therapy, Gene knockout technologies. Introduction to genome editing CRISPR CAS 9.	10	CO5
Text Book			

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

1. Sathyanarayana.U.,2011. Biotechnology. Books and Allied private limited, Kolkata.
2. Elements of Biotechnology, 2020.P.K.Gupta
3. Biotechnology, 2018.R.C.Dubey

Reference Books

1. Primrose S.B and Twyman, R.M. 2006. **Principles of Gene Manipulation and Genomics**. [Seventh Edition]. Blackwell Publishing Co., USA.
2. Ernst-L. Winnacker. 2003. **From Genes to Clones**. Panima Publishing Co., Bangalore.
3. Reece, R.J. 2004. **Analysis of Genes and Genomes**. John Wiley and Sons Ltd., USA.
4. Brown, T.A. 2007. **Genomes**. [Third Edition]. Garland Science, USA.
5. Joseph Sambrook and David W. Russell, 2001. **Molecular cloning - A laboratory manual Volume 1 to 3**. [Third Edition]. Cold Spring Harbor Laboratory Press, New York.
6. James D. Watson, Richard M. Myers, Amy A. Caudy, Jan A. Witkowski. 2006. **Recombinant DNA**. [Third Edition]. W.H Freeman & Company, New York.
7. Micklos, D.A., Freyer, G.A. and Crotty, D.A. 2003. **DNA science**. [Second Edition]. Cold Spring Harbor Laboratory Press, New York.
8. Satheesh, M.K. 2011. **Bioethics and Biosafety**. I.K. International, New Delhi.

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1	Know the types of enzymes used in genetic engineering.
CO2	Demonstrate the types of vectors used in genetic engineering and different strains used.
CO3	Explain about the construction of gene libraries and screen the recombinants
CO4	Apply the various strategies involved in gene cloning
CO5	Apply their knowledge in the genetic engineering application

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	H	H	M	H	M	H	H	H
CO2	H	M	H	H	H	M	M	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	H	H	M	M	H	H	H	H	H	H
CO5	H	H	M	H	M	M	M	H	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTEL201	DSE I: BIOPHYSICS AND BIOINSTRUMENTATION	SEMESTER-II	
Course Objective:			
To understand the basic concept and analytical techniques in Bioinstrumentation.			
Credits:3		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	Care and maintenance: Weighing Balance, Incubators, Hot air oven, Laminar air flow and pH meter: Laws of thermodynamics, concept of free energy. Electromagnetic Spectrum, Beer Lambert's law.	10	CO1
II	Principles and applications of Colorimetry, UV - VIS Spectroscopy, IR, Raman Spectroscopy, Atomic Absorption Spectroscopy, and FTIR., NMR, Flame Photometry, Spectrofluorometer, MALDI TOF.	10	CO2
III	Principles and applications of AGE, SDS-PAGE, Native PAGE, Isoelectric focusing, Immuno-electrophoresis, Capillary electrophoresis. Principles, and applications of TLC, Column, GC-MS, HPLC, Ion exchange, Gel Permeation and Affinity Chromatography.	10	CO3
IV	Centrifugation Methods -Sedimentation, Centrifugation - rotor, motor, types of centrifuges - low and high speed, ultra- centrifuges, Types of centrifugation - Analytical and Preparative.	10	CO4
V	Methods of imaging -MRI, Mammogram, Ultrasound. GM Counter, Scintillation Counter, Autoradiography, Flow Cytometry.	10	CO5
Text Book			
<ol style="list-style-type: none"> 1. Ghatak, KL(2011). Techniques and methods in biology, Prentice Hall India Learning Private Limited, New Delhi. 2. Kumar, P(2016). Fundamentals and techniques of biophysics and molecular biology. Pathfinder Publications, New Delhi. 3. Swargiary, A(2017). Biological tools and techniques. Kalyani Publications, New Delhi. 4. Wilson, K and Walker, J (2010). Principles and techniques of biochemistry and molecular biology, Seventh edn, Cambridge University Press, London. 			
Reference Books			

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

<ol style="list-style-type: none"> 1. Boyer.R.F. 1993. Modern Experiments in Biochemistry. [Second Edition]. Benjamin/Cummings Publishing Company, Red wood City, California. 2. Upadhyay,2005. Biophysical Chemistry, Himalaya Publications. 3. Wilson.K.and Walker.2003,Practical Biochemistry.[First Edition]. Cambridge University Press. 4. David, J.H. and Hazel Peck. 1998. Analytical Biochemistry. [Third Edition]. Prentice Hall an Imprint of Pearson Education. 5. Rickwood D & Hames BD. Gel electrophoresis of Nucleic acids 6. Satheesh,M.K.2011. Bioethics and Biosafety.I.K.International, New Delhi. 7. Donaldpavia,Gory M Lipmas & George S Kriz. Introduction to spectroscopy

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Maintain the instruments with care and know the working principles of Each basic laboratory instruments
CO2	Gain knowledge about the separation process using electrophoresis and chromatographic techniques.
CO3	Handle the instruments and measure OD value, Absorbance and Concentration of specific constituents present in the unknown sample.
CO4	Gain knowledge on principles and techniques of centrifuge.
CO5	Gain knowledge on principles and techniques of Imaging techniques.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	H	H	M	H	M	H	H
CO2	M	H	M	H	H	M	H	M	M	H
CO3	M	H	M	M	H	M	H	M	M	H
CO4	M	H	M	M	H	M	H	M	H	H
CO5	M	H	M	M	H	M	H	M	H	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTEL202	DSE II: ARTIFICIAL INTELLIGENCE AND BIOINFORMATICS	SEMESTER-II	
Course Objective: <ol style="list-style-type: none"> To understand the basic concepts of Artificial Intelligence its principles and techniques and its search strategies. To understand the basics in Bioinformatics. 			
Credits:3		Total Hours: 50	
UNIT	CONTENT	Hrs	CO
I	Fundamentals of Artificial Intelligence: Introduction - Definition-Time lines of Artificial Intelligence - Branches of Artificial Intelligence-Production systems-state space representation, A.I. representation, Representation of Knowledge -Applications of Artificial intelligence. Role of AI in bioinformatics.	10	CO1
II	Search Strategies: Uninformed Search: Formulation of real - world problems, Breadth First Search, Depth First Search, Depth Limited Search, Bidirectional Search-Informed Search: Generate & test, Hill Climbing, Best First Search, A* and AO* Algorithm, Constraint satisfaction.	10	CO2
III	Basics of Bioinformatics and sequence alignment: Bioinformatics - Basics, Applications - Classification of Biological Database - Sequence Alignment: sequence search using FASTA and BLAST programs - Pair wise sequence alignment and Multiple sequence alignment. Local and Global alignment (Smith - Waterman and Needle man - Wunsch algorithm). Substitution matrices, Scoring matrices-PAM, BLOSUM and Dot plot.	10	CO3
IV	Phylogenetic Analysis: Overview of Tree analysis. Cladistics, Phenetics and Distances. Various tree types. Overview of Bootstrapping. Tools - Clustal Omega, PHYLIP and MEGA. Problems and errors in phylogenetic reconstruction. Overview of AIn Phylogenetic analysis.	10	CO4
V	Drug design and docking: Drug properties, Protein Structures - Structural databases- PDB, CATH, SCOP; Chemical Databases - ZINC, Pubchem, Chembl. Introduction to docking methods: Structure-based drug designing approaches: Ligand-based drug designing approaches -Tools and Molecular docking programs: AutoDock, HEX.	10	CO5
Reference Books			

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

- Dassanayake S.Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- ThiagarajanB, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, Simminder Kaur Thukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N,Rastogi.P, 2004. Bioinformatics methods and applications, Prentice -Hall of India private limited, New Delhi.
- Lohars.Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephenmisener and Stephen A.Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Understand the fundamentals of Artificial Intelligence
CO2	Understand the knowledge of search strategies
CO3	Analyze the basics of bioinformatics and sequence alignment
CO4	Intrepret the biological data in computational methods & tools for Solving research problems easily
CO5	Predict the gene structure and also construct phylogenetic tree for Studying the similarity and evolutionary relationship within the organism

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	H	H	M	H	M	H	H
CO2	M	H	M	H	H	M	H	M	M	H
CO3	M	H	M	M	H	M	H	M	M	H
CO4	M	H	M	M	H	M	H	M	H	H
CO5	M	H	M	M	H	M	H	M	H	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PBTMP201	DSC PRACTICAL - II	SEMESTER-II
Credits:2		
UNIT	CONTENTS	Total Hrs:60
1.	Microbial Enzyme production using fermentor (Amylase/Protease)	5
2.	Cell disruption using Sonicator	2
3.	Precipitation of protein by Ammonium sulphate Precipitation and Salting-out by Dialysis method	6
4.	Estimation of Protein by Lowry's method	5
5.	SDS- PAGE	6
6.	Immobilization, Wine production and estimation of alcohol by potassium dichromate method	6
7.	ABO grouping, WIDAL Test (Slide and Tube methods), Enzyme Linked Immunosorbent Assay (ELISA)	6
8.	Antigen-Antibody interaction- Ouchterlony Double Diffusion, Rocket Immunoelectrophoresis, Counter Current Immunoelectrophoresis	6
9.	Isolation of Genomic DNA from Bacteria Isolation of plasmid DNA	6
10.	Restriction Digestion and Ligation	6
11.	Bacterial Transformation	6

REFERENCE BOOKS:

1. *Joseph Sambrook and David W.Russell,2001.Molecular cloning - A Laboratory manual Volume 1 to 3.*[Third Edition].Cold Spring Harbor Laboratory Press, New York.
2. Aneja, K.R. 2003. **Experiments in Microbiology, Plant pathology and Biotechnology.** [Fourth Edition]. New age international.
3. *Cappucino,J.G and Sherman,N.2012. Microbiology - A laboratory manual.* [Seventh Edition].Pearson Education Inc.
- 4.*Ramnik Sood.2006.Medical Laboratory Technology.* Jaypee Brothers Medical Publishers Ltd., New Delhi.
- 5.*Janarthanan,S. and Vincent,S.2009.Practical Biotechnology: Methods and Protocols.*[Second Edition].Universities press, (India) Pvt Ltd, Hyderabad.
- 6.**Dr.S.Rajan & R.Selvi Crhisty, 2015.** Experimental procedures in Life sciences, First edition. Anjanaa Book house, Koyempedu, Chennai.

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBCBTI201	MDC I: DIAGNOSTIC BIOCHEMISTRY	SEMESTER-II	
Course Objectives: The Course aims <ul style="list-style-type: none"> To enable the students to develop practical and interpretative skills to contribute effectively in diagnostic haematology and clinical biochemistry 			
Credits:2		Total Hours:30	
UNIT	CONTENTS	Hrs	CO
I	Clinical Laboratory: Introduction, types and set-up. Basic laboratory safety, hazards in the clinical laboratory, safety with chemical/reagents, first aid in laboratory accidents. Fundamental chemistry - Indicators, solutes, solvents and solutions.	6	CO1
II	Clinical Haematology: Ways of obtaining blood, Separation of serum and plasma, Anticoagulants, Blood collection system, Complete blood cell count (CBC), Erythrocyte sedimentation rate. Automation in haematology, bleeding time, clotting time.	6	CO2
III	Urine analysis and Stool examination: Physicochemical characteristics of urine, preservation of specimen, gross examination of urine and chemical examination of urine-tests for glucose, proteins, aminoacids, ketone bodies, bile salts, bile pigments. Stool examination - Specimen collection, test for occult blood, microscopic examination of stool.	6	CO3
IV	Clinical Chemistry and Enzymology: Diabetes Mellitus - Introduction, types, diagnostic tests - Glucose, glycosylated haemoglobin. Estimation and interpretation of cholesterol, urea, creatinine and protein in blood samples. Enzymology - Role of AST and ALT in diagnosis of diseases.	6	CO4

V	Organ function tests: Liver function test: Functions of the Liver, Tests based on abnormalities of bile pigments (Jaundice). Renal Function Test: Renal clearance test (Creatinine and urea), dilution test, phenol red test, principles of precise tests of renal function – Glomerular filtration rate, renal plasma flow and maximal tubular capacity.	6	CO5
Text Book			
1.	<i>Ramnik Sood.</i> 2006. Medical Laboratory Technology .[First Edition].Jaypee Brother’s Medical Publishers Ltd., New Delhi		
2.	<i>KanaiL.Mukherjee.</i> 2005. Medical Laboratory Technology, Volume I . Tata McGraw-Hill Publishing Co. New Delhi		

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Practice the safe laboratory process and reagent preparation
CO2	Explain the general concepts of specimens handling methods and analysis of blood cells and clinical labs.
CO3	Recite the handling and analytical procedures of urines and stool samples.
CO4	Describe the general concepts and methods in diagnosis of clinical disorders
CO5	Perform various laboratory procedures to assess the functional status of the organs

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	H	H	H	M	H	M
CO2	H	H	M	H	H	H	H	M	H	M
CO3	H	H	M	H	H	H	H	M	H	M
CO4	H	H	M	H	H	H	H	M	H	M
CO5	H	H	M	H	H	H	H	M	H	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PBCMBIP201 /24PBCBTIP201	MDC PRACTICAL I: DIAGNOSTIC BIOCHEMISTRY	SEMESTER-II	
Course Objectives: The Course aims			
<ul style="list-style-type: none"> • To enable the students to develop practical knowledge in handling and testing the biological samples 			
Credit:2		Total Hours:24	
S.No.	EXPERIMENT	Hrs	CO
I. Clinical haematology			
1.	Enumeration of WBC and RBC	3	1
2.	Estimation of haemoglobin (Sahli's method)	3	1
3.	Erythrocyte sedimentation rate (Westergren's method)	3	1
II. Blood analysis			
4.	Estimation of glucose in blood (Nelson Somogyi's method).	3	2
5.	Estimation of urea in blood (DAM method).	3	2
6.	Estimation of creatinine in blood (Jaffe's method).	3	2
III. Urine analysis			
7.	Estimation of creatinine in urine (Jaffe's method).	3	2
8.	Qualitative analysis of normal and abnormal constituents in urine	3	3
Reference Books:			
1.	<i>Harold Varley</i> .1980. Practical Biochemistry. Volume I& II. [Fifth Edition].CBS Publishers, New Delhi		

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to:

CO1	Perform blood cell analysis procedures
CO2	Estimate the presence of metabolites in blood and urine
CO3	Use the tests to identify normal and abnormal constituents in urine by Qualitative analysis

Prepared By

(Course Coordinator)

Approved By

(BoS Chairman)

24PMBBTI201	MDC I: CLINICAL MICROBIOLOGY	SEMESTER-II	
Course Objectives:			
<ul style="list-style-type: none"> • To enable the learners to know basics in clinical Microbiology. • To learn the diagnosis of infectious diseases. • To know about the modern approaches in clinical microbiology. 			
Credits: 02		Total Hours:30	
UNIT	CONTENTS	Hrs	CO
I	Infection: Sources of infection - transmission of infection - types of infection. Classification of microbes based on hazard- Types of diseases - disease carriers.	06	CO1
II	Collection and transport of clinical specimens: urine, pus, faeces, sputum and blood.	06	CO2
III	Microbiological examination of samples: sputum, pus, faeces And urine. Diagnosis of anaerobic infections.	06	CO3
IV	Serological diagnosis of microbial diseases: Antigen tests - Agglutination test for pregnancy, Elek's gel precipitation test, ELISA. Antibody tests -WIDAL, ASO. Monoclonal antibodies in clinical microbiology.	06	CO4
V	Molecular diagnosis of infectious diseases: Tuberculosis, Malaria, AIDS. RFLP as a molecular marker in disease diagnosis.	06	CO5

TEXT BOOKS:

1. *Ananthanarayan, R. and Jayaram Paniker, C.K.* 2007. **Text Book of Microbiology**. [Seventh Edition]. Orient Longman Ltd., Chennai.
2. *Lansing M Prescott, John P Harley and Donald A Klein.* 2007. **Microbiology**. [Seventh Edition]. McGraw Hill, New York.

REFERENCE BOOKS:

1. *Madigan, M.T., Martinko, J.M. and Parker, J.* 2000. **Brock Biology of Microorganisms**. [Twelfth Edition]. Pearson Benjamin Cummings, San Francisco, USA.
2. *Mackie and McCarthy* 1994. **Medical Microbiology**. [Fortieth Edition]. Churchill Livingstone, New York.

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Evaluate the infectious disease caused by microorganisms.
CO2	Apply the methods of collection and processing of clinical samples.
CO3	Apply the preliminary detection of pathogens for disease diagnosis.
CO4	Assess the serological detection of pathogens.
CO5	Develop diagnose the disease based on molecular methods.

Mapping

PS O CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	M	M	M	H	M	M
CO2	M	H	H	H	M	M	M	H	M	M
CO3	M	M	H	H	H	H	H	H	M	H
CO4	M	M	H	H	H	M	M	M	M	H
CO5	H	H	H	H	H	H	H	H	H	H

H-High; M-Medium; L-Low

Prepared By

(Course Coordinator)

Approved By

(BoS Chairman)

24PMBBTIP201	MDC PRACTICAL I: CLINICAL MICROBIOLOGY	SEMESTER-II	
Course Objectives:			
The course aims			
<ul style="list-style-type: none"> • To learn the basic techniques in clinical microbiology. • To acquire knowledge on identification of clinical pathogens. 			
Credits: 02		Total Hours:24	
Experiment	CONTENTS	Hrs	CO
1.	Colony morphology of pathogenic bacteria on selective media.	3	CO1
2.	Morphological characterization of pathogenic Bacteria by differential staining.	6	CO1
3.	Identification of pathogenic bacteria by preliminary test, biochemical test and special test. a) <i>Staphylococcus aureus</i> b) <i>Pseudomonas aeruginosa</i>	6	CO1
4.	Culture methods of fungi i. Media usage-PDA, SDA, Corn meal agar	3	CO2
5.	Examination of fungi by Lactophenol cotton blue stain.	3	CO2
6.	Examination of <i>Candida albicans</i> -Gram's stain, Germ tube test.	3	CO2
Reference Books:			
1.	<i>Gerald Collee, J. Barie P. Marmion, Andrew, G. Fraser and Anthony Simmons.</i> 1996. Mackie and MacCartney Practical Medical Microbiology. Fourteenth edition. Churchill Livingstone Publishers.		
2.	<i>Sundararaj, T.</i> Microbiology Laboratory Manual. Dr.A.L.Mudaliyar Post Graduate Institute of Basic Medical Sciences, Chennai.		

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Identify and detect the pathogenic bacteria based on the morphological and physiological studies.
CO2	Evaluate the mycological diseases.

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PVE201	VALUE ADDED COURSE: HUMAN RIGHTS	SEMESTER-II	
Course Objectives			
The Course aims			
<ul style="list-style-type: none"> • To make the students to understand the concepts of human rights. 			
Credits:2		Total Hours:25	
UNIT	CONTENTS	Hrs	CO
I	Human Rights: Definition - Historical Evolution-Classification of Rights - Universal Declaration of Human Rights - International Covenants on Economic and Social Rights -Constitutional Provisionfor Human Rights - Fundamental Rights - Directive Principles of the State Policy - Indian Constitution.	5	CO1
II	Civil and Political Rights: Right to Work - Right to Personal Freedom - Right to Freedom of Expression - Right to Property - Right to Education - Right to Equality-Right to Religion - Right to Form Associations and Unions - Right to Movement-Right to Family - Right to Contract - Right to Constitutional Remedies - Right to Vote and Contest in Elections - Right to Hold Public Offices-Right to Petition - Right to Information - Right to Criticize the Government - Right to Democratic Governance.	5	CO2
III	Economic Rights: Right to Work - Right to Adequate Wages -Right to Reasonable Hours of Work - Right to Fair Working Conditions - Right to Self - Government in Industry - Customer Rights - Social and Cultural Rights - Right to Life - Right to Clean Environment.	5	CO3
IV	Women's Rights: Right to Inheritance- Right to Marriage - Divorce and Remarry -Right to Adoption - Right to Education - Right to Employment and Career. Advancement - Rights Relating to Dowry - Right for Equality - Right for Safe Working Conditions - Children's Rights - Right to Protection and Care - Right to Education - Issues Related with Infanticide - Street Children - Child Labour-	5	CO4

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	Bonded Labour - Refugees Rights - Minority Rights - Dalit Rights- Tribal Rights- Nomads Rights.		
V	Human Rights Violation: International, National, Regional Level Organizations to Protect Human Rights - UNO - National Commission for Human Rights - State Commissions - Non-Governmental Organizations and Human Rights - Amnesty Terrorism and Human Rights - Emergency and Human Rights - Judiciary and Human Rights - Media and Human Rights - Police and Human Rights.	5	CO5

WebReferences

https://idwfed.org/en/about-us-1/idwf-constitution https://www.womenlawsindia.com/legal-awareness/women-rights-in-india/ https://projectworldimpact.com/cause/Human-Trafficking

Reference Books

1	<i>Paul Singh. Human Rights and Legal System.</i> Himalaya Publishing House, New Delhi.
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COURSE OUTCOMES (CO)

After completing the course the students will be able to

CO1	Understand the core principles of human rights philosophy
CO2	Know the importance and functions of human rights commission
CO3	Apply their rights for democracy, human rights and gender equality
CO4	Know the rights from the Governance, economic and social development through various Acts
CO5	Understand the right to information Act, rights for women, children, Nomads, refugees And various sector of people in our country

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

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24PLS201	AEC: CAREER COMPETENCY SKILLS - I	SEMESTER-II	
Course Objectives:			
The course aims			
<ul style="list-style-type: none"> • To enhance employability skills and to develop career competency. 			
Credits:1		TotalHours:25	
UNIT	CONTENTS	Hrs	CO
I	Interview Skills: 1.1 Interview Skills: Opening& Closing Expressions –Dress code-Dos and Don'ts In Interview 1.2 Resume Preparation: Cover Letters-Types of resume. Practice: Mock Interview with basic and advanced Interview questions Practice: Draft updated version of resume & cover letter.	5	CO1
II	Soft Skills: Interpersonal Skills–Swoc analysis- Problem Solving Skills. Practice: Speaking on interpersonal skills. Activity on problem solving skills.	3	CO2
III	Professional Skills: Public Speaking-Group Discussion-Creative Thinking. Practice: Non-technical presentation & Group Discussion Assessment can be based on presentation in the class	3	CO3
IV	Professional Writing Skills: Report writing: Progress report-Feasibility Memos and Circulars.	3	CO4
V	Self-improvement-CALL-Language Techniques and Concepts, E-learning	3	CO5
Text Book:			
1	<i>Know Yourself & Know the World</i>		
Reference Book:			
1	<i>Alex, K. Soft Skills New Delhi, S.Chand & Company Ltd, 2012.</i>		

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COURSE OUTCOMES (CO)

After completion of the course, the students will be able to:

CO1	Understand the types of Interviews, interview skills
CO2	Developing Resume content and structures.
CO3	Improving soft skill & group discussion
CO4	Types of skills, Attain the different level of Learning Skills.
CO5	Self-improvements and learning techniques

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

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24PBTM301	DSC IX: PLANT TISSUE AND ANIMAL CELL CULTURE TECHNOLOGY	SEMESTER - III	
Course Objectives: To learn the technique in plant tissue culture and animal cell culture.			
Credits: 5		Total Hours: 50	
UNIT	CONTENTS	Hrs	CO
I	Architecture of Plants – tissues and organs, Plant response to abiotic stress (Flood, drought and high salinity) and biotic stress (insect), absorption and transportation of water and nutrients by the plants, Transpiration, Seed storage proteins.	8	CO1
II	Principles of plant tissue culture, PTC laboratory organization, Plant tissue culture media, sterilization of Explant Callus and suspension culture, Micropropagation, Somaclonal variation, Somatic embryogenesis, Haploid plant production, Isolation and culture of protoplast, Somatic hybridization and Cybridization, Viral free plant production – Meristem culture, Hardening.	12	CO2
III	Physiological effects and mechanism of action of the auxins, cytokinins, gibberellins and abscissic acid. Biosynthesis and function of ethylene.	6	CO3
IV	An Introduction about animal cell culture, Planning and Construction of Lab layout, Equipments - Laminar-flow hood, CO2 Incubators, Inverted microscope, Cryostorage containers, Aseptic concepts and Cell culture vessel. Preparation of Media-defined media and supplements, Types of cell culture media; Physical and chemical property of Medium, Balanced salts, Antibiotics, growth supplements; Fetal bovine serum; Serum free media. Biosafety Cabinet and Biosafety levels.	14	CO4
V	Primary culture – Isolation of tissues and disaggregation methods, Subculture and Cell lines. Types of primary culture; separation; Continuous cell lines; Suspension culture; Application of Animal cell culture.	10	CO5
Text Book			
1	R Keshavachandran and K V Peter. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan.		
2	Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue culture. Scientific Publishers, New Delhi.		
3	Kalian Kumar De (2003). An introduction to plant tissue culture, New central book agency pvt. Ltd.		

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4	S Ignacimuthu (2006). <i>Biotechnology: An introduction</i> . Narosa Publishing House.
5	Narayanswamy. <i>Plant Cell and Tissue Culture</i> . McGraw Hill.
Reference Books	
1	<i>Bhojwani, S.S. and Razdan, M.K.</i> 2008. Plant Tissue Culture - Theory and Practice . Elsevier Publishers, New Delhi.
2	<i>Chawla, H.S.</i> 1998. Biotechnology in Crop Improvement . International Book Distribution Co., New Delhi.
3	<i>Slater, A., Scott, N. and Fowler. M.</i> 2008. Plant Biotechnology - The Genetic Manipulation of Plants . [Second Edition]. Oxford Publications, Oxford, UK.
4	<i>Hopkins, W.G., and Hiiner, N.P.A.</i> 2004. Introduction to Plant Physiology . [Third Edition]. John Wiley and Sons, New Jersey, USA.
5	L Gamborg, G C Philips (Eds.) (2005). <i>Plant cell, tissue and organ culture: Fundamental methods</i> . Narosa Publishing House.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Know the details about the growth strategies in plants
CO2	Understand the concepts of developing artificial techniques to grow plants
CO3	Get knowledge about the biomedical applications of plant components
CO4	Know the details of the animal cell culturing
CO5	Understand the methods of developing artificial animal cell cultures in laboratory

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	H	H	H	M	H	H	H
CO2	M	H	H	H	H	H	H	H	M	H
CO3	M	H	H	H	H	H	H	M	H	H
CO4	M	H	H	H	H	H	H	M	M	H
CO5	M	H	H	H	M	H	H	M	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM302	DSC X: RESEARCH METHODOLOGY, BIOETHICS AND IPR	SEMESTER - III	
Course objectives			
<ul style="list-style-type: none"> • To achieve competence and proficiency in the theory of and practice of research. • To offer basic knowledge of ethical issues in medicine, health and the life sciences. • To introduce fundamental aspects of Intellectual property rights. 			
Credits: 3		Total Hours: 40	
UNIT	CONTENTS	Hrs	CO
I	Research – Meaning and objectives of research. Types of research – Basic and applied research. Essential steps in research. Experimental designs- Hypothesis and Null-hypothesis, Basic principle of experiment. Experimental unit and sampling unit, Experimental error, Replication, Generalization, Controls, Randomization, Measurements. Few common experimental designs.	8	CO1
II	Research Problem Identification & Formulation: Defining and formulating the research problem, Selecting the problem. Literature collection – Source for literature collection, Need of literature review, Review and bibliography. Preparation of Research Proposal for funding.	8	CO2
III	Literature citation: Formulation of research objectives and their importance, Computer and its role in research. Report writing and scholarly publishing. Research report – components of research report, Research report– Tables and Figures. Research report–Formatting and typing. Format of thesis.	8	CO3
IV	Bioethics in Research: Ethics-ethical issues, ethical committees (Human & Animal). Ethical issues in clinical research. Ethical issues related to Publishing, Authorship, Plagiarism and Self-Plagiarism. Contemporary issues in Research ethics.	8	CO4
V	Intellectual Property Rights (IPR): Introduction to IPR, Patentable life science process and products, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design. Procedure for IPR registration, the effect of registration and term of protection. Govt of India’s National	8	CO5

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	IPR Policy and Career opportunities in IPR.		
Text Book			
1	Kumar, R. (2011). Research Methodology: a step-by-step guide for beginners (3rd edition) . London, UK: TJ International Ltd, Padstow, Cornwall.		
2	Gurumani, N. (2017). Research methodology for biological sciences . MJP Publishers, Chennai.		
3	Kothari, C.R. (2019). Research Methodology: Methods and Techniques . 4 th Edition, New Age International Publishers, New Delhi.		
4	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper . Sage Publications		
5	Satheesh, M. K. 2011. Bioethics and Biosafety . I.K. International, New Delhi.		
Reference Books			
1	Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management . India, IN: Cengage Learning India Private Limited.		
2	Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9		
3	Intellectual Property A Primer for Academia by Prof. Rupinder Tewari Ms. Mamta Bhardwa		
4	Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.		
5	Felix Thiele, Richard E. Ashcroft (2005). Bioethics in a Small World. Springer.		
WEB REFERENCES:			
1	http://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/		
2	https://epgp.inflibnet.ac.in/ahl.php?csrno=1174		
3	https://bioethics.msu.edu/what-is-bioethics		
4	https://ipindia.gov.in/		
5	https://www.investopedia.com/terms/i/intellectualproperty.asp		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Can learn the fundamental details of research and will have knowledge on how to design a research work
CO2	Will understand what is a research problem, how to identify the research gap and how to formulate a hypothesis and objectives of the research
CO3	Could gain knowledge on how to interpret the research data, how to write a research report and how to publish a research paper
CO4	Might acquire fundamental knowledge of various bioethics in research
CO5	Can create awareness for students on intellectual property rights and their by-laws

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	H	M	H	H	H
CO2	H	H	H	H	H	H	M	M	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	M	H	H	H	M	H	H	M	H	H
CO5	M	H	H	H	M	H	H	M	M	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTM303	DSC XI : BIOSTATISTICS	SEMESTER - III	
OBJECTIVE: <ul style="list-style-type: none"> • To familiarize the application of biostatistics in biology. • To know about the research concepts. • To learn the strategies of research field and also to provide knowledge to understand the role of statistics in research 			
UNIT Credit: 3	CONTENTS	Total Hours: 50	
		Hrs	CO
Unit - I	Statistics: Introduction - Definition of Statistics - Functions of Statistics - Applications and Limitations of Statistics. Collection of data: Primary and Secondary data - Methods of collecting primary data - Sources of secondary data. Classification and Tabulation of data: Types of classification - Tabulation of data - Parts of a table - Types of tables. Diagrammatic and Graphical Representation: Types of diagrams - Graphs - Graphs of frequency distributions.	10	CO1
Unit - II	Measures of Central Tendency: Arithmetic Mean (except weighted mean and corrected values) - Median - Mode - Merits and demerits - Geometric mean - Harmonic Mean.	10	CO2
Unit - III	Measures of Dispersion: Range - Quartile deviation - Standard deviation - Coefficient of variation.	10	CO3
Unit - IV	Correlation Analysis: Types of correlation - Methods of Correlation - Karl Pearson's Coefficient	10	CO4

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	- Rank correlation coefficient. Regression Analysis: Regression lines (except graphing) - Regression equations.		
Unit - V	Test of Hypothesis: Population - Sample - Procedure of testing hypothesis - Types of errors - Standard error - t test - Chi-square test of independence of attributes. Analysis of Variance: One way classification - Two way classification.	10	CO5
TEXT BOOKS			
1	S.P.Gupta, 2008. STATISTICAL METHODS,[Thirty Seventh Edition] S. Chand and Company Ltd., New Delhi.		
2	Sancheti,D,C and Kapoor V.K 2005. STATISTICS.[Seventh Editions]. S, Chand And Company limited, New Delhi.		
3	P.S.S. Sunder Rao, J. Richard, Introduction to Biostatistics and Research Methods, Prentice-Hall of India Private Limited, 2006.		
4	S. C. Gupta and V. K. Kapoor (2003): Applied Statistics, Sultan Chand & Sons, Delhi.		
REFERENCE BOOKS			
1	Marcello Pagano and Kimberley Gauvreau (2000): Principles of Bio-Statistics, Duxbury: Thomson Learning, USA		
2	Jerrold H. Zar. (2003). Biostatistical Analysis. (4th ed.). Pearson Education (P) Ltd, New Delhi.		
3	Diggle PJ. , Time Series: A Biostatistical Introduction, 1990, Clarendon Press, Oxford.		

Course Outcomes (CO)

After completion of the course, the students will be able to

CO 1	Learn the importance of statistics
CO 2	Understand the concepts of measures of central tendency
CO 3	Know the concepts of measures of dispersion
CO 4	Gain knowledge on correlation and regression analyses
CO 5	Test the samples using testing of hypothesis

MAPPING										
PO/PSO CO	PO1	PO 2	PO 3	PO 4	PO 5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	L	L	M	M	M	L	M	L	H	H
CO 2	M	M	M	M	H	L	M	L	M	M
CO 3	M	M	M	M	H	L	M	M	H	H
CO 4	M	M	H	M	H	L	M	M	H	H
CO 5	M	M	H	M	H	L	M	L	H	H

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTEL301	DSE I: DEVELOPMENTAL BIOLOGY	SEMESTER - III	
Course objectives			
<ul style="list-style-type: none"> To learn the fundamentals of Developmental biology. 			
Credits: 3		Total Hours: 50	
UNIT	CONTENTS	Hrs	CO
I	Foundation of developmental Biology: History of developmental biology, types of development, strategies in developmental biology, phase of animal development. Major molecular and cellular component of development: genes and proteins, and transcription factors and signal molecule.	10	CO1
II	Basic mechanism of development: Cell division - molecular view, Morphogenetic movement - morphogenesis, cellular process, cell - cell adhesion, cell migration. Cell to cell interaction - induction, signal, competency, morphogens. Growth - mechanism, types, dynamic and factors. Differentiation: Potency, specification, differentiation.	10	CO2
III	Early phases of ontogenic development: Gametogenesis - maternal gene product, migration of germ cells, Spermatogenesis, Oogenesis - types of eggs, Fertilization - fertilization in sea urchin and mammals. Cleavage - cell division in cleavage, patterns of cleavage, cellular mechanisms in cleavage. Fate map, gastrulation and axis formation.	10	CO3
IV	Early development and organogenesis: Early development in fishes - development of zebra fish and early development in birds - development of chick, early development in mammals. Organogenesis in animals: formation of central nervous system. Development of peripheral nervous system. Fate of neural crest cells - regions of neural crest - cranial and trunk neural crest. Organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and	10	CO4

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	phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum		
V	Sex determination and development: Sexual orientation, mechanisms of sex determination - chromosomal sex determination, sex determination in mammals and drosophila. Development of genital systems - early development of gonads, development of male and female genital ducts and glands. Development and evolution - developmental repatterning - heterochrony, heterotopy, heterometry and heterotypy. Origin of novelties, developmental constraints in evolution.	10	CO5

Text Book

1	Chattopadhyay S. An Introduction to Developmental Biology. Books and Allied (P) Ltd. Kolkata, 1 st Edition, 2016.
2	Rastogi, V B., 2020. A Text Book Of Animal Distribution & Developmental Biology. KNRN Publications.
3	Developmental Biology, Eighth Edition" by Scott F Gilbert

Reference Books

1	Developmental Biology (2016) 11th Edition, Gilbert, S. and Barresi, M. Sinauer Associates, USA
2	Molecular Cell Biology (2016) 8th Edition, Lodish, H., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Martin, K. W.H. Freeman and Company.
3	Principles of Development (2011) 3rd Edition, Wolpert, L. Smith, J., Jessell, T., Lawrence, P., Robertson, E. and Meyerowitz, E. Oxford University Press.
4	Kalthoff Klaus (2001) Analysis of Biological Development, 2nd ed. Boston, MA: Mc Graw-Hill, ISBN : 0071180788

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Explain historical perspective of Developmental biology.
CO2	Demonstrate the fundamentals of development biology.
CO3	Differentiate gametogenesis, fertilization and early development
CO4	Illustrate the Morphogenesis and organogenesis in animal.

CO5	Illustrate the Morphogenesis and organogenesis in animal.
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MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	M	M	M	M	M	M	M
CO2	H	M	M	M	M	M	M	H	H	H
CO3	H	M	M	M	M	M	H	H	M	M
CO4	H	M	M	M	M	M	M	M	H	H
CO5	H	M	M	M	M	M	H	H	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTEL302	DSE II: EVOLUTION AND BIODIVERSITY	SEMESTER - III	
Course objectives			
<ul style="list-style-type: none"> To understand the evolutionary concept and biodiversity 			
Credits: 3		Total Hours: 50	
UNIT	CONTENTS	Hrs	CO
I	Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.	8	CO1
II	Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.	12	CO2
III	Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.	10	CO3
IV	Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.	10	CO4
V	Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent. Organisms of conservation concern: Rare, endangered species. Conservation strategies.	10	CO5
Text Book			

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1	Veer Bala Rastogi. 12 th Edition. Organic evolution. Kedarnat Ramnath, Meerut, Delhi.
2	Jha AP, 1997. Genes and Evolution. Mac Millan India Limited.
3	Douglas J Futuyma and Mark Kirkpatric, 2017. Evolution. Oxford University press.
4	Primack R.B. (2006) Essentials of Conservation Biology (4 th ed.), Sinauer Associates, Sunderland.

Reference Books

1	Futuyma and Kirkpatrick. 2022. Evolution. 5 th Edition. Sinauer Associates (an imprint of Oxford University Press). ISBN-10: 0197619614. ISBN-13: 978-0197619612.
2	Emlen and Zimmer. 2019. Evolution: Making Sense of Life. 3 rd Edition. W.H. Freeman. IBSN-10: 1319079865. ISBN-13: 978-1319079864.
3	Freeman and Herron. 2013. Evolutionary Analysis. 5 th Edition. Pearson. ISBN-10: 0321616677. ISBN-13: 978-0321616678
4	Kalthoff Klaus (2001) Analysis of Biological Development, 2 nd ed. Boston, MA: Mc Graw-Hill, ISBN : 0071180788
5	Grimmett R., Inskipp C. and Inskipp T. (2001) Pocket Guide to the Birds of the Indian Subcontinent, Oxford University Press, Oxford.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Evolutionary concepts of organisms.
CO2	Orgin of prokaryotes and unicellular and multi cellular organism.
CO3	Evolutionary history of various organisms.
CO4	Principles and methods of taxonomy.
CO5	The classification of plant, animal and microorganism.

Mapping

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	H	M	H	H	H	M	H	H
CO2	H	H	H	H	H	H	M	M	H	M
CO3	H	H	M	H	H	H	H	H	H	M
CO4	H	M	H	M	H	H	H	H	M	M
CO5	H	H	H	M	H	H	H	M	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBCMBI301/ 24PBCBTI301	MDC II: PHARMACEUTICAL BIOCHEMISTRY	SEMESTER-III	
Course Objectives: The Course aims <ul style="list-style-type: none"> To enable the students to learn about Pharmacodynamics and pharmacokinetics of drugs. To make the students aware of Plant therapeutics 			
Credits: 2		Total Hours: 30	
UNIT	CONTENTS	Hrs	CO
I	Drugs: Drug -Definition, Nomenclature, Structural feature and pharmacology activity, prodrug concept. Classification of drugs based on their source and - Plant, animal, mineral and synthetic, based on action. Routes of drug administration, Drug absorption-mechanism. Factors influencing drug absorption	06	CO1
II	Distribution and elimination of drugs. Metabolism- Phase I, II reactions. Factors influencing drug distribution and elimination. Mechanism of drug action- Physical, Chemical, Enzymes, Receptors. Drug-Receptor interactions: Receptor - Definition. Agonists, partial aganoists, inverse agonists and antagonists. Drug action not mediated through receptor.	06	CO2
III	Adverse drug reactions- Definition, Classification and drug induced side effects, biological effects of drug abuse and drug dependence, tachyphylaxis, idiosyneracy, drug allergy, drug tolerance and intolerance. Drug discovery- Animal toxicity studies and clinical evaluation Phase I-IV (Elementary details)	06	CO3
IV	Phytomedicine: Definition and Scope of Phytomedicine. Indian Medicinal systems- Ayurveda, Siddha and Unani. Medicinal properties and active principles of plant parts (leaves, flowers, roots, seeds, rhizome, bark etc). Role of medicinal and aromatic plants in national economy.	06	CO4
V	Secondary metabolites of plants - Alkaloids, flavonoids and terpenoids, phenols - occurrence, distribution and functions. (Synthesis not required). Extraction of Phytopharmaceuticals or crude drugs - (Aqueous, Methonol and Chloroform extracts) maceration, percolation (soxhlet) extraction. Pharmacological Screening of Plant Extracts (In vitro, In vivo and Toxicological Screening).	06	CO5
Text Books			

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

1.	<i>Tripathi, K. D.</i> 1999. Essentials of Medical Pharmacology . [Fourth Edition]. Jaypee Brothers Medical Publishers, New Delhi (UNIT - I, II & III).
2.	<i>Kokate, C. K., Purohit, A. P. and Gokhale, S.B.</i> 2007. Pharmacognosy . [Thirty Seventh Edition]. Nirali Prakasham, Pune. (UNIT - IV & V)
Reference Books	
1.	<i>Satoskar, R. S., Nirmala N. Rege and Bhandarkar S.D,</i> 2011. Pharmacology and Pharmacotherapeutics [Twenty-Second edition]. Popular Prakashan Pvt Ltd, Mumbai
2.	<i>Roseline, A.</i> 2011. Pharmacognosy . M.J.P Publishers, Chennai

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Describe the drug sources, classification and its pharmacodynamics
CO2	Explain the mechanisms of action and fate of drugs inside living organisms
CO3	Analyze the effects of adverse drug reactions
CO4	Appreciate the various medical systems that utilize phytoconstituents as medicines
CO5	Explore the new strategies in the development of efficient drugs to combat diseases from plants

MAPPING

PO,PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	H	M	H	H	M	H	M	H
CO2	H	M	H	M	H	H	M	H	M	H
CO3	H	M	H	M	H	H	M	H	M	H
CO4	H	M	H	M	H	H	M	H	M	H
CO5	H	M	H	M	H	H	M	H	M	H

H-High; M-Medium; L-Low

**Prepared by
Course Co-Ordinator**

**Approved by
BOS Chairman**

24PBCMBIP301/ 24PBCBTIP301	MDC PRACTICAL II: PHARMACEUTICAL BIOCHEMISTRY	SEMESTER - III	
Course Objectives:			
The Course aims			
<ul style="list-style-type: none"> • To enable the students to understand the basic concepts in extraction, screening, quantification process of secondary metabolites 			
Credits: 2		Total Hours: 24	
S.No.	EXPERIMENTS	Hrs	CO
1.	Extraction of phytoconstituents of neem leaves using water and methanol as solvents- Maceration and Soxhlet extraction	6	1
2.	Preliminary phytochemical screening for the presence of following constituents (i) Carbohydrates (ii) Lipids (iii) Proteins and Amino acids (iv) Phenols (v) Flavonoids (vi) Anthraquinones (vii) Alkaloids (viii) Terpenoids (xi) Glycosides (x) Saponins	3	1
3.	Quantitative estimation of proteins (Lowry's method).	3	2
4.	Quantitative estimation of carbohydrates (Anthrone method).	3	2
5.	Quantitative estimation of phenols (Singleton and Rossi's method).	3	2
6.	Isolation and partial purification of phytoconstituents (Phenol and Flavonoids) using Chromatographic techniques (TLC)	6	2
Reference Books			
1.	<i>Kokate, C.K., Purohit, A.P. and Gokhsale, S.B. 2008. Phytochemical Methods. NiraliPrakasham, Pune</i>		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Extract and screen the presence of various plant metabolites
CO2	Quantify the presence of biomolecules and secondary metabolites in samples

**Prepared by
Course Co-Ordinator**

**Approved by
BOS Chairman**

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PMBBCI301/ 24PMBBTI301	MDC II : INDUSTRIAL MICROBIOLOGY	SEMESTER III	
Course Objectives: The course aims 1. To learn the basics of bioprocess techniques. 2. To know about fermentor design and production of various fermented products.			
Credits: 02		Total Hours: 30	
UNIT	CONTENTS	Hrs	CO
I	An Introduction To Fermentation Process: Historical development of industrial microbiology- Component parts of a fermentation process - Screening of industrial microorganisms- primary screening - Crowded plate method, auxanography, indicator dye and enrichment. Secondary screening. Preservation of microorganisms - lyophilization, cryogenic storage.	06	CO1
II	Strain Improvement And Media Formulation: rDNA technology. Medium formulation and sterilization - batch, continuous. Types of fermentation -submerged - solid state fermentation.	06	CO2
III	Fermentor: Components and parts of fermentor - Body construction - stirring and mixing - scale up window - control of pH, temperature, foam and pressure - types of bioreactors - Air lift and cylindro conical bioreactors.	06	CO3
IV	Microbial Production Of Fermented Products: Antibiotics - Penicillin. Organic acid - Citric acid. Vitamin - Vitamin B12. Enzyme - α -amylase. Wine.	06	CO4
V	Downstream Processing: Intracellular products: Cell disruption methods - Mechanical, Physical, Chemical. Extracellular products: Solid to Liquid Separation: Flotation, Flocculation, Filtration and Centrifugation - Concentration: Evaporation - Liquid -Liquid Extraction: Membrane filtration, Precipitation- Purification - Chromatography. Formulation: Drying, Freeze drying and Crystallization.	06	CO5

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

Text Books:	
1.	<i>Stanbury, P.F., Whitaker, A., and Hall, S.J., 2012. Principles of Fermentation technology.</i> Reed Elsevier India Ltd., New Delhi.
2.	<i>Patel, A.H., 2022. An Introduction to Industrial Microbiology.</i> MacMillan India Ltd., Chennai.

Reference Books:	
1.	<i>Michael J Waites, John S Roackey, Neil L. Morgan and Garry Highton. 2006. Industrial Microbiology - An Introduction.</i> Blackwell Science Ltd., USA. <i>Hugo, W.B. and Russell, A.D. 2023. Pharmaceutical Microbiology.</i> [Ninth Edition]. Blackwell Scientific Company Ltd., USA.
2.	

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Recall the basics and importance of industrially important microbes.
CO2	Apply the techniques for the formulation of media for microbial products.
CO3	Develop the suitable conditions for maximum product yield.
CO4	Apply fermentation technology for production of microbial products.
CO5	Demonstrate chemotherapeutic drugs production under <i>invitro</i> conditions.

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

MAPPING										
PO & PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	M	H	H	M	H	H	H
CO2	M	H	M	M	H	H	M	H	H	H
CO3	M	H	M	M	H	H	M	H	H	H
CO4	M	H	M	M	H	H	M	H	H	H
CO5	M	H	M	M	H	H	M	H	H	H

H - High; M- Medium; L - Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PMBBCIP301/ 24PMBBTIP301	MDC PRACTICAL II: INDUSTRIAL MICROBIOLOGY	SEMESTER II	
Course Objectives:			
The course aims			
<ul style="list-style-type: none"> • To learn the basic techniques in industrial microbiology. • To acquire knowledge on antibiotics and its susceptibility. 			
Credits: 02		Total Hours: 24	
Experiment	CONTENTS	Hrs	CO
1.	Screening of antibiotic producing organisms from soil.	3	CO1
2.	Screening of amylase enzyme producing organisms from soil.	3	CO1
3.	Antibiotic sensitivity disc preparation.	3	CO1
4.	MIC determination by filter paper disc assay.	3	CO2
5.	Antibiotic susceptibility method- Kirby Bauer method.	3	CO2
6.	Evaluation of disinfectant- Phenol Coefficient method.	3	CO2
7.	Wine production and Estimation	6	CO2
Reference Books:			
1.	<i>Gerald Collee, J. Barie P. Marmion, Andrew, G. Fraser and Anthony Simmons. 1996. Mackie and MacCartney Practical Medical Microbiology. Fourteenth edition. Churchill Livingstone Publishers.</i>		
2.	<i>Sundararaj, T. Microbiology Laboratory Manual. Dr.A.L.Mudaliyar Post Graduate Institute of Basic Medical Sciences, Chennai.</i>		

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Assess antibiotic and enzyme production and produce industrially important products.
CO2	evaluate the susceptibility of antibiotics and disinfectants.

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

24PBTMP301	DSC PRACTICAL-III	SEMESTER - III	
OBJECTIVE: Lab in Developmental biology, Plant and Animal tissue culture technology.			
Credit: 3	LIST OF EXPERIMENTS	Total Hours: 60	
S.No		Hrs	CO
1)	Media preparation for Animal Cell Culture and Sterilization.	06	CO1
2)	Preparation of Chick embryo Fibroblast culture	06	
3)	Determination of viability of cells using Trypan blue exclusion assay	06	CO2
4)	Establishment of Primary cell lines	06	
5)	Isolation of Protoplast	06	CO3
6)	Isolation of Genomic DNA from Plant by CTAB method	06	
7)	Preparation of media for Plant Tissue Culture and sterilization	06	CO4
8)	Callus induction	06	
9)	Micropropagation	06	
10)	Seed germination, Root and Shoot induction	06	

REFERENCE BOOKS	
1	<i>Joseph Sambrook and David W. Russell, 2001. Molecular cloning - A laboratory manual Volume 1 to 3. [Third Edition]. Cold Spring Harbor Laboratory Press, New York.</i>
2	<i>Janarthanan,S. and Vincent,S.2009. Practical Biotechnology: Methods and Protocols. [Second Edition]. Universities press, (India) Pvt Ltd, Hyderabad.</i>
3	<i>Sudha Gangal, 2010. Principles and Practice of Animal Tissue Culture. [Second Edition]. University Press (India) Pvt. Ltd.</i>
4	<i>Freshney, R.I.2005.Culture of Animal Cells: A manual of basic technique. [Fifth Edition]. John Wiley and Sons, New Jersey.</i>
5	<i>Aneja, K.R. 2003. Experiments in Microbiology, Plant pathology and Biotechnology. [Fourth Edition]. New age international.</i>
6	<i>Bhojwani, S.S. and Razdan, M.K. 2008. Plant Tissue Culture- Theory and Practice. Elsevier Publishers, New Delhi.</i>

Prepared By

Approved By

24PBTMP302	DSC PRACTICAL IV: STATISTICAL SOFTWARE (SPSS)	SEMESTER- III	
The Course aims <ul style="list-style-type: none"> • To give a good grip on concepts in analyzing the data using statistical software 			
Credit:2		Total Hours: 24	
PROGRAM	CONTENTS	Hrs.	CO
1	Diagrams and graphs	03	CO1
2	Measures of Central Tendency	03	CO2
3	Measures of Dispersion	03	CO2
4	Correlation Coefficient (Karl Pearson and Spearman Rank Method)	03	CO3
5	Regression lines	03	CO3
6	Small Sample Test (t and F)	03	CO4
7	Chi-square Test for Independence of Attributes.	03	CO4
8	ANOVA (one way and two way classification)	03	CO4
REFERENCE BOOKS			
1.	<i>ShentanJ. Coakes, Lyndall Steed and Peta Dzidic. SPSS 13.0 version for Windows Analysis without Anguish.</i> John Wiley & Sons, Australia.		
2.	<i>Andy Field.2006.Discovering Statistics using SPSS.[Second Edition].</i> SAGE Publications.		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Demonstrate the data in diagrammatic and graphical representation
CO2	Find the averages and measures dispersion
CO3	Calculate correlation and regression for huge amount data
CO4	Gain knowledge about test of significance

Prepared by
Course Co-Ordinator

Approved by
BOS Chairman

24PBTM401	DSC XII: FOOD AND PHARMACEUTICAL BIOTECHNOLOGY	SEMESTER - IV	
Course objectives			
<ol style="list-style-type: none"> 1. To understand the basics about the food and food products. 2. To understand the basics about the pharmaceutical biotechnology 			
Credits: 6		Total Hours: 50	
UNIT	CONTENTS	Hrs	CO
I	Constituents and dietary sources of food – Carbohydrates, Lipids, Proteins, Water, Vitamins and Minerals, Fermented Cereals food: Soy Sauce, Miso, Idli. Fermented fish products. Fermentation of vegetables: Sauerkraut Pickles, Cheese, Yoghurt.	10	CO1
II	Production of bread, distilled beverages- wine and beer. Production of food flavourant and colorants, Production of baker’s yeast, Food spoilage – Factors responsible for spoilage. Poultry products and processing.	10	CO2
III	Principles and methods of food preservation: Asepsis removal, Anaerobic conditions, Preservation by use of high temperature, low temperature, drying, food additives, radiation, Pasteurization, Blanching, Canning, Drying and Dehydration. Application of Nanotechnology in food preservation. Various packaging methods.	10	CO3
IV	History and scope of Pharmaceutical biotechnology, Production of antibiotics from the microbes- penicillin, streptomycin, Manufacturing of drugs and principles. Packing techniques of Drugs and tablets.	10	CO4
V	Quality assurance and control – concept of good manufacturing practices, role of FDA, and their release into the market, Hormones. Drug metabolism – biotransformation of drugs, enzymes responsible for biotransformation, microsomal and non-microsomal mechanisms, Pharmacology - pharmacodynamics pharmacokinetics, FDA, FSSAI, ISO.	10	CO5
Text Books			
1	<i>Jay, J.M.</i> 1987. Modern Food Microbiology . [Third Edition]. CBS Publications, New Delhi.		
2	Shakuntala Manay and Shadasharasamy, 1997. Foods; Facts and principles, New Age International Publishers, New Delhi.		

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3	P.Fellows.1988. Food Processing Technology. Principles and practice. Ellis Horwood International publishers, Chichester, England.
4	Crosby,N.T.1981. Food packaging Materials Applied Science Publishers, London.
Reference Books	
1	<i>Daan,J.,Crommelin,A.,RobertD.Sindelar,BerndMeibohm,2008.Pharmaceutical Biotechnology- Fundamentals and Applications.</i> Informa Healthcare USA, Inc.
2	<i>Toledo, R.T.1980. Fundamentals of Food Processing.</i> [Third Edition]. AVI Publishing Company, USA.
3	Food Processing: Principles and Applications edited by J. Scott Smith and Y.H. Hui. 2004. Published by Blackwell Publishing, 2004.
4	<i>Kayser.O.and Müller,R.H.2004. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications.</i> Wiley Publications.

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1	Explain dietary sources and fermented food products.
CO2	Illustrate the production of beverages, food colorants as well as factors responsible for food spoilage.
CO3	Demonstrate the principles and methods of food preservation.
CO4	Know the production, manufacturing of antibiotics and drugs and tablet packaging..
CO5	Learn the role of FDA, drug metabolism and pharmacology.

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	H	M	M	H	H	H
CO2	H	H	H	H	H	H	H	M	H	M
CO3	H	H	H	H	H	H	H	H	H	M
CO4	H	H	H	M	H	H	H	H	H	M
CO5	H	H	H	H	H	H	H	H	M	M

H-High; M-Medium; L-Low

**Prepared By
(Course Coordinator)**

**Approved By
(BoS Chairman)**

24PBTM402	DSC XIII: ENVIRONMENTAL BIOTECHNOLOGY	SEMESTER - IV	
Course objectives			
To know about environment and to get knowledge about applications of Biotechnology to protect and to develop our environment.			
Credits: 5		Total Hours: 50	
UNIT	CONTENTS	Hrs	CO
I	Basic concepts and issues, Environmental pollution – air, water and soil, its control measures. Ozone depletion, UV-B, green-house effect and acid rain. Environmental Impact Assessment- Introduction, steps and its importance. Impact of chemicals and biological warfare agents on environment.	10	CO1
II	Aerobic System -Biological processes for domestic and industrial waste water treatments; Activated sludge process, Trickling filters, Biological filters, Rotating biological contractors, Fluidized bed reactor, Expanded bed reactor, Inverse fluidized bed biofilm reactor, Packed bed reactors, Air- sparged reactors, Anaerobic System- Anaerobic biological treatment - Contact digesters, Packed column reactors, UASB.	10	CO2
III	Introduction, constraints and priorities of Bioremediation, Bio augmentation, <i>in situ</i> , <i>ex situ</i> , intrinsic & engineered bioremediation, Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Bio sparging; Liquid phase bioremediation - Suspended bioreactors, Fixed biofilm reactors. Bioremediation of oil contaminated soil and water.	10	CO3
IV	Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects. Production of nonconventional fuels - Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery. CO ₂ sequestration in the environment.	10	CO4
V	Introduction - Xenobiotic compounds, recalcitrance. Biodegradation of Xenobiotics. Application of Biotechnology for hazardous waste management – examples - cyanide detoxification	10	CO5

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	- detoxification of oxalate, urea and toxic organics like phenols.		
Text Book			
1	<i>Rao,C.S.1999. Environmental Pollution Control Engineering. [First Edition]. NewAge International (P) Limited, New Delhi.</i>		
2	<i>Atlas and Bartha. 1998. Microbial ecology. [Fourth Edition]. Benjamin Science Publishing (P) Ltd.</i>		
3	<i>Indu Shekhar Thakur. 2011. Environmental Biotechnology-Basic concepts and applications [Second Edition]. I.K. International Publishing House PvtLtd.</i>		
Reference Books			
1	<i>Wesley,W.and Eckenfelder,J.R.2000.Industrial Water Pollution Control.[Third Edition]. Mc Graw - Hill Higher Education.</i>		
2	<i>Evans, G. M. and Furlong, J. C. 2003. Environmental Biotechnology: Theory and Application. John Wiley & Sons Ltd ISBN 0-470-84372-1 (HB)</i>		
3	<i>Martin Alexander, 1999. Biodegradation & Bioremediation. Academic Press.</i>		
4	<i>Ronald.L.CrawfordandDonL.Crawford,1998.Bioremediation Principles and Application.[First Edition]. Cambridge University Press.</i>		

COURSE OUTCOMES:	
At the end of the course, the students will be able to	
CO1	Solve the environmental issue through biotechnological approaches.
CO2	Treat the industrial waste water by biological treatment.
CO3	Apply bioremediation to the contaminated soil and water.
CO4	To use microbes to leach metals and to produce biogas.
CO5	Manage the hazardous waste and to detoxify them.

MAPPING:

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	M	H	M	H	M	H
CO2	M	H	H	M	H	H	H	H	H	H
CO3	H	H	H	H	H	H	M	H	M	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H

H-High; M-Medium; L-Low

Prepared By

(Course Coordinator)

Approved By

(BoS Chairman)

GUIDELINES

1. SUBMISSION OF RECORD NOTE BOOKS AND PROJECT DISSERTATION:

Candidates appearing for Practical Examinations and Project Viva-Voce shall submit Bonafide Record Note Books/Dissertation prescribed for Practical/Project Viva-Voce Examinations, otherwise the candidates will not be permitted to appear for the Practical/ Project Viva-Voce Examinations.

2. PASSING MINIMUM AND INTERNAL MARK DISTRIBUTION (Theory, Practical and Project)

THEORY:

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 50 marks put together out of 100 in the Comprehensive Examination in each Theory paper with a passing minimum of 38 marks in External out of 75.

Internal Marks Distribution [CA-Total Marks: 25]

Attendance	:5 Marks
Assignment	:5 Marks
Seminar	:5 Marks
Internal Examinations	:10 Marks
Total	: 25 Marks

Question paper pattern for theory examinations (Maximums marks: 75)

PART-A (10 x 1 = 10 Marks)

Answer all questions (MCQ)

(Two questions from each unit)

PART-B (5 x 5= 25 Marks)

Either or Type questions

(One question from each unit with Internal Choice questions)

PART-C (5 × 8= 40 Marks)

Either or Type questions

(One question from each unit with Internal Choice questions)

PRACTICAL:

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 50 marks put together out of 100 in the Comprehensive Examination in each Practical paper with a passing minimum of 30 marks in External out of 60.

Marks Distribution

Continuous Assessment (CA)- 40marks

Comprehensive Examination (CE)-60marks

Internal Marks Distribution [CA-Total Marks: 40]

Experiment	:10 Marks
Attendance	:5 Marks
Record	:5 Marks
Internal Examinations	:20 Marks
Total	: 40Marks

Comprehensive Exam Marks Distribution [CE-Total Marks: 60]

Major experiment	:25 Marks
Minor experiment	:15 Marks
Spotters	:5X3=15 Marks
Viva-voce	:05 Marks
Total	: 60Marks

Key for evaluation of Practical Examination

1. Major(25Marks)

Procedure	:15Marks
Performance	:05Marks
Result	:05Marks

2. Minor (15Marks)

Procedure	:10Marks
Performance	:03Marks
Result	:02Marks

3. **Spotters** :5x3=15 Marks

4. **Viva-Voce** :05 Marks

SUMMER INTERNSHIP:

The student has to undergo Summer Internship at the end of II semester for a minimum of 15days.

He/She has to submit the report, present their work and it will be evaluated by an Internal examiner.

PROJECT WORK /DISSERTATION

The project work shall be carried out by each student in III & IV semester and has to complete the work at the end Semester.

- Upon completion of the project work/dissertation the candidate will be required to appear for a viva-voce conducted by an external examiner.
- The Student has to attend three reviews before completing his/her Project.
- All three reviews will be reviewed by Subject expert.
- A candidate failing to secure the prescribed passing minimum in the dissertation shall be required to re-submit the dissertation with the necessary modifications.

Mark Distribution Pattern

Comprehensive Examination (CE) :60 Marks
Continuous Assessment (CA) :40 Marks

The candidate shall be declared to have passed the Examination, if the candidate secures not less than 50 marks put together out of 100. In the Comprehensive Examination in Project with a passing minimum of 30 marks in External out of 60.

Internal Mark Distribution [CA-Total Marks: 40 Marks]

1. Attendance	:	10Marks
2. Review (2)	:	20Marks
3. Presentation:		10Marks
Total	:	40Marks

External Mark Distribution [CE-Total Marks:60 Marks]

1. Project report	: 20Marks
2. Research work done	: 20Marks
3. Presentation	: 10 Marks
4. Viva-Voce	:10Marks
Total	: 60 Marks

AEC: CCS (100% Internal Evaluation)

CCS Internal Marks Distribution (CA-Total Marks: 100)

Attendance:	10 Marks
Assignment / Listening / Speaking:	50 Marks (5 Assignments Compulsory)
Class test:	40 Marks (2 Test Compulsory)
Total:	100 Marks

The candidate shall be declared to have passed the examination if he / she secure at least 40 marks for UG Programme and at least 50 marks for PG Programme, out of a total of 100 marks.

MULTI DISCIPLINARY COURSES (MDC)

S.NO	SUBJECT CODE	SUBJECT	SEMESTER	OFFERED TO THE STUDENTS OF
1	24PBTMBI201/ 24PBTBCI201	MDC I: Plant Tissue culture technology	II	Microbiology/Biochemistry
2	24PBTMBIP201/ 24PBTBCIP201	MDC Practical I: Plant Tissue culture technology	II	Microbiology/Biochemistry
3	24PBTMBI301/ 24PBTBCI301	MDC II: Animal Cell culture technology	III	Microbiology/Biochemistry
4	24PBTMBIP301/ 24PBTBCIP301	MDC Practical II: Animal Cell culture technology	III	Microbiology/Biochemistry

24PBTMBI201/ 24PBTBCI201	MDC I: PLANT TISSUE CULTURE TECHNOLOGY	SEMESTER- II	
Course Objectives:			
The Course aims			
<ul style="list-style-type: none"> To understand the basic techniques in plant tissue culture. 			
Credits:2		Total Hours:30	
UNIT	CONTENTS	Hrs	CO
I	Introduction to Plant cells: Types of plant cells, Principles of plant tissue culture, Tissue culture media, Growth regulators and Sterilization techniques.	06	CO1
II	Callus and suspension culture, Micropropagation, Meristem culture, Somatic embryogenesis, Protoplast isolation, Fusion of protoplast, Somaclonal variations.	06	CO2
III	<i>Agrobacterium</i> mediated gene transfer, <i>Agrobacterium</i> -based vectors, direct gene transfer methods - electroporation, microinjection, particle bombardment.	06	CO3
IV	Genetic engineering for quality improvement-Protein, lipids, carbohydrates, and vitamins, Production of resistant plants - Herbicide resistance, Insect resistance (Bt approach), Abiotic stress tolerance plant production-Drought, temperature and salt.	06	CO4
V	Secondary metabolites from plants: Alkaloids, flavonoids and phenolic compounds, Germplasm conservation.	06	CO5
Text Book			
1	<i>Bhojwani, S.S., and Razdan, M.K.</i> 2008. Plant Tissue Culture - Theory And Practice. Elsevier Publishers, New Delhi.		
Reference Books			
1	<i>Chawla, H.S.</i> 1998. Biotechnology in Crop Improvement. International Book Distribution Co., New Delhi.		

M.Sc.,Biotechnology (Students admitted from 2024-2025 onwards)

2	<i>Hopkins, W.G. and Hiiner,N.P.A.2004. Introduction to Plant Physiology. [Third Edition].John Wiley and Sons, New Jersey, USA.</i>
3	<i>Jain, V.K. 2013. Fundamentals of Plant Physiology. [Fifth Edition]. S. Chand and Company, NewYork.</i>
4	<i>Trivedi, P.C.2004. Advances in Plant Physiology. [Third Edition]. I.K.International Publications Pvt Ltd., New Delhi.</i>

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Simplify the types of plant cells and will able to utilize various Sterilization techniques
CO2	Utilize the micropropagation and isolation of plant tissue
CO3	Analyze the techniques for Transfer gene by biological and physical method
CO4	Contrast the benefits and develop the genetically modified crops
CO5	Demonstrate the Extraction and identification of secondary metabolites

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	H	M	M	M	M	H	H
CO2	H	M	M	H	H	M	M	M	H	H
CO3	H	M	M	H	M	M	H	H	M	M
CO4	H	M	M	H	L	M	M	M	H	H
CO5	H	M	M	H	M	M	H	H	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTMBIP201/ 24PBTBCIP201	MDC PRACTICAL I: PLANT TISSUE CULTURE TECHNOLOGY	SEMESTER-II	
Course Objectives: The Course aims <ul style="list-style-type: none"> • To get hands on experience on Plant tissue culture. 			
Credits:2		Total Hours: 24	
S.No	EXPERIMENT	Hrs	CO
1.	Media preparation	06	CO1
2.	Hormone stock solution preparation	06	
3.	Callus induction	03	
4.	Micropropagation	03	
5.	Protoplast isolation	03	
6.	Synthetic seed preparation	03	
Reference Book			
1	<i>Aneja, K.R.</i> 2003. Experiments in Microbiology, Plant pathology and Biotechnology. [Fourth Edition].New age international.		
2	<i>Bhojwani, S.S.and Razdan, M.K.</i> 2008. Plant Tissue Culture–Theory and Practice. Elsevier Publishers, NewDelhi.		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Prepare media for plant tissue culture and cultivate the plant tissues/cells.
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Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTMBI301/ 24PBTBCI301	MDC II: ANIMAL CELL CULTURE TECHNOLOGY	SEMESTER - III	
Course Objectives: The Course aims <ul style="list-style-type: none"> To understand the basic techniques in Animal cell culture. 			
Credits: 2		Total Hours: 30	
UNIT	CONTENTS	Hrs	CO
I	Introduction to Animal cell culture, Applications of cell culture, Designing the cell culture laboratory - washing and sterilization area, Storage area and cell culture room, Equipments in tissue culture laboratory - Inverted Microscope, Centrifuge, Laminar flow benches, CO2 incubator.	06	CO1
II	Glass ware and other plastic ware in tissue culture Substrate materials for growing cells, cell culture vessels, culture media - Properties and special requirements, Complete media, Conditioned media.	06	CO2
III	Type of cell culture - Isolation of primary explants culture, Isolation of cells and disaggregation method cell culture, organ culture.	06	CO3
IV	Cell culture-Transformation, Differentiation and Dedifferentiation, Growth curve of cells, Types of microbial contamination, Stem cell culture.	06	CO4
V	Applications of Animal cell culture technology -Somatic cell fusion, Transgenic fish and sheep.	06	CO5

Reference Books	
1	<i>Sudha Gangal, 2010. Principles and Practice of Animal Tissue Culture. [Second Edition]. University Press (India) Pvt. Ltd.</i>
2	<i>Freshney, R.I. 2005. Culture of Animal Cells: A manual of basic technique. [Fifth Edition]. John Wiley and Sons, New Jersey.</i>

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Handle animal cells and familiar with instruments
CO2	Prepare animal tissue culture media for culturing animal cells
CO3	Disaggregate the animal tissues
CO4	Differentiate cells and stem cells
CO5	Apply the animal cell culture technology in day to day life

MAPPING

PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	H	M	M	M	M	H	H
CO2	H	M	M	M	H	M	M	M	H	H
CO3	H	H	M	H	M	M	H	H	M	M
CO4	H	M	M	M	L	M	M	M	H	H
CO5	H	M	M	H	M	M	H	H	M	M

H-High; M-Medium; L-Low

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)

24PBTMBIP301/ 24PBTBCIP301	MDC II: ANIMAL CELL CULTURE TECHNOLOGY	SEMESTER -III	
Course objectives: The Course aims <ul style="list-style-type: none"> • To get hands on experience on Animal cell culture. 			
Credits:2		Total Hours: 24	
S.No	EXPERIMENT	Hrs	CO
1.	Sterilization techniques in Animal cell culture	06	CO1
2.	Media preparation for Animal cell culture	06	
3.	Primary culture of Chick embryo fibroblast	03	CO2
4.	Trypsinization and subculturing	06	
5.	Determination of viability of cells using Trypan blue stain.	03	CO3
Reference Book			
1	<i>Freshney, R.I.</i> 2005. Culture of Animal cells: A manual of basic technique. [Fifth edition]. John Wiley and Sons, New Jersey.		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Sterilize the media and utensils for Animal cell culture
CO2	Cultivate the animal cells and maintain it for further studies.
CO3	Analyze viable cells.

Prepared By
(Course Coordinator)

Approved By
(BoS Chairman)