DHANALAKSHMI SRINIVASAN

COLLEGE OF ARTS AND SCIENCE FOR WOMEN (AUTONOMOUS)

Affiliated to Bharathidasan University, Tiruchirappalli

(Nationally Re-Accredited with A++ Grade by NAAC)

Perambalur – 621212.

M.SC BIOTECHNOLOGY

Choice Based Credit System-Learning Outcomes Based Curriculum Framework (CBCS-LOCF)

(Applicable to the candidates admitted from the academic year 2024-25 onwards)

PG BIOTECHNOLOGY									
Programme Pattern									
Sem	**Course**	**Course Title**	**Course Code**	**Hrs**	**Credit**	**Exam hrs**	**CIA**	**SE**	**Total**
I	CORE COURSE-I	Biochemistry and Biophysics	24PBT1C1	6	6	3	25	75	100
	CORE COURSE-II	Cell and Molecular Biology	24PBT1C2	5	5	3	25	75	100
	CORE COURSE-III	Microbiology	24PBT1C3	5	5	3	25	75	100
	CORE PRACTICAL-I	Lab in Cell and Molecular Biology and Microbiology	24PBT1C1P	6	3	6	40	60	100
	CORE ELECTIVE-I	A) Bioinformatics	24PBT1E1A	5	3	3	25	75	100
		B.) Biostatistics	24PBT1E1B						
	VALUE ADDED COURSE-1	Biofertilizer/ Biopesticides	24PBT1VAC	3	2	3	25	75	100
				30	**24**				**600**
II	CORE COURSE-IV	Enzyme Technology and Bioinstrumentation	24PBT2C4	5	5	3	25	75	100
	CORE COURSE-V	rDNA Technology	24PBT2C5	5	5	3	25	75	100
	CORE COURSE-VI	Microbial Technology	24PBT2C6	4	4	3	25	75	100
	CORE COURSE-VII	Immunology	24PBT2C7	4	4	3	25	75	100
	CORE PRACTICAL-II	Lab in Enzyme Technology , Recombinant DNA Technology and Immunology	24PBT2C2P	6	3	6	40	60	100

	INDUSTRIAL BASED COURSE	Bioentrepreneurship	24PBT2I	3	3	3	25	75	100
	NON MAJOR ELECTIVE-I	A.) Artificial Intelligence in Biology	24PBT2N1A						
		B.) Herbal Medicine	24PBT2N1B	3	2	3	25	75	100
		Self-Paced learning-Mooc		-	2*	3			
				30	**26**				**700**
III	CORE COURSE-VIII	Plant Biotechnology	24PBT3C8	6	6	3	25	75	100
	CORE COURSE-IX	Animal Biotechnology	24PBT3C9	5	5	3	25	75	100
	CORE COURSE-X	Environmental biotechnology	24PBT3C10	5	5	3	25	75	100
	CORE PRACTICAL-III	Lab in Plant, Animal &Environmental biotechnology	24PBT3C3P	6	3	6	40	60	100
	CORE ELECTIVE-II	A.) Genomics and Proteomics	24PBT3E2A			3	25	75	100
		B.) Agricultural Biotechnology	24PBT3E2B	5	3				
	NONMAJORE LECTIVE-II	A.) Bioremediation	24PBT3N2A	3	2	3	25	75	100
		B.) Food biotechnology	24PBT3N2B						
		Internship/Field Study/ Industrial Visit	24P3IV		1				100
		Self-paced learning-II Online course			2*				
				30	**25**				**600**
IV	CORE COURSE-XI	Research Methodology	24PBT4C11	6	6	3	25	75	100
	CORE ELECTIVE-III	Marine Biotechnology	24PBT4E3A	6	3	3	25	75	100
		IPR, Biosafety and Bioethics	24PBT4E3B						
	ROJECT WORK	Project Work	24PBT4PW	18	6	3	40	60	100
				30	**15**				**300**
			TOTAL	**120**	**90**				**2200**
					90(4*)				**2200**

DHANALAKSHMI SRINIVASAN

COLLEGE OF ARTS AND SCIENCE FOR WOMEN (AUTONOMOUS)

Affiliated to Bharathidasan University, Tiruchirappalli

(Nationally Re-Accredited with A++ Grade by NAAC)

Perambalur – 621212.

M.Sc., BIOTECHNOLOGY

Choice Based Credit System-Learning Outcomes Based Curriculum Framework (CBCS-LOCF)

(Applicable to the candidates admitted from the academic year 2024-25 onwards)

The College Offers M.Sc., Biotechnology

Course Duration : 2 Years (4 Semester)

Course Value 90

	Theory	Practical /Field work	Dissertation	Total
Core papers	56 credits	9 credits	6 credits	71 credits
Elective papers	9 credits	1 credits	Nil	10 credits
Value added course	2 credits	Nil	Nil	2 credits
Non major elective	4 credits	Nil	Nil	4 credits
Industrial based course	3 credits	Nil	Nil	3 credits

M.Sc. Biotechnology program that includes theory and Practical in various areas of biotechnology. Additionally, it comprises one individual dissertation project in the 4th semester. These projects aim to enhance knowledge and research skills in biotechnology throughout the course.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- To impart theoretical and practical knowledge and skills that underpins the various branches of biotechnology.
- To enable the students to have a thorough understanding and knowledge of different branches of biotechnology.
- To make the students develop the ability to think analytically in solving problems concerned with biotechnology

PROGRAMME OUTCOMES

- Graduates will be able to analyse and interpret data
- Graduates will be able to engage in socially relevant research
- The graduates will acquire the skills in approaching and solving challenges related to healthcare, agriculture and environmental sectors through Biotechnological approaches.
- It will provide the students to develop independent learning skills in all biochemical and biotechnology studies.
- This course will help in contributing to the education of academics which impart its effect for university to play an active role in other advanced studies.

PROGRAMME SPECIFIC OUTCOMES

- Post graduates will acquire knowledge in the domain of Biotechnology with respect to emerging concepts and techniques.
- Post Graduates will be able to identify, understand, design, perform experiments and apply the acquired skills in solving complex biotechnology problems using modern tools and techniques.
- Post graduates will gain the theoretical and practical exposure to the basic and the advanced fields of biotechnology.
- Post graduate will develop confidence for self-education and ability for life-long learning.

CORE COURSE- I

BIOCHEMISTRY AND BIOPHYSICS

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1C1**	**Credit**	**: 06**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

OBJECTIVES: To gain a basic knowledge about the chemical bonding in biological system. To have a detailed knowledge about the function and properties of biomolecules and to learn about the basic metabolic reactions of living organisms. To have a basic knowledge about the enzymes and biological energy transducers. Thorough understanding of the analytical techniques and equipment used in biological science and to have a fundamental knowledge regarding the Microscopy and Spectroscopy. To acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles.

UNIT I - CHEMICAL BONDING IN BIOLOGICAL SYSTEM

Percentage solution, molarity, normality, molality, properties of water- hydrogen bonding, hydrophobic interactions, acids bases and their concepts, buffers, Henderson-Hassel batch Equation & biological buffers, and electrolytes & their functions – acidity, alkalainity and pH determination - Basic Thermodynamics, laws of thermodynamics - Enthalpy and Entropy relations.

UNIT II: BIOMOLECULES

Biomolecules – Introduction- classification, function and properties. Carbohydrate Metabolism: Glycolysis & TCA cycle and its Energetics. Transamination and oxidation domination reactions of amino acids. Amino acids catabolisms (phenylketonuria, albinism). Protein metabolism – Urea cycle and its significance, pathway controlling protein degradation. Metabolic disorders associated with protein metabolism. Lipid Metabolism: Biosynthesis of Fatty acids; Triglycerides; Phospholipids; Sterols. β-oxidation of fatty acids

UNIT III: ENZYMES

Classification and nomenclature of enzymes - physico chemical nature of enzymes – enzyme kinetics – mechanism of enzyme action – factors affecting enzyme activity, industrially important enzymes.

UNIT IV: BASIC INSTRUMENTS

pH meter, isoelectric focusing. Principles and application of light microscopy, phase Contrast, Bright and Dark field Microscopy fluorescence Microscopy, Electron Microscopy- TEM, SEM, Confocal microscopy and atomic absorption microscopy.

Diffraction Methods: Principles, Components and applications of X-ray crystallography. Determination of crystal structure, colorimeter, Spectroscopy – Raman effect, UV-Visible, Mass spectroscopy, Atomic Absorption spectroscopy, NMR –Experimental techniques and instrumentation, LASER -Principle and applications**.**

UNIT V: TRACER TECHNIQUES

Radioactive and stable isotopes: Pattern and rate of radioactive decay isotope-Half life, GM counter, solid and liquid scintillation counter, Radiation dosimetry, Radio tracer technique, Autoradiography. Application of isotopes in Biology.

UNIT VI: Latest Learning's (For CIA Purpose only)

Latest development related to the course during the semester concerned

TEXT BOOK(S):

1.Biochemistry, Sathyanarayanan.U and Chakrapani.C, (2013), Books and allied (P) Ltd

2.Fundamentals of Biochemistry, Deb,A.C., (7^{th} Edition). New central agency.

3.Fundamentals of Biochemistry, Jain, J.L., (2005), (6^{th} Edition), S.Chand Publications

4.Enzymes, Ashokan.P, 2006, Chinna Publications

5. Molecular Biology, Freifelder. D, 1996, II Edition, Narosa Publishing House, New Delhi.

6.Biophysical chemistry – principles and techniques, Upadhyay, Upadhyay and Nath, 3^{rd}edition, 2002, Himalaya publishing home.

7.Laboratory manual in biochemistry, J.Jayaram 1981, Wiley publisher.

8.Bioinstrumentation, L. Veerakumari, 1^{st} edition 2011, MJP publishers**.**

REFERENCE BOOK(S)

1. Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5th edition 2000, Cambridge University press.
2. Analytical biochemistry, D. Holme and H.Peck, 3rd edition 1998, long
3. man.
4. Physical biochemistry- application to biochemistry and molecular biology, Frei Felder, 2nd edition, 1982, W. H.Freeman and company, San Fransisco.
5. Introduction to Protein Structure, Carl Branden and John Tooze, 1999, Second Edition,Garland Publishing.
6. Biochemistry, Garrett.R and Grisham.C, 2010, 4th Edition, Saunders College Publishing.
6. Principles of Biochemistry, Lehninger, Nelson, David.L and M.M.Cox, 2013. 6th Edition,W.H.Freeman & Co.

NET REFERENCE:

- NPTEL: Chemistry and Biochemistry - NOC:Essentials of Biomolecules : Nucleic AcidsandPeptides
- https://archive.nptel.ac.in/content/storage2/courses/104103018/pdf/mod3.pdf Enzyme Definition and Classification - Creative Enzymes (creative-enzymes.com)Microscopy: Intro to microscopes & how they work (article) | Khan Academy Tracer Technique - YouTube
- https://www.pursuitphysics.in/2020/08/radiation-detectors-part-1.html https://microscopiaiwm.com/2021/03/18/autoradiography https://onlinecourses.nptel.ac.in/noc20_mm22/preview https://onlinecourses.nptel.ac.in/noc20_bt18/preview https://onlinecourses.nptel.ac.in/noc21_cy13/preview

COURSE OUTCOMES		Knowledge Level
Upon Completion of course the students will be able to		
CO - 1	Knowledge for preparation of different buffers	K1
CO - 2	Students will be imparted complete knowledge about structure and function of different biomolecules (proteins, lipids, nucleic acids, and carbohydrates) found in living cells.	K2
CO - 3	Evaluating the mechanism of enzyme action	K5
CO - 4	Understand the principles of instruments	K4
CO - 5	Apply the concepts of bioanalytical techniques in biotechnology research	K3

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
1	**24PBT1C1**		**CORE COURSE-I :**BIOPHYSICS AND BIOCHEMISTRY							**6**	**6**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	3	2	2	3	2	3	2	2
CO2	2	3	2	2	3	3	2	3	2	2	2
CO3	3	2	2	2	3	2	3	2	3	2	2
CO4	2	3	2	3	2	3	2	3	3	3	3
CO5	3	2	3	3	2	3	2	3	2	3	2
Mean Overall Score											2.4 HIGH

CORE COURSE- II

CELL & MOLECULAR BIOLOGY

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1C2**	**Credit**	**: 05**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

OBJECTIVES: Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.Students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells.This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.Understand the essentials of molecular biology: replication, transcription and translation; enzymes involved inthe central dogma of life, proofreading, inhibitors and post modifications. Knowledgeable in mutant and it types, genetic recombination, linkage, multifactor crosses; mutation: causative agents, types and the mechanism of repair; complementation and intragenic complementation.

UNIT I: CELL THEORY

Cell as a basic unit - classification of cell types - cell theory - organization of plant and animalcells - comparison of microbial, plant and animal cells. An Overview of Cells: prokaryotic andeukaryotic cells, cell size and shape, Phage's, Viroid's and Mycoplasma. Structure of Cell andits organelles: Molecules of cell, Plasma membranes (Structure, models, functions, channels, pumps and receptors) Membrane lipids, proteins and carbohydrates - Plasmodesmata. Ultra structure of organelles: ribosome, ER and Golgi body. Nucleus - Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromosomes and its types.

UNIT II: DNA REPLICATION AND REPAIR

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNAreplication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments,Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replicationin eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT III: TRANSCRIPTION

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancersequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

UNIT IV: TRANSLATION

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post- translational modifications and its importance.

UNIT V: REGULATION OF GENE EXPRESSION

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of generegulation, Prokaryotic gene regulation –lac and trp operon, Regulation of gene expression withreference to λ phage life cycle.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

TEXT BOOK(S):

1. JFriefelder, David. "Molecular Biology." Narosa Publications, 1999.
2. Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hill, 2003.
3. Karp, Gerald "Cell and Molecular Biology: Concepts and Experiments" 4th Edition, JohnWiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition,Panima Publishing, 1993.
5. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).

REFERENCE BOOK(S):

6. Molecular Biology: Genes to Proteins" Tropp, Burton E. 3rd Edition. Jones and Bartlett
7. Molecular Biotechnology: Principles and Applications of Recombinant DNA" Glick, B.R.and J.J. Pasternak. 4th Edition.

NET REFRENCES:

NPTEL: Biotechnology - NOC:Cell Biology: Cellular organization, division and processesCell Biology: Cellular organization, division and processes - Course (nptel.ac.in) https://youtu.be/WsofH466lqk

https://youtu.be/QcBYTA7uVXk

https://youtu.be/vqY-PvUKm8Q

CO. No.	COURSE OUTCOMES	Cognitive level
On completion of this course, the students will be able to		
CO-1	Describe the basic structure and functioning of the genetic elements.	K1
CO-2	Explain the molecular mechanisms of bacterial & eukaryotic transcription, and translation respectively.	K2& K3
CO-3	Examine the causative factors of genetic related disorder.	K4
CO-4	Compare and contrast the mechanisms of bacterial and eukaryotic DNA replication and DNA repair.	K3
CO-5	Create appropriate DNA profiling tools and inspect the efficacy of particular techniques in their research projects.	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
I	**24PBT1C2**		**CORE COURSE:II** CELL AND MOLECULAR BIOLOGY							**5**	**5**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE COURSE- III

MICROBIOLOGY

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1C3**	**Credit**	**: 05**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.
- To know about the Microorganisms, its structure and classification.
- To learn about the isolation and general characteristics of Microorganisms.
- To study about the pathogens, its diagnostic methods, prevention and treatment for the diseases.
- Motivate the students to become a successful Entrepreneur.

UNIT I: Basic Microbiology

Introduction to Microbiology: Scope of microbiology and emerging avenues, Development of microbiology, Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya),

UNIT II: Ultra structure of Prokaryotic and Eukaryotic

Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Cilia, flagella, cytoskeleton, cytomembrane systems, mitochondria and chloroplast Comparison of Prokaryotic and Eukaryotic cell.

UNIT III: Microbial Nutrition, Growth and reproduction of microorganisms

Cultivation of microorganisms; culture media and types of culture media. Nutritional requirements of microorganisms - nutritional classification of bacteria. Growth curve, Mathematical expression of growth; Measurement of growth and growth yields, counting of bacteria, Synchronous growth, and continuous culture, growth as affected by environmental factors. Reproduction - sexual and asexual.

UNIT IV: Sterilization and Preservation of Microorganisms:

Sterilization - Physical methods, chemical methods and Radiation methods, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP and GMP, Preservation of Microorganisms- lyophilisation and Cryopreservation.

UNIT V: Medical Microbiology:

Disease causing bacteria, virus, fungi, and protozoan's; Fungal diseases, Host parasite interaction-recognition and entry process of different pathogens in plants and animals, Toxins produced, Vaccines, Anti-microbial agents, Antibiotics and disinfectants, National Immunization Programme

UNIT VI: Latest Learning's (For CIA Purpose only)

Latest development related to the course during the semester concerned

TEXT BOOKS

- A text book of Microbiology – R. C. Dubey, Dr. K. Maheswari, 2012, M. Chand Publishers 1st Edition.
- Prescott's Microbiology, 10th,6 Edition *Authors: Joanne Willey, Linda Sherwood and Christopher J. Woolverton*
- Text book of Microbiology – D. R. Arora and B. Arora, 2008, CBS Publications; 3rd Edition
- Marine Microbial Diversity, Karl, D & Buckley, M, 2005, American academy of microbiology, Washington.
- Brock Biology of Microorganisms, 14th EditionAuthors: Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock.
- Microbiology: An Introduction, 13th Edition.Authors: Gerard J. Tortora, Berdell R. Funke and Christine L. Case

REFERENCES

- General Microbiology Vol. II – Dr. CB Powar and Dr. H.F. Daginawala, 2010, Himalaya Publishing House.
- Biological Oceanography, Miller, C.,Wheeler, P.A, 2012, Wiley-Blackwell Scientific Publications.

NET REFERENCE:

https://youtu.be/3Vmsan6oq8E
https://onlinecourses.swayam2.ac.in/cec22_bt20/preview
https://youtu.be/TAZgW6222fs
https://microbenotes.com/scope-and-applications-of-microbiology/
https://youtu.be/H0qPVxRCI5o
https://youtu.be/xjYdOcT6s1Y
https://thebiologynotes.com/microbial-growth-and-nutrition/#microbial-growth-and-nutrition

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	Basic knowledge on different structure and characteristics of microbes	K1&K2
CO-2	Understand the applied aspects of microbiology	K2
CO-3	Understand the role of beneficial microorganisms in the environment and the application to benefit mankind.	K3
CO-4	List and describe the mechanisms of action of major chemotherapeutic agents that control microorganisms	K4
CO-5	Explain about factors responsible for the virulence of different pathogenic microorganisms.	K5

Mapping with Programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
I	**24PBT1C3**		**CORE COURSE III:** MICROBIOLOGY							**5**	**5**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	3	2	2	3	2	2	2
CO2	2	3	3	3	2	3	2	3	3	2	3
CO3	3	3	2	2	2	3	2	3	3	2	2
CO4	3	2	2	3	3	2	2	3	2	3	2
CO5	3	3	2	3	3	2	2	2	3	2	3
Mean Overall Score											2.4 HIGH

CORE PRACTICAL-I

LAB IN CELL & MOLECULAR BIOLOGY AND MICROBIOLOGY

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1C1P**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 06**

CELL AND MOLECULAR BIOLOGY

1. Prokaryotic & amp; eukaryotic cell - structure observation.
2. Identification of –
   Parenchyma, collenchyma, sclerenchyma, columnar epithelium, squamous epithelium.
3. Leishman Staining and Giemsa Staining.
4. Staining for different stages of mitosis and meiosis.
5. Total (WBC, RBC) & differential count of human blood cells.
6. Extraction of DNA and RNA
7. Estimation of DNA and RNA.
8. Isolation of Plasmid DNA.
9. Mutagenesis in Bacteria: The Ames test
10. Transformation in E. coli.

MICROBIOLOGY

1. Laboratory Rules and Regulations of Microbiology
2. Preparation of glassware and sterilization
3. Preparation of culture media for bacteria
4. Pure Culture Technique—Pour Plate, Spread Plate and Streak Plate Methods.
5. Serial Dilution Technique.
6. Isolation of Microorganism from Soil, Water and Spoiled Food.
7. Motility of bacterial cell
8. Staining of Bacteria- Simple, Gram's, Spore, Capsule.
9. Fungal Staining --- Wet Mount technique.
10. Biochemical characterization of Bacteria.
11. Antibiotic sensitivity test

REFERENCE BOOKS

- Practical Immunology, F. C. Hay, M. R. Olwyn. P. N. Westwood. N. L. Hudson, 2002, 4 Ed, UK: Blackwell Company Ltd.
- Hand Book of Practical and Clinical Immunology. G. P. Talwar. 2009, 2 Ed, Vol. II, New Delhi: CBS Publishers and Distributors.
- Molecular Cloning: A Laboratory Manual J. Sambrook and M. Green. 2012. 4 Ed. (3 Volume set). New York: spring Harbor Laboratory Press.
- Laboratory Manual for Genetic Engineering. J. Vennison, 2009, New Delhi: PHI learning Private ltd.

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	Basic knowledge on different structure and characteristics of microbes	K1 &K2
CO-2	Understand the applied aspects of microbiology	K3
CO-3	Understand the role of beneficial microorganisms in the environment and the application to benefit mankind.	K5
CO-4	List and describe the mechanisms of action of major chemotherapeutic agents that control microorganisms	K4
CO-5	Explain about factors responsible for the virulence of different pathogenic microorganisms.	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
I	**24PBT1C1P**		**CORE PRACTICAL I**:LAB IN CELL AND MOLECULAR BIOLOGY ANDMICROBIOLOGY							**6**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE ELECTIVE I

A) BIOINFORMATICS

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1E1A**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To introduce the students to the field of bioinformatics.
- To know about the Biological Database.
- To learn about the sequence analysis and Phylogenetic analysis.
- To study about the Chem informatics
- Motivate the students to become a successful medical coder.

UNIT I:

Basics of Bioinformatics: Introduction to Bioinformatics; Computers in Biology to understand Biological System; Basic commands of Windows, Unix and Linux operating systems; Concept of open resources in Bioinformatics.

UNIT II:

Biological Databases Different types of Genebank databases, Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA, Protein and nucleic acid databases.

UNIT III:

Sequence Analysis Collecting and storing the sequence, Sequence alignment, Pair wise alignment techniques, Dot matrix method, Multiple sequence alignment, CLUSTAL W and CLUSTAL X.Phylogenetic analysis: construction of phylogenetic tree, Role of phylogenetic tree in evolutionary studies

UNIT IV:

Cheminformatics: Introduction; Cheminformatics tools; Chemical structure representation (SMILES and SMARTS); Chemical Databases: CSD, ACD, WDI, Chembank, PUBCHEM, Chemical Structure file formats; Structural Isomers; Structure visualization.

UNIT V:

Medical and Pharmacy Informatics: Introduction to pharmacy informatics, Medical Transcription, Role of informatics to enhance the services provided by pharmaceutical care givers. Health Information Systems Architecture, Health Data Management, Medical Coding, Telemedicine and Telehealth, Ethics in medical informatics.

UNIT VI: Latest Learning's (For CIA Purpose only)

Latest development related to the course during the semester concerned

REFERENCE AND TEXTBOOKS: -

- Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K.& Watson, JD. (1991). Molecular Biology of the
- cell. Oxford (3rd ed.).Garland publishers.
- De Robertis, E. D., & De Robertis, E. M. (1987). Cell and molecular biology. Lea & Febiger.
- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2004). Overhead Transparency Set for Lehninger
- Principles of Biochemistry (4th ed.). WH Freeman.
- Murray, R. K., Granner, D. K., Mayes, P. A.,& Rodwell, V. W., (2006). Harper's Biochemistry(27thed.). McGraw Hill

COURSE OUTCOME

- To give students knowledge of and competence in use of bioinformatical methods central to conduction of molecular biological research projects.
- Give students basic competences in the use of bioinformatical tools.
- Emphasis on bioinformatics related to exploration of proteins and includes analyses of sequences, database searches, and sequence comparison.
- Give an introduction to analysis of DNA sequences, genes and genomes, gene expression and systems biology.

NET REFERENCES

1. https://www.ebi.ac.uk
2. PCB_Lect11_Phylogen_Trees.ppt (nih.gov)
3. *https://www.youtube.com/watch?v=qQ7rIpB4oOw*

   https://www.northeastern.edu/graduate/blog/what-is-bioinformatics

   https://www.youtube.com/watch?v=A5HJDTdf9yM
4. https://nptel.ac.in/courses/102106065
5. https://archive.nptel.ac.in/content/storage2/courses/pmrf/102106065/noc22-bt12_week2.pdf

COURSE OUTCOME

BIOINFORMATICS Course Code: 24PBT1E1A		
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO-1	To get introduced to the basic concepts of Bioinformatics	K1&K2
CO-2	To understand the databases uses and application of bioinformatics	K3
CO-3	Classify different types of Biological Databases	K4
CO-4	Introduction to the basics of sequence alignment and analysis	K5
CO-5	Explain about phylogenetic analysis and sequence submission tools	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
1	**24PBT1E1A**		**CORE ELECTIVE I:** BIOINFORMATICS							**5**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	3	2	3	3	2	2	2
CO2	2	3	3	2	3	2	3	2	2	2	2
CO3	2	3	3	2	3	2	3	3	2	3	3
CO4	3	2	3	3	2	3	2	3	2	3	3
CO5	2	3	3	2	3	2	2	2	3	2	2
Mean Overall Score											2.4

CORE ELECTIVE 1
B: BIOSTATISTICS

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1E1B**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES:

- Understand the concepts behind collection and presentation of data
- Understand the measures of central tendency and dispersion along with related analysis
- Interpret and analyse data using statistical tools and design experiment

UNIT-I:
Probability theory: Sample space, Axioms of probability theory. Conditional probability, independent events. Baye's theorem, Examples.

UNIT II:

Arithmetic mean, geometric mean, harmonic mean, median and mode for. Examples and problems. Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, skewness and kurtosis. Examples and problems.

UNIT III:

Scatter diagram, Idea of correlation, types of correlation, Spearman's rank correlation coefficient: with and without ties. Regression, Lines of regression, regression coefficients, relation between regression coefficients and correlation coefficient.

UNIT IV:

Concepts of attributes, Notation, Classification dichotomy, class frequency, order of classes, positive and negative class frequencies, ultimate class frequencies, relation between class frequencies, consistency of attributes, (three attributes) Independence and association of two attributes, Yule's coefficient of association Q. Coefficient of colligation Y. Relation between them and problems.

UNIT-V:

Bivariate distributions: Discrete bivariate distributions, continuous bivariate distributions. Covariance and correlation. Conditional distribution and conditional mean, Bivariate normal distribution, Examples.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCES

1. Fundamentals of Mathematical Statistics. Sultan Chand & Sons Publications, New Delhi : Gupta S.C. and Kapoor

2. Fundamentals of Biostatistics, Kanishka Publishers: Dutta, N. K.

3. Statistical Methods: Gupta S. P 4. Fundamentals of Statistics Vol. I and II, World Press, Calcutta: Goon, Gupta and Dasgupta

COURSE OUTCOME

BIOSTATISTICS Course Code: 24PBT1E1B		
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO-1	To get introduced to the basic concepts of Biostatistics	K1
CO-2	To understand the databases uses and application of bioinformatics	K1&K3
CO-3	Classify different types of Biological Databases	K2
CO-4	Introduction to the basics of sequence alignment and analysis	K4
CO-5	Explain about phylogenetic analysis and sequence submission tools	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
I	**24PBT1E1B**		**CORE ELECTIVE** I:BIOSTATISTICS							**5**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

VALUE ADDED COURSE – I

BIO-FERTILIZERS

Semester	**: I**	**Max. Marks**	**: 100**
Course Code	**: 24PBT1VAC**	**Credit**	**: 02**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

OBJECTIVES

- To understand the microorganisms are used as biofertilizers.
- To have knowledge on technologies for production of bio inoculum.
- To get full confident to become an entrepreneur.

UNIT- I INTRODUCTION TO BIOFERTILIZERS:

Microbes used as bio-fertilizer – Classification – Symbiotic N_2 Fixers: Rhizobium – Isolation, characterization, and Identification- application – large scale production.

UNIT – II SYMBIOTIC N_2 FIXERS:

Isolation, Identification large scale production, crop response, and field application of *Cyanobacteria* and *Azolla*. Isolation and characterization of Frankia – Actinorhizal nodules – non-leguminous crop symbiosis.

UNIT –III NON SYMBIOTIC N_2 FIXERS:

Isolation, Identification large scale production, crop response, and field application of *Azospirillium, Azotobacter, Clostridium, Klebseilla* and *Anabaena*

UNIT – IV PHOSPHATE SOLUBILIZERS:

Isolation, characterization, mass inoculums production, field application of *Bacillus* sps. and *Pseudomonas*- Phosphate solublization mechanism.

UNIT- V MYCORRHIZAL BIOFERTILIZERS:

Classification, Isolation, Identification, Mass inoculums production, field application of Ecto and Endo mycorrhizae – VAM

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

TEXT BOOKS

1. Kannaiyan S, 2003. Biotechnology of Biofertilizers, CHIPS, Texas (Unit- I-V).

2. Subbu Rao, N.S, 2000. Biofertilizers in Agriculture, Oxford & IBH Publishing Co, New Delhi (Unit- 1-II).
3. http://www.fnca.mext.go.jp/english/bf/bfm/pdf/4_4_Phosphate_Solubilizers0403.pdf (Unit- III-V)
4. Free e-Book: http://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf

REFERENCES

1. Himadri Panda, Dharamvir Hota, 2007. Biofertilizers and Organic Farming, 2007, Gene-Tech Books (Unit- I-V).
2. H. A. Modi, 2012. Microbial Inoculants and Biofertilizer Technology, Neha Publishers & Distributors (Unit- I-V)
3. H.C. Lakshman, Channabasava A, Biofertilizers and Biopesticides, 2014. Neha Publishers & Distributors (I-II).

COURSE OUTCOME

COURSE OUTCOMES		**Knowledge Level**
Upon Completion of course the students will be able to		
CO - 1	Get a deep foundation about microorganisms.	K1
CO - 2	Students will gain knowledge on uses of biofertilizers	K2
CO - 3	Explain technologies for production of bio inoculum.	K3& K4
CO - 4	Gain knowledge about how the microorganisms are used as biofertilizers.	K3
CO - 5	Apply the knowledge to become an entrepreneur.	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
1	**24PBT1VAC**		**VALUE ADDED COURSE**: BIOFERTILIZERS							**3**	**2**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	3	3	2	2	3	2	2
CO2	3	3	2	3	2	3	2	3	3	2	3
CO3	3	2	3	2	3	3	2	2	2	3	2
CO4	3	3	2	3	3	2	2	2	3	3	3
CO5	2	3	3	2	2	2	3	3	2	3	2
Mean Overall Score											2.2 HIGH

CORE COURSE – IV

ENZYME TECHNOLOGY & BIOINSTRUMENTATION

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2C4**	**Credit**	**: 05**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To have a basic knowledge about the enzymes and biological energy transducers
- Describe the various metabolic pathways involved in cells for its normal functioning.
- Thorough understanding of the analytical techniques and equipment used in biological science.
- To have a fundamental knowledge regarding the Microscopy, Spectroscopy, Centrifugation.
- To acquire knowledge on the Chromatographic method for the separation of biological products
- To acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles.
- To make students learn about modern instruments for various analytical works

UNIT I: ENZYMES

Structure, classification and nomenclature of enzymes - physico chemical nature of enzymes – enzyme kinetics – mechanism of enzyme action – factors affecting enzyme activity.

UNIT- II: ENZYME TECHNOLOGY

Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Diagnostic enzymes. Immobilization of enzymes and their applications. Abzymes.

UNIT III: SEPARATION TECHNIQUES

Basic principle of centrifugation, and its types - Ultra Centrifugation (Preparative and analytical), Density gradient Centrifugation, Rate zonal centrifugation, Differential centrifugation. Standard Sedimentation coefficient. Chromatography: Chromatography - Principle, instrumentation and application of Paper Chromatography, Adsorption chromatography, Ion exchange Chromatography, Thin layer Chromatography, Affinity chromatography, HPLC and GC.

UNIT IV: DIFFRACTION METHODS

Principles, Components and applications of X-ray crystallography. Braggs equation, Reciprocal lattice concept, Miller index and Unit cell, Determination of crystal structure, colorimeter, Spectroscopy – Raman effect, UV-Visible, Mass spectroscopy, Atomic Absorption spectroscopy, NMR –Experimental techniques and instrumentation, ESR. LASER and MASER - Principle and applications.

UNIT V: ELECTROPHORETIC TECHNIQUES

Electrophoresis- Agarose Gel Electrophoresis, SDS-PAGE, Native Gel, 2D gel and gradient Gel Electrophoresis, Pulsed field Gel Electrophoresis (PFGE).

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned.

TEXT BOOKS

- Enzymes Technology, Ashokan. P, 2022.
- Biophysical chemistry – principles and techniques, Upadhyay, Upadhyay and Nath, 3rd edition, 2002, Himalaya publishing home.
- Bioinstrumentation, L. Veerakumari, 1st edition 2011, MJP publishers.

REFERENCE BOOKS

- Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
- Analytical biochemistry and separation techniques-A laboratory manual, P. Palanivelu 2nd edition 2001 tulsi books centre.
- Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5th edition 2000, Cambridge University press.

NET REFERENCES

www.explainthe stuff.com
www.chemguide.co.uk.
https://youtu.be/hmFgUVsKwBA
https://archive.nptel.ac.in/content/storage2/courses/104103018/pdf/mod3.pdf
https://archive.nptel.ac.in/content/storage2/courses/102103047/PDF/mod3.pdf

COURSE OUTCOME

ENZYME TECHNOLOGY & BIOINSTRUMENTATION Course Code: 24PBT2C4		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	Helps to remember the basics of enzymes	K1
CO - 2	To understand the industrial uses and application of enzymes	K3 &K5
CO - 3	Analyzing how to isolate cellular constituents	K2
CO - 4	Realize the need of centrifuges and their uses in research	K5
CO - 5	Apply the concepts of bio analytical techniques in biotechnology research	K4

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
II	**24PBT2C4**		**CORE COURSE IV**:ENZYME TECHNOLOGY AND BIOINSTRUMENTATION							**5**	**5**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE COURSE – V
RECOMBINANT DNA TECHNOLOGY

Semester:	**II**	**Max. Marks:**	**100**
Course Code:	**24PBT2C5**	**Credit:**	**05**
Total Periods:	**30**	**Exam Hrs**	**03**

OBJECTIVES:

- This paper is aimed to study the various principles underlying genetic engineering that forms the basis of rDNA technology.
- To study the methodologies, and in brief the applications and related issues of rDNA technology.

UNIT – I Basic Concepts

Introduction to Recombinant DNA technology - Enzymes in molecularbiology-Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T4polynucleotide kinase; Linker, Adaptors, Homopolymers.

UNIT – II Cloning Vectors

Expression Cassette & Viral vectors: Promoters (Constitutive, Inducible,Tissue specific),Terminators, Reporters, Markers (Antibiotic resistant,Herbicide resistant, Antimetabolite);Vectors in gene cloning – Plasmids (pBR322, pUC), Bacteriophages (Phage lamda and M13), Cosmids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno associated virus, Baculovirus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus. Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.

UNIT – III Gene Transfer

Gene transfer Methods – Transformation – Physical method (Electroporation, Electrofushon, Microinjection, Particle bombardment, Liposome mediated transfer); Chemical method (PEG mediated, DEAE Dextran mediated, CaPO4 mediated genetransfer); Biological method (Agrobacterium mediated gene transfer). Expression systems – Prokaryotes (Bacteria) and Eukaryotes (Yeast, Mammalian and Insect cell lines).

UNIT – IV Genetic Engineering

Screening & Selection methods – Insertional inactivation, Blue-White selection, colony– insitu hybridization, In vitro selection, In vitro translation, Radioactive antibody test, DNA labelling, dotblot hybridization, Gene Silencing, RNA interference and antisense therapy. Gene Knockout. Blotting techniques – Southern,Northern, Western and South-Western.

UNIT – V Molecular techniques

Molecular Techniques – RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library. Bioethics & Biosafety in genetic engineering; IPR & Patenting. Applications of genetic engineering in medicine, agriculture, veterinary and industry.

UNIT VI: Latest Learning's (For CIA Purpose only)

Latest development related to the course during the semester concerned

TEXT BOOKS REFERENCES

1. Glick R. and J. J. Pasternak. 2003. Molecular Biotechnology (Ed:3). ASMPress, Washington.
2. Old RW and SB Primrose. 2014. Principles of gene manipulation(Ed:4).Blackwell scientific publications, London.
3. Alberts, B., Johnson, A., Lewis, J., M., Roberts, K., and P. Walter.Molecular Biology of the Cell, Fourth Edition. Garland & Co. 2002.
4. Harvey Lodish, Arnold Berk, et al. 2016.Molecular Cell Biology

REFERENCE BOOKS

1. Brown T. A. 2016. Gene cloning – An introduction. VNR (UK) co. Ltd,England.
2. James D Watson et al., 2007. Recombinant DNA (Ed:2) WH freemanand co., New York.
3. Lodish H et al., Molecular Cell Biology, Sixth edition, W.H Freeman &Co. 2007.
4. Keya Chaudhur,2012. Recombinant DNA Technology,
5. Muhammad Sarwar Khan, Iqrar Ahmad Khan, et al. 2019Applied Molecular Biotechnology: The Next Generation of Genetic Engineering

NET REFERENCES

1. https://www.canada.ca
2. https://www.britanica.com
3. https://archive.nptel.ac.in
4. https://nptel.ac.in/courses/102106025
5. https://archive.nptel.ac.in/courses/102/106/102106025/

COURSE OUTCOME

RECOMBINANT DNA TECHNOLOGY Course Code: **24PBT2C5**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO-1	To get introduced to the basic concepts of Recombinant DNA Technology	K1
CO-2	Acquired skills on techniques of construction of recombinant DNA- cloning vectors	K2 &K1
CO-3	Introduction of rDNA into bacterial cells-gene transfer methods	K3
CO-4	Realize the screening and selection methods in genetic engineering	K4
CO-5	Construction of genomic DNA library and cDNAlibrary	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
II	**24PBT2C5**		**CORE COURSE V:RECOMBINANT DNA TECHNOLOGY**							**5**	**5**
Course Outcomes	Programme Outcome (POs)					Programme specific outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	3	3	2	3	2	3	2	2
CO2	3	3	2	3	2	3	2	2	2	3	2
CO3	2	3	3	2	3	2	3	2	3	3	3
CO4	2	3	2	2	3	3	2	3	2	2	2
CO5	3	2	3	3	2	3	2	2	3	3	3
Mean Overall Score											2.4 HIGH

CORE COURSE-VI

MICROBIAL TECHNOLOGY

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2C6**	**Credit**	**: 04**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To acquire knowledge on the basic principles of fermentation.
- To obtain knowledge on selection of microorganisms for industrial application.
- To acquire new ideas in the utilization of alternative microorganisms for the improvement in product yield

UNIT – I FERMENTATION TECHNOLOGY

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Media formulation and optimization. Basic concepts- batch, Continuous and fed batch culture, selection methods for industrially important microorganisms. Strain improvement, preservation, and properties of industrial strains. Immobilization: differentmatrices, whole cell and enzyme immobilization.

UNIT –II FERMENTOR AND ITS TYPES

Fermenter – Design & Types: Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a bioreactor, Impellers, baffles and sparger,sterilization. Types of reactors-submerged reactor – mechanically stirred draught- tube reactor- continuous flow stir type reactor – airlift reactor- jet loop reactor, surface reactor, packed bed reactor, Fluidized bed reactor.

UNIT –III CONTROL OF BIOPROCESS PARAMETERS

Bioprocess control and monitoring variables – O_2 requirement and uptake, Foam and antifoams, their effect on oxygen transfer, factors affecting KLa. Flow measurement and control, control system – manual and automatic. Application and the role of computers in bioprocess. Fermentation economics. Biosensors: construction and application.

UNIT –IV DOWNSTREAM PROCESSING

Down-stream processing: Introduction, recovery of microbial cells, precipitation, filtration- theory of filtration, batch and continuous filters. Centrifugation. Cell disruption – physical and chemical methods. Extraction liquid-liquid extraction and aqueous-two phase extraction. Chromatography, membrane processes, drying and crystallization.

UNIT –V PRODUCTION STRATEGIES OF INDUSTRIAL PRODUCTS

Production strategies for industrial products: (Lactic acid and Ethanol), therapeutics (Insulin and Interferon), antibiotics (Cephalosporin), Microbial enzymes (Chitinase, Glucose Oxidase, Lipase), Exopolysaccharides (Pullulan). Use of immobilized cells, enzymes to produceprotease, Use of fungi in industry including food industry: fuel cells, Use of fungi in agriculture and environmental applications: Biofertilizers, Bioremediation and Biological control. Animal cell culture technology to produce recombinant vaccines.

UNIT –VI: Latest Learnings (For CIA Purpose only)

Latest development related to the course during the semester concerned.

Books for study

- Stanbury P.F. *et al*., 2016. Principles of Fermentation Technology, Butterworth-Heinemann, UK. (Unit I, Unit II, Unit III and Unit IV)
- Principles and Applications of Fermentation Technology, Vinay Sharma Arindam Kuila (2018)
- Principles of Fermentation Technology Reginald franco-2022.
- Modern Technologies and Their Influence in Fermentation Quality. Santiago Benito -2020.
- Vikas Mishra *et al*., 2017. Fermentation Microbiology & Biotechnology.

Books for References

- Bailey J and D.F. Ollis. 2017. Biochemical Engineering Fundamentals (Ed: 2) IndianEdition: McGraw-Hill, NY
- Cinar A *et al*., 2013. Batch Fermentation - Modeling, Monitoring and Control. Dekker. USA.
- Optimization of Enzymatic kinetics by Fed Batch Fermentation- Praveena J.Jadeja-2015
- Fed-Batch Fermentation: A Practical Guide to Scalable Recombinant Protein Production in Escherichia Coli: 42 (Woodhead Publishing Series in Biomedicine)G.G.Moulton-2014.

NET REFERENCES

1. www.britannica.com/science/fermentation
2. https://microbenotes.com/fermentation
3. https://www.biologydiscussion.com/industrial-microbiology-2/fermentor
4. https://www.biotechnologynotes.com/industrial-biotechnology/
5. https://www.youtube.com/watch?v=Uut1cUs6GpA
6. https://www.sciencedirect.com/topics/engineering/downstream-processing
7. https://www.youtube.com/watch?v=pHYI8C-8sIk

COURSE OUTCOME

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	Acquire knowledge on the basic principles of fermentation andtechnologies used in the development of fermented food products.	K1
CO-2	Examine and classify the microbial growth kinetics, differenttypes of fermentation, selection of microorganisms for industrial application and production of different fermented food products.	K2
CO-3	Analyze the importance of ethics in fermentation technology inthe selective production of commercial products.	K5
CO-4	Evaluate the outcomes of fermentation methods when employing specific group of microorganisms in correlation with thesubstrate.	K4
CO-5	Assess new ideas in the utilization of alternative microorganisms for the improvement in product yield and design a protocol forthe operation of basic bioprocess operation.	K3

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
II	**24PBT2C6**		**CORE COURSE VI:**MICROBIAL TECHNOLOGY							**4**	**4**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE COURSE – VII

IMMUNOLOGY

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2C7**	**Credit**	**: 04**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- This course is designed to impart the students to understand the importance of immunology and its theoretical aspects and on the principles of immunology.
- It also explains the various antigen-antibody reactions involved in diseases, Concept of Monoclonal antibodies and vaccine development.
- To learn the various human haematological techniques.
- Understand human and animal cell culture methods.
- Study about the recent advancement in immunology and know about the diagnostic methods for human infectious diseases.

UNIT I: Immune system and Immune Response

Innate and acquired immunity, structure and functions of immune cells- T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophil's, Neutrophils, Mast cells. Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.

UNIT II: Antigens and Antibodies

Structure and properties of antigens –Iso and alloantigen's-antigen specificity, Haptens and adjuvants-structure and properties. Immunoglobulin's-Structure and properties, types and subtypes. Generation of immunological diversity. Complement system- component, properties and functions. Complement pathways and biological significance.

UNIT III: Major Histocompatibility Complex, Allergy and Autoimmunity

Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy.

Hypersensitivity Reactions: Allergy, Hypersensitivity reactions- types (I, II, III, and IV), Autoimmunity**,** Autoimmune diseases- Hashimoto's disease, Systemic lupus erythematosus, AIDS.

UNIT IV: Immunological Techniques

Agglutination-Blood grouping, Widal test, precipitation-Immunodiffusion-Single, Double, Radial and Rocket Immunoelectrophoresis, immune- fluorescence, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of Monoclonal antibodies, Coomb's test

UNIT V: Immunization

Vaccines- conventional, adjuvants, viral vaccines, vaccines to other infectious agents, tumour vaccines, Peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes and role of WHO in immunization programs - BCG, small pox, DPT, polio, measles, Hepatitis-B.

UNIT VI: Latest Learning's (For CIA Purpose only)

Latest development related to the course during the semester concerned

TEXT BOOKS

- Immunology by I.M. Roitt, J.Brostoff and D.K Male(1993) Gower medical publishing, London
- Immunology – short course by E.Benjamini, G.sunshine and Leskpwitz willy-liss 1996.
- Richard M.hyde 1995 Immunology III edition ELBS London
- J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork.
- Ferencik, Miroslav (2013). Handbook of Immunochemistry. Netherlands: Springer.

REFERENCES

- An Introduction to Immunology, Narosa Publishing House, Chennai. 3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
- I.R.Tizard, 1995, Immunology: An Introduction, 4th edition, Saunders College Publishers, New York. 5.
- I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
- A. Bul and K.Abbas, 1994, Cellular and Molecular immunology.
- Roitt's Essential Immunology, 13th Edition Peter J. Delves, Seamus J.Martin, Dennis R. Burton, Ivan M. Roitt (2017)
- Immunology 9th Edition David Male, Stokes Peebles, Victoria Male (2020)

NET REFERENCES

https://onlinecourses.nptel.ac.in/noc22_bt40/preview

https://microbenotes.com/immunological-techniques/

https://en.wikipedia.org/wiki/Antigen-antibody_interaction

https://www.sigmaaldrich.com/IN/en/technical-documents/technical-article/protein-biology/elisa/antigens-epitopes-antibodies

https://www.toppr.com/guides/biology/human-health-and-diseases/antigen-and-antibody/

COURSE OUTCOME

COURSE OUTCOMES		Knowledge Level
Upon Completion of course the students will be able to		
CO - 1	Get a deep foundation in the immunological processes.	K1&K2
CO - 2	Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion	K2&K3
CO - 3	Explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development.	K4
CO - 4	Apply the knowledge of immune associated mechanisms in medical biotechnology research.	K5
CO - 5	Design experiment to see effect of drug molecule on immune response	K4

Mapping with programme Outcomes

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
II	**24PBT2C7**		**CORE COURSE –VII: IMMUNOLOGY**							**4**	**4**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	3	3	2	3	2	3	2	2
CO2	3	3	2	3	2	3	2	2	2	3	2
CO3	2	3	3	2	3	2	3	2	3	3	3
CO4	2	3	2	2	3	3	2	3	2	2	2
CO5	3	2	3	3	2	3	2	2	3	3	3
									Mean Overall Score		2.4 HIGH

CORE PRACTICAL-II

LAB IN ENZYME TECHNOLOGY ,RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2C2P**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 06**

COURSE OBJECTIVE

- To understand the various techniques.
- Students will able to perform varieties of techniques.

Enzyme Technology

1. Isolation of industrially important microorganisms.
2. Screening of industrial microorganisms
3. Factors influencing and affecting the growth of microorganisms.
4. Microbial products: Ethanol, Citric acid, Lactic acid and Amylase.
5. Production of organic acids - Citric acid production & estimation
6. Screening Production and assay for lipase producing organisms
7. Penicillin production and estimation

Recombinant DNA Technology

1. Agarose gel electrophoresis
2. Isolation of genomic and plasmid DNA from bacteria
3. Isolation of total RNA from plant tissue
4. Isolation of genomic DNA from Plant tissue
5. Restriction digestion
6. Ligation of DNA
7. Transformation of bacteria by Calcium chloride method
8. Blue-White screening method
9. Gel elution of DNA

IMMUNOLOGY

1. Agglutination test-ABO blood grouping, Rh Typing
2. Agglutination test -WIDAL test, CRP and ASO
3. Double Immuno diffusion
4. Radial Immuno diffusion
5. Immuno electrophoresis
6. Rocket immuno electrophoresis
7. Total count of RBC

8. Total count of WBC
9. Differential staining of WBC
10. Demonstration of ELISA
11. Demonstration of Lymphoid organs in rat
12. Demonstration of Western blotting.

References

- Laboratory Manual for Genetic Engineering. J. Vennison, 2019, New Delhi: PHI learning Private ltd,
- Analytical biochemistry and separation techniques-A laboratory manual, P. Palanivelu, 2 nd edition 2011, Tulsi books center.
- Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5 th edition 2014, Cambridge University Press.

REFERENCE BOOKS

- Practical Immunology, F. C. Hay, M. R. Olwyn. P. N. Westwood. N. L. Hudson, 2002, 4 Ed, UK: Blackwell Company Ltd.
- Hand Book of Practical and Clinical Immunology. G. P. Talwar. 2009, 2 Ed, Vol. II, New Delhi: CBS Publishers and Distributors.
- Molecular Cloning: A Laboratory Manual J. Sambrook and M. Green. 2012. 4 Ed. (3 Volume set). New York: spring Harbor Laboratory Press.
- Laboratory Manual for Genetic Engineering. J. Venison++, 2009, New Delhi: PHI learning

COURSE OUTCOME:

CORE PRACTICAL-II **LAB IN ENZYME TECHNOLOGY ,RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY** Course Code: **24PBT2C2P**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO-1	To get introduced to the basic knowledge about microorganism	K1
CO-2	Acquired skills on techniques of construction of recombinant DNA- cloning vectors	K2 &K1
CO-3	Realize the screening and selection methods in genetic engineering	K3
CO-4	Experiment to see blood grouping	K4
CO-5	Acquired skills on techniques of blotting	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
II	**24PBT2C2P**		**CORE PRACTICAL II**:LAB IN ENZYME TECHNOLOGY,RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY							**6**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

IBC-II

BIOENTREPRENEURSHIP

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2I**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To learn the basics of Entrepreneurship
- To know the various kinds of entrepreneurs
- To develop knowledge on business ideas
- To understand about business environment
- To aware of business risks

UNIT I

Introduction to Entrepreneurship – Meaning and concept of entrepreneurship; Need and Importance of entrepreneurship; The history of entrepreneurship development; Skills and characteristic of suCORE COURSEessful entrepreneurs; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Role of entrepreneurship in economic development; Evolution and Growth of Entrepreneurship in India.

UNIT II

Types of Entrepreneurs; Ethical Entrepreneurship; Entrepreneurial Value: Values, Attitudes and Motivation; The entrepreneurial decision process, and role models; Self-Assessment of Qualities; Skills, Resources and Dreams; Roles of society and family in the growth of an entrepreneur.

UNIT III

Generating business idea; Sources of new ideas; Methods of generating ideas; Creative problem solving; Opportunity recognition and assessment; Environmental scanning; Competitor and industry analysis; Feasibility study - Market feasibility, Marketing plan; marketing research for the new venture, Steps in preparing marketing plan; Technical/operational feasibility; Financial feasibility.

UNIT IV

Introduction to Business and its Environment; Components of a business plan; Meaning and significance of a business plan; Challenges of New Venture Strategies; Start-up Policy Framework and Incentives; drawing business plan; Preparing project report; Business Plan Preparation; Presenting business plan to investors; Execution of Business Plan; Business Incubation Centers.

UNIT V

Entrepreneurs - as problem solvers; Risk taking-Concept; types of business risks; Barriers to Entrepreneurship; Support structure for promoting entrepreneurship (various government schemes); Entrepreneurial Culture; Entrepreneurial Society; Women Entrepreneurship; Rural Entrepreneurship.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCES

1. Entrepreneurship - Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND.2009.
2. Entrepreneurship - Brace R., and R., Duane Ireland, Pearson Prentice Hall, New Jersy (USA).2022
3. Entrepreneurship - Lall, Madhurima, and Shikha Sahai, Excel Book, New Delhi. 2008
4. Entrepreneurship Development and Small Business Enterprises - Charantimath, Poornima, Pearson Education, New Delhi.2009
5. Entrepreneurship- New Venture Creation – David H. Holt 1992.

NET REFERENCES

https://onlinecourses.nptel.ac.in/noc20_mg35/preview
https://onlinecourses.nptel.ac.in/noc21_mg63/preview
https://eduarticle.medium.com/growth-of-entrepreneurship-in-india-8887fb557f0b

COURSE OUTCOMES

BIOENTREPRENEURSHIP Course Code: 24PBT2I1		
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO - 1	Understand about the fundamentals of Entrepreneurship	K1
CO - 2	Categorize the entrepreneurs	K2
CO - 3	Understand and develop business ideas	K5
CO - 4	Gain knowledge on business environment	K4
CO - 5	Acquire knowledge on various risks in business	K3

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
II	24PBT2I		**IBC: BIOENTREPRENEURSHIP**							**3**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	2	2	3	3	3	2	2
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	3	3
CO4	2	2	2	3	2	3	3	2	3	3	3
CO5	3	3	2	2	2	3	3	2	3	3	3
Mean Overall Score											2.4

NME:1

A.) BASICS OF ARTIFICIAL INTELLIGENCE

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2N1A**	**Credit**	**: 02**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVE:

To develop semantic-based and context-aware systems to acquire, organize process, share and use the knowledge embedded in multimedia content. Research will aim to maximize automation of the complete knowledge lifecycle and achieve semantic interoperability between Web resources and services. The fieldof Robotics is a multi disciplinary as robots are amazingly complex system comprising mechanical, electrical, electronic H/W and S/W and issues germane to all these.

UNIT- I

AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the conceptof rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT -II

Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A* ,AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions**.**

UNIT -III

Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and dempstershafertheory.

UNIT - IV

First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning,Decisiontrees,Explanationbasedlearning,Statistical Learning methods ,Reinforcement Learning.

UNIT - V

Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems how expert systems works, problem areas addressed by expert systems, expert

systems factors, types of expert systems, expert systems and the internet interacts web, knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition, machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts reasoning in artificial intelligence, inference with rules, with frames: model based reasoning, case based reasoning, explanation & meta knowledge inference with uncertainty representing uncertain

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCE BOOKS:-

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", SecondEdition, PearsonEducation
2. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence : a logical approach",Oxford University Press.
3. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problemsolving", FourthEdition, Pearson Education.
4. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

COURSE OUTCOME

A.) BASICS OF ARTIFICIAL INTELLIGENCE		
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO - 1	Foundation of AI and history of AI intelligent agents	K1&K2
CO - 2	Searching for solutions, uniformed search strategies	K3
CO - 3	Predicate logic- logic programming	K5
CO - 4	Learning from observation Inductive learning	K4
CO - 5	Types of expert systems, expert systems and the internet interacts web	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
II	**24PBT2N1A**		**NME-I-A**)BASICS OF ARTIFICIAL INTELLIGENCE							**3**	**2**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

NME-II

B.) HERBAL MEDICINE

Semester	**: II**	**Max. Marks**	**: 100**
Course Code	**: 24PBT2N1B**	**Credit**	**: 02**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

Course Objectives:

- To Understand the Basics of Herbal Medicine
- Understand the significance of medicinal plants in promoting human health, balanced nutrition, and maintaining overall well-being.
- Identify and understand the nutritional and medicinal value of everyday plants, fruits, and vegetables, fostering their integration into daily diets for improved health.

Unit I HERBAL MEDICINES

Herbal medicines – definition, history and its scope – Indian system of medicines-Siddha, Ayurvedha and Unani systems. Application of Herbal medicines

Unit II IMPORTANCE OF MEDICINAL PLANTS

Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins). Quality control and Quality Assurance of Herbal medicines.

Unit III TRIBAL MEDICINE

Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – *Aegle marmelos, Ficus benghalensis, Curcuma domestica, Cyanodon dactylon and Sesamum indicum.*

Unit IV UTILITY OF SOME MEDICINAL PLANTS

Traditional knowledge and utility of some medicinal plants in Tamilnadu –*Solanum trilobatum, Cardiospermum halicacabum, Vitex negundo, Adathoda vasica, Azadirachta indica, Gloriosa superba, Eclipta alba, Aristolochia indica* and *Phyllanthus fraternus.*

Unit V PLANTS IN DAY TODAY LIFE

Plants in day today life – *Ocimum sanctum, Centella asiatica, Cassia auriculata, Aloe vera.* Nutritive and medicinal value of some fruits (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate) and vegetables - Greens (*Moringa, Solanum nigrum* Cabbage).

UNIT VI: LATEST LEARNING'S (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

References

- Ethnobiology – R.K.Sinha & Shweta Sinha. Surabhe Publications – Jaipur.2001
- Tribal medicine – D.C. Pal & S.K. Jain Naya Prakash, 206, Bidhan Sarani, Calcutta , 1998
- Contribution to Indian ethnobotany – S.K. Jain, 3rd edition, Scientific publishers, B.No. 91, Jodhpur, India. 2001
- A Manual of Ethnobotany – S.K.Jain, 2nd edition, 1995.
- H.Panda .2017.Hand book on Herbal Medicine.
- Andrew Chevallier 2016.Encyclopedia Of Herbal Medicine

NET REFERENCES

https://medlineplus.gov https://www.youtube.com/watch?v=s8jCBt_itAU

https://www.slideshare.net/siddharthanand5/herbal-medicine-29034823
https://www.youtube.com/watch?v=-rD5mBomyWU

https://www.youtube.com/watch?v=wrB8LG8K-_M
https://www.youtube.com/watch?v=akU2We1Dw1E https://www.youtube.com/watch?v=PqyUOyIaI_M

https://www.youtube.com/watch?v=cy7l45Qn8to

https://www.youtube.com/watch?v=o9MOfCP5wJc

COURSE OUTCOME

HERBAL MEDICINE		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO-1	Scope and history of herbal medicine	K1
CO-2	Importance of herbal Medicine	K2
CO-3	Disease and diagnosis and treatment of tribal medicine	K3
CO-4	Traditional knowledge and utility of some medicinal plants in Tamil Nadu	K5
CO-5	Plants in day today life	K4

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
II	**24PBT2N1B**		**NME I : HERBAL MEDICINE**							**3**	**2**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	3	2	3	3	3	2	3
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	3	3
CO4	2	2	2	3	2	3	3	2	3	2	2
CO5	3	3	2	2	2	3	2	2	3	3	2
Mean Overall Score											2.4 HIGH

CORE COURSE-VIII

PLANT BIOTECHNOLOGY

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3C8**	**Credit**	**: 06**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- It gives introduction to the plant tissue culture, maintenance of its lab and production of plants by employing various tissue culture technique.
- It describes the study of microscopical technique for cytological analysis
- It discusses about various plant transformation technique.
- The techniques of animal cell culture and its industrial applications are described.
- Describe the secondary metabolite production and its application.

PLANT BIOTECHNOLOGY

UNIT-I Applications of Plant Biotechnology in Crop Improvement

Introduction to plant tissue culture, lab facilities and operations, tissue culture media: preparation and handling, establishing aseptic cultures;Micropropagation via axillary and adventitious shoot proliferation; Somatic embryogenesis; production of artificial seeds; Double haploid production by androgenesis and gynogenesis; triploid production by endosperm culture; production of virus free plants by meristem, shoot-tip culture; Cell Suspension cultures; protoplast isolation and regeneration, somatichybridization and cybridization; protoclonal, somaclonal and gametoclonal variation for crop improvement; Cryopreservation.

UNIT-II Micro techniques

Cytology and various staining procedures for ploidyanalysis; microscopy with special emphasis on confocal, scanning and transmission electron microscopy; Principles and applications of flow cytometry and cell sorting; histological techniques

UNIT-III Plant Genetic Engineering and Production of Transgenic Plants

Genetic material of plant cells with an introduction to chloroplast and mitochondrial DNA; Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Modes of gene delivery in plants: Particleb o m b a r d m

e n t , electroporation, microinjection;*Agrobacterium* mediated gene transfer, Ti and Ri plasmids; Screening and selection of transformants, Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples.

UNIT-IV Molecular Farming and Applications

Aims and scope,production of industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines; manipulation of metabolic pathways for production of fatty acids, industrial oils, terpenoids, flavanoids etc.

UNIT-V Pathogenesis related Proteins and Bioactive compounds

PR proteins- Bacterial resistant genes and fungal resistant genes.Defense mechanism: Biology of plant-pathogen interaction. Phytochemical compounds produced in plants: Nitrogen containing compounds, Alkaloids, Phenolics (Anthocyanins, Benzofurans, Coumarins, Flavones and Tannins), Plant pigments and terpenoids Monoterpenoids, Diterpenoids, Triterpenoids, Phytosterols, Carotenoids) Quantitative and qualitative estimation of phytochemicals, Methods for separation of phytochemicals- HPLC. Plant cell culture-based bioreactor production of plant secondary metabolites.

UNIT VI: Latest Learnings (For CIA Purpose only)

Latest development related to the course during the semester concerned.

Text Books:

1. Avinash sharma, Megha Ragavan *etal* Plant Tissue Culture: Theory and Practice, a Revised Edition, Elsevier Science, 2020
2. Nirmala- 2022 -Plant Biotechnology-
3. H.K.Das, 2017. Plant biotechnology - the genetic manipulation of plants,2nd edition
4. Chawla HS, 2020. Introduction to Plant Biotechnology (3rd edition) CRC Press
5. Nigel Halford, 2014. Plant Biotechnology – Current and Future Applications of Genetically Modified Crops. Wiley Publishers.
6. Zingare AK, 2013. Biotechnology in Plant Improvement. Satyam Publishers
7. Nigel Halford, 2014. Plant Biotechnology – Current and Future Applications of Genetically Modified Crops. Wiley Publishers.
8. Zingare AK, 2013. Biotechnology in Plant Improvement. Satyam Publishers

REFERENCE BOOKS:

1. Kari Herrmenn Ndumann etal 2020,Plant Cell and Tissue Culture – A Tool in Biotechnology: Basics and Application
2. Sant saran Bhojwan-,Prem kumar Dantu -2016Plant Tissue Culture: An Introductory Text.
3. Bhatia, Sharma, Dahiya, Bera, 2015. Modern Applications of Plant Biotechnology in Pharmaceutical Sciences, 1st edition, Academic Press.

NET REFERENCES:

https://archive.nptel.ac.in/courses/102/103/102103016/#

https://www.britannica.com/science/tissue-culture

https://www.onlinebiologynotes.com/plants-transformation-methods-and-applications/

https://video.search.yahoo.com/search/video?fr=mcafee&ei=UTF-8&p=plant+tissue+culture+-youtube&type=E211US826G0#action=view&id=3&vid=b528ed91127afb89ac8b97c31f4054d6

https://video.search.yahoo.com/search/video;_ylt=Awr4_muNC3Fj0xkgvcj7w8QF;_ylu=c2VjA3NlYXJjaAR2dGlkAw--;_ylc=X1MDOTY3ODEzMDcEX3IDMgRmcgNtY2FmZWUEZnIyA3A6cyx2OnYsbTpzYixyZ246dG9wBGdwcmlkA0w3QzVVeHkzUThLaS5MMm1LU1VoTUEEbl9yc2x0AzAEbl9zdWdnAzAEb3JpZ2luA3ZpZGVvLnNlYXJjaC55YWhvby5jb20EcG9zAzAEcHFzdHIDBHBxc3RybAMwBHFzdHJsAzE4BHF1ZXJ5A0J0JTIwY290dG9uJTIwLXlvdXR1YmUEdF9zdG1wAzE2NjgzNTMwNzk-?p=Bt+cotton+-youtube&ei=UTF-8&fr2=p%3As%2Cv%3Av%2Cm%3Asb%2Crgn%3Atop&fr=mcafee&type=E211US826G0

COURSE OUTCOME:

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe the basic idea on plant culture techniques.	K1
CO-2	outline the mechanism of genetic engineering technology in the production of transgenic plants.	K2
CO-3	experiment with the various plant tissue culture media for the plant regeneration.	K3
CO-4	compare and interrogate with new ideas in techniques in plant biotechnology & interpret them to solve complex problems.	K4
CO-5	inspect and plan for the production of artificial seeds and hardening of plants.	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBT3C8**		CORE COURSE VIII:PLANT BIOTECHNOLOGY							**6**	**6**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE COURSE-IX

ANIMAL BIOTECHNOLOGY

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3C9**	**Credit**	**: 05**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- It gives introduction to the various transformation techniques employed in animal systems.
- It also describes the application of genetically modified animals in the various fields of science.
- The techniques of animal cell culture and its industrial and medical applications are described.
- Understand the basic properties of cancer cells.
- Describe the principle and application of gene manipulation.
- Illustrate how transgenic animals can be produced with a specific gene of interest and their clinical advantages.

UNIT I: ANIMAL CELL CULTURE

Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Culture and maintenance of primary and established cell lines. Cell adhesion, Cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis.

UNIT II: STEM CELLS AND TISSUE ENGINEERING

Scope of tissue engineering, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

UNIT III: TRANSGENIC ANIMALS AND ANIMAL CLONING

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock and humans.

UNIT IV: APPLICATIONS OF ANIMAL BIOTECHNOLOGY

Improvement of biomass, disease resistant, recombinant for poultry, livestock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, Interferons, and Cell culture based vaccines..

UNIT V: ANIMAL MODELS

Use of cell lines as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned.

TEXT BOOKS

- Animal Biotechnology, M. M. Ranga, 2nd Edition, 2003, Agrobios India.
- Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., NewYork.
- Animal Biotechnology, Surya Prakash Mishra,2018 Sri Padmavathi Publications
- Animal Biotechnology, V. Kumaresan,2019.

REFERENCES

- Animal Biotechnology, Ballinic C.A., Philips J.P and Moo Young M. Pergamon press, New York. 1989.
- Molecular Biology of Gene, Watson J.D.et al. (6^{th} Ed.) Publisher Benjamin Cummings, 2007.
- Methods in Enzymology guide to molecular cloning techniques, Berger S. L. and A.R. Kimmel. (Vol 152). Academic Press Inc. San Diego.1996
- Molecular Biotechnology, Glick, B.R. and Pasternak J.J.ASM Press, Washington DC.2003.
- Methods in Cell Biology, Jenni, P, Mather and David Barnes, (Vol 57) Academic Press, 2001.
- Molecular Biology of the Gene, Watson J.D et al. (6^{th} Ed), the Benjamin Cummings Pub.Co.Inc.USA.2008

NET REFERENCES

https://www.youtube.com/watch?v=oc4Q5bzE978

https://archive.nptel.ac.in/courses/102/104/102104059/

https://nptel.ac.in/courses/102106036

https://www.digimat.in/nptel/courses/video/113108071/L18.html

COURSE OUTCOME

ANIMAL BIOTECHNOLOGY Course Code: 24PBT3C9		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	The students will gain an insight into the concepts and techniques of animal biotechnology and its wide industrial and medicinal applications.	K2 & k3
CO - 2	Describe the mechanism of gene therapy and its uses.	K1
CO - 3	Illustrate how different blood products like antibodies, hormones and vaccines are produced industrially.	K5
CO - 4	Describe the features of stem cell and their application.	K4
CO - 5	Differentiate between the different methods adopted for generating transgenic animals.	K6

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
III	**24PBT3C9**		**CORE COURSE IX: ANIMAL BIOTECHNOLOGY**							**5**	**5**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	3	2	3	3	2	3	3
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	2	2
CO4	2	2	2	3	2	3	3	2	3	3	3
CO5	3	3	2	2	2	3	2	3	3	3	3
Mean Overall Score											2.4

CORE COURSE:X

ENVIRONMENTAL BIOTECHNOLOGY

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3C10**	**Credit**	**: 05**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- This course will give a knowledge about the environmental issues of water pollution, solid waste management and their treatment.
- Environmental biotechnology is the conservation of resources via the recycling of waste materials.
- The recoveries of more valuable products such as metals, oils, and vitamins are important aspects of this technology.
- Environmental biotechnology in particular is the application of processes for the protection and restoration of the quality of the environment.
- Environmental biotechnology can be used to detect, prevent and remediate the emission of pollutants into the environment in a number of ways.

UNIT – I: INTRODUCTION

Environment - basic concepts and issues, global environmental problems - ozone depletion, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management. An overview of atmosphere, hydrosphere, lithosphere and anthrosphere - environmental problems.

UNIT – II: ENVIRONMENTAL POLLUTION

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

UNIT – III: WASTE WATER TREATMENT

Microbiology of waste water treatment, aerobic process - activated sludge, oxidation ponds, trickling filter. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries

UNIT – IV: SOLID WASTE MANAGEMENT

Types of solid wastes - Solid waste characteristics and its impact on environment. Solid waste disposal; land filling, incineration. Xenobiotic compounds - organic (chlorinated hydrocarbons, substituted simple aromatic compounds, poly aromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radio nuclides, phosphates, nitrates).

UNIT – V: BIOLOGICAL PROCESS

Role of immobilized cells/enzymes in treatment of toxic compounds. Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control, Bioremediation of xenobiotics in environment - ecological consideration, decay behaviour and degradative plasmids. Molecular techniques in bioremediation.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

OUTCOME OF THIS PAPER

- Knowledge in various fields of environment and its pollution, waste water treatment, solid waste treatment and biological process like immobilization, bioremediation.

- Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environment

TEXT BOOK

1. Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development Jeyabalan Sangeetha, Devarajan Thangadurai, et al.2016.

2. Environmental Biotechnology, 2nd: Basic Concepts and Applications, Indu Shekhar Thakur,2019.

REFERENCES

1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.

2 Jogdand, S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.

3. Technoglous, G., Burton,F.L. and Stensel, H.D. 2004. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc.,Tata Mc Graw Hill, NewDelhi.

4. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. NewDelhi.

5. Allsopp, D. and K.J. Seal. 1986. Introduction to Biodeterioration. ELBS/Edward Arnold, London.

6. Athie, D. and C.C. Cerri. 1990. The Use of Macrophytes in Water Pollution Control, Pergamon Press, Oxford.

7. Chin, K.K. and K. Kumarasivam. 1986. Industrial Water Technology Treatment, Resuse and Recycling . Pergamon Press, Oxford.

NET REFERENCES

https://onlinecourses.nptel.ac.in

https://www.biologydiscussion.com

https://archive.nptel.ac.in/courses/102/105/102105088/

https://www.youtube.com/watch?v=fpGEUn18H4E

https://www.youtube.com/watch?v=nL354fxAfBk

COURSE OUTCOME

ENVIRONMENTAL BIOTECHNOLOGY Course Code: 24PBT3C10		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	The students will gain an insight into the concepts and techniques of Environmental biotechnology and its wide industrial applications.	K2 & k3
CO - 2	Apply the concepts of biotechnology in Environmental biotechnology	K1
CO - 3	Describe the concept of pollution management	K5
CO - 4	Bioremediation and biodegradation principles, processes and applications will be discussed along with advanced applications in wastewater, oil recovery, biohydrometallurgy, biofuel, carbon storage and capture, etc.	K4
CO - 5	This course will offer the students a broad sense of understanding on how modern biotechnology is developed to achieve better environmental protection and sustainability through the use of microbes and microbial communities in pollution abatement to mitigation of climate change, bioenergy, biomaterial to enzyme discovery.	K6

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
III	24PBT3C10		**CORE COURSE X: ENVIRONMENTAL BIOTECHNOLOGY**							**5**	**5**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	3	2	3	3	2	2	2
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	3	3	3
CO4	2	2	2	3	2	3	3	2	3	3	3
CO5	3	3	2	2	2	3	2	3	2	3	2
Mean Overall Score											2.4

CORE PRACTICAL-III
LAB IN PLANT, ANIMAL & ENVIRONMENTAL BIOTECHNOLOGY

Semester	**: IV**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3C3P**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 06**

COURSE OBJECTIVE

Encourage the students to get self-employability by learning all these techniques.

PLANT BIOTECHNOLOGY

1. Preparation of plant tissue culture media and Organ culture

   (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Anther culture for the production of haploids.
4. Isolation, culture and fusion of protoplasts.
5. Isolation of plant genomic DNA from plant by CTAB method
6. Synthetic seeds (Entrapment method).
7. Establishment and maintenance of suspension culture.
8. Separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot
9. Extraction & Separation of Chlorophyll A & B using Column Chromatography.

ANIMAL BIOTECHNOLOGY

1. Preparation of Media for cell culture.
2. Trypsinization.
3. Cell viability test.
4. Cell counting.
5. Cytotoxicity testing
6. Animal Handling and care

ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of total dissolved solids, BOD and COD of water sample.
2. Estimation of Chromium in Industrial effluent by colorimetry.
3. Estimation of Calcium & Chloride in water sample by titration method.
4. Isolation of bacteriophages from sewage.

5. Sludge analysis (a) Organic matter, (b) Nitrogen (c) Phosphorous (d) Potassium.
6. Biodegradation of industrial aromatic compounds.
7. Determination of Phosphate and nitrate from sewage samples.
8. Microbial analysis of water-MPN technique.
9. Assessment of air quality – Enumeration of microbes.

REFERENCES

- Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., New York.
- Plant Tissue culture theory & practical, Bhojwani and Razdan, M.K, 2004.
- Tissue culture, methods and application, Hurse P.I. and Patterson.
- Handbook of cell and Organ culture M.K Marchan, D, J. (2^{nd}Ed). Burgess Pub. Co., Minneapolis, USA. (1964).
- Plant cell culture – A Practical Approach, Dixon, L.A. and R.A. Gonzales. , Revan Press, New York.
- Plant Tissue Culture Methods and Applications in Agriculture, Quak, F. Academic Press, New York. (1981)

LAB IN PLANT, ANIMAL & ENVIRONMENTAL BIOTECHNOLOGY Course Code: 24PBT3C3P		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	The students will gain an insight into the concepts and techniques of animal biotechnology	K2 & k3
CO - 2	Separation and estimation of secondary metabolites	K1
CO - 3	Microbial analysis of water	K3
CO - 4	Isolation of DNA	K4
CO - 5	Biodegradation of industrial aromatic compounds	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBT3C3P**		CORE PRACTICAL III:LAB IN PLANT,ANIMAL AND ENVIRONMENTAL BIOTECHNOLOGY							**6**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

CORE ELECTIVE- II

GENOMICS AND PROTEOMICS

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3E2A**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

OBJECTIVES:

To impart in depth knowledge on genomics and proteomics. This paper is also designed to provide knowledge on genomics and proteomics function and also their applications.

Unit – I: BASICS OF GENOMICS AND PROTEOMICS

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

Unit – II: GENOME MAPPING

Genetic and physical maps; markers for genetic mapping; methods andtechniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping.

Unit – III: COMPARATIVE GENOMICS

Identification and classification of organisms using molecular markers-16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs;determining gene location in genome sequence.

Unit – IV: PROTEOMICS

Aims, strategies and challenges in proteomics; proteomics technologies:2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast2-hybrid system, proteome databases.

Unit – V: FUNCTIONAL GENOMICS AND PROTEOMICS

Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein protein and protein- DNA interactions; protein chips and functional proteomics; clinical andbiomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCES:

1. Necia Grant Cooper; (Ed.) 1994.The Human Genome Project; Deciphering the blueprint of heredity University Science books, CA, USA.

2. Gary zweiger, 2003. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences.. Tata McGraw-Hill Publishers, New Delhi.

3. Howard L McLeod1 and William E Evans. 2001. PHARMACOGENOMICS: Unlocking the Human Genome for Better Drug Therapy. Annu. Rev. Pharmacol. Toxicol.41:101–121.

4. Evans W.E. and Relling, M.V. 1999. Pharmacogenomics: translating functional genomics into rational therapeutics. Science 286:487

5. Satoskar, R.S., Bhandarkar, S.D and Annapure, S.S. 1999. Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai.

6. Branden, C and J.Troze, 1999. Introduction to Protein Structure. Second Edition.Garland Publishing, New Delhi.

7. Baxevanis, A.D and Ouellette, B.F.F. Eds. 2001. Bioinformatics: A Practical Guide tothe Analysis of Genes and Proteins. Wiley Interscience. New York.

8. Higgins, D and Taylor, W (Eds). 2000. Bioinformatics: Sequence, Structure and Databnks.Oxford University Press, Oxford

GENOMICS AND PROTEOMICS Course Code: **24PBT3E2A**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	The students will gain an prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast	K2 & k3
CO - 2	Apply the concepts of Genetic and physical maps; markers for genetic mapping	K1
CO - 3	Describe the concept Comparative genomics	K5
CO - 4	Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast2-hybrid system, proteome databases	K4

CO - 5	Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosome.	K6

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBT3E2A**		CORE ELECTIVE II:GENOMICS AND PROTEOMICS							**5**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
Mean Overall Score											2.2 HIGH

ELECTIVE COURSE-II

B. AGRICULTURAL BIOTECHNOLOGY

Semester	**: III**	**Max. Marks**	**: 75**
Course Code	**: 24PBT3E2B**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

OBJECTIVES: This course will give an idea about the basic principles and techniques involved in plant tissue culture and to understand the concepts of crop improvement and achievements of biotechnology in Agricultural.

UNIT I: PLANT TISSUE CULTURE

Basic techniques and tools in Plant Tissue Culture.Establishment of plant tissue culture lab: equipment, culture vessels,surface sterilization of various explants, pretreatment of explant, subculture and repeated transfer of explants and cultures.Composition of various tissue culture media and their preparation. Establishment of callus, suspension cultures, organogenesis and embryogenesis, Meristem tip culture, Hardening of plants, Techniques of anther, embryo and ovule culture.Protoplast isolation, culture and fusion. Artificial seed (synthetic seed).

UNIT II: CROP IMPROVEMENT

Crop improvement – Advantages of biotechnological methods over conventional methods of crop improvement. Homozygous plant production through anther ,pollen culture
Embryo rescue embryo culture in rearing viable hybrid embryos Endosperm culture production of triploids , Somaclonal and gametoclonal variations and their applications in crop improvement

UNIT III: BIOREACTORS IN PLANT PRODUCTION

Designing, Fabrication, Assembly, Accessories of reactors – Working principles – Media selection – Microbes multiplication. Use of bioreactors in plant production & Scale-up Marker assisted selection – introduction to markers (RFLP, AFLP, microsatellites, RAPD, QTL), generation of maps using markers, case studies of MAS, virus indexing. Green fluorescent & red fluorescent protein – Plantibody production – plants as tool for recombinant protein production – vaccine product in plants,

UNIT IV: TRANSGENICS IN CROP IMPROVEMENT

Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages. Transgene stability and gene silencing.
Application of Plant Transformation: Herbicide resistance - Disease resistance - Virus resistance-Nematode resistance. Abiotic stress tolerance: drought and salt. Postharvest losses: long shelf life of fruits and flowers.

UNIT V: AGRO-BIOTECHNOLOGY

Case studies in agro-biotechnology – one each from following crops a) cereal, b) pulse, c) oil seed d) ornamental e) vegetable. Agricultural biotechnology and agribusiness. Economic value of herbals and herbal drugs. Identification,cultivation and micropropagation of herbals, biotechnological exploitation.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCES BOOK(S)

1. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology, CRC Press, USA
2. Agricultural biotechnology, 1st edition, (2008) Raw at H, Oxford Book Co, India.
3. Agrobiotechnology and plant tissue culture, Bhojwa ni SS, Soh WY, Oxford & IBH Publ, India
4. Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India

AGRICULTURAL BIOTECHNOLOGY Course Code: **24PBT3E2B**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	The students will gain an Basic techniques and tools in Plant Tissue Culture.Establishment of plant tissue culture lab	K2 & k3
CO - 2	Apply the concepts of Crop improvement – Advantages of biotechnological methods over conventional methods of crop improvement	K1
CO - 3	Describe the concept Bioreactors in Plant production	K5
CO - 4	Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages	K4
CO - 5	Economic value of herbals and herbal drugs. Identification,cultivation and micropropagation of herbals, biotechnological exploitation.	K6

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBT3E2B**		CORE ELECTIVE II: AGRICULTURAL BIOTECHNOLOGY							**5**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
										Mean Overall Score	2.2 HIGH

NME - II

A.) BIOREMEDIATION

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3N2A**	**Credit**	**: 02**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES:

- To impact basic concept of bioremediation and its types
- To understand the bioremediation technologies.
- To focus the advance molecular techniques to facilitate bioremediation technology.
- To focus on advanced nuclear remediation program.
- To apply the concepts of bioremediation technology to the real time problems

UNIT I BIOREMEDIATION

Introduction to Bioremediation: Types of Bioremediation, Factors affection Bioremediation .Microbes for Bioremediation: Essential Characteristics of Microbes for Bioremediation, Microbial Adapadation for Adverse conditions. Microbes involved in Bioremediation. Metabolic process involved in bioremediation. Bioremediation Techniques : Insitu & Exsitu bioremediation techniques.

UNIT II SPECIFIC TECHNOLOGIES OF BIOREMEDIATION

specific advantages and disadvantages of specific bioremediation technologies - land farming, biopiles, prepared beds, biosparging, composting, pump and treat method, bioventing, constructed wet lands use of bioreactors for bioremediation.

UNIT III BIOREMEDIATION OF CHLORINATED COMPOUNDS AND MOLECULAR TECHNIQUES

Bioremediation of phenols, chlorinated phenols, heterocyclic compounds, chlorinated aliphatic compounds, cyanides, dyes; Rhizoremediation: a beneficial plant-microbe interaction;

Molecular techniques in bioremediation- Enhanced biodegradation through pathway engineering; Biodegradation of polyhalogenated compounds by genetically engineered bacteria.

UNIT IV NUCLEAR WASTE BIOREMEDIATION

Spent fuel characterization, storage and disposal; Partitioning, transmutation and conditioning; Measurement of Radioactivity in the environment; Basic actinide research.

UNIT V HEAVY METAL AND OIL SPILL BIOREMEDIATION

Heavy metal pollution & sources; Accumulation and concentration of metals. Microbial interactions with heavy metals – resistance &tolerance ;Microbial transformation; Biosorption of heavy metals by microbial biomass and secondary metabolites and Biosurfactants. Advantages of biosurfactants over chemical surfactants.; Biotechnology and oil spills; Improved oil recovery.

UNIT VI: Latest Learnings (For CIA Purpose only)

Latest development related to the course during the semester concerne

REFERENCES

1. Bruce E. Rittmann, Perry L. M, Environmental Biotechnology: Principles and Applications, 2nd Edition, 2020
2. Deepak Kumar Yadav, Pradeep Kumar, Pardeep Singh, Daniel Vallero Hazardous Waste Management, 2021
3. Milind Mohan Naik , Santosh Kumar Dubey Marine Pollution and Microbial Remediation 1st ed 2017
4. Phillip L. Buckingham , Jeffrey C. Evans," Hazardous Waste Management" Waveland Pr Inc; Reissue edition 1, 2010.
5. Singh A., Kuhad R.C. and Ward O.P. (2009). Advances in Applied Bioremediation. Springer-Verlag Berlin Heidelberg, Germany.
6. P. Rajendran, P. Guansekaran, "Microbial Bioremediation", Mjp Publishers, 2011.

NET REFERENCES:

NPTEL :: Civil Engineering - NOC:Environmental Remediation of Contaminated Sites

152396579624QuadrantIE-TEXT.pdf (inflibnet.ac.in)

e-PGPathshala (inflibnet.ac.in)

Types of bioremediation (slideshare.net)

Biodegradation and Bioremediation of Organic Compounds by Lawrence Wackett, PhD - YouTube

Bioremediation || Environment || Science and Technology - YouTube

COURSE OUTCOME

BIOREMEDIATION Course Code: 24PBT3N2A		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	On completion of this course, the students will be able to describe the basic concepts of Bioremediation	K1
CO - 2	Apply the bioremediation technologies.	K2
CO - 3	Design the experiments using various molecular techniques of Bioremediation	K3
CO - 4	Formulate and assess experimental problems in nuclear waste bioremediation.	K4
CO - 5	Gives knowledge about heavy metals and its	K5

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
III	24PBT3N2A		**NME II**: BIOREMEDIATION							**3**	**2**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	2	2	3	3	3	2	2
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	3	3
CO4	2	2	2	3	2	3	2	2	3	2	2
CO5	3	3	2	2	2	3	3	2	3	3	3
										Mean Overall Score	2.4

NME-II

B.) FOOD BIOTECHNOLOGY

Semester	**: III**	**Max. Marks**	**: 100**
Course Code	**: 24PBT3N2B**	**Credit**	**: 02**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- It gives introduction of the composition and nutritional value present in the food.
- It describes the study of microbes associated with food and about food spoilage and intoxication.
- It discusses about steps of food processing and preservation.
- It describes about the production and utilization of food
- Describe the steps involved in packaging.

UNIT-I

Introduction, general aspects of food industry, world food demand and Indian scenario, constituents of food, quality and nutritive aspects Food additives, standards, deteriorativefactors and their control, preliminaryprocessing methods, conversion and preservation operation.Food groups classification; Composition and nutritive value of cereals, millets and pulses; milk and animal products (meat, poultry and fish products). Constituent of food – contribution to texture, flavour and organoleptic properties of food;

UNIT-II

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food additives – intentional and non-intentional and their functions. Food borne diseases – infections and intoxications, Food spoilage – causes.

UNIT- III

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing. Use of high temperatures – sterilization, pasteurization, blanching, canning – concept, procedure & application; Low temperature storage – Factors affecting quality of frozenfoods; irradiation preservation of foods.

UNIT-IV

Soft and alcoholic beverages, diary products, meat, poultry and fish products, treatment and disposal of food processing wastes.Bread and baked goods, dairy products – milk processing,

cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; confectionery, beverages.

UNIT – V

Introduction, Food Protection, P r o d u c t Containment, Product Communication, Product Convenience, Mass Transfer in Packaging Materials. Innovations in Food Packaging, Food Packaging and Product Shelf-life, Food canning technology, fundamentals of food canning technology. Heat sterilization of canned food, containers metal, glass and flexible packaging. Canning procedures for fruits, vegetables,meats, poultry marine products

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerne

TEXT BOOK

- P.J. Fellows.2009. Food processing technology. Principles and practice. (Ed: 3). Woodhead Publishing Series in Food Science, Technology and Nutrition.
- Sivasankar B. 2002. Food processing and preservation, Prentice Hall, New Delhi.(Unit III and Unit IV)

REFERENCES

1. James G.Brennan. 2006. Food processing handbook, 2nd Edition. Wiley Publishers.
2. Desrosier, N.W. 2006.The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Janet D.Ward. 2013. Principles of Food Science. 4th Edition. Goodheart- Willcox
4. Fundamentals of Food Engineering by Stanley Charm.
5. Introduction to Food Engineering - R. Paul Singh, DennisR.
6. Heid, J.L. and Joslyn, M.A., Fundamentals of Food Processing Operation, The AVI Publishing Co; Westport,1967.
7. Heldman, D.R., Food Process Engineering, The AVIPublishing Co; Westport, 1975.
8. Hall, C.W; Farall,A.W. & Rippen,A.L; Encyclopedia of FoodEngineering, Van Nostrand – Reinhold

NET REFERENCES:

https://archive.nptel.ac.in/courses/102/103/102103044/

https://biologyreader.com/food-preservation-techniques.html#:~:text=Food%20preservation%20maintains%20asepsis%2C%20which%20means%20%E2%80%9Ckeeping%20out,destroys%20microorganisms%20by%20methods%20like%20pasteurization%2C%20irradiation%20etc.

https://www.britannica.com/topic/food-additive

https://www.youtube.com/watch?v=ExZJDU1yN2I

https://video.search.yahoo.com/search/video?fr=mcafee&ei=UTF-8&p=food+borne+disease+youtube&type=E211US826G0#id=1&vid=500bdb28dc6df2709665ceb6391e45e1&action=click

COURSE OUTCOME

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	acquire understanding on the chemical nature and association of microbes with food.	K1
CO-2	explain the principles and different methods used in food processing and preservation.	K2
CO-3	classify different methodologies and approaches involved in the production of different food products.	K3
CO-4	evaluate and identify a food science issue or problem.	K4, K5
CO-5	critical thinking and problem-solving skills to address current challenges in the food industry.	K5

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	24PBT3N2B		**NME-II**-B)FOOD BIOTECHNOLOGY							**3**	**2**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
									Mean Overall Score		2.2 HIGH

CORECOURSE- XI

RESEARCH METHODOLOGY

Semester	**: IV**	**Max. Marks**	**: 100**
Course Code	**: 24PBT4C11**	**Credit**	**: 06**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.
- To understand science frameworks for scientific inquiry
- To understand the various methods for conducting empirical research
- To examine trends and patterns in the use of various research methods
- To get knowledge to prepare research documents for publication
- To screen and select the correct journals to publish their research findings
- To articulate informed opinion about the value of empirical research

UNIT I: BIOSAFETY

Biosafety regulations - Good laboratory practices - Good manufacturing practices in industry. Storage and disposal of hazardous wastes: radioactive materials – pathogenic strains. GMO's and their release in environment. Experimental protocol approvals -Levels of containment - Environmental aspects of biotech applications.

UNIT II: RESEARCH IN BIOLOGICAL SCIENCES

Research: research in Biological sciences- Objective – thrust areas and research priorities in Biotechnology to meet global competency- Origin of the research problem - Collection of literature: Internet –library – index card preparation - Experimental approach. Setting up of a Laboratory: laboratory administration – collaborations - inventories and inspections – personnel – Recruitment hiring – mentoring - promoting and terminating.

UNIT III: MANUSCRIPT PREPARATION

Scientific communication: Introduction – manuscript preparation: Original – review – short communication. Thesis writing - Proof correction – symbols used for correction- preparation for Oral and poster presentation – preparation of Power Point presentations - communication skills for effective presentation.

UNIT IV: RESEARCH PUBLICATIONS

Standards of journals: national and international – online and printed – paid and unpaid – peer reviewed journal – SCI journals – impact factor- h-index.

Research engines: Elsiever, Springer, Pubmed, Google scholar, Academic journals, online digital library- Social network for research community: Research gate, Research Pages, Frontiers Research Network, Elsevier Lab.

UNIT V: RESEARCH PROPOSAL

Writing research proposal for getting financial support – Sponsoring agencies – (DST, DBT, UGC, CSIR, ICMR, MoEF, MoEs, DRDO, DRDE, TNSCTE, TNSCST and NABARD). Research ethics – Intellectual property Rights – Overcome the difficulties in biological research.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned.

TEXT BOOKS

- Research methodology for biological science, Gurumani N, 2009, MIP publisher.
- Essentials of Research Design & Methodology, Geofferey R, Marczyk, David De Mattea, David Festinga, 2005, John Wiley & Sons Publisher.
- Handbook of research methodology 2017, Shanti Bhushan Mishra, Shashi Alok.
- Biological Safety: Principles and Practices, 5th Edition , 2017 Dawn P. Wooley, Karen B. Byers

REFERENCES

- Guide to publish a scienctifc paper, Ann M. Korner, 1996, Bioscript Press.
- How to write and Publish a scientific paper, Rober A. Day, 1996, Cambridge Univeristy Press.
- Bio-Statistics, Arora, PN and Malhan, PK, Himalaya Publishing House.
- Fundamentals of Bio-Statistics Veer Bala Rastogi, Ane Book India.

NET REFERENCES

1. https://archive.nptel.ac.in/courses/102/104/102104061/
2. https://onlinecourses.nptel.ac.in/noc20_hs06/preview
3. https://youtu.be/E2gGF1rburw
4. https://www.youtube.com/watch?v=BECG9ban4rs

COURSE OUTCOME

RESEARCH METHODOLOGY Course Code: 24PBT4C11		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	Get knowledge on research proposal preparation and apply to the sponsoring agencies.	K1
CO - 2	Benefits through socio-research networks.	K2
CO - 3	Understanding of the history and methodologies of scientific research, applying these to recent published papers	K3
CO - 4	Understanding and practicing scientific reading, writing, presentations	K4
CO - 5	Appreciating scientific ethics through case studies.	K5

Relationship Matrix											
Semester	**Course code**	**Title of the course**								**Hours**	**Credits**
IV	24PBT4C11	**RESEARCH METHODOLOGY**								**6**	**6**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	2	2	3	3	3	2	2
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	3	3
CO4	2	2	2	3	2	3	2	2	3	2	2
CO5	3	3	2	2	2	3	3	2	3	3	3
										Mean Overall Score	2.4

CORE ELECTIVE-III

A. MARINE BIOTECHNOLOGY

Semester	**: IV**	**Max. Marks**	**: 75**
Course Code	**: 24PBT4E3A**	**Credit**	**: 03**
Total Periods	**: 75**	**Exam Hrs**	**: 03**

OBJECTIVES: To impart knowledge on marine microbes. This paper is also designed to provide knowledge on active compound in marine microbes and their applications in various aspects.

UNIT I: BASICS OF MARINE BIOTECHNOLOGY

Biotechnology in marine science- history of marine biotechnology application in aquaculture, pharmaceutical, environment remediation, biofouling and biocorrosion.

UNIT II: DEVELOPMENTAL BIOTECHNOLOGY

Developmental biotechnology induced breeding in-vitro fertilization cryopreservation biotechnological tools - ELISA, FISH, PCR Gene probes, dot immuno binding activity, monoclonal antibodies biosafety ethics.

UNIT III: BIOACTIVE COMPOUNDS

Bioactive marine natural products membrane receptors, anti tumor compounds, anti inflammatory / analgesic compounds, anti viral agents, isolation and identification of marine bioactive compounds such as labile proteins, toxins, carotenoids bioterminator Commercial development of marine natural products-chitosan, chitin.

UNIT IV: ALGAL BIOTECHNOLOGY

Algal biotechnology - single cell protein, hydrocolloids, agarose, carrageen alginates and otherby products. Marine Enzyme sources and their applications, Marine Lipid sources and their applications.

UNIT V:APPLICATIONS

Pharmaceutical compounds: antibiotics, antiviral compounds, antitumour compounds, enzymes, surfactants, other potentially useful microbial products such as marine cements,

biominerals, antifouling compounds and other applications.

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

REFERENCE BOOK(S)

1. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.

2. Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms,Science Pub Inc.

3. Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.

4. David H. Attaway, 2001.Marine Biotechnology,Volume 1, Pharmaceutical and BioactiveNatural Products.

5. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science &Biotechnology) Wiley Interscience.

6. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York.

COURSE OUTCOME

MARINE BIOTECHNOLOGY Course Code: **24PBT4E3A**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	Get knowledge on Biotechnology in marine science- history of marine biotechnology	K1
CO - 2	Benefits through Developmental biotechnology induced breeding in-vitro fertilization cryopreservation biotechnological tools	K2
CO - 3	Understanding of the Bioactive marine natural products membrane receptors	K3
CO - 4	Understanding Algal biotechnology - single cell protein	K4
CO - 5	Pharmaceutical compounds: antibiotics, antiviral compounds	K6

Mapping with programme Outcomes:

Relationship Matrix											
Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
IV	**24PBT4E3A**		CORE ELECTIVE III:MARINE BIOTECHNOLGY							**6**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	3	2	2
CO2	2	3	3	2	3	2	3	3	2	3	3
CO3	3	3	2	2	2	3	3	2	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2	2
CO5	3	3	2	3	2	2	3	2	2	3	2
									Mean Overall Score		2.2 HIGH

CORE COURSE-III

B. IPR, BIOSAFETY AND BIOETHICS

Semester	**: IV**	**Max. Marks**	**: 100**
Course Code	**: 24PBT4E3B**	**Credit**	**: 03**
Total Periods	**: 30**	**Exam Hrs**	**: 03**

COURSE OBJECTIVES

- This course is planned to give an understanding about Biostatistics, Bioethics, IPR and Legal Protection, Patent Filing and Infringement and Biosafety.
- To introduce the biosafety regulations and ethical concepts in biotechnology.
- To emphasize on IPR issues and need for knowledge in patents in biotechnology.
- Interpret the basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.
- Recognize the importance of biosafety practices and guidelines in research.

UNIT I: INTELLECTUAL PROPERTYRIGHTS

Introduction to IPR, Types of IPR- Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR - patentable and non patentables, patending life, legal protection of Biotechnological inventions. Introduction to History of GATT, WTO, WIPO and TRIPS

UNIT II : CONCEPT OF 'PRIOR ART' AND BASICS OF PATENTS

Invention in context of "prior art"; Patent databases; Searching International Databases; Country wise patent searches (USPTO, EPO, India etc.); Analysis and report formation, Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; Madrid agreement; Hague agreement; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

UNIT III : PATENT FILING AND INFRINGEMENT

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting- introduction to

existing schemes; Publication of patents - Patent infringement- meaning, scope, litigation, case studies and examples

UNIT IV BIOETHICS

Introduction to ethics and bioethics, framework for ethical decision making.Benefits and risks of genetic engineering – ethical aspects of genetic testing – Reproductive cloning , terapeutic cloning ; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopirvcy – Ethical implications of human genome project, human cloning, designer babies, biowarfare

UNIT V BIOSAFETY AND GUIDELINES

Introduction- biosafety issues in biotechnology – historical background- Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; **Biosafety guidelines** –Guidelines and regulations (National and international including Cartegana Protocol) Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture

UNIT VI: LATEST LEARNINGS (FOR CIA PURPOSE ONLY)

Latest development related to the course during the semester concerned

OUTCOME OF THIS PAPER:

- On completion of this unit of study, students should be able to: Apply intellectual property law principles (including copyright, patents, designs and trademarks)
- To real problems and analyse the social impact of intellectual property law and policy
- Analyses ethical and professional issues which arise in the intellectual property law context

TEXT BOOKS:

1. Goel and Parashar 2013.IPR, Biosafety and Bioethics.

2. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.

REFERENCES:

1. Goel And Parashar, 2013.IPR, Biosafety and Bioethics
2. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
3. Kankanala, K . C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra

IPR, BIOSAFETY AND BIOETHICS Course Code: **24PBT4E3B**		
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	Get knowledge on Introduction to IPR, Types of IPR	K1
CO - 2	Benefits through Invention in context of "prior art"; Patent databases; Searching International Databases	K2
CO - 3	Understanding of the Patent application- forms and guidelines, fee structure, time frames	K3
CO - 4	Understanding Introduction to ethics and bioethics	K4
CO - 5	Introduction- biosafety issues in biotechnology	K6

Relationship Matrix											
Semester	**Course code**		**Title of the course**							**Hours**	**Credits**
IV	**24PBT4E3B**		**CORE ELECTIVE III :IPR, BIOSAFETY AND BIOETHICS**							**6**	**3**
Course Outcomes	**Programme Outcome (POs)**					**Programme specific outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	2	2	3	3	3	2	2
CO2	3	2	2	3	2	2	3	2	3	3	2
CO3	3	3	2	3	2	3	3	2	2	3	3
CO4	2	2	2	3	2	3	2	2	3	2	2
CO5	3	3	2	2	2	3	3	2	3	3	3
										Mean Overall Score	2.4