SENGUNTHAR ARTS AND SCIENCE COLLEGE

(Autonomous)

(Affiliated to Periyar University, Salem and Approved by AICTE, New Delhi)
An ISO 9001:2015 Certified Institutions.
Recognised under section 2(f) and12 (B) of the UGC Act, 1956 and Accredited by NAAC with A+
TIRUCHENGODE–637205, NAMAKKAL DT., TAMIL NADU
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REGULATIONS AND SYLLABUS

M.Sc., BIOTECNOLOGY

(CBCS –LOCF)

(Academic Year 2024-25 onwards)

INTRODUCTION

The curriculum and course material for the Master of Science (M.Sc.) in Biotechnology were created to satisfy the requirements of the UGC-CSIR (NET) and (SLET) exams. The choice-based credit system of learning helps students build a strong foundation in fundamental subjects, specialize in the fields that best suit their interests and skills, and get in-depth knowledge of a variety of biotechnology-related topics. Through the learning of fundamental concepts for structural elucidation with hyphenated techniques, understanding of the fundamental biological process and rationale towards computers, and the design and implementation of novel synthetic methods, the students develop their aptitude for academic and professional skills in addition to their experimental skills. The curriculum's new initiative will encourage pupils to conduct research and enhance their entrepreneurialskills.

AIM

The course aims to provide knowledge about the disciplines of biology, immunology, cell engineering, fermentation, etc. M.sc. Biotechnology course is designed in a way that it provides adequate knowledge of biotechnology and related subjects such as molecular biology, food technology, molecular biotechnology, etc.

ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the Degree of Master of Science in Biotechnology (PG) course shall be required to have passed the B.Sc., degree in any Life Science (Biotechnology / Botany / Zoology / Biology / Microbiology / Microbial Gene technology / Bioinstrumentation / Bioinformatics / Biochemistry / Chemistry / Agriculture / Marine Biology / Home Science / Farm Science / Nutrition and Dietetics / Integrated Biology / Plant Science / Animal Science / Fisheries Science / Aquaculture / Mathematics with Physics, Chemistry as Ancillary / Medical Lab Technology / as allied subject of this University or an Examination of any other university accepted by the Syndicate as equivalent there to shall be eligible for admission to M. Sc., Degree course in Biotechnology.

PROGRAMME OUTCOMES

REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAME WORK (CBCS) FOR UNDER GRADUATE	
Programme	**M.Sc. BIO-TECHNOLOGY**
Programme Code	24PBT
Duration	**PG– 2 YEARS**
Programme Outcomes (POs)	**PO1: Problem Solving Skill :** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO9 : Multicultural competence** Possess knowledge of the values and beliefs of multiple culture sand a global perspective. **PO10: Moreland ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one‘s life of sources; draw valid conclusions and support themwith evidence and examples, and addressing opposing viewpoints.

Programme Specific Outcomes (PSO)

Programme Specific Outcomes (PSOs)	**PSO1–Placement** To prepare the students who will demonstrate respect full engagement with others 'ideas, behaviors, and beliefs and apply diverse frames of reference to decisions and actions. **PSO2-Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3–Research and Development** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development. **PSO4–Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO5–Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

	POs										**PSOs**				
	P01	**P02**	**P03**	**P04**	**P05**	**P06**	**P07**	**P08**	**P09**	**P10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CLO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Correlation between POs and PSOs *(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix);*

1 – Low, 2 – Medium, 3 – High, 0 – No Correlatio

I YEAR

S.No	Course Category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
SEMESTER–I									
1	Core Paper-I	**24S1PBT01**	Biochemistry	6	-	4	25	75	100
2	Core Paper-II	**24S1PBT02**	Molecular Genetics	6	-	4	25	75	100
3	Core Paper-III	**24S1PBT03**	Molecular Cell Biology	6	-	4	25	75	100
4	Core Practical-I	**24S1PBTP01**	Practical–I (A)Biochemistry (B)Molecular Genetics (C)Molecular Cell biology	-	6	4	40	60	100
5	Elective–I	**24S1PBTE01**	Bioinstrumentation	3	-	2	25	75	100
		24S1PBTE02	Phyto chemistry						
6	Elective-II	**24S1PBTE03**	Enzymology	3	-	2	25	75	100
		24S1PBTE04	Food Technology						
Total				**24**	**06**	**20**			

S.No	Course category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
SEMESTER–II									
1	Core Paper-IV	**24S2PBT04**	Microbiology	5	-	4	25	75	100
2	Core Paper-V	**24S2PBT05**	Plant and Animal Biotechnology	5	-	4	25	75	100
3	Core Paper-VI	**24S2PBT06**	Genetic Engineering	5	-	4	25	75	100
4	Core Practical II	**24S2PBTP02**	Practical– II (A) Microbiology (B) Plant and Animal Biotechnology (C) Genetic Engineering	-	6	4	40	60	100
5	Elective Paper -III	**24S2PBTE05**	Regulatory affairs and Industrial standards	3	-	2	25	75	100
		24S2PBTE06	Pharmaceutical Biotechnology						
6	Elective Paper- IV	**24S2PBTE07**	Environmental Biotechnology	3	-	2	25	75	100
		24S2PBTE08	Marine Biotechnology						
7	NME - I	**24S2PBTN01**	Gene manipulation Technology	3	-	2	25	75	100
8	Human Rights		Human Rights	2	-	2	25	75	100
Total				**26**	**6**	**24**			

SEMESTER – I

FIRST YEAR - SEMESTER I

CORE I - BIOCHEMISTRY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBT01	Core-I	**Theory**	Y	Y	-	6	4

Learning Objectives

- The paper imparts a thorough knowledge on the basics of all the Biochemical concepts, metabolic reactions and its regulation.
- The student will get to understand the core concepts of metabolism and physiological processes of the body in both healthy and disease state.
- To understanding chemical properties: How the chemical properties of molecules determine how they react and interact with each other.
- To understanding chemical reactions: How living organisms use different types of chemical reactions.
- Developing analytical, technical, and critical thinking skills: To contribute to the discipline after graduation.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	**Programme Outcomes**
CO1	To understand the basics of pH and related principles and carbohydrate metabolism.	PO1
CO2	To provide basic knowledge about lipid metabolism and related significance.	PO1,PO2
CO3	To enlighten the students on Bio-energetic and Biological oxidation pathways.	PO4,PO6
CO4	To update the knowledge on Amino acids and Protein.	PO4,PO5, PO6
CO5	To assess and appraise the role of Nucleic acids.	PO3,PO8

FIRST YEAR-SEMESTER I

CORE I–BIOCHEMISTRY

Unit	Details	No. of Hours
I	**Basic Concept of Biochemistry:** pH, pK. Acid, base. Buffers-Henderson- Haselbach equation. Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluco neo genesis, pentose phosphate pathway, glycolysis, citric acid cycle, glyoxalayate pathway . ***Power Point Presentation on Principles of Biochemistry**	**18**
II	**Lipid metabolism:** Nomenclature, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Oxidation of fatty acids, ß-oxidation, alpha and gamma oxidation.	**18**
III	**Energy and metabolism –** Concept of energy, Principle of thermodynamics. Laws of thermodynamics, Biological oxidation: Electron transport chain, oxidative phosphorylation. Photosynthesis (Oxygenic and An oxygenic), Hormonal regulation of fatty acids and carbohydrates metabolisms.	**18**
IV	**Chemistry of Amino Acid and Proteins**: Nomenclature, Classification, structure, chemical and physical properties. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids, Urea cycle.	**18**
V	**Nucleic Acids Metabolism:** Nomenclature, Classification, structure, chemical and physical properties. *De novo* and salvage synthesis of purine and pyrimidine bases, nucleosides and nucleotides. Catabolism of purine and pyrimidine bases. Synthetic analogues of nitrogenous bases. *** Model Preparation on DNA and RNA structure.**	**18**
	Total	**90**
***Model Preparation and Power Point Presentation - related to the above topics are to be Considered for Internal Exam only**		

Text books

- P.L.Soni,AText-bookofInorganicChemistry,12th Edition,2015, S. Chand & Sons publications
- AbhilashaShourie,ShilpaS,Chapadgoankar&AnamikaSingh(2020)TextbookofBiochemistry1st Edition
- J.L.Jain, 2016, Fundamentals of Biochemistry,S. Chandpublication,7thedition.

❖ A.C.Deb, 2016, Fundamentals of Biochemistry, New central bookagencies, 7th edition.

Reference books

❖ Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2016. Schaum. Outline of Biochemistry, 6th Edition (Schaum. s Outline Series), McGraw-Hill.

❖ Sathyanarayana. U and U. Chakrapani., 2015. Biochemistry. Books and Allied private limited, Kolkata.

❖ Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2015.Biochemistry, 9th Edition, W. H. Freeman

Web Resources

❖ mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm

❖ www.biochemweb.org/

❖ http://golgi.harvard.edu/biopages.html

❖ webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03	PS04	PS05
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	13	12	12	13	13	12	13	12	15	14	14	13
Average	2.4	2.4	2.4	2.6	2.4	2.4	2.6	2.6	2.4	2.6	2.4	3	2.8	2.8	2.6

CORE II – MOLECULAR GENETICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBT02	Core-II	**Theory**	Y	Y	-	6	4

Learning Objectives

- The paper imparts a thorough knowledge on the basics of all the Genetics concepts, molecules and its regulation.
- The student will get to understand the core concepts of molecules and genetics.
- Students will acquire a broad understanding of current molecular genetics and genomics including current areas of research and research methodologies.
- Students will master data analysis and learn to critically evaluate their own data and data in the research literature.
- Students will demonstrate ability to use evolutionary theory and related equations to model and predict population change or stability.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.	**PO1**
CO2	Identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various Chromosomal abnormalities.	**PO1,PO2**
CO3	Make the students understand different range of DNA damage and range of their tools for their detection an.	**PO4,PO6**
CO4	Learn the concepts of the transposons and their applications.	**PO4,PO5, PO6**
CO5	Detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution	**PO3,PO8**

Unit	Details	No.of Hours
I	**Cellular and molecular basis of Inheritance.** Genes and chromosomes, Co-linearity of Genes and Proteins, Genetic code. Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudo genes). ***Model Preparation on Chromosome Structure**	18
II	**Gene expression and Mutation**: Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation induced mutation. Chromosomal Abnormalities and associated genetic diseases.	18
III	**DNA Damage and Repair mechanism**: Internal and external agents causing DNA damages, Mechanisms of DNA damage (transition, transversion, frame shift, nonsense mutations), Repair mechanisms (Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair).	18
IV	**Population Genetics:** Allele and genotype frequencies, Random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, autosomal and X-linked frequencies. Inbreeding, genetics and evolution, random genetic drift, Karyo typing and Chromosomal mapping	18
V	**Extra chromosomal heredity:** Biology of Plasmids, their discovery, structure and types. Replication and partitioning, Incompatibility and copy number control-natural and artificial plasmid transfer and their applications-Genomics and Modern methodologies in understanding genome -Human Genome Project, DNA markers-VNTR, STR, microsatellite, SNP and their detection techniques. ***Field Visit- Genetics Laboratory and Report submission**	18
	Total	**90**
***Model Preparation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text books

- Principles of Genetics-8th Edition, Gardner, Simmons and Snustad, 2006.
- Genetics- Kavitha B. Ahluwalia, New Age International Pvt Ltd and Publishers, New Delhi, 2016
- Robert Brooker, 2016. Genetics-Analysis and Principles.6th edition. McGraw-Hill.
- Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, 2018.

Mapping with programme outcomes and programme specific outcome

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	3	2	3	2	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	3	3	3	3	3	2	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	3	3	2	2	3	3	3	2	3	3	2
Total	13	12	14	12	12	12	13	13	12	13	12	14	14	13	12
Average	2.6	2.4	2.8	2.4	2.6	2.4	2.6	2.6	2.4	2.6	2.4	2.8	2.8	2.6	2.4

CORE III – MOLECULAR CELL BIOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBT03	Core-III	**Theory**	Y	Y	-	6	4

Learning Objectives

- The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation.
- The student will get to understand the core concepts of molecules and cell biology.
- Students will be able to understand and integrate knowledge of chemical and biological principles of living systems.
- Students will develop quantitative skills in order to collect, analyze and interpret experimental data.
- Students will be able to explain the molecular and cellular basis of physiological functions.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular Recognition.	**PO1**
CO2	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism	**PO1,PO2**
CO3	Demonstrate knowledge and understanding of the principles and basic mechanisms of nuclear envelope and its functions.	**PO4,PO6**
CO4	Understand the metabolic pathways and the process of transmission of extracellular signals	**PO4,PO5**
CO5	Demonstrate the operation of various microscopes and microtomy in the laboratory	**PO3,PO8**

Unit	Details	No.of Hours
I	**Basic properties of cells** - Cell dimension, size of the cells and their composition, Cell theory. Microscopy types and its Application in cell biology. Biomembranes - structural organization and the transport systems (Passive, Active and Bulk transport), Cell-Cell adhesion-Cell junctions, Extra cellular matrix Components and its role. ***Model Preparation on Microscope**	**18**
II	**Central Dogma of Molecular Biology:** Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and Post translational modification. Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretary and membrane proteins across ER – post-translational modification, protein glycosylation – mechanism and regulation of vesicular transport – golgi and post- golgi sorting and processing– receptor mediated endocytosis;	**18**
III	**Nucleus and Chromosome organization:** Nuclear envelope – Nuclear pore complexes - nuclear matrix–organization of chromatin – super coiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model)- Global structure of chromosome – (Lampbrush and polytene Chromosomes).	**18**
IV	**Cell cycle and Cell Signaling:** Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways.	**18**
V	**Oncogenes in Cell Survival and Cell Death:** Multistage cancer development Mitogens, carcinogens, oncogenes and proto- oncogenes, tumor suppressor genes-Rb, p53, Apoptosis and significance of apoptosis. ***Field Visit : Adyar Cancer Institute and Report Submission** Self-study: Caspase 9 structure and mechanisms	**18**
	Total	**90**
***Model Preparation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text books

- Karp, G., 2018, Cell Biology, Sixth edition, John Wiley & Sons, New York.
- David E.Sadva. 2016. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.

- Prakash S. Lohar, 2019. Cell and Molecular Biology.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2015. Molecular Biology of the Cell, Fifth edition. Garland Science

Mapping with programme outcomes and programme specific outcome

	Pos										**PSOs**				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03	PS04	PS05
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	13	12	12	13	13	12	13	12	15	14	14	13
Average	2.4	2.4	2.4	2.6	2.4	2.4	2.6	2.6	2.4	2.6	2.4	3	2.8	2.8	2.6

CORE PRACTICAL -I- Biochemistry, Molecular Genetics & Molecular Cell biology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTP01	Core Practical-I	**Practical**	-	-	-	6	4

Learning Objectives

- The practical will establish a basic study skills on the subject and will improve the student‘s ability to calculate and improve their practical skill and knowledge.
- Understanding the catalytic role of enzymes
- Understanding the importance of enzyme inhibitors in designing new drugs
- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Students will understand how these cellular components are used to generate and utilize energy in cells

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Illustrate basic biochemistry procedures	**PO1**
CO2	study the methods of estimation of bio molecules	**PO1,PO2**
CO3	isolate &Analyze DNA,RNA & protein	**PO4,PO6**
CO4	critically analyze the isolated bio molecules	**PO4,PO5,PO6**
CO5	Evaluate the quality and purity of DNA, RNA& Protein	**PO3,PO8**

Unit	Details	Hours
A	**(A) Biochemistry–Practical** **Major** 1. Extraction of Proteins from biological materials 2. SDS PAGE 3. Estimation of Proteins by Lowry‘s method 4. Estimation of RNA by orcinol method 5. Estimation of DNA by diphenylamine method 6. Estimation of Carbohydrate by Anthrone method **Minor Experiments** 1. Preparation of biological buffer-phosphate buffer 2. Separation of amino acids by Paper Chromatography 3. Separation of sugars by Thin layer Chromatography **Demo Experiments** 1. Gel permeation chromatography, 2. Affinity chromatography, 3. Ion. Exchange chromatography 4. Western blotting 5. PCR	30
B	**(B) Molecular Genetics–Practical** **Major** 1. Agarose gel electrophoresis of DNA 2. Restriction digestion of DNA 3. Giant chromosome studies in Chironomous larvae 4. Cell counting and cell viability 5. Meiotic study in flower buds and cockroach or grasshopper. **Minor** 1. Isolation of DNA from bacteria. 2. Plasmid DNA isolation. 3. Preparation of metaphase chromosomes forms blood.	30
C	**Demo Experiments** 1. Introduction to Microtome and types 2. Microtomy-Fixation of tissue 3. Microtomy-Embedding 4. Microtomy-Sectioning of tissue 5. H&E Staining of tissues 6. Preparation of tissue culture medium and membrane filtration 7. Embryonic development and stem cells (serpulid polychaete Hydroides Elegans /chick/frog)	30

ELECTIVE-I – BIOINSTRUMENTATION

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTE01	Elective –I	**Theory**	Y	Y	-	3	3

Learning Objectives

- ❖ The paper imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology.
- ❖ The student will get to understand the core concepts of biological instruments and their principles.
- ❖ Understand the use of basic biomedical instrumentation, principles and techniques of preparative analytical.
- ❖ Understand the theory and application of Chromatography techniques

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Introduction and various types of Microscopic techniques	**PO1**
CO2	Impart understanding on centrifugation instruments and techniques	**PO1,PO2**
CO3	Separation of Bio molecules	**PO4,PO6**
CO4	Analytical methods on Spectroscopic Analysis	**PO4,PO5**
CO5	Understand the application and Detection on Bioinstrumentation	**PO3,PO8**

Unit	Details	No. of Hours
I	**Microscopic Techniques** - Principles and application- Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Confocal Microscopy and Flow Cytometry. ***Poster Preparation on Types of Microscope**	**9**
II	**Types of Chromatography and Centrifugation:** Principle and Applications of various types of centrifuges, Chromatography Techniques: Principle and Application of Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC& HPLC.	**9**
III	**Types of Electrophoresis and Blotting Techniques**: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, SDS PAGE, Iso- electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (immuno fixation EP) ELISA, RIA, Southern and Western Blotting. PCR and RT-PCR, Microarray (DNA, Proteins).	**9**
IV	**Types of Spectroscopy:** Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, Atomic Absorption Spectroscopy, X-ray Spectroscopy.	**9**
V	**Radio-isotopic Techniques:** Introduction to Radio isotopes, Uses and their Biological Applications, Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Auto radio graphy, RIA, Radiation Dosimetry, Health effects of Radiations. ***Field Visit: Atomic Power station and Report submission** Self-Study : Inverted Microscope	**9**
	Total	**45**
***Model Preparation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text books

- Keith Wilson, John Walker, 2018. Principles and Techniques of Biochemistry and Molecular Biology (7th Edition), Cambridge University Press
- MetzlerD.E.2001, the chemical reactions of living cells–AcademicPress.2nd edition.
- L.Veerakumari (2016), Bioinstrumentation MJP Publisher Kindle edition.
- Holcapek,M.,Byrdwell,Wm.C.2017.HandbookofAdvancedChromatography/Mass Spectrometry Techniques, Elsevier

Mapping with Programme Outcomes and Programm Specific Outcomes
: 3 Strong, 2 – Medium, 1 – Low

	POs										PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	2	3	3	2	2	2	3	2	3	3	3	3	3	3	2
CO2	2	3	2	2	2	3	3	3	2	2	3	2	3	2	3
CO3	3	2	2	3	3	2	2	3	2	3	2	3	2	3	3
CO4	2	3	3	2	2	3	2	2	3	3	2	3	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3	3	3	3	3	3
Total	12	13	13	11	12	12	13	12	13	14	13	14	13	14	14
Average	2.4	2.6	2.6	2.2	2.4	2.4	2.6	2.4	2.6	2.8	2.6	2.8	2.6	2.8	2.8

ELECTIVE-I – PHYTOCHEMISTRY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTE02	Elective –I	**Theory**	Y	Y	-	3	3

Learning Objectives

- ❖ Know the importance of ethno pharmacology in drug discovery
- ❖ Know the Different methods used for preparation, collection and extraction of herbal medicines
- ❖ Know biosynthesis pathways of secondary metabolites
- ❖ Identify the different chemical structures, biosynthetic origin, extraction, characterization, pharmacological action.
- ❖ To impart knowledge on basic principles of Herbal Drug Science.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To study the history and scope of plant derived drugs	**PO1**
CO2	To study the characteristic and importance of major Phytochemicals	**PO1,PO2**
CO3	To know the extraction, purification and characterization of Phytochemicals	**PO4,PO6**
CO4	To know the process for development of plant drugs Course outcome	**PO4,PO5**
CO5	Knowledge on the history and scope of plant derived drugs	**PO3,PO8**

Unit	Details	No. of Hours
I	**Secondary metabolites and classification:** Phytochemistry - Definition, history, principal, secondary metabolites: Definition, classification, occurrence and distribution in plants, their function, chemical constituents. Alkaloids, Terpenoids, flavonoids, steroids coumarins, volatile oils and other related compounds. ***Power Point Presentation on Classification of Metabolites**	9
II	**Biosynthetic pathway of phytochemical and its applications:** Biosynthetic pathway of secondary metabolites: Shikimic acid pathway, Acetate-Mevalonate pathway, pathway for commercially important phytochemicals: Ephedrine, taxol and Vinca Alkaloids. Application of phytochemicals in medicine, pharmaceuticals, food, flavor and cosmetic industries.	9
III	**Biologically active secondary metabolites:** Biological source, uses and chemical constituents of bio active compounds: carbohydrate and derived compound–gums (Acaciagum, Indiangumandgum Arabic, isabgol), pectin – Ghatti gum). Glycosides (Alove, Digitalis, Olender, Dioscorea, Ginseng, Vanilla, Shatavari). Cyanogenic glycosides – (Amygdalin). Alkaloids (Belladonna, Ergot; Rauwolfia, Cinchona, Opium, Holarrhenna, Ashwagandha, Cocao). Tannins (Malbar Kino, Arjuna, Black catechu). Volatile oil (Peppermint, Pudina, Sandalwood oil, Chinese cinnamon, Citronella oil, Clove, Gaultheria oil. Resins (Indian cannabis,Ginger).Lipid–(Almondoil,Ricebranoil, Safflower oil). Enzymes and protein drugs - Bromelin, Papain, Malt extract, Gelatinum, Ficin).	9
IV	**Extraction of Phytochemicals:** Extraction methods of phytochemical: organic solvent extraction, extraction with supercritical gas, steam distillation, soxhlet extraction, Purification, concentration, lyophilization. Qualitative screening of phytochemical compounds. Quantification 52 compound: TLC, HPLC, GC-MS, LC-MS .Characterization of phytochemical spectroscopic analysis UV-VIS, IR, NMR and MASS Spectra, FTIR.	9
V	**Quantification of Phytochemicals Quantification of Bioactive compounds**: TLC, HPLC, GC-MS, LC-MS .Characterization of phytochemical spectroscopic analysis UV-VIS, IR, NMR and MASS Spectra, FTIR. ***Poster preparation on Bioactive compounds** Self Study: Photosynthetic	9
	Total	45
***Power Point Presentation and Poster preparation - related to the above topics are to be Considered for Internal Exam only**		

Text books

- Phytochemical Drug Discovery for Central Nervous System Disorders, Biochemistry and Therapeutic Effects, Chukwuebuka Egbuna, Mithun Rudrapal, 2023.
- Recent Frontiers of Phytochemicals, Applications in Food, Pharmacy, Cosmetics and Biotechnology, Siddhartha Pati, Tanmay Sarkar, Dibyajit Lahiri. 2023

Mapping with Programme Outcomes and Programme Specific Outcomes : 3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	3	2	3	2	3	3	3	3	3	3	2
CO2	2	3	2	3	2	3	3	3	2	2	3	2	3	2	3
CO3	3	2	2	3	3	2	2	3	2	2	2	3	2	3	3
CO4	2	3	3	2	2	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	2	3	2	3	2	3	3	3	3	3	3	2
Total	13	14	13	12	13	12	13	12	13	13	14	14	13	14	13
Average	2.6	2.8	2.6	2.4	2.6	2.4	2.6	2.4	2.6	2.6	2.8	2.8	2.6	2.8	2.6

ELECTIVE-II – ENZYMOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTE03	Elective –II	**Theory**	Y	Y	-	3	3

Learning Objectives

- The subject imparts knowledge on the fundamentals of enzyme structure and its kinetics.
- The student will be provided with a basic knowledge and understanding about the functions of enzyme as well as the industrial application of enzymes.
- To acquire fundamental knowledge on enzymes and their importance in biological reactions.
- To understand ability to difference between a chemical catalyst and biocatalyst.
- Exposure to the nature of non-protein enzymes such as ribozymes.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Explain the basics of enzyme nomenclature and properties	**PO1**
CO2	Classify and Cognize the native and immobilized enzyme	**PO1,PO2**
CO3	Examine the equations of steady state kinetics	**PO4,PO6**
CO4	Assess extraction and downstream processing of enzymes	**PO4,PO5**
CO5	Compile the uses of enzymes and design enzymes for Industrial and Clinical application	**PO3,PO8**

Unit	Details	No. of Hours
I	**Enzymes:** Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by Precipitation, liquid-liquid extraction methods. ***Power Point Presentation on Classification of Enzymes**	**9**
II	**Enzyme Kinetics:** Kinetics of catalyzed reaction: Single substrate reactions, bi-substrate reactions, concept of Michaelis –Menten and Limitations. Lineweaver burk plot, Hanes wolf equation, Eadiehoofstee equation, Inhibition of enzyme activity	**9**
III	**Purification and immobilization of Enzymes**: Enzyme isolation, disruption, fractionation, purification and concentration methods, Methods of purity estimation, purification related data presentation, advantages, Micro-environmental effects.	**9**
IV	**Industrial production of enzymes**: Basic concept of industrial scale and optimization, amylase, glucose oxidase, lipase, protease, production and their uses.	**9**
V	**Challenges and future Trends:** Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from extreme thermophillic and Hyper thermophilic Archaea and Bacteria, application of enzymes in research diagnostics and industry. ***Field Visit – Food Industry and Report Submission** Self-Study: Thromboplastin Enzyme	**9**
	Total	**45**
***Power Point Presentation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text books

- Nicholas C. Price and Lewis Stevens., 2010. Fundamentals of Enzymology. Oxford University Press, New Delhi
- Lehninger, Nelson and Cox, 2017, Principles of Biochemistry-4th edition,WH Freeman and Company, New York, USA
- GeoffreyL, Zubay, Biochemistry-2018.

Web Reference

- www.lsbu.ac.uk/biology/enztech/
- www.lsbu.ac.uk/biology/enzyme/

- http://www.aetlted.com/tech/applications.html

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	2	3	3	2	2	2	3	2	3	3	3	3	3	3	2
CO2	3	3	2	3	2	3	3	3	2	2	3	2	3	2	3
CO3	3	2	2	3	3	2	2	3	2	3	2	3	2	3	3
CO4	3	3	3	2	2	3	2	2	3	3	2	3	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3	3	3	3	3	3
Total	14	13	13	12	12	12	13	12	13	14	13	14	13	14	14
Average	2.8	2.6	2.6	2.4	2.4	2.4	2.6	2.4	2.6	2.8	2.6	2.8	2.6	2.8	2.8

ELECTIVE-II – FOOD TECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTE04	Elective –II	**Theory**	Y	Y	-	3	3

Learning Objectives

- ❖ The subject imparts knowledge on the fundamentals of food preservatives and additives.
- ❖ The student will be provided with a basic knowledge and understanding about the functions of enzyme as well as the industrial application of enzymes.
- ❖ They will be able to design, implement and evaluate a research-based project to meet demands of the society.
- ❖ Students will get the ability to use appropriate techniques, skills, and modern tools in the food industry and the academic profession.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Explain the basics food preservative techniques	**PO1**
CO2	Classify and summarize the detailed methodologies of food preservative techniques	**PO1,PO2**
CO3	Examine the packing system of food and additives	**PO4,PO6**
CO4	Assess extraction and downstream processing of food	**PO4,PO5**
CO5	Compile the uses of food and design the packages for Industrial and public.	**PO3,PO8**

Unit	Details	No. of Hours
I	**Introduction to Food Technology:** Importance and Source of Food biotechnology. Microorganism associated with food-bacteria, fungi, & yeast. Enzymes in food preparation. Food Contamination. Food preservation and food spoilage-types. Canning of foods. ***Power Point Presentation on Microorganism Associated bacteria**	**9**
II	**Biological Hazards and Food bore Diseases prevention** – infection, in-toxification – Salmonellosis, poliomyelitis. Food colors (natural and artificial food colourants), Food flavoring agents.	**9**
III	**Food engineering operations**: Characteristics of food Raw materials, preparative operations in food industry, cleaning of food raw materials, sorting of foods, grading of foods.	**9**
IV	**Food Standards and Quality Control:** Sensory evaluation of food quality, quality factors for consumer safety, food safety standards. FSSA, HACCP and FDA. Processing plant -Cleaning and sanitation methods.	**9**
V	**Food Processing Plant Design and Layout:** plant design – design, construction, functionality of building, design & fabrication of equipment. Plant layout Pest proofing/ fumigation methods. Water supply to food processing unit. ***Field Visit: Food Industry and Report Submission** Self-Study: Food Good Manufacturing Practices	**9**
	Total	**45**
***Power Point Presentation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text books

- WilliamC. Frazier, Dennis C. Westhoff. 2017. Food Microbiology. McGraw Hill Publications.
- D.G.Rao. 2018. Fundamentals of Food Engineering. PHI Learning Pvt. Ltd.

Reference book

- Yiu Hui &G. Khachatourians. 1995. Food Biotechnology. Wiley-Inter science
- Bibek, Laramie & Bhunia. 2004. Fundamentals of Food Microbiology. CRC Press
- B. Siva. 2011. Food Processing & Preservation PHIL earning Pvt. Ltd.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	POs										PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	3	2	3	2	3	3	3	3	3	3	2
CO2	2	3	2	3	2	3	3	3	2	2	3	2	3	2	3
CO3	3	2	2	3	3	2	2	3	2	2	2	3	2	3	3
CO4	2	3	3	2	2	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	2	3	2	3	2	3	3	3	3	3	3	2
Total	13	14	13	12	13	12	13	12	13	13	14	14	13	14	13
Average	2.6	2.8	2.6	2.4	2.6	2.4	2.6	2.4	2.6	2.6	2.8	2.8	2.6	2.8	2.6

SEMESTER – II

CORE IV – MICROBIOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBT04	Core-IV	**Theory**	Y	Y	-	5	4

Learning Objectives

- Explain how microbes affect our daily lives
- Apply pure culture technique
- Observe and measure microbial growth
- Develop core competencies in microbiology: structure and function, information flow, energy transfer and evolution
- Manipulate bacteria genetically to address biological questions

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.	**PO1**
CO2	To provide basic knowledge about microbial culture, identification of microbes, Principle and working of microscopes and sterilization techniques	**PO1,PO2**
CO3	To enlighten the students on host microbe interaction and Epidemiology of Microbial disease	**PO4,PO6**
CO4	To update the knowledge on epidemic and pandemic diseases.	**PO4,PO5**
CO5	To assess and appraise the role of novel microbes in environment and integrate them In specific innovative approaches.	**PO3,PO8**

Unit	Details	No. of Hours
I	**History and taxonomy of microbes**: Study of well-known microbiologists and their contributions. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism-Methanogenesis, acetogenesis and auxotrophs. ***Model Preparation on Growth Curve**	**15**
II	**Microbial culture, identification, and control:** Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining. Microscopy: principles and applications of Bright field, florescent, Scanning electron microscopes. Microbial growth control: Physical and Chemical methods.	**15**
III	**Microbiome-host interactions in health and disease:** Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Microbial interaction: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of diseases.	**15**
IV	**Introduction to Microbial Disease**: General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Cholera, Typhoid, COVID-19, AIDS, Malaria, and Candidiasis.	**15**
V	**Agricultural Microbiology:** Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere, Rhizobium Azospirillum, Azolla, BGA. ***Field Visit – TNAU and Report Submission** Self-study - Preservation of microbes	**15**
	Total	**75**
***Model Preparation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Prescott's Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594.
- Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
- Ananthanarayan and Paniker‘s (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251.
- Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, and McGraw Hill.
- Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018. 9. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11.
- Agriculture Microbiology, 2016. E-Course Developed By TNAU(ICAR)

Web Resources

- https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdfISBN978- 92-4-156553-0. https://doi.org/10.3389/fmicb.2020.631736
- https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	POs										**PSOs**				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03	PS04	PS05
CO1	3	3	2	2	2	2	2	3	3	3	2	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	3	2	3	2	3
CO3	2	2	2	3	2	3	3	2	2	2	2	3	2	3	3
CO4	3	2	3	2	2	3	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	2	3	3	3	3	2
Total	12	11	11	13	11	13	13	13	12	12	13	14	13	14	13
Average	2.4	2.2	2.2	2.6	2.2	2.6	2.6	2.6	2.4	2.4	2.6	2.8	2.6	2.8	2.6

CORE V – PLANT AND ANIMAL BIOTECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBT05	Core-IV	**Theory**	Y	Y	-	5	4

Learning Objectives

- The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals.
- The student will get to understand the core concepts of biotechnology.
- To provide hands on experience related to Animal Cell Culture,
- To the principles and applications of plant tissue culture and animal cell culture.
- Basic sterilization techniques and culture media preparation.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To impart theoretical knowledge on various techniques of plant biotechnology like Tissue culture, plant genetic transformation and their application in industries.	**PO1**
CO2	Importance of secondary metabolites and production in plants.	**PO1,PO2**
CO3	To develop concepts, principles and processes in animal biotechnology.	**PO4,PO6**
CO4	Concept and different types in Animal Cell Culture and animal cell lines.	**PO4,PO5**
CO5	Useofmolecularbiologytechniquesgeneticallyengineertheanimalstoimprove Sustainability, productivity and suitability for pharmaceutical and industrial applications.	**PO3,PO8**

Unit	Details	No. of Hours
I	**Introduction to Tissue Culture** - composition of media, Micro propagation, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed Production. ***Power Point Presentation on Embryogensis**	15
II	**Plant Genetic Transformation techniques and Markers:** Plant Transformation Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Plant engineering towards the development of enriched Food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps, RAPD markers, QTL, Map based cloning and Molecular marker assisted selection.	15
III	**Principles of Animal Cell Culture:** History and Scope of animal cell culture-Types of Cell culture- Primary and Secondary culture: cell lines, Culture cultivation condition – preparation and sterilization of cell culture media-media composition- role of CO2, serum, antibiotics, and growth factor in cell lines	15
IV	**Disaggregation of tissue and primary culture:** cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, and cryopreservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, Apoptosis and its determination, cytotoxicity assays.	15
V	**Application of animal cell culture:** in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human Diseases. ***Field Visit – Veterinary College and Report Submission** Self-study - MTT assay	15
	Total	75
***Power Point Presentation and Field Visit - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- Razdan.M.K. 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.
- Chawla.H.S. 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New Delhi.
- IanFreshney, 2010. Culture of animal cells. 6th edition, Wiley-Black well publishers.
- Slater, 2008.PlantBiotechnology: The Genetic manipulation of plants, Second Edition, Oxford University Press, USA.
- J.D.Watson, Gillman,J. WitknowskiandM.Zoller, 2006. RecombinantDNA.3rded.
- W.H.Freeman.26K.Dass.2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.

- H.Kreuzer & A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
- M.Sudhir.2000.AppliedBiotechnology&PlantGenetics.Dominantpublishers&Distributors.
- Genetic Engineering of Animals by (Ed) A.Puhler, VCHPublishers, Weinheim, FRG, 1993.
- Animal Cell culture Practical approach. Ed. JohnR.W.Masters, Oxford.2004.
- Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	13	12	12	13	13	12	13	12	15	14	14	13
Average	2.4	2.4	2.4	2.6	2.4	2.4	2.6	2.6	2.4	2.6	2.4	3	2.8	2.8	2.6

CORE VI – GENETIC ENGINEERING

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBT06	Core-IV	**Theory**	Y	Y	-	5	4

Learning Objectives

- The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals.
- The student will get to understand the core concepts of biotechnology.
- To modify an organism's genetic makeup to create new organisms with desired characteristics.
- To involves implanting a desired gene into a host organism
- A tool that use to rearrange genes and create new DNA combinations

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Understanding the basic steps of gene cloning and the role of enzymes and Vectors responsible for gene manipulation, transformation and genetic engineering.	**PO1**
CO2	Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.	**PO1,PO2**
CO3	Acquiring theoretical knowledge in the techniques, tools, and application and Safety measures of genetic engineering.	**PO4,PO6**
CO4	Describes the genome mapping and sequencing and methods for gene therapy.	**PO4,PO5**
CO5	Elucidate different techniques involved in genetic engineering	**PO3,PO8**

Unit	Details	No. of Hours
I	**Genetic engineering tools**: Gene cloning Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation. ***Power Point Presentation on rDNA Technology**	**15**
II	**Vectors and Cloning Methods:** E. Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria -ColE1,p15A,R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Plasmids, Phagemids. Cloning in gram-positive bacteria (Bacillussubtilis)	**15**
III	Cloning in yeast Saccharomyces cerevisae. Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Construction of gene libraries: Genomic and cDNA library, Specialized cloning vector for cDNA; Synthesis of Specific RNA in vitro; Vectors for cloning promoters And terminators; vectors with adjustable copy number	**15**
IV	**PCR and Sequencing** - Nucleic acid hybridization techniques Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing). Second generation Sequencing methods.	**15**
V	**Molecular techniques in prenatal diagnosis:** Site directed mutagenesis; DNA microarray, gene therapy, Transgenic animals (knockout mice) and plants (Flavrsavr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, Modern Concepts in Genetic Analysis. ***Seminar on Modern Concept in Genetic Analysis** Self-study -Lambda bacteriophage	**15**
	Total	**75**
***Power Point Presentation and Seminar - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- T.A.Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
- Sandy B. Primroseand Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
- Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
- Raymond Rodriguez and DavidT. Denhart 2003.Vectors, A survey of molecular cloning vectors.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	POs										PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	2	2	3	2	3	2	3	2
CO5	2	2	2	3	3	3	2	2	3	3	3	3	3	3	3
Total	12	12	11	13	13	12	13	12	12	13	12	14	14	13	13
Average	2.4	2.4	2.2	2.6	2.6	2.4	2.6	2.4	2.4	2.6	2.4	2.8	2.8	2.6	2.6

PRACTICAL - II- Microbiology, Plant and Animal Biotechnology & Genetic Engineering

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PBTP02	Core Practical-II	**Practical**	-	-	Y	6	4

Learning Objectives

- The practical will establish a basic study skill on the subject and will improve the student's ability to have hands on experience on the above core subjects.
- Students should be able to identify and describe different types of microorganisms
- Students should understand sterilization techniques used to ensure safety and quality in manufacturing,
- To develop students' Knowledge and understanding of key aspect of plant biotechnology
- To introduce students to the principle, practices and application of animal biotechnology

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	**Programme Outcomes**
CO1	Isolate and identify microbes from various sources.	**PO1**
CO2	Characterize microbes.	**PO1,PO2**
CO3	Examine Plant and Animal cells and their functions	**PO4,PO6**
CO4	Assess extracted DNA, RNA and protein for rDNA technology	**PO4,PO5**
CO5	To study cloning tools	**PO3,PO8**

Unit	Details	Hours
A	**(A) Microbiology-Practical** **1.** Sterilization of glassware using dry heat-hot air oven 2. Sterilization of media. 3. Liquid media preparation–nutrient broth 4. Solid media preparation–SDA plates 5. Preparation of Agar slants 6. Streak plate method 7. Pour plate method 8. Spread plate method 9. Gram staining and morphological characterization of microbes. 10. Negative staining of bacteria 11. IMVIC test of enteric bacteria 12. Isolation of microbes from soil, water and air. 13. Isolation of pure culture of E.coli 14. Determination of growth curve of bacteria–E.coli	30
B	**(B)Plant and Animal Biotechnology** 1. Plant tissue culture media preparation 2. Plant tissue culture sterilization techniques. 3. Callus induction. 4. Isolation of plant protoplast 5. Protoplast viability test. 6. Mass culture of Chlorella/Spirulina 7. Introduction to Animal Cell culture: Procedure for handling cells and medium. 8. Cleaning and sterilization of glassware and plastic tissue culture flasks 9. Preparation of tissue culture media 10. Preparation of single cells suspension from chicken liver (Primary cell culture). 11. Trypsinization of established cell culture. 12. Cell counting and viability-staining of cells Vital Staining (Trypan blue) MTT Assay	30
C	**(C) Genetic Engineering –Practical** 1. Preparation of plasmid DNA by alkaline lysis method. 2. Elution of DNA from Agarose gel. 3. Restriction enzyme digestion. 4. Ligation. 5. Competent cell preparation 6. Amplification of DNA-PCR 7. Determination of molecular weight of DNA by electrophoresis.)	30

ELECTIVE III – REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBTE05	Elective-III	**Theory**	Y	Y	-	3	3

Learning Objectives

- The subject imparts knowledge on the fundamentals of regulatory requirement in industries.
- The student will be provided with a basic knowledge and understanding about the regulatory affairs based on biotechnological industry requirements.
- To provide a sound knowledge and understanding of Global regulatory affairs.
- To create a thorough understanding of important regulatory concepts.
- To Deliver innovative, breakthrough regulatory strategies for product development and registration

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body‘s requirements	**PO1**
CO2	Describe the Scientific, technical knowledge about various food preservation techniques	**PO1,PO2**
CO3	Describe the basic concepts of packing of food materials, various parameters observed during packaging	**PO4,PO6**
CO4	Describe the testing of food materials and identifying of microbial food contaminant	**PO4,PO5**
CO5	Explain the basic of food safety management system, good manufacturing practice and good hygienic practices	**PO3,PO8**

Unit	Details	No. of Hours
I	**Planning, Organization and setting of Food testing** Laboratory and laboratory safety: Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017, documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety.	**9**
II	**Principles of Food Preservation technology**: Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology. Temperature reduction: Chilling, Freezing, Radiation: Ionizing Radiation, Microwave, Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields, Hurdle technology, ultrasonic and ohmich heating etc. ***Power Point Presentation on Preservation Technology**	**9**
III	**Principles of Food Packaging technology**: Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical properties: Glass, metals, paper, plastics, Biodegradable and edible films and coatings aseptic packaging and combinations, Selection of packaging material and design for various food commodities including fresh produce (Fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods. Evaluation and Packaging.	**9**
IV	**Food Microbiology and testing:** Introduction of Food microbiology: Classification and nomenclature of microorganisms. Morphology and structure of microorganisms in foods (yeast and Molds, Bacterial cells viruses), Important genera of mold, yeast, bacteria (Gram positive and Gram negative, facultative aerobic and anaerobic, endospore forming bacteria and non-sporulating bacteria), Bacterial groups (lactic acid, acetic acid, butyric acid etc.,), thermophilic, proteolytic, saccharomyticetc, coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics: Reproduction and growth. Thermal destruction of microorganisms: Thermal death time, D-Value,Z- Value, F-Value, thermal death time curve, 12 D Concept, Microbial food spoilage and food borne diseases, food pathogens, bacillus *cereus and other bacillus species*, Methods for the Microbiological examination of foods: Sampling activity and sampling plan, pure culture isolation: streaking, serial dilution and plating, cultivation, maintenance and preservation/stocking of pure culture, Observation of Indicator organisms: Direct examination, enumeration methods, plate count, MPN, biochemical test, Rapid methods Detection of specific organisms.	**9**

V	HACCP and Food safety management systems: ISO22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite programs, HACCP principles, some limitation of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, and food safety management risk analysis. Traceability food products recall and Sanitation. **Self-Study: Global regulatory affairs**	**9**
	Total	**45**
***Power Point Presentation - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- ISO9001,Qualitymanagementsystems–Requirements
- ISO17034Generalrequirementsforthe competence of reference material producers
- ISO/IEC17043Conformityassessment – General requirements for proficiency testing.
- Food safety standards authority regulation 2011.

Mapping with Programme Outcomes and Programme Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	POs										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	2	3
CO4	3	3	3	2	2	2	3	2	2	3	2	3	2	3	2
CO5	2	2	2	3	3	3	2	2	3	3	3	3	3	3	3
Total	12	12	11	13	13	12	13	12	12	13	12	14	14	13	13
Average	2.4	2.4	2.2	2.6	2.6	2.4	2.6	2.4	2.4	2.6	2.4	2.8	2.8	2.6	2.6

ELECTIVE III – PHARMACEUTICAL BIOTECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBTE06	Elective-III	**Theory**	Y	Y	-	3	3

Learning Objectives

- The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology.
- The student will be provided with a basic knowledge and understanding about the pharmaceutical products produced based on biotechnological methods and its biomedical applications.
- Understanding the importance of Immobilized enzymes in Pharmaceutical Industries.
- Learning about how genetic engineering can be used to produce pharmaceuticals
- Learning how pharmaceutical biotechnology can help understand diseases and develop new treatments

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	Explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor	**PO1**
CO2	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology	**PO1,PO2**
CO3	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques	**PO4,PO6**
CO4	Describe the concept so hybridoma technology, microbial biotransformation and microbial bio-transformed products	**PO4,PO5**
CO5	Explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio safety methods	**PO3,PO8**

Unit	Details	No. of Hours
I	**Introduction to pharmaceutical biotechnology:** Biosensors-Working and applications of biosensors in pharmaceutical Industries; Pharmacology and Ethno pharmacology: Scope, Applications and Importance.	9
II	**Vaccine Production:** Scientific, technical and economic aspects of vaccine Research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Recombinant DNA technology, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis- B (iii) Hormones – Insulin.	9
III	**Hybridoma technology** - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of the production of – penicillins, citric acid, Vitamin B12, Glutamicacid and Griseofulvin Somatic gene therapy, Xeno transplantation in pharmaceutical biotechnology, Biosafety in pharmaceutical industry. ***Power Point Presentation on Fermenter Design**	9
IV	**Drug Examination:** Pharmacological activity of Plant drugs, Plant Chemicalsin modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic Substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio- transformation. Criteria for pharmacological Evaluation of drugs.	9
V	**Clinical Pharmacology:** Drug therapy, therapeutic situation, benefits and risk of use of drugs, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action, factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and Causes of ADR; principle clinical manifestations and Treatment of ADR, General principles of management of drug poisonings; antidotes, classification of drugs. **Self-Study : Drug Design**	9
	Total	45
***Power point Presentation - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- Harbans lal, 2011. Pharmaceuticals biochemistry. CBS Publishers and distributors Pvt. Ltd, Chennai.
- CarlosA. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
- Daniel Figeys (Ed.).2005.Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
- Kayser,O and MullerR.H..2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH

- Leon Shargel, Andrew B.C. Yu, SusannaWu-Pong, and Yu Andrew B.C.2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies

Web Resources

- https://tugasakhirsttifbogor.files.wordpress.com/2018/08/pharmaceutical-biotechnology.pdf
- http://library.nuft.edu.ua/ebook/file/Gad2007.pdf
- https://oasis.iik.ac.id:9443/library/repository/a932eb462c49885a2c72755977036b81.pdf

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	POs										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	3	3	3	3	2	3	3	3	3	3	2
CO2	3	3	2	3	3	3	3	2	3	2	3	2	3	2	3
CO3	3	3	3	3	3	2	3	3	3	3	2	3	2	3	3
CO4	3	2	3	3	2	3	3	3	3	3	2	3	2	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
Total	15	14	14	14	14	14	15	14	13	14	13	14	13	14	14
Average	3	2.8	2.8	2.8	2.8	2.8	3	2.4	2.6	2.8	2.6	2.8	2.6	2.8	2.8

ELECTIVE IV – ENVIRONMENTAL BIOTECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBTE07	Elective-IV	**Theory**	Y	Y	-	3	3

Learning Objectives

- The subject imparts knowledge on the fundamentals of ecology and pollution.
- The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.
- understand the environmental and biological challenges facing society
- Understand and assimilate the specific concepts and terminology of environmental biotechnology
- Properties of microorganisms with potential application to environmental biotechnology processes

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	**Programme Outcomes**
CO1	Explain Various Waste Management Methods	**PO1**
CO2	Classify Potential Methods Of Biodegrading Organic Pollutants.	**PO1,PO2**
CO3	Examine The Techniques Involved In Remediation Of Polluted Environments	**PO4,PO6**
CO4	Assess Types Of Pollution &Its Control	**PO4,PO5**
CO5	Compile Biotechnological Approaches To Degrade Xenobiotic Compounds	**PO3,PO8**

Unit	Details	No. of Hours
I	Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution ***Model Preparation on Types of Pollution**	**9**
II	**Biofilm Kinetics:** Completely mixed biofilm reactor- Soluble microbial products and inert biomass-Special- case biofilm solution. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Engineering design of reactors- Reactors in series.	**9**
III	**Waste Management:** Waste water management, source of waste water, Waste water treatment-physical, Chemical and Biological treatment. Microbiology of Waste water; Aerobic and anaerobic process, BOD and COD.	**9**
IV	**Toxicity:** Types and Test for evaluating Toxicity. Biosensors, Bio monitoring of toxic materials Bio magnification, Bio-mining and Bio fuels	**9**
V	**Bioremediation;** *In-situ and Ex-situ* Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production. **Self-Study: Conservation Biology**	**9**
	Total	**45**
***Model Preparation - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- Gareth M. Evans, Gareth G. Evans, Judy Furlong 2011
- Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
- M. Moo-Young, W. A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
- M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
- Stanley E. Manahan, 2009.Environmental Chemistry, Ninth Edition, CRC Press.

Web Resources

- lbewww.epfl.ch/LBE/Default_E.htm
- http://lbe.epfl.ch

Mapping with Programme Outcomes and Programm Specific Outcomes: 3 Strong, 2 – Medium, 1 – Low

	Pos										PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	13	12	12	13	13	12	13	12	15	14	14	13
Average	2.4	2.4	2.4	2.6	2.4	2.4	2.6	2.6	2.4	2.6	2.4	3	2.8	2.8	2.6

ELECTIVE III – MARINE BIOTECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBTE08	Elective-IV	**Theory**	Y	Y	-	3	3

Learning Objectives

- The subject imparts knowledge on the fundamentals of ecology and pollution.
- The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.
- Impart knowledge of the fundamentals, developments and methodologies and avenues in biotechnology specialization in marine areas.
- To introduce students to the fundamental concepts and principles of marine biology and biotechnology.
- To supply trained manpower in the field of Marine Biotechnology**.**

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To gain employment in state and federal marine laboratories as well as private Marine companies and aquariums.	**PO1**
CO2	To understand the extensive under water and field research abilities coupled With synergistic molecular bench skills.	**PO1,PO2**
CO3	To assess the benefits of marine biotechnology is its potential to produce novel pharmaceuticals.	**PO4,PO6**
CO4	To enlighten the marine organisms such as sponges, tunicates, and algae are a rich source of biologically active compounds, including anti-cancer, anti-inflammatory, and anti-viral agents.	**PO4,PO5**
CO5	To develop the new pharmaceutical drugs, chemical products, enzymes, and other products and processes	**PO3,PO8**

Unit	Details	No. of Hours
I	**Biotechnology in marine science**: history of marine biotechnology application in aquaculture, pharmaceutical, environment remediation, biofouling and biocorroison.	9
II	**Developmental biotechnology:** Induced breeding in-vitro fertilization cryopreservation biotechnological tools- ELISA, FISH, PCR Gene probes, dot immune binding activity, and monoclonal antibodies biosafety ethics.	9
III	**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 bio terminator Commercial development of marine natural products- chitosan, chitin. ***Power Point presentation on Anti-inflammatory**	9
IV	**Marine Bioactive and their Application:** Algal biotechnology single cell protein, hydrocolloids, agarose, carrageen alginates and other by-products. Marine Enzymes sources and their applications Marine Lipids sources and their applications.	9
V	**Microbial biodegradation:** Natural and synthetic material in the marine environment- pesticide. Bioremediation of xenobiotic soil, heavy metals, pesticides, plastics, etc. Mining and metal biotechnology. **Self-Study: Marine Biodiversity**	9
	Total	45
***Power point presentation- related to the above topics are to be Considered for Internal Exam only**		

Text Books

- David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
- RitaR.Colwell1984. Biotechnology in the Marine Sciences (Advancesin Marine Science & Biotechnology) Wiley Interscience.
- Scheupr,P.J.(Ed.),1984.Chemistry of Marine Natural Products, Chemical and Biological Perspectives. Vol. IIII, Academic Press, New York.

Reference books

- Italy,E (Eds).1998,NewDevelopmentsinMarineBiotechnology,PlenumPub. Corp.
- Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Geneticsof Marine Organisms, Science Pub Inc.
- Y.LeGalandH.O.Halvorson1998, New Developments in Marine Biotechnology. Springer.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	13	12	12	13	13	12	13	12	15	14	14	13
Average	2.4	2.4	2.4	2.6	2.4	2.4	2.6	2.6	2.4	2.6	2.4	3	2.8	2.8	2.6

NME- GENE MANIPULATION TECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PBTN01	Non Major – I	**Theory**	Y	Y	-	3	2

Learning Objectives

- To understand more about the science that under lies the development of genetically modified organisms and in particular how gene transfer is brought about
- To know something of the potential benefits and uncertainties associated with gene transfer and the high levels of technical ingenuity involved
- To understand more the science that under pins the development of Golden Rice and understand why the usefulness of this product has proved so contentious.
- Describe general techniques used by genetic engineers to modify DNA.

Course Outcomes		
Course Outcomes	**On completion of this course, students will able to**	**Programme Outcomes**
CO1	To gain employment in state and federal marine laboratories as well as private Marine companies and aquariums.	**PO1**
CO2	To understand the extensive under water and field research abilities coupled With synergistic molecular bench skills.	**PO1,PO2**
CO3	To assess the benefits of marine biotechnology is its potential to produce novel pharmaceuticals.	**PO4,PO6**
CO4	To enlighten the marine organisms such as sponges, tunicates, and algae are a rich source of biologically active compounds, including anti-cancer, anti-inflammatory, and anti-viral agents.	**PO4,PO5**
CO5	To develop the new pharmaceutical drugs, chemical products, enzymes, and other products and processes	**PO3,PO8**

Unit	Details	No. of Hours
I	Basics of Gene Manipulation Technology- Restriction Enzymes-Cutting and Joining Reactions-Vectors- Selection of Recombinants- Agarose Gel Electrophoresis-Southern Blotting- Hybridization- Autoradiography-PCR-Native Page- SDS-Page- 2D Gel Electrophoresis- Western Blotting. ***Power Point Presentation on Western Blotting.**	**9**
II	Constructions of DNA Libraries: Vectors Used In the Construction of CDNA and Genomic DNA Libraries- Chromosome Walking- Positive Selection and Subtractive Hybridization- Preparation Of (BAC/YAC Library).	**9**
III	Genome Sequencing and Transcriptomics:Sanger_s Sequencing, Whole Genome Shot gun Sequencing- Comparative Genome Sequencing-Transcriptome Analysis- DNA Microarray- Expression of Recombinant Proteins.	**9**
IV	Protein Engineering & Pharmaceutical Products: Site Directed Mutagenesis-Protein Analysis- Therapeutic Protein- Vaccines.	**9**
V	Applications of Gene Cloning- creating Transgenic Animals and Plants-Reporter Genes- Animal Cloning, Gene expression in plants- Bio safety and Bioethics. **Self-Study: Gene Editing**	**9**
	Total	**45**
***Power point presentation - related to the above topics are to be Considered for Internal Exam only**		

Text Books

- T.A. Brown1995.Gene Cloning and Introduction.
- Thiel 2002. Biotechnology Nucleic Acids to Protein: A Laboratory Project. Tatamcgraw. hill
- .R.W.Old & S.B. Primrose, Principles Of Gene Manipulation, Fifth Edition, Black well Science
- Genetic Engineering Principles And Methods By Setlow, JaneK.(VOLUME 24)
- Bernard R Glick and Jack. J.Pasternack, 1994, Molecular Biotechnology, ASM Press.
- Kaushik.B.D.DeepakKumar.Shamim.Md.2019.Biofertilizers and Biopesticides in Sustainable Agriculture. 1st Edition. Apple Academic Press. USA.
- Aneesa Padiniakkara. Aparna Thankappan, Fernando GomesSouza.Jr.SabuThomas.2018. Biopolymers and Biomaterials. CRC press, USA.
- A text book on Molecular Biotechnology by Glick.

Mapping with Programme Outcomes and Programm Specific Outcomes:

3 Strong, 2 – Medium, 1 – Low

	Pos										**PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**
CO1	2	3	3	2	2	2	3	2	3	3	3	3	3	3	2
CO2	3	3	2	2	2	3	3	3	2	2	3	2	3	2	3
CO3	3	2	2	3	3	2	2	3	2	3	2	3	2	3	3
CO4	2	3	3	3	2	3	2	2	3	3	2	3	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3	3	3	3	3	2
Total	13	13	13	12	12	12	13	12	13	14	13	14	13	14	13
Average	2.6	2.6	2.6	2.4	2.4	2.4	2.6	2.4	2.6	2.8	2.6	2.8	2.6	2.8	2.6